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Attention vs. accessibility: the role of different cue types for non-canonical sentence production in German

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Introduction: There is evidence of close links between the allocation of attention and the production of language. For instance, while speakers commonly produce active sentences when they describe an event with an agent acting on a patient, this preference can shift once the patient is in the spotlight of attention (e.g., by means of a brief attentional cue preceding the patient). In this case, speakers are more prone to produce non-canonical sentences such as passives. Critically, however, whereas attentional cueing is particularly effective for speakers of English, it has proven less effective for speakers of languages like German that differ from English in terms of case-marking and word order flexibility. This observation begs the question of how German speakers respond to alternative cue types that differ in the conceptual and lexical information they provide. In the current study, we address this question by directly comparing the effect of different cue types on sentence production.

Methods: German-speaking participants were asked to describe transitive event scenes while their eye gaze was monitored via eye tracking. Prior to scene onset, participants saw one of three different cue types: a short attentional cue preceding the patient character, a long attentional cue, or a centrally presented pre-view of the patient (referential cue).

Results and discussion: Our results demonstrate that different cue types led to differences in speakers' propensity to produce passives. Critically, referential cueing was more effective than attentional cueing in increasing German speakers' rate of passive production, contra to what has previously been reported for English speakers. At the same time, the cues resulted in different viewing behavior, demonstrating that an increase in visual attention does not necessarily go hand in hand with an increase in passivization. Consequently, our findings show that a direct link between the allocation of attention and speakers' structural choices may not always be licensed.

KEYWORDS

sentence production, attention, cueing, individual variation, passivization, sentence planning, accessibility

1. Introduction

If you were asked to describe a picture of an event, you would have to start somewhere. For instance, if you saw a girl kissing a boy, you could describe this event in different ways, depending on which character you chose to mention first. In English, you could start an utterance by first mentioning the agent as in "The girl is kissing the boy." Alternatively, you could start an utterance by mentioning the patient first, as in "The boy is being kissed by the girl." Whether a character is more prominent and tends to be mentioned first can be

influenced by a number of different factors. One central factor is the so-called accessibility of a character. Accessibility is defined as "the ease with which the mental representation of some potential referent can be activated in or retrieved from memory" (Bock and Warren, 1985, p. 50). For instance, in some of her early work, Bock (1986) showed that English speakers who generally preferred to produce active structures (such as "The girl is kissing the boy"), produced more passives once the accessibility of the patient was increased. Specifically, speakers were more likely to produce passive sentences when the patient had been primed by a semantically-related word (e.g., by presenting the word "son" prior to the word "boy"). In the same vein, Konopka and Meyer (2014) observed that speakers produced more passives when the patient was already pre-activated due to a priming picture which was semantically related to the patient. Myachykov et al. (2018) also found an increase in passivization when a picture of the patient character had already been presented prior to the event to be described. Taken together, these findings suggest that once the patient is conceptually more accessible and its lemma more easily retrieved from memory, speakers are more prone to start their utterances with the patient, even if they have to switch to a non-canonical passive structure.

However, similar observations of an increase in passives have been made without recurring to processes involved in language production, specifically lemma-activation in the mental lexicon, namely by simply manipulating a speaker's allocation of attention (e.g., Tomlin, 1995; Gleitman et al., 2007; Myachykov et al., 2009). For instance, in a seminal demonstration of this, English speakers were asked to describe a short video clip with one cartoon fish eating another one (Tomlin, 1995). Whereas by default participants showed a strong preference to describe the video in terms of an active clause (e.g., "The red fish is eating the blue fish"), this bias shifted once the speakers' attention was directed to the patient. When the "patient fish" was cued by means of a little arrow presented on top of it, speakers almost exclusively used a passive construction to describe the event (e.g., "The blue fish is being eaten by the red fish"). While the manipulation of attention in the fish film paradigm has sometimes been criticized as too "brutal" (Bock et al., 2004) or "blatant" (Gleitman et al., 2007), similar effects have also been attested for more subtle forms of attentional cueing. For instance, Gleitman et al. (2007) asked English speaking participants to describe pictures of transitive events in which either the agent or the patient was preceded by a very brief attentional cue (i.e., a small black square presented for 60–75 ms in the place where one of the event characters was about to appear). Although the cue was not even noticed by participants, they were more inclined to produce passive utterances when the patient rather than the agent had been cued (Gleitman et al., 2007). Converging evidence comes from several studies by Myachykov et al. (2009, 2011b). The authors found that English speakers produced more passives when the depicted patient had been preceded by a very brief attentional cue, lending further support to the claim that attentional orienting can affect sentence production and grammatical role assignment. That is, once the patient is in the "spotlight of attention," speakers are more likely to start an utterance with this character and to assign the patient the most prominent grammatical role (i.e., the subject role).

1.1. Attention vs. accessibility: effects of different cue types

The abovementioned findings suggest that both attentional orienting and the accessibility of the patient character affect sentence production in similar ways, resulting in an increase of passive sentences. However, it is yet unclear which of these factors is more influential in shaping sentence structure. On one proposal, the allocation of attention *per se* has been argued to be critical for modulating sentence structure (e.g., Myachykov et al., 2018). This proposal is based on the following argument: since the attentional cue (a small circle or square) is meaningless and does not provide any conceptual information about the upcoming character, the increase of passive sentences has to be attributed to attentional orienting while other factors such as the activation of conceptual or lexical information of the cued character are of no added value for grammatical role assignment and syntactic encoding (cf. Myachykov et al., 2018). Myachykov et al. (2018) put this claim to the test by comparing three different types of cues: speakers of English were either presented with an attentional cue for the duration of 70 ms or for a longer duration of 700 ms (Myachykov et al., 2018, also see Myachykov et al., 2012). In addition, a more informative type of cue was used by presenting the preview of one of the upcoming characters (referential cueing). Unlike attentional cueing, the preview of a character allows for activating conceptual and lexical information, thereby increasing the accessibility of a character. Critically, whereas Myachykov et al. (2018) observed an effect of cue duration, the type of cue did not matter. That is, English speakers were more likely to produce passives when the attentional cue was explicit and lasted for a longer duration but there was no additional increase of passivization for the referential cue. Since the activation of lexical information by the referential cue did not increase the rate of passivization over and above the mere allocation of attention, this finding led the authors to conclude that attentional orienting by itself rather than the accessibility of the patient character is critical for grammatical role assignment.

