Animacy and attention play different roles in children's language production

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Abstract

While effects of animacy and attention have been studied quite extensively in adult speakers, less is known about their role in child language production. In the present study we fill this gap by testing German-speaking preschool children in two language production tasks using eye-tracking. We find that animacy does neither affect the production of transitive sentences nor the production of conjoined noun phrases. By contrast, we find significant effects of attentional orienting. Children were more likely to first fixate an entity when it had been preceded by a visual cue and was hence in their focus of attention. While this held true across tasks, attentional orienting only affected children's production of conjoined noun phrases but not the production of transitive sentences. Effects of attentional orienting therefore seem conditioned by language production affordances. In sum, our findings provide new evidence that animacy and attention play different roles in children's language production.

Keywords: animacy; attentional cueing; language production; language acquisition; eye-tracking

Introduction

Whether something is alive or not plays a central role in human cognition. This special status of animacy is also reflected in human language. For instance, across languages, animate referents – like human beings or animals – tend to be mentioned earlier in a sentence than inanimate entities (Branigan & Feleki, 1999; de Swart et al., 2008). Animate entities also take up more prominent syntactic roles such as the role of the sentential subject (McDonald et al., 1993). For instance, when asked to reproduce sentences involving an animate and an inanimate entity (e.g., *The music soothed the child*), English speakers are more likely to erroneously remember animate referents as subjects, even if this leads to the production of passive sentences (e.g., *The child was soothed by the music*) (McDonald et al., 1993). Speakers are also more likely to produce a passive construction when the patient is animate rather than inanimate (Esaulova et al., 2019; Ferreira, 1994; Harris, 1978). Together, these findings underline the key role of animacy for language production. However, other factors seem to affect speakers' language production in similar ways to animacy. One of these factors is the speaker's focus of attention (e.g., Gleitman et al., 2007; Myachykov et al., 2012). For instance, speakers are more likely to first mention a depicted character when it has been preceded by a brief visual cue – a small dot – which draws the speaker's attention to the respective character (e.g., Gleitman et al., 2007). In the same vein, speakers are more likely to assign the subject role to the visually cued patient, resulting in an increase of passive sentences (e.g., Gleitman et al., 2007). As these findings suggest, attentional orienting seems to affect language production in similar ways as does animacy. However, effects of animacy and attention also differ when considering affordances of language production. For instance, effects of animacy have been argued to exclusively play a role for grammatical role assignment (i.e., by assigning an animate entity the subject role in transitive sentences, e.g., McDonald et al., 1993). According to this view, animacy is tied to subjecthood and considered irrelevant for processes of linear ordering. This argument is based on observations that effects of animacy are often absent at the phrase level, i.e., when it comes to the order of conjoined noun phrases. For instance, when asked to remember sentences such as "The key and the manager were nowhere to be found", speakers did not reverse the order of nouns when the inanimate noun (*key*) preceded the animate noun (*manager*) in a conjoined noun phrase (McDonald et al., 1993; Tanaka et al., 2011). However, unlike effects of animacy, attentional orienting seems effective in both transitive sentences and conjoined noun phrases. Thus, regardless of sentence type, speakers were more likely to first mention the entity that was visually cued and therefore in the spotlight of attention (Gleitman et al., 2007). Taken together, although effects of animacy and attentional orienting seem to evoke similar effects, they also differ in the way they affect language production. However, so far, the two factors have been mainly studied in isolation, rendering a direct comparison difficult (for an exception see e.g., Esaulova et al., 2019). What is more, while both factors have been studied quite extensively in adult speakers, far less is known about the role of animacy and attentional orienting in child language production. In the present study, we seek to fill this gap by investigating how children respond to manipulations of animacy and attention. For this, we zoom in on two syntactic structures that differ in their susceptibility to animacy and attention in adult speakers: transitive sentences and conjoined noun phrases. Children provide an interesting test bed in this context because they show different levels of expertise regarding these structures. Specifically, while children master the production of conjoined noun phrases from early on (e.g., Lust & Mervis, 1980), it takes them substantially more time to acquire the syntax of transitive sentences, especially non-canonical structures like passives

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(e.g., Marchman et al., 1991). Thus, by examining structures of different complexity, our study will speak to the question whether effects of animacy and attention differ depending on language production affordances. More broadly, our study will address how children respond to manipulations of animacy and attentional orienting, two factors that are central for adult language production but whose role is less clear in children. By addressing this open issue, our study will shed new light on child language production, providing insights into how children handle different conceptual, attentional, and linguistic affordances.

