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Lateralized imagery for sentence content: Testing grammar, gender and demonstratives

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Abstract

We investigated imagery by making participants (n=530) draw stick-figure drawings of sentences containing a transitive action ("She kisses him"). Previous findings show that prominent features of meaning and sentence structure are placed to the left in drawings, according to reading direction. We replicated three findings: the first mentioned element is placed on the left more often, the agent is placed on the left, and the grammatical subject is placed on the left. We further tested hypotheses related to deixis and gender. By adding adverbs (here and there), that work as demonstratives in Danish, we tested whether deictic proximity is translated into a leftward bias. This hypothesis was not supported. Analyses of gender tested the presence of a gender identification and a gender stereotype bias, where either own or male gender is given prominence and thus placed on the left. We were unable to support for either of the gender hypotheses.

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

Introduction

Exposure to language and linguistic structure, both written and spoken, modulates parts of cognitive function that have hitherto been considered non-linguistic. One such case is imagery (e.g. Stroustrup & Wallentin, in press; Tylén, et al., 2010).

A simple way to study an influence on imagery is to ask participants to make drawings of linguistic content (Dobel, et al., 2007; Maass & Russo, 2003; Stroustrup & Wallentin, in press). 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; Maass & Russo, 2003; Maass, et al., 2014; Stroustrup & Wallentin, in press). Recently, Stroustrup and Wallentin (in press) 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 tendency to make prominent features appear on the left in drawings. The first aim of the present study was to replicate these three effects.

In order to further investigate the degree to which attentional prominence in general could be linked to left-ward positioning in imagery, we tested two additional discourse elements: deictic linguistic markers, such as demonstratives, which are known to function as attentional markers (Diessel, 1999, 2006) and different effects of gender identification, which could also be imagined to work as an attractor of attention.

Demonstratives

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

Based on corpus data, Kirsner (1979, p. 361-364) suggested that proximal demonstratives are more often associated with referents perceived to be more 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. We used these findings to hypothesize that sentence elements referenced with a proximal demonstrative would be drawn to the left more often than elements referenced by a distal demonstrative.

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 are almost always in the oblique case (e.g. "hende her" [her here]). Demonstratives therefore ususally appear in the object position in sentences.

Gender and prominence

Gendered pronouns (like "he" and "she") are the only case marked linguistic elements in Danish (as is also the case for English). In our previous experiment (Stroustrup & Wallentin, in press), we therefore used gendered personal pronouns in order to create distinguishable entities in the participant's drawings with unambiguous grammatical roles. Gender, however, could be imagined to play an independent role in the formatting of drawings from imagery.

Gender biases exist among both adults (Koenig, et al., 2011) and adolescents, such as high school students (Chalabaev, et al., 2013; Steffens, et al., 2010; Ter Bogt, et al., 2010), that were participants in the 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). Could such experiental asymmetries cause participants to have an asymmetric ordering of gender roles in imagery as well?

Gender biases exist in 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). Due to such biases, listeners may therefore tend to put the male character to the left of the female in a drawing, regardless of their actual order in the sentence.

An additional own-gender bias could be hypothesized to play a role in imagery for sentences with gendered content. Children are known to exhibit own-gender biases in memory (Signorella, et al., 1997). Face recognition is another field where an own-gender bias has often been observed (Herlitz & Lovén, 2013; Lovén, et al., 2011; Rehnman & Herlitz, 2006; Wolff, et al., 2013; Wright & Sladden, 2003). Thus, participants chould be more prone to draw their own gender on the left, granting it more prominence than the opposite gender.

Materials and methods

Participants The experiment was 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. Participants were informed about their rights and all signed a written consent form.

Stimuli and Materials 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]. 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 sentences for each verb as illustrated in figure 1.

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

Figure 1: Example sentences. FF/MF: Female/Male named First, FA/MA: Female/Male Agent; FS/MS: Female/Male sentence Subject; DD/PD: Distal (there)/Proximal (here) Demonstrative.

A total of 11x16 sentences were constructed. We divided the sentences into 22 stimulus sets of 8 sentences, using each verb and sentence construction only once per set in a counterbalanced order.

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. During the experiment, sentences were played using a standard lap-top computer with portable speakers.

The test materials consisted of 8 numbered frames (17 cm x 10,7 cm) for the drawings, 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.