Crucially, however, this conclusion is exclusively based on speakers of English and may not generalize to speakers of other languages who have been shown to be less susceptible to attentional cueing than English speakers. Thus, whereas a very brief attentional cue served to increase the number of passive utterances in English speakers, it did not increase the number of passive utterances in speakers of Finnish (Myachykov et al., 2011a) German (Esaulova et al., 2019), Korean (Hwang and Kaiser, 2015), and Russian (Myachykov and Tomlin, 2008). The reasons for this cross-linguistic variation in the effectiveness of attentional cueing are not entirely clear. On one proposal, typological differences in case marking have been argued to be critical (see e.g., Norcliffe and Konopka, 2015; but see Schlenter et al., 2022). While Finnish, German, Korean, and Russian are typologically diverse languages, they are all case-marking languages, whereas in English no case marking is used for full noun phrases. The necessity to mark case on a noun phrase requires to specify the syntactic function of this phrase as subject or object. By contrast, English speakers are "free" of this obligation and might simply start their utterance with the character their attention was drawn to, resulting in an increased propensity to produce passives even when very subtle forms of

cueing are used. An alternative but related suggestion has been made by Hwang and Kaiser (2015) who propose that speakers of case-marking languages show a reduced effect of attentional cueing because of the availability of structural alternatives (see also Myachykov et al., 2012) and, thus, alternative syntactic function assignments. According to their "syntactic flexibility" account, the more structural alternatives are available to describe a transitive event, the less likely a speaker of a case-marking language may be to deviate from the canonical sentence structure. In support of this assumption, Hwang and Kaiser (2014) found that Korean speakers, unlike English speakers (Ferreira, 1996), showed a slow-down in sentence production when they could choose between alternative syntactic function assignments, suggesting that it becomes more costly for speakers to change between structural alternatives when they have more options available. Consequently, speakers of case-marking languages who have more structural alternatives at their disposal may be less prone to switch sentence structure in response to very subtle attentional cueing.

Although it is not clear what exactly is driving the differences between English and other languages when it comes to attentional cueing, the abovementioned studies consistently show that speakers of languages that differ from English in terms of case-marking and word order flexibility are rather immune to a very subtle attentional cue (e.g., Myachykov and Tomlin, 2008; Myachykov et al., 2011a; Hwang and Kaiser, 2015; Esaulova et al., 2019). However, comparatively little is known about how speakers of such languages respond to alternative types of cueing. For German, there is some first evidence to suggest that a more explicit, long attentional cue can increase the number of passives compared to a baseline without cueing (Esaulova et al., 2021). Likewise, a referential cue has been found to be effective in increasing the rate of passives in German speakers (Esaulova et al., 2020). However, while suggestive of the notion that German speakers are not entirely immune to cueing, a direct comparison of different cue types is currently missing. Yet, a systematic comparison is necessary in order to illuminate the factors that trigger structural choices in a language like German. How much and what kind of information is necessary for German speakers in order to deviate from their canonical sentence production strategies?

German provides an interesting test case in this regard because, on the one hand, it is a Germanic language closely related to English, while at the same time it is a case-marking language like Russian and Korean which indicates syntactic function by case-marking, allowing for more alternatives in word order than English. Consequently, a direct comparison of different cue types serves to illuminate whether patterns found in English generalize to languages that differ from English in terms of case marking and word order flexibility. As outlined above, English speakers produced a greater number of passives when they were presented with an explicit attentional cue lasting for 700 ms but there was no additional increase for a more informative type of cue (referential cue) (cf. Myachykov et al., 2018). These findings suggest that attention rather than accessibility is central when it comes to English speakers' structural choices. A similar pattern may hold true cross-linguistically: on the one hand, it could be that speakers of German simply need a more explicit, hence longer, attentional cue in order to produce passives but that providing conceptual and lexical information about a character does not add anything over and above the mere allocation of attention (just as in English). On the other hand, it could be that typological differences between English and German have a more profound impact concerning the relative efficiency of different cue types. It is possible that speakers of German may require additional information—beyond attentional orienting—in order to deviate from their canonical sentence production preference. One central difference between English and German is that German uses overt case-marking on the determiner preceding a noun. This implies that speakers of German have to commit to a syntactic function of the first noun phrase even before they produce the first word of a sentence (i.e., the determiner). Consequently, by boosting the lexical accessibility of the patient character, this likely co-activates case information of the corresponding determiner, which by default is nominative (e.g., Emonds, 1985). Speakers of German may then be nudged to proceed with a passive sentence in which the patient is realized as the nominative case-marked subject. Hence, unlike for English speakers, providing lexical information in terms of a referential cue may lead to a greater increase of passives in German speakers compared to attentional cueing which does not yet activate lexical and case information. Consequently, a direct comparison between different cue types in speakers of a case marking language provides important insights into the cross-linguistic validity concerning the influence of visual attention vs. lexical accessibility on sentence production.

1.2. The present study

In the present study, we sought to address this issue by examining the influence of three different cue types on sentence production in German speakers. For this, we combined and re-analyzed three data-sets of our previously published sentence production studies using eye-tracking (Esaulova et al., 2019, 2020, 2021). This direct comparison allows us to examine whether (a) speakers of German differ in their susceptibility to the different cue types, and (b) which feature of the cue matters most for the production of passives in German speakers. On the one hand, it is possible that German speakers behave similarly to English speakers in that the duration of the attentional cue is critical (longer cue = more passives) but that referential information is of no added value for the rate of passive production. Alternatively, it is possible that German speakers deviate from speakers of English in that a referential cue may be more effective in eliciting passives than the mere allocation of attention induced by an uninformative attentional cue. Support of the latter would suggest that increasing the lexical accessibility of a character by pre-activating its lemma would contribute to grammatical role assignment and syntactic encoding, contra to what has been reported for speakers of English (e.g., Myachykov et al., 2018).

In order to investigate effects of different cue types on German speakers' structural choices in more depth, we also took into account speaker-specific variation. This approach hinges on the observation that there is considerable variability among speakers when it comes to language processing and use (for an overview see e.g., Kidd et al., 2018). For instance, when Kidd (2012) tested 4- to 6-year-old English-speaking children in a syntactic priming task that served to prime the English passive construction, he

observed remarkable variation among children. Whereas some children only produced very few passives (or none at all), others were much more likely to produce this type of construction after being primed (Kidd, 2012). Similar variation has been obtained for syntactic priming experiments in adult speakers (Branigan and Messenger, 2016). Based on these findings, it appears likely that speakers differ with regard to their propensity to produce passives. However, previous studies on attentional cueing have exclusively focused on analyses at the group level, thereby ignoring potential individual variability. By contrast, here we sought to take into account speaker-specific variation in order to illuminate cueing effects beyond the group level: How many speakers are actually susceptible to cueing by producing more passives after cueing compared to when no cue is presented? One could assume that a highly effective cue also influences a greater number of speakers, while a less effective cue likely influences fewer speakers. Hence, taking into account individual behavior provides additional insights into the effectiveness of cueing, thereby illuminating the interplay between different cue types and sentence production.

Finally, we made use of eye tracking during sentence production in order to gain more detailed insights into the effects of different cue types. To this end, we examined how the different cues affect first fixations upon scene onset. In line with previous findings, we expected that attentional cueing leads to an increase of first fixations to the cued patient character compared to baseline. By directly comparing the different attentional cues (i.e., short/implicit vs. long/explicit), we can then examine whether the longer attentional cue is also more effective in directing speaker's visual attention to the cued character. Furthermore, since in the referential cueing condition participants are presented with a preview of the patient character, it appears likely that they do not show an increased amount of first fixation to this character as it is no longer visually novel. By directly comparing attentional and referential types of cues, we can then measure whether previewing the patient character results in the same or different viewing patterns compared to attentional cueing.