Animacy and attention in child language production

Effects of animacy already appear influential during language acquisition (Drenhaus & Féry, 2008; Harris, 1978; Lempert, 1989, 1990; Prat-Sala et al., 2000). For instance, when English-speaking children were asked to describe pictures of transitive events, they were more likely to produce passives when the patient was animate rather than inanimate (e.g. Harris, 1978). However, unlike for animacy, hardly any studies have investigated the role of attentional orienting in children's sentence production. In one exception to this, 3- to 5-year-old children were asked to describe transitive events which an experimenter enacted with puppets (e.g., a cat hitting a dog) (Ibbotson et al., 2013). When the experimenter's eye-gaze was directed toward the 'patient puppet' (with the purpose of drawing attention to the patient of the event), children were also more likely to start their utterances with the patient, resulting in a greater propensity to produce passive structures (Ibbotson et al., 2013). Critically, however, although the increase of passive sentences could be a response to attentional orienting, Ibbotson and colleagues (2013) did not provide a direct measure of children's allocation of attention. Hence, these findings leave open the question whether children's sentence production is indeed affected by attention. In the current study, we seek to address this open question by manipulating children's allocation of attention in terms of a brief meaningless visual cue preceding the patient, akin to previous studies in adults (e.g. Gleitman et al., 2007). To verify whether attentional orienting is indeed effective, we will make use of eye-tracking during language production. In addition to attentional cueing, we also manipulate the animacy status of the patient. By examining attentional orienting and animacy in tandem, we can shed light on a number of open questions: To what extent do animacy and attentional orienting affect children's language production patterns? Are the effects similar or different? What types of utterances do children produce in response to these manipulations? The latter question is of particular interest since children may not be as proficient and flexible as adults when it comes to the production of alternative syntactic structures. For instance, even though children have some knowledge of passive structures from quite early on (e.g., even at the age of 3 years and earlier, Bencini & Valian, 2008; Shimpi et al., 2007), the production of passives remains dispreferred and difficult for children (Marchman et al., 1991). To address this issue, we focus on linguistic structures of different complexity. In addition to transitive sentences that require grammatical role assignment and that may pose challenges in the context of non-canonical sentences structures (such as passives), we also examine effects of animacy and attention at the phrase level (by asking children to produce conjoined noun phrases). This way, our study will shed light on whether effects of animacy and attention differ depending on structural affordances. Such affordances may be particularly pronounced in children as they are still in the process of acquiring non-canonical sentence structures. Furthermore, by taking into account the phrase level, we can assess whether previously reported findings for adults replicate in children. Specifically, whereas effects of animacy appear to be restricted to the description of transitive events, effects of attention have been observed both at the sentence and the phrase level. If similar asymmetries hold true for child language production, we expect attentional orienting but not animacy to affect the production of conjoined noun phrases.

Methodology

Effects of animacy and attentional orienting on children's language production were examined in two tasks, *a noun pair naming task* assessing children's production of conjoined noun phrases, and an *event description task* assessing the production of transitive sentences.

Participants

35 German-speaking preschool children (mean age: 4;05; range 4;00 to 5;11 years, 16 female, 19 male) were recruited and tested in various daycare centres in Germany. The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Commission of Cologne University's Faculty of Medicine. Prior to testing, all caretakers gave informed written consent for their children to participate in the study.

Procedure

Children were first familiarized with the experimental setting and the eye-tracker (Eyelink Portable Duo). Prior to the experiments, a 5-point calibration was performed to ensure the validity of eye gaze patterns. Children were first tested in the noun pair naming task, followed by the event description task.