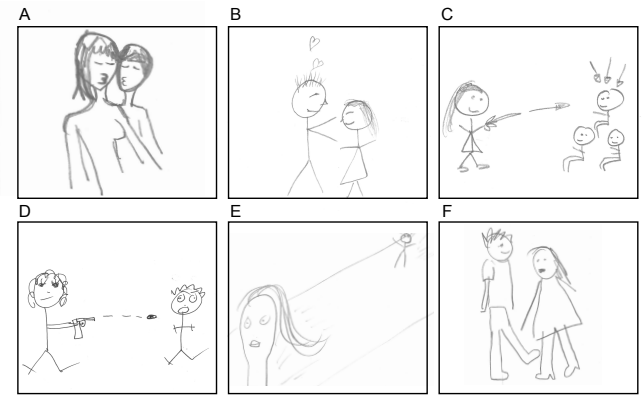

Figure 2: Example drawings. Participants were asked to draw stick figures illustrating the content of sentences read aloud to them, e.g. using English glossing: A: “This girl, he is kissed by” [FF, FA, MS, PD]; B: "That girl, he hugs" [FF, MA, MS, DD]; C: “He is being pointed out by that girl” [MF, FA, 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]. See figure 1 for abbreviations

.

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. Each test-sentence was played twice. Drawing began immediately after the 2nd sentence presentation. Participants were given 60 s. to finish each drawing. Participants were instructed not to focus on the aesthetic qualities of their drawings, but simply to draw stick figures depicting the contents of the sentences (see Figure 2).

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, et al., 2015) in R incorporating a maximum likelihood model fit (Laplace Approximation).

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]” or “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. An initial regression analysis (see supplementary materials) 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.

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 ($z=1.44$, $p<0.15$). Distribution across dependent variables can be seen from Figure 3.

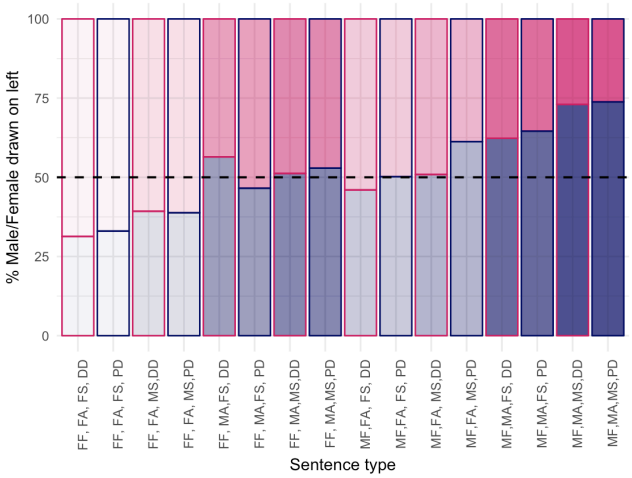

Figure 3: Percentage drawings with the female/male character on the left for each sentence type. Chance level=50%. See figure 1 for abbreviations.

Placement of the characters in the drawing was significantly affected by who (male/female) was named FIRST ($\chi^2(1)=109.58$, $p(fdr)<0.0001$). An effect was found for whether the female/male character was the AGENT ($\chi^2(1)=115.98$, $p(fdr)<0.0001$), and for whether the female/male character was the grammatical sentence SUBJECT ($\chi^2(1)=20.75$, $p(fdr)<0.0001$). 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

interaction between Demonstrative and grammatical subject ($\chi^2(1)=1.45$, *p(uncorrected)*=0.23). Lastly, we found no main effect of participant gender ($\chi^2(1)=1.98$, *p(uncorrected)*=0.16), i.e. participants were not prone to draw their own gender more to the left.

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, in press). 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, et al., 1993; Vaid, et al., 2011), on aesthetic preference (Chokron & De Agostini, 2000; Maass, et al., 2007), and in the perception of violence (Maass, et al., 2007), also when it applies to calling a foul in a soccer game (Kranjec, et al., 2010).

Other studies have also shown how linguistic structure is linked to attention in sentence production experiments (Gleitman, et al., 2007; Myachykov, et al., 2013; Myachykov & Garrod, 2008; Myachykov, et al., 2012; Myachykov & Tomlin, 2008; Myachykov, et al., 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 (Myachykov & Garrod, 2008; 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. Demonstratives, thus, may not be associated with a left-ward bias like 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 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. 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, in press), 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 as 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 interact with drawing and sentence comprehension (Boiteau & Almor, 2017; Braswell & Rosengren, 2002), e.g. right-handers 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/patiant 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.

Summary

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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