To gain more detailed insights into the effects exerted by the different cue types, we also analyzed eye gaze patterns beyond first fixations. Specifically, we examined the time course of passive production in an early time window prior to speech onset (0–600 ms), similar to previous studies on lexical accessibility (e.g., Ganushchak et al., 2017). Attentional orienting and lexical accessibility are likely to affect different stages of sentence production (also see Myachykov et al., 2018). During the production of a sentence, speakers first have to create a preverbal message—a nonlinguistic, conceptual representation of the event to be described. In a next step, called formulation, speakers have to retrieve the relevant lemmas and to specify the grammatical relations between the characters engaged in the event (e.g., Levelt, 1989). Presenting a preview of the patient or a semantically related picture as done in previous studies on accessibility not only facilitates conceptual processing (such as object recognition and categorization) but also lemma retrieval, by already activating the relevant lemma or a lemma with similar semantic features. By contrast, visually directing a speaker's attention to the patient character does not yet offer this kind of information. Rather, attentional orienting may bias the speaker to visually process the cued character earlier, thereby making it a preferred candidate for starting the process of conceptualization (see e.g., Myachykov et al., 2012). Thus, while the manipulation of attention in terms of a visual cue likely targets a stage before sentence production even started—by manipulating the starting point for conceptualization—accessibility affects the later process of lemma activation. In line with this assumption, it has been shown that the preview of an upcoming lexical item yields a reaction time benefit in picture naming such that speakers are faster in initiating sentences when preceded by a preview (e.g., Wheeldon et al., 2013; Hardy et al., 2020). However, although it appears likely that attentional and referential cueing target different stages of sentence production, a direct comparison between different cue types on eye gaze patterns is currently missing. While previous studies on English have employed eye-tracking in order to examine the effect of different cue types (e.g., Myachykov et al., 2012, 2018), the main purpose of eye-tracking was to ensure the effectiveness of cueing (i.e., whether speakers' attention was indeed shifted to the cued character). However, the use of eye tracking during sentence production can provide valuable insights into the planning processes of speakers' utterances. In the present study, we take advantage of this in order to probe the effects of different cue types during the production of passive sentences. Since previous findings have shown that speakers fixate characters in the order of mention before they start an utterance (e.g., Gleitman et al., 2007; Hwang and Kaiser, 2015), we expect that during the production of a passive, speakers are more inclined to look at the patient in an early time window, prior to speech onset. However, as outlined above, attentional and referential cues vary in the information they convey about the patient, likely targeting different stages of sentence production. If true, then this difference should also become visible in the time course of sentence planning. Specifically, if lexical information is already available after referential cueing, participants should be less likely to look to the patient character before initiating an utterance, since the corresponding lemma has already been retrieved (see e.g., Ganushchak et al., 2017 for similar effects of reduced looks to the lexically activated agent character during the production of active sentences). By contrast, a similar reduction is not expected for attentional cueing since lexical information is not yet available. Hence, by directly comparing the time course of passive planning, our study serves to provide new insights into sentence production as a response to differently informative types of cues.

2. Materials and methods

To directly compare the impact of various cue types on sentence production and viewing behavior, we combined and re-analyzed data-sets from three previous studies (Esaulova et al., 2019, 2020, 2021). German-speaking participants were asked to describe visual scenes depicting an agent acting on a patient. Prior to scene onset, the patient character was highlighted by one of three different cue types. On half of the trials, no cue was presented (baseline condition). Unlike in our previous work, the combination of the different data-sets allowed us to directly compare the effects of cue type on German speakers' sentence production. This is possible because all participants were tested in exactly the same experimental set-up and with the same materials, the only

difference being the type of cue that was presented. To arrive at a systematic comparison, we took into account three different measures that cannot be directly assessed from our previous papers: a direct comparison of the rate of passives (i), a comparison of the number of individuals affected by the different cues (ii), as well as a direct comparison of eye movement patterns (iii).

2.1. Participants

In total, 136 native speakers of German were tested. All participants were students and were offered either monetary compensation or course credit for their participation. A cohort of 44 participants (mean age: 23 years; 36 female, eight male) was presented with a short attentional cue, 45 participants (mean age: 23 years; 36 female, nine male) were presented with a long attentional cue, and 47 participants (mean age: 22 years; 41 female, six male) were presented with a referential cue. All participants were also exposed to a baseline condition during which no cueing occurred. None of the participants reported any language or attention disorders and all had normal or corrected-to-normal vision. Ethical approval for the study was granted by the Ethics Commission of Cologne University's Faculty of Medicine (approval number 16-134). Participants provided their written informed consent to participate in this study.

2.2. Design

A set of 56 experimental items was presented which consisted of black-and-white drawings of transitive events. The depicted agents and patients were comparable with respect to their size and visual complexity. The spatial distance between the two characters was kept constant. All agents and patients were depictions of German masculine nouns that were matched in terms of frequency and syllable length. On half of the experimental trials, transitive event scenes were preceded by a blank screen (no cueing condition = baseline) and on the other half, one of three different cues preceded the transitive event scene. Cue type varied as a between-subject factor. Participants were either presented with an attentional cue (a red circle located at the position where the patient would appear next) for the duration of 60 ms (short cue) or for 700 ms (long cue; see Figure 1 for illustration). Alternatively participants were presented with the preview of the patient character which was located in the center of the screen and presented for the duration of 700 ms (referential cue). Experimental items were interspersed with 56 filler items depicting two objects placed next to one another without any event involved (e.g., a circle next to a star).

2.3. Procedure

Participants were seated in front of an LCD monitor at a distance of ∼60 cm. Eye-movement data were recorded from the dominant eye using an EyeLink 1000 Plus eye tracker (SR Research Ltd.) at a sampling rate of 500 Hz. A nine-point calibration procedure was performed before the experiment and repeated if necessary to ensure the accuracy of recordings. Before each trial, a target (a small black circle) was presented in the center of the screen which participants had to fixate in order for a trial to begin. Participants were instructed to describe each of the depicted event scenes in one sentence. Verbal responses were recorded via a headset. During a familiarization phase, participants were shown a picture of a transitive event and heard three examples of syntactic structures that could be used to describe the scene [active (SVO), active (OVS), and passive]. Participants were also shown an example of a filler item displaying two objects next to one another and simultaneously heard examples of descriptions using locative sentences (e.g., "The star is next to the circle"). After two practice trials, seven experimental blocks were presented (each consisting of eight experimental items and eight filler items that were presented in random order). The entire experimental session lasted for ∼45 min.