Experimental tasks

Noun pair naming task In the noun pair naming task, children were presented with pictures of two characters (e.g. a clown and a dwarf, see Figure 1, panel a). Depicted nouns were matched in terms of gender (only masculine nouns were used), syllable length, visual complexity, and frequency. Children were asked to name the two characters by producing a conjoined noun phrase. We manipulated the animacy status of the left character which was either an animate character in

the baseline condition or an inanimate entity in the 'inanimate' condition. Furthermore, children's allocation of attention was manipulated by means of a brief visual cue presented in the place where the left character was about to appear (cueing condition). Two experimental lists were created, consisting of 24 items presented in pseudo-randomized order (i.e., 24 noun pairs, with 8 pairs in the 'inanimate' condition, 8 pairs in the cueing condition, and 8 pairs in the baseline condition). We measured children's eye gaze to the characters as well as their order of mention (i.e., whether they first mentioned the left character or not).

Event description task To ensure a direct comparison between the two tasks, the event description task was designed to be as similar as possible to the noun pair naming task. The same noun pairs were presented, however with the difference that the characters were involved in a transitive event with an agent acting upon a patient (e.g. a clown pushing a dwarf, see Figure 1, panel b). To keep the task comparable to the noun pair naming task, the patient was depicted to the left of the agent (see Figure 1). We manipulated the animacy status of the patient which was either an animate character in the baseline condition or an inanimate entity in the inanimate condition. Furthermore, children's allocation of attention was manipulated by means of a brief visual cue presented in the place where the animate patient character was about to appear. In the baseline condition, no cue was presented. Four pseudo-random experimental lists were created, consisting of 24 presented items (i.e., 24 noun pairs, with 8 pairs in the 'inanimate' condition, 8 pairs in the cueing condition, and 8 pairs in the baseline condition). We measured children's eye gaze to the characters as well as their order of mention (i.e., whether they first mentioned the patient or not).

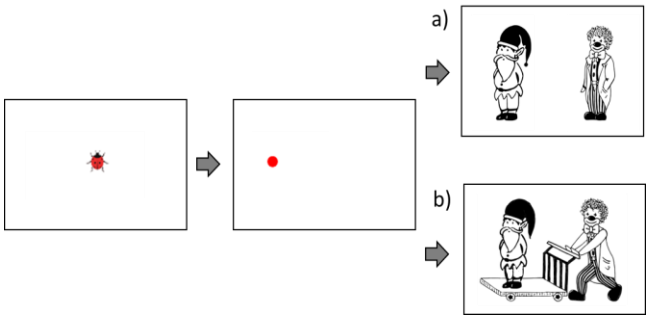

Figure 1: Depiction of an experimental trial (cueing condition) of the noun pair naming task (panel a) and the event description task (panel b)

Results

Noun pair naming task

Eye-tracking results For the noun pair naming task, our final sample consisted of 30 children (5 children had to be excluded because they were not able to perform or to finish the task). To examine the effect of animacy and attentional cueing on children's first fixations, we conducted a generalized linear mixed effects logistic regression, with the baseline condition (animate, non-cued) as a reference category which was compared to the condition of an inanimate object, and a cued animate character. The final model included random intercepts and slopes for participants and random intercepts for items. The model revealed no significant effect of (in)animacy on children's first fixations, z.ratio = 0.43, p = .87. By contrast, the model revealed a significant increase in first fixations after cueing compared to the baseline without cueing, z.ratio = -6.84, p < .0001, suggesting that children were more likely to first fixate the left character when it had been cued compared to baseline (see Figure 2, panel a, for illustration).

Language production results When examining children's order of mention, we found that in the baseline condition, children first mentioned the left character 55% of the time. When changing the animacy status of the left character to an inanimate object, children produced 56% left-first responses. In the cueing condition, children produced 68% of left-first utterances. To further examine the effect of animacy and attentional cueing on children's order of mention, we conducted a generalized linear mixed effects logistic regression, with the baseline condition (animate, non-cued character located on the left) as a reference category which was compared to the condition of an inanimate entity, and a cued animate entity (both also located on the left). The final model included random intercepts and slopes for participants and random intercepts for items. The model revealed no significant effect of (in)animacy on left-first utterances, z.ratio = -0.20, p = .67. By contrast, the model yielded a significant effect of cueing on children's left-first utterances, z.ratio = 2.87, p = .004, showing that children were more likely to start their utterances with the character when it had been cued (see Figure 2, panel b, for illustration). Additionally, we examined whether children's first looks were predictive of their order of mention. We found that children's order of mention depended on where they looked first, as revealed by a significant influence of first fixation (left vs. right character) on children's propensity to first mention a character, $\chi 2$ = 54.73, p < .001. These findings suggest that children's first fixations come to modulate their ordering preferences in conjoined noun phrases.