3. Results

3.1. Types of utterances

Overall, participants produced 6,722 active voice descriptions (88%) and 893 passive voice descriptions (12%). In the short cue condition, participants produced 75 (6%) passives after cueing compared to 77 (6%) passives in the baseline condition. When presented with a longer attentional cue, participants produced 168 (13%) passives compared to 110 (9%) passives in the baseline condition. Finally, for the referential cue, participants produced 323 (25%) passives after cueing compared to 140 (11%) in the baseline condition.

3.2. Effects of cue type on structural choice

All statistical analyses were performed in R (R version 4.0.4). General linear mixed effects models were performed using the afex package (Singmann et al., 2021). Significant interactions were followed-up using Tukey contrasts to control for multiple comparisons using the emmeans package (Lenth et al., 2021). To examine the effect of cue type on participants' structural choices, we analyzed whether participants produced passive sentences (=1) or not (=0) in a mixed effects logistic regression model. The model included cueing (cue vs. baseline), cue type (brief, long, referential), and their interaction as fixed effects, and participants and items as random effects. Since the full model did not converge, we removed random slopes for participants. The converging model included random intercepts (but not random slopes) for participants and items. Deviation coding was used for all factors (i.e., cueing and cue type).

The model yielded a significant effect of cueing, $\chi^2 = 58.96$, $p < 0.001$ as well as of cue type, $\chi^2 = 12.17$, $p = 0.002$. Furthermore, the model revealed a significant interaction between cueing and cue type, $\chi^2 = 44.20$, $p < 0.001$, suggesting that the cues differed in their effectiveness to elicit passive structures. *Post hoc* comparisons (Tukey corrected) yielded no significant differences in the rate of passives for the three baseline conditions (i.e., when no cueing preceded the patient; all p-values > 0.05). Compared

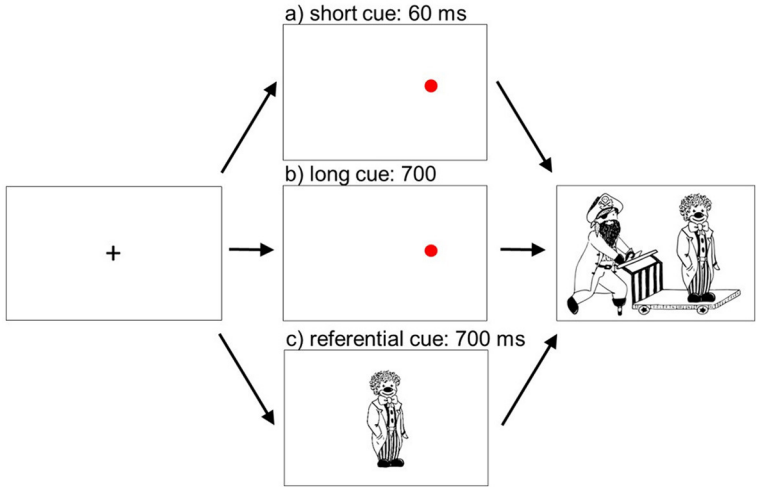

FIGURE 1
Illustration of the different cue types. Participants were either presented with no cue (baseline) or with one of three different cue types: a short attentional cue (a), a long attentional cue (b), or a referential cue (c).

to baseline, there was no significant increase in passivizations for the short attentional cue, *z*.ratio = 0.20, $p = 0.84$. By contrast, the long attentional cue led to an increase in participants' aptitude to produce passives compared to baseline, *z*.ratio = 4.79, $p < 0.001$. Likewise, the referential cue led to more passives compared to baseline, *z*.ratio = 11.57, $p < 0.001$. When comparing the different cueing conditions, *post hoc* comparisons revealed no significant difference between the short and the long attentional cue, *z*.ratio = 1.88, $p = 0.14$. However, there were significant differences between the short attentional cue and the referential cue, *z*.ratio = 4.33, $p < 0.001$, with participants producing more passives after viewing a referential cue compared to a short attentional cue. Additionally, participants were more likely to produce passives after viewing a referential cue than after viewing a long attentional cue, *z*.ratio = 2.44, $p < 0.05$, suggesting that lexical accessibility exerts a stronger effect on structural choices than visual attention.

3.3. Individual variation in the production of passives

In a next step, we took into account individual variation regarding the effect of cueing on speakers' structural choices. As already evident in the count data depicted in Figure 2, we observed quite substantial individual variation regarding speakers' propensity to produce passives. The number of produced passives per speaker ranged from 0 to 51 (of 56 produced sentences, i.e., 0%−91%). Critically, our findings demonstrate that a number of participants did not produce passives at all (see Table 1 for an overview).

We then analyzed how many of those participants who produced passive constructions displayed a cueing effect in the expected direction (i.e., by producing a greater number of passives after cueing compared to baseline). In the short cue condition, only five of 14 participants (36%) showed a cueing effect in the expected direction. However, none of these participants showed a significant difference between cued and baseline trials as assessed by individual chi square tests. In the long cue condition, 11 of 19 participants (58%) showed a cueing effect. Of these, four participants displayed a significant difference between cued and baseline trials as established by individual chi square tests. During referential cueing, 27 of 31 participants (87%) showed a cueing effect in the expected direction by producing more passives after cueing compared to baseline. Ten of these participants displayed a significant difference between cued and baseline trials as established by individual chi square tests.

3.4. Effects of cue type on eye gaze data (first fixations)

To examine whether cueing influenced participants' eye gaze, we analyzed on how many trials participants first fixated the patient character after scene onset. Fixations were detected by the algorithm implemented in the EyeLink tracker's on-line parser (cf. https://www.sr-research.com/). The parser determines the onset of a fixation by computing the offset of the previous saccade, hence we determined first fixations as the event that followed the first saccade after stimulus onset (i.e., the transitive event to be described). We found that when participants had encountered a short attentional cue, participants first fixated the patient in 730 trials (60%) compared to 572 trials (47%) in the baseline condition. When presented with a longer attentional cue, participants initially fixated the patient in 1,050 trials (84%) compared to 569 trials (45%) in the baseline condition. Finally, when exposed to the referential cue, participants first fixated the

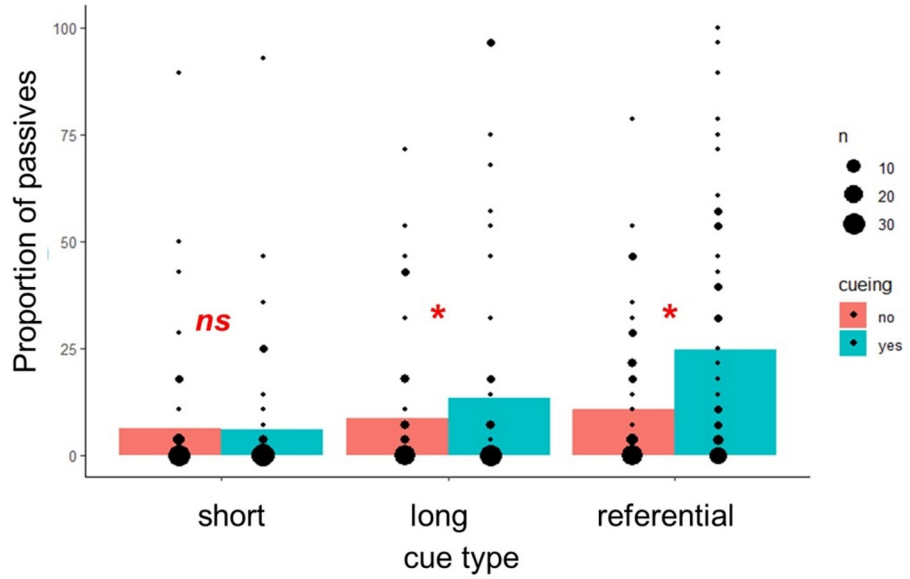

FIGURE 2
Proportion of produced passives for the three different cues compared to baseline. Count data are plotted with dot size referring to the number of participants producing the respective proportion of passives. *, Significant difference; ns, non-significant difference.

patient in 581 trials (45%) compared to 619 trials (48%) in the baseline condition.

To examine the effect of cue type on participants' fixations to the patient character, we analyzed whether participants first fixated the patient character (=1) or not (=0) in a mixed effects logistic regression model. The model included cueing (cue vs. baseline), cue type (short, long, referential), and their interaction as fixed effects, and subject and items as random effects (with random slopes and intercepts for participants, and random intercepts for items). Deviation coding was used for all factors (i.e., cueing and cue type). The model yielded a significant effect of cueing ($\chi^2 = 88.00$, $p < 0.001$) as well as of cue type ($\chi^2 = 69.80$, $p < 0.001$) on participants' first fixations. Furthermore, the model revealed a significant interaction between cueing and cue type ($\chi^2 = 103.44$, $p < 0.001$). *Post hoc* comparisons (Tukey corrected) yielded no significant differences in first fixations for the three baseline conditions (i.e., when no cueing preceded the patient; all p-values > 0.05, also see Figure 3 for illustration). Compared to baseline, *post hoc* comparisons revealed a significant increase of first fixations to patients for the short attentional cue (z.ratio $= -4.04$, $p < 0.001$) as well as for the long attentional cue (z.ratio $= -14.14$, $p < 0.001$). By contrast, the referential cue did not increase the proportion of first fixations to the patient character compared to baseline (z.ratio $= 1.16$, $p = 0.34$). Furthermore, there were significant differences between the short and the long attentional cue (z.ratio $= 7.57$, $p < 0.001$), with more fixations to the patient character after viewing a long compared to a short attentional cue. Additionally, participants were less likely to fixate the patient after referential cueing than after both types of attentional cueing, as *post hoc* comparisons revealed significant differences between the referential cue and the short cue (z.ratio $= -3.36$, $p < 0.001$), as well as between the referential cue and the long cue (z.ratio $= 10.80$, $p < 0.001$; also see Figure 3 for illustration).

TABLE 1 **Number of participants producing no passives during the different cueing tasks.**

Cue type	Number of participants producing no passives (percentage in brackets)
Short cue	30 (of 44 participants; 68%)
Long cue	26 (of 45 participants; 58%)
Referential cue	16 (of 47 participants; 34%)

3.5. Linking eye gaze data to sentence production

In a next step, we combined the analysis of participants' first fixations and their structural choices. This was done in order to examine whether first fixations on each trial were predictive of speakers' propensity to produce passive sentences. To address this question, we assessed the influence of "first fixation" on whether participants produced passive sentences (=1) or not (=0). For each cue type (short, long, referential), we calculated mixed effect logistic regression models with first fixations (patient vs. agent) as fixed effect (deviation coded) and by-participant as well as by-item intercepts as random effects on participants' structural choices. For the short cue, the model revealed a significant effect of first fixation ($\chi^2 = 13.38$, $p < 0.001$), indicating that participants were more likely to produce a passive when their first fixations were on the patient than on the agent of the depicted action. We also observed an effect of first fixation on passive production for the long cue (first fixation: $\chi^2 = 9.32$, $p = 0.002$) as well as for the referential cue ($\chi^2 = 10.67$, $p < 0.001$), suggesting that for all types of cues a greater propensity to first fixate the patient was linked to an increase of passive production.

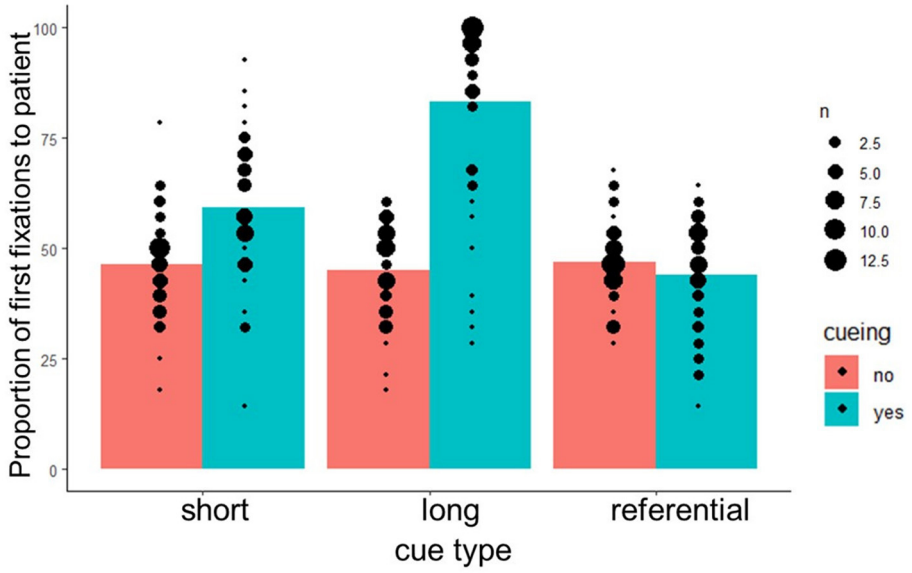

FIGURE 3
Proportion of first fixations to the patient for the three different cues compared to baseline. Count data are plotted with dot size referring to the number of participants displaying the respective proportion of first looks.

3.6. Effects of cue types on sentence planning during the first 600 ms

To gain a better understanding of speakers' viewing patterns during the production of non-canonical sentences beyond first fixations, we analyzed the time course of speakers' eye-gaze behavior during sentence planning for passive utterances. We analyzed fixations of the patient and agent within each 20 ms bin of every trial for the time window between 0 and 600 ms after scene onset by using mixed-effects logistic regression. Looks to the patient were analyzed relative to looks to the patient and agent, meaning that no other on-screen looks were included. The logistic regression model for passive utterances revealed a significant effect of cue type ($\chi^2 = 14.61$, $p < 0.001$). *Post hoc* comparisons revealed no significant differences in patient fixations for the short attentional cue vs. the long attentional cue during the production of passives (z.ratio $= 0.3$, $p = 0.95$). However, there was a greater proportion of patient fixations for the short attentional cue as opposed to the referential cue (z.ratio $= -2.62$, $p = 0.03$), and for the long attentional cue as opposed to the referential cue (z.ratio $= 3.93$, $p < 0.001$). These findings suggest that attentional cueing resulted in viewing patterns that were different from referential cueing. The time course with the proportion of fixations on patient and agent from scene onset is displayed in Figure 4.