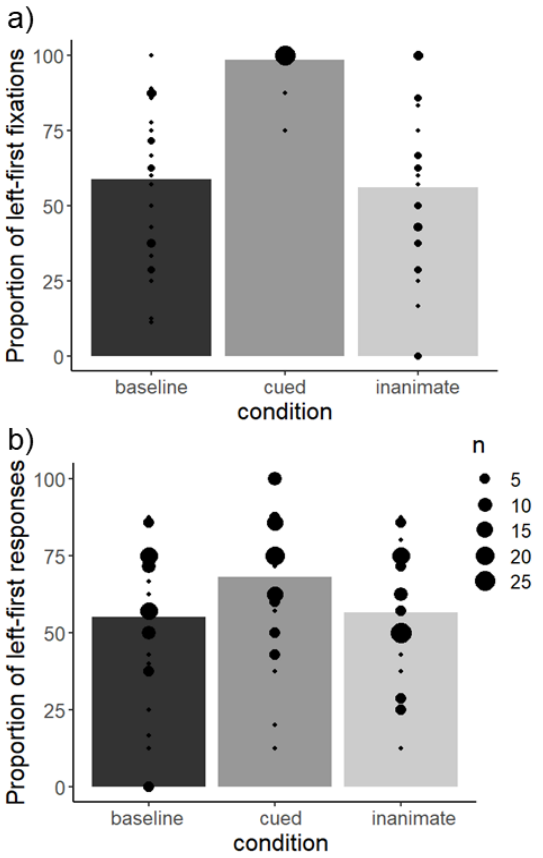

Figure 2: Proportion of first fixations to the left character (panel a) and proportion of left-first responses (panel b) in the noun pair naming task

Event description task

Eye-tracking results For the event description task, our final sample consisted of 27 children (8 children had to be excluded because they were unable to perform or to finish the task). To examine the effect of animacy and attentional cueing on children's first fixations to the patient, we conducted a generalized linear mixed effects logistic regression, with the baseline condition (animate, non-cued) as a reference category which was compared to the condition of an inanimate patient, and to an animate patient preceded by the attentional cue. The final model included random intercepts and slopes for participants and random intercepts for items. We found that children were more likely to first fixate the patient when it had been cued compared to baseline, z.ratio = -7.34, p <.0001. By contrast, compared to baseline, there was no significant effect of (in)animacy on children's first fixations, z.ratio = 1.85, p = .12 (see Figure 3, for illustration).

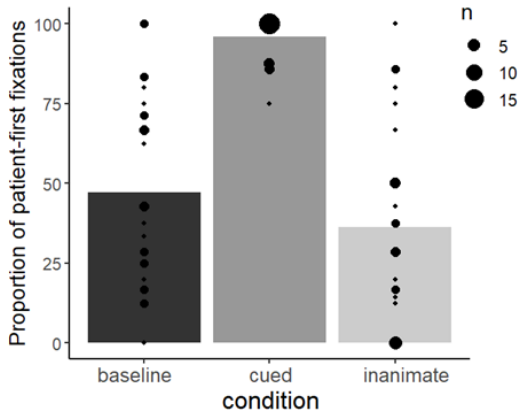

Figure 3: Proportion of first fixations to the patient in the event description task

Sentence production results Children predominantly produced active sentences, beginning their utterances with the agent (97% of the cases). In total, children produced 21 patient-first utterances, with 6 passive sentences (5 full passives), 1 OSV sentence, and 14 alternative structures. The alternative structures mainly consisted of utterances where children started out by mentioning the patient first, but then restarted in order to produce a canonical active sentence with the agent as subject (such as "The dwarf…, the clown is pushing the dwarf."). While numerically, children were more likely to produce patient-first utterances in the cued condition (n = 11, 5%), they also produced patient-first utterances in the baseline condition (n = 6, 3%) and in the inanimate condition (n = 4, 2%, see Figure 4, for illustration). The very low number of patient-first utterances did not allow for a reasonable statistical comparison.[1]