4. Discussion

In the present study, our goal was to directly compare the impact of different cue types on German speakers' sentence production and viewing behavior. This comparison allowed us to zoom in on how sentence production is modulated in response to differently informative cues—an issue that has been investigated for English but not for other languages. Furthermore, by investigating German—a language that differs from English in typological properties such as case-marking and word order flexibility, our study provides an interesting test case for the previously observed prime role of attention for non-canonical sentence production. In the following, we will discuss our results with regard to German speakers' structural choices (1) and their viewing patterns, including the link between eye gaze and sentence production (2). Finally, we will allude to the observed individual variation concerning effects of cueing on speakers' structural choices (3).

4.1. Effects of different cue types on structural choices

Our results show that different cue types differed in their effectiveness to elicit passive sentences in German speakers. We found that a short attentional cue did not alter German speakers' aptitude to produce passives compared to baseline (cf. Esaulova et al., 2019). By contrast, a long attentional cue was effective in increasing speaker's rate of passive production compared to baseline (cf. Esaulova et al., 2021). However, when directly comparing the two types of attentional cues, both did not differ from one another in terms of their effectiveness to elicit passive sentences, suggesting that attentional cueing did not have a strong effect on passivization in German. At the same time, however, we found that lexical accessibility—as manipulated by referential cueing—led to a more substantial increase of passives.

Most centrally, our findings point to cross-linguistic differences between speakers of German and English. Whereas previous findings have shown that for English speakers the mere allocation of attention was sufficient to trigger the production of non-canonical sentences (i.e., passives), our results paint a different

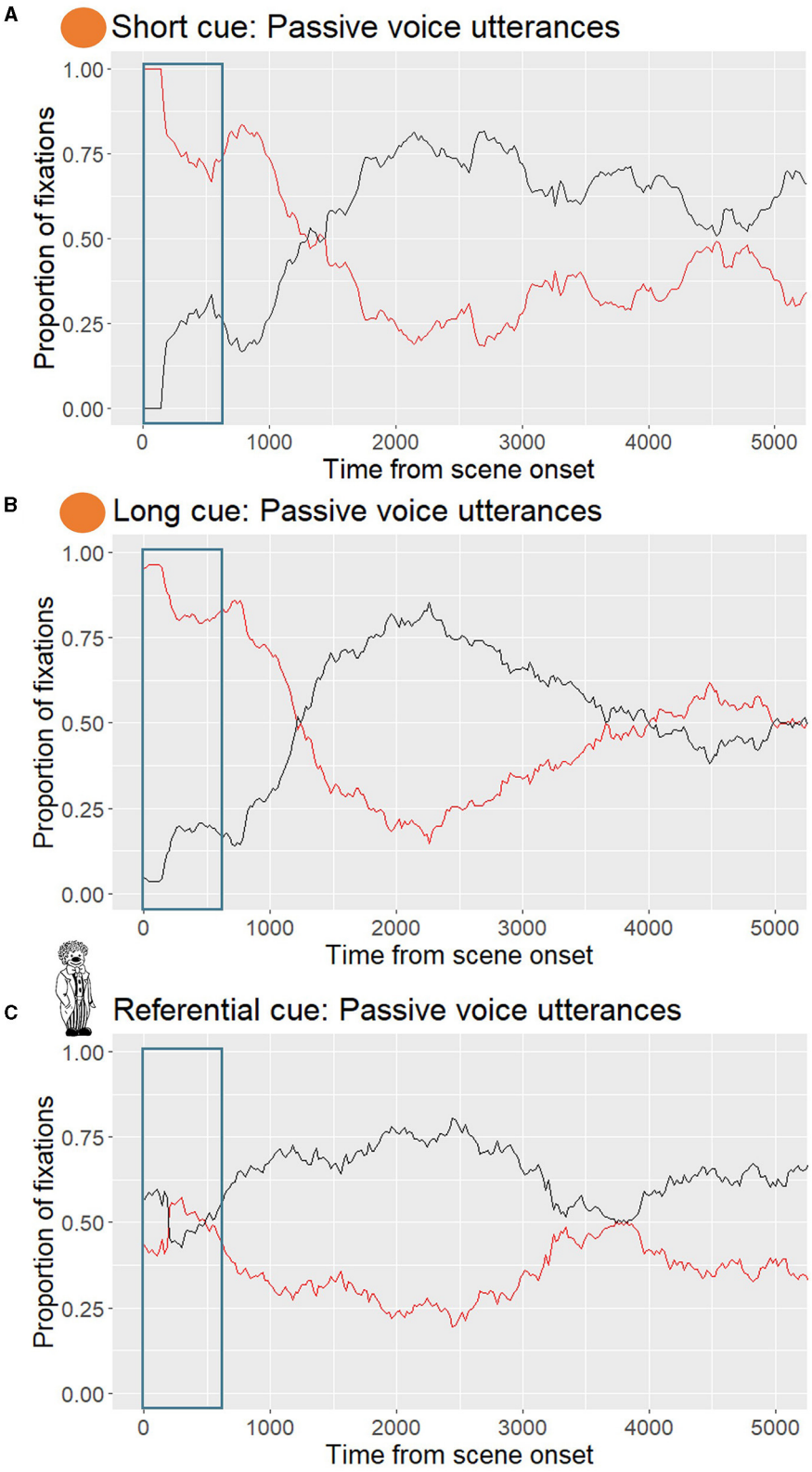

FIGURE 4
Time course of speakers' fixations to patients (red) as opposed to agents (black) during the production of passives after a short cue **(A)**, a long cue **(B)**, and after a referential cue **(C)**.

picture for speakers of German. We found that referential cueing was much more effective in increasing German speakers' propensity to produce passives than attentional orienting. This was true even though the long attentional and referential cue lasted for the exact same duration and although speakers' propensity to produce passives did not differ in the baseline condition when no cueing was employed. Our direct comparison of different cue types therefore shows that the lexical accessibility of the patient—over and above the mere allocation of attention—appears critical for German speakers' structural choices, challenging the notion that attentional orienting is the main factor modulating grammatical role assignment as claimed for English speakers (Myachykov et al., 2018). This observation is further supported when taking into account speaker-specific behavior. When presented with a short attentional cue, we found that only the minority of speakers displayed a cueing effect in the expected direction (more passives after cueing compared to baseline). Furthermore, only around half of the participants showed a cueing effect when the long attentional cue was presented, suggesting that attentional cueing is only moderately effective in eliciting passive sentences in German speakers. By contrast, the majority of German speakers displayed a cueing effect after referential cueing, again suggesting that the accessibility of the patient exerts a stronger effect than the mere allocation of attention, contra to findings in English.

What could explain these cross-linguistic differences in the effectiveness of attentional cueing and why is referential cueing more effective in invoking passive utterances than attentional cueing in speakers of German? We want to propose that the difference in the effectiveness of attentional and referential cueing in German speakers is grounded in the fact that both types of cueing target different stages of language production, resulting in different consequences for a case-marking language like German. A common assumption in the production literature is that the planning process is divided into at least two processes (Levelt, 1989): a conceptualization process, involving the generation of the preverbal message, and a formulation process during which lemmas are selected and the grammatical relations that hold between them are specified to finally convey who did what to whom. While attentional cueing might influence the starting point for conceptualization by directing speaker's gaze to the cued character, referential cueing operates during the formulation stage and increases the accessibility of a character by activating its lemma during the character's preview. Meta-analyses of the time course of processes involved in picture naming have revealed that lemma retrieval is usually achieved at around 300 ms (e.g., Indefrey and Levelt, 2000; Indefrey, 2011). Thus, a preview of 700 ms as in our study is sufficient to activate the lemma describing the previewed character, and subsequently also serves to activate the phonological and grammatical information that is stored in its corresponding lexeme. German nouns have a grammatical gender (i.e., masculine, feminine or neuter), considered to be an arbitrary, lexically stored, syntactic feature of the noun (Schriefers et al., 2002). Gender in German is expressed on the determiner preceding the noun. According to psycholinguistic models, activation of a noun's lemma activates this gender information and a determiner is selected accordingly (Schriefers et al., 2002; Schiller and Caramazza, 2003). As German determiners fuse gender, number and case information, the activated determiner also necessarily expresses case information, which—in the default case—is the nominative case (Emonds, 1985). Thus, a preview of the patient character is likely to result in the activation and production of a noun phrase where the determiner expresses default nominative case. Given the activation of this noun phrase due to referential cueing, the easiest way to proceed with the utterance then is to produce a passive clause where the patient is realized as the nominative case-marked subject. By contrast, unlike referential cueing, attentional cueing does not lead to a prior activation of the lemma referring to the patient, thus, no nominative case-marked noun phrase is activated by the cue. Therefore attentional cueing does not nudge German speakers to produce passives to the same degree as referential cueing. Crucially, this pattern may be different from English. Since in English no overt case marking is required for full noun phrases, English speakers can start the production of a passive right away, even if triggered by only very subtle forms of attentional cueing.

While our findings suggest that German speakers differ from English speakers with regard to the relative importance of visual attention vs. lexical accessibility, a number of differences in experimental design have to be mentioned. First, in the present study we employed a between-subject design, while previous findings in English are based on a within-subject design in which the same participants were exposed to different types of cues (see Myachykov et al., 2018). While a within-subject design might allow for an even more direct comparison, it should be noted that we did not observe any differences in the baseline condition (i.e., in the absence of cueing), thus licensing a direct comparison between the different cue types in our between-subject study. However, future studies should test whether our findings also replicate in a within-subject design. Another methodological difference concerns the location of the referential cue. While Myachykov et al. manipulated both location and character preview concurrently, in the present study we examined effects of accessibility (preview) in the absence of attentional orienting by presenting the preview in the center of the screen. Could such differences in design contribute to the observed discrepancies we observe between English and German? Previous findings suggest otherwise, as German speakers were found to produce a substantial number of passives when a referential cue was not presented centrally but in the location where the patient was about to appear (i.e., 32%, cf. Schlenter et al., 2022). While we remain cautious of directly comparing our results to the results of Schlenter et al. (2022) as they did not employ a baseline condition without cueing, their results nonetheless suggest that the rate of passives after referential cueing is comparable to—and likely even greater—than the rate of passives we observe in the current study. Thus, we can be safe to conclude that referential cueing appears to be particularly effective in speakers of German, much more so than the mere allocation of visual attention.

As outlined above, any direct comparison between absolute values such as the proportion of passives in English vs. German is difficult because of differences in experimental materials, design, etc. However, our within-language comparison of German speakers provides insights into the relative contributions of differently informative cue types, resulting in a pattern—rather than an absolute value—which can then be compared to the pattern observed for English. For German speakers, the simplified pattern

of passive production could be summarized as follows: short attentional cue = long attentional cue < referential cue. This pattern deviates from the pattern previously observed in English: short attentional cue < long attentional cue = referential cue. However, in order to find out whether the different patterns are indeed due to typological differences in terms of case-marking and word order flexibility, it would be worthwhile to investigate the effect of different cue types in speakers of additional languages that share or vary in certain typological features. For instance, there is some first evidence to suggest that referential cueing results in a similar increase of passives as the manipulation of visual prominence in speakers of French, another language devoid of most overt case marking (Stanford and Delage, 2021). By contrast, one would expect that other case-marking languages reveal a pattern that is more similar to the one we observed for German. Although so far a direct comparison of different cue types is lacking for other case-marking languages, there is some first evidence in line with this proposal. For instance, whereas speakers of Korean did not change their sentence production preferences on the basis of a brief attentional cue (e.g., Hwang and Kaiser, 2015), they produced more passives when presented with a lexical prime that explicitly named the patient character (e.g., Kim, 2011; Cho et al., 2023; but see Hwang and Kaiser, 2015). However, more work is necessary in order to find out whether patterns in German may indeed generalize to other case-marking languages like Korean. Thus, it is possible that more fine-grained differences arise depending on how case-marking is realized in a specific language. For instance, whereas German marks case on the determiner preceding a noun, Russian and Korean only provide case information after the noun, which may influence effects of cueing on sentence production. More generally, languages like German and Korean differ in terms of numerous other typological features such as verb placement and whether the language makes use of pro-drop or not (e.g., Kashima and Kashima, 1998). Consequently, future work—both within and across languages—is required in order to reveal which typological features are indeed relevant in shaping sentence production as a response to differently informative cues.

4.2. Effects of different cue types on speakers' gaze patterns

When focusing on speakers' viewing patterns, we observed significant differences between cue types. While both the short and the long attentional cue led to a significant increase in first looks to the patient, we also observed significant differences between the short and the long attentional cue. Specifically, the long attentional cue was significantly more effective in directing speakers' eye gaze to the patient character (84% first fixations after cueing) than the short attentional cue (60% first fixations after cueing). By contrast, for referential cueing, there was no increase in German speakers' propensity to first fixate the patient after cueing compared to baseline (45% first fixations after cueing). These findings suggest that the different types of cueing had different effects on speakers' allocation of attention. Whereas the short and the long attentional cue indeed served to direct a speaker's attention to the patient character, the same did not hold for referential cueing.