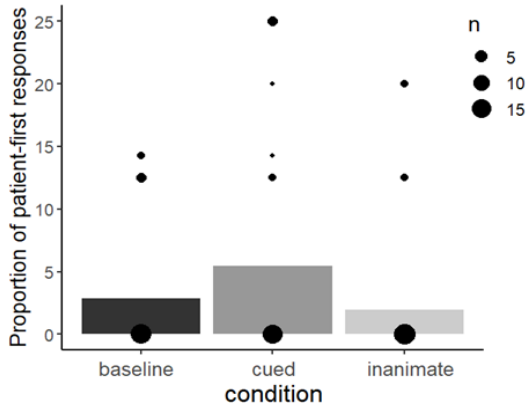

Figure 4: Proportion of patient-first responses in the event description task

[1] A generalized linear mixed effects logistic regression model neither revealed a significant effect of 'attentional cueing' (z.ratio = 1.49, p = .13) nor of '(in)animacy' (z.ratio = .61, p = .93).

Discussion

Our findings shed new light on the role of animacy and attentional orienting – two factors that are known to influence adult language production but whose role has been less clear in children. Overall, our findings were as follows: We did not observe any effect of animacy on children's first fixations, whereas attentional orienting was highly effective in modulating children's allocation of attention. However, attentional orienting only affected language production at the phrase level (i.e., when conjoined noun phrases were produced) but did not affect the description of transitive events. In the following, we will discuss our findings in more detail.

Effects of animacy and attention at the phrase level

We found that attentional orienting was highly effective in modulating children's eye-gaze in the noun pair naming task, as demonstrated by children's first fixations. Thus, children were much more likely to initially fixate a character when it had been cued by a small meaningless dot compared to a baseline without cueing. Children were also more likely to first mention a character when it had been visually cued and was hence in their spotlight of attention. At the same time, we found that children's first fixations to a character were predictive of their ordering preferences: What was looked at first by a child, was also more likely to be mentioned first. Together, our findings provide compelling evidence that attentional orienting is already effective in children and comes to modulate their order of mention. By contrast, we did not observe any effects of animacy in the same task. This observation is in line with previous findings that have found no animacy effects on adult speakers' production of conjoined noun phrases (e.g., McDonald et al., 1993). However, our findings contrast with other observations that have reported effects of animacy at the phrase level (e.g., Franz et al., 2021). What could cause this discrepancy? Critically, it should be noted that the distinction between animate and inanimate entities is not necessarily clear-cut but often characterized by a lack of agreement in animacy ratings (e.g., Radanović et al., 2016; Westbury, 2023). For instance, students rated the animacy status of giraffes or babies at about 50 (out of 100, see Radanović et al., 2016), demonstrating that even seemingly clear cases of animate entities do not necessarily lead to consensus in terms of people's judgements. This lack of consensus may also contribute to the discrepant findings regarding animacy effects at the phrase level (such as in the production of conjoined noun phrases). Based on these findings, it is possible that children in our study did not display an effect of animacy because they did not judge the depicted characters (e.g. clown, dwarf, etc.) as 'sufficiently' animate. Previous studies that found animacy effects on children's production of conjoined noun phrases also included animals (such as bunny, owl or dolphin, see e.g., Dolscheid et al., 2024; Franz et al., 2021), which children may have judged as better candidates of animate entities. Additionally, effects of animacy may have been mitigated by the fact that children frequently encounter inanimate entities that nonetheless bear features of animacy (such as flying carpets or talking cars in the context of cartoons). While future studies should investigate this issue in more detail, our findings suggest that animacy does not affect children's production of conjoined noun phrases. By contrast, the very same task revealed that attentional orienting was effective in changing children's production strategies, suggesting that bottom-up cues – like attentional cueing – may be more relevant for children's linear ordering than conceptual factors such as animacy.