To gain insights into the relationship between viewing behavior and language production, we directly linked participants' eye gaze patterns to their sentence production strategies. This step allowed us to examine whether speakers' initial fixations to the patient character were predictive of their structural choices. Indeed, we observed that for all cue types speakers were more likely to produce passives when they had initially fixated the patient character. Thus, our findings align with earlier observations by Gleitman et al. (2007), demonstrating a connection between first looks and first mention (and hence subject assignment), in accordance with a linear incremental sentence planning strategy which assumes that speakers can start a sentence as soon as a single phrase has been planned. Crucially, however, while our findings replicate previous observations that speakers initially look at the character they mention first, our findings also suggest that different cue types have a different effect with regard to the link between viewing patterns and sentence production. For attentional cueing, we found that only the long attentional cue but not the short attentional cue was effective in increasing speakers' aptitude to produce passives compared to baseline, suggesting that a certain threshold of attentional orienting is necessary in order to affect German speakers' aptitude to produce passives. Crucially, however, even if participants initially looked at the patient in the great majority of trials (>80%) as was the case for the long attentional cue, the increase in passive production was only modest and not significantly different from the effect of a short attentional cue which failed to be effective in eliciting passives compared to baseline. By contrast, after referential cueing, German speakers were much more inclined to produce passives even in the absence of a concomitant increase of first fixations to the patient. Therefore, our findings suggest that the propensity to produce passives does not have to be tied to an increase of visual attention to the patient character.

To further elucidate speakers' viewing patterns during the production of non-canonical sentences, we directly compared the effects of the different cue types beyond first fixations. We found that the different types of cues led to different viewing patterns during the planning of passive sentences. Whereas both attentional cues led to an early and sustained increase of patient fixations during the first 600 ms after scene onset, the same was not observed for referential cueing. Rather, when speakers had encountered a referential cue, fixations to the patient character were attenuated compared to attentional cueing. Thus, although the same sentence structure (i.e., a passive) was produced, participants were less likely to fixate the patient character after referential cueing than after attentional cueing. The attenuated initial fixation to the patient character after referential cueing might arise because speakers had already visually encountered the patient character during the referential preview, and therefore may have been less prone to fixate this character again. However, since speakers continued to look away from the patient, this probably reflects that speakers had already retrieved the corresponding lemma of the cued patient (especially given that lemma retrieval is usually achieved at around 300 ms during picture naming tasks, see e.g., Indefrey and Levelt, 2000; Indefrey, 2011). This reduction in looks is in line with previous findings for the production of active sentences (Ganushchak et al., 2017). Ganushchak et al. found that referents who were directly mentioned in the preceding context

and for which lexical information was, thus, already activated were accompanied by a reduction of looks in the time course of sentence planning. In line with these findings, the reduction of patient fixations for the referential cue in our study could be interpreted as a signature of lexical access. Hence, our findings suggest that conceptualization and lemma retrieval may have already been accomplished after referential cueing such that speakers can already allocate their attention to the action as well as to the other relevant character of the event. By contrast, an attentional cue provides no information relevant for the conceptualization and lemma retrieval of the patient character but requires the speaker to first visually engage with the patient, as reflected in a sustained increase of patient fixations after attentional cueing.

In sum, our findings show that a direct link between the allocation of attention and speakers' structural choices may not always be licensed. That is, an increase of visual attention to the patient character does not necessarily lead to an increase of passives as illustrated by the short attentional cue in our study. At the same time, an increase of passivization is not necessarily tied to an increase in visual attention either, as is the case for the referential cue. Taken together then, our findings challenge the idea of a one-to-one link between attentional orienting and speakers' sentence production strategies (also see Bock et al., 2004, for a similar point).

4.3. Individual variation in the production of passives

Finally, we took into account individual behavior as an additional way of assessing the effectiveness of cueing. We reasoned that if a cue is very effective, this should not only become visible at the group level but also pertain to the individual level. Our results indeed suggest that different cue types also differ in their effectiveness at the level of individual speakers. Thus, a greater number of speakers was affected by a referential cue compared to attentional cueing. More generally, our results point to quite substantial variation when it comes to speakers' aptitude to produce passives, akin to what has been observed for syntactic priming in children (Kidd, 2012) and adults (Branigan and Messenger, 2016). What could cause this speaker-specific variation? It is possible that self-priming explains our results. That is, once participants produce passives early in the experiment, they may also be more likely to produce passives later on, and the same could be true for active structures. While this is a possibility, it is unlikely to be the sole explanation: for one, experimental items were interspersed with fillers to ensure that participants also had to produce alternative structures (such as "The clock is next to the key"). Most importantly, if self-priming was the only reason for speaker-specific behavior, then participants should be equally likely to prime themselves during cued and non-cued (baseline) trials. However, at least for a number of participants, we find support of a significant cueing effect in that they are more likely to produce a passive during cued than during non-cued trials, rendering self-priming unlikely to be the sole explanation for the individual variation we observe.

Alternatively, it could be that other factors underlie speaker-specific preferences in producing passives. As previous findings show, differences in passive comprehension can be attributed to education-related differences (Dabrowska and Street, 2006; also see Street and Dabrowska, 2010). Whereas less educated participants displayed difficulties in comprehending passive sentences but not actives, better educated participants displayed no difficulties for the two different sentence structures (e.g., Dabrowska and Street, 2006). These results suggest that differences in the comprehension of non-canonical sentence types are possibly linked to differences in how frequently speakers are exposed to such structures. However, this explanation is unlikely to account for our data because our sample consisted of a rather homogenous population of students with a comparable educational background. Yet, it is possible that more subtle differences such as reading preferences or language aptitude may have contributed to the observed individual variation [see e.g., Dabrowska (2018) for evidence that such differences can affect the comprehension of non-canonical sentence structures]. While future studies have to examine this possibility more closely, our results provide some first evidence that speakers are not equally susceptible to manipulations of cueing. Critically, by moving away from exclusively examining results at the group level, speaker-specific variation provides an additional window into the different effectiveness of various cue types.

5. Conclusions

Our findings provide new evidence concerning speakers' aptitude to produce non-canonical sentence structures. We observe speaker-specific variation as well as differences concerning the type of cue that is used. Specifically, different cue types are differently effective in modulating German speakers' tendencies to produce passives and in shaping their viewing patterns. Whereas attentional cueing leads to an increase of first fixations to the patient but not necessarily to an increase in passivization, the reverse seems to apply to referential cueing. Thus, an increase of passives due to referential cueing is not bound to an increase of attentional resources, demonstrating that structural choices can be decoupled from "pure" effects of attentional orienting. Finally, our findings highlight cross-linguistic differences. Unlike for English speakers, German speakers are much more susceptible to referential cueing than to attentional cueing, suggesting that lexical accessibility rather than attention plays a more decisive role for grammatical role assignment in German. Taken together, our results suggest that speakers of English and German, two languages that differ in terms of case-marking and word order flexibility, display differences when it comes to links between attention and sentence production.

Data availability statement

The datasets and the scripts used for data analyses are publicly available on OSF: https://osf.io/g7re6/.

Ethics statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Commission of Cologne University's Faculty of Medicine (approval number 16-134). The studies were conducted in accordance with the local legislation and

institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SD: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Supervision, Visualization, Writing—original draft, Writing—review & editing. MP: Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Writing—review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

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