Effects of animacy and attention on sentence production

We found that attentional cueing was also highly effective in allocating children's attention in the event description task. However, despite being effective in shifting children's attentional focus, attentional orienting did not suffice to increase children's propensity to produce patient-first structures like passives. This absence of a cueing effect on sentence structure contrasts with findings for adult speakers (e.g., Gleitman et al., 2007, also see Dolscheid & Penke, 2023). One likely explanation for these conflicting findings is that children are less flexible than adults in their production of non-canonical sentences such as passives (e.g., Marchman et al., 1991). In line with this proposal, children mainly produced active sentences in the event description task, with only very few instances of passives. This finding illustrates that children preferred the production of active sentences, resulting in a bias that is not easily overridden by the increased prominence of the patient in terms of attentional orienting. Furthermore, if children started an utterance with the patient, about two thirds of these utterances were not passives but rather took the form of restarts (like "A fisher, a farmer is pushing the fisher"). This observation held true even if children reliably mastered the comprehension of passives (as measured by an act-out-task), suggesting once more that children are not yet as flexible as adults in producing passive sentences. In conclusion, our results show that attentional cueing does not invariably affect language production but rather that its effects depend on additional affordances imposed by language structure. Unlike for transitive events in which children display a strong bias of first mentioning the agent because of their preference to produce canonical active sentences, children did not face similar biases when producing conjoined noun phrases. That is, in the baseline condition, children were about equally likely to first mention the left or the right character. Making one of the characters more prominent in terms of attentional orienting in this task could thus easily nudge children towards mentioning the cued character first. Based on these findings, we can conclude that attentional orienting comes to shape children's language production, but only when attention does not conflict with language production affordances (i.e., if children do not have to overcome strong preferences regarding sentence structure). However, when attention and production preferences are in conflict, children continue to begin their utterance with the agent as sentence-initial

subject, suggesting that children adhere to sentence structure preferences (i.e., the production of canonical active sentences) rather than by choosing a starting point based on whatever attracts their attention.

Like with attentional orienting, we did not observe any effect of animacy on children's event descriptions either, contrasting with previous observations that children and adults are susceptible to effects of animacy when it comes to sentence production (e.g., Harris, 1978; Esaulova et al., 2019). What could explain this discrepancy? As outlined above, judgments of animacy may not always be consistent for depicted stimuli (with animate entities being judged as inanimate and vice versa, e.g., Radanović et al., 2016; Westbury, 2023). Another reason for the discrepant findings might be that most previous studies have manipulated the animacy status of both the agent and patient concurrently. That is, an increase in the production of non-canonical utterances like passives or object-dislocated constructions was most pronounced when an inanimate agent acted upon an animate patient (e.g., A man was hit by a swing, see e.g., Harris, 1978; Prat-Sala et al., 2000). By contrast, in our study we exclusively manipulated the animacy status of the patient while the agent remained unaltered (i.e., animate). It is likely that the presence of an animate agent has attenuated the production of non-canonical structures. Yet, it should be noted that adult German speakers were still susceptible to manipulations of patient animacy when tested in a design that was similar to ours, producing a greater number of passives when an animate agent acted upon an animate rather than an inanimate patient (e.g., Esaulova et al., 2019). Therefore, our observation that children did not produce more patient-first utterances in response to patient animacy is again likely because children are less flexible in their production of non-canonical sentences (e.g., Marchman et al., 1991). Thus, children's strong propensity to adhere to the production of canonical active sentences may have outranked effects of animacy in the event description task.

Summary and conclusions

In sum, our study sheds new light on children's language production patterns in response to animacy and attention. We found different effects of animacy and attentional orienting. While both did not affect children's propensity to produce non-canonical structures such as passives, attentional orienting but not animacy affected children's language production at the phrase level. That is, during the production of conjoined noun phrases, children were more likely to start an utterance with an entity that had been cued and was hence in their focus of attention. Our findings therefore provide first evidence that children's language production patterns are already susceptible to effects of attentional orienting. However, this effect seems restricted to the phrase level (i.e., to processes of coordination) rather than influencing grammatical role assignment, demonstrating that attentional orienting is effective only in certain contexts. When attentional and production biases compete, as is the case when the patient of a transitive event is visually cued, children do not simply start their sentence production based on what captures their attention but rather resort to their preferred sentence structure (i.e., active sentences). Thus, unlike adults, children appear less flexible in adjusting their sentence structure in response to attentional orienting and animacy.

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