Young children's drawings and descriptions of layouts and objects

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Abstract

Young children tend to prioritize objects over layouts in their drawings, often juxtaposing "floating" objects in the picture plane instead of grounding those objects in drawn representations of the extended layout. In the present study, we explore whether implicitly directing children's attention to elements of the extended layout through a drawing's communicative goal—to indicate the location of a hidden target to someone else—might lead children to draw more layout information. By comparing children's drawings to a different group of children's verbal descriptions, moreover, we explore how communicative medium affects children's inclusion of layout and object information. If attention modulates children's symbolic communication about layouts and objects, then children should both draw and talk about layouts and objects when they are relevant to the communicative task. If there are challenges or advantages specific to either medium, then children might treat layouts and objects differently when drawing versus describing them. We find evidence for both of these possibilities: Attention affects what children include in symbolic communication, like drawings and language, but children are more concise in their inclusion of relevant layout or object information in language versus drawings.

Keywords: drawing, language, child development, layouts, objects, spatial cognition, spatial language

Introduction

Children treat layout information in their surroundings, like the walls of a room, and object information in their surroundings, like the furniture in a room, differently during navigation both with and without spatial symbols like maps, pictures, and language (Dillon & Spelke, 2015, 2017; Hermer & Spelke, 1996; Learmonth, Newcombe, & Huttenlocher, 2001). For example, to determine their position in space during navigation, both humans and other animals use layout information automatically but must attend to and learn to use the positions of objects and landmarks (Cheng & Newcombe, 2005; Doeller & Burgess, 2008; Doeller, King, & Burgess, 2008; Hermer & Spelke, 1996, 1994; Lee, Sovrano, & Spelke, 2012).

During symbol-guided navigation using maps and pictures, moreover, young children show an early preference for object information. For example, Dillon and Spelke (2017) found that when using line drawings as maps to find target locations in a room, 4-year-old children consistently judged drawings depicting just the room's objects as more informative, even when children's own search behavior was more accurate with drawings depicting just the room's walls.

Children's drawing production (Machón, 2013; Piaget & Inhelder, 1967) shows the same prioritization of object information as their drawing interpretation. For example, Dillon (2021) found that when 4-year-children were asked to draw exactly what they saw when either sitting in a large "fort," with three rectangular walls and three rectangular objects, or sitting in front of a small "toy" version of the fort, children in the fort condition tended to include the fort's objects but omit its walls. Children in the toy condition, in contrast, drew the object parts that corresponded to both the fort's objects as well as its walls. One possible explanation for children's prioritization of objects over layouts in their production of spatial symbols like drawings is that, as communicative tools, drawings may prioritize those elements in the navigable environment, like objects, that we explicitly attend to.

To explore this possibility in the present study, we introduced a specific communicative goal to a symbolic production task to implicitly draw children's attention to different spatial elements in the navigable environment. We asked 4-year-old children to use drawings to communicate the location of targets in a room to another person. These targets were either near walls in the room, directing children's attention to layout information, or near objects in the room, directing children's attention to object information. To examine whether the inclusion of layout and object information was specific to drawing, we also compared children's drawing production to another group of children's production in a different symbolic medium: language. If attention modulates children's symbolic communication about layouts and objects, then children should both draw and talk about layouts and objects when they are relevant to the communicative task. If there are challenges or advantages specific to either medium, then children might treat layouts and objects differently when drawing versus describing them.

Methods

The methods and analysis plan were preregistered on the Open Science Framework prior to data collection (https://osf.io/6784t/).

Participants

Twenty-three typically developing, English-speaking 4-year-old children (11 females; M_{age} = 4 years 5 months; *range*: 4 years 0 months to 4 years 10 months), N = 13 in the drawing condition and N = 10 in the language condition, participated in the study. An additional 8 children participated but were excluded based on the preregistered exclusion criteria: for not completing the task (3); for not following directions (4); and for experimenter error (1). Included children contributed data from at least four of their six trials.

We had preregistered a sample size of 80 children, but we were forced to stop data collection before this sample size was met because of the COVID-19 pandemic's suspension of in-person research. The planned sample size was chosen to maximize our power to detect interactions among our variables and differences in corrected pairwise contrasts. Our failing to meet this planned sample size may thus limit our ability to detect some differences.

Participants were recruited from a large database of families who had expressed interest in participating in research studies at our university. All participants received a small thank-you gift as well as up to $20 travel reimbursement upon request. The use of human participants for this study was approved by the Institutional Review Board on the Use of Human Subjects at our university.

Design

The study took place in a 9' x 12' gray "fort" composed of three walls and three objects set inside a perfectly cylindrical room (see Figure 1). Six black disks on the floor indicated the six possible target locations. For each trial, one of those disks had a glittery gold bottom (the "golden spot"), which specified it as the target for that trial. The location of the target across the six trials was semi-random across children such that each location was the target approximately the same number of times in each of the six ordinal positions.

Participants were randomly assigned to either the drawing or language condition in which they were asked to draw or describe the location of the target for each trial for a research assistant who would use that drawing or description to find the target. For each drawing or description, we enumerated the total number of spatial elements drawn or described as our primary outcome variable. We also evaluated the research assistant's search behavior using the drawings or descriptions.

Procedure

For each of six trials, the children were told that they were playing a game with their team member, an adult research assistant whom they met and got to know in the waiting room prior to the start of the study. The children's goal was to draw or describe where the golden spot was so that the research assistant could find it using only what they drew or described. To start the study, the children entered the fort and sat down in front of the closed door with one experimenter and one coder while the research assistant stayed outside in a different room. The children completed two practice trials in which they drew or described the location of a golden spot on a picture. That picture also had four differently sized and oriented gray triangles. The experimenter first directed the children's attention to each of the four triangles by pointing and saying, "Here's something!" and then the experimenter indicated where the golden spot was. The experimenter instructed the children to draw or describe whichever of the clues they pointed to that would help the research assistant best find the golden spot using only their drawing or description. After the children completed each practice drawing or description, the research assistant entered the fort and took their best guess as to the location of the golden spot in the picture as the children watched.

After these two practice trials, the children were told that they were now going to make drawings or descriptions that would show the research assistant where to search for the golden spot in the fort itself. The experimenter first directed the children's attention to the three walls and three objects that composed the fort. The experimenter pointed to each element, saying, "Here's something!" Then, the experimenter asked the children to point to each element. Next, the experimenter showed the children where the golden spot was by flipping over one of the black disks to reveal its glittery gold bottom. The experimenter flipped the disk back over so that only its black side was visible. Finally, the experimenter reminded the children that they should give the best clues they could in their drawings or descriptions to help the research assistant, their teammate, find the golden spot.

The children's responses were coded in real time using an iPad by the coder present in the room (see **Coding** below). When the children completed a drawing or description, they were asked to reveal the golden spot to show that they remembered where it was. The children rarely erred, but if they did, the experimenter showed them the golden spot again and started the trial over. After each drawing or description, the children were asked to identify the referents of all of the shapes in their drawings or of all of the nouns in their descriptions by touching those elements in the room when the experimenter pointed to each shape or repeated each noun. Each element the children drew or described counted as one instance. After each trial, the children left the room, and the research assistant used the children's drawing or description to search for the golden spot. The children did not watch where the research assistant searched. The script (https://osf.io/5dhvg/) provides additional details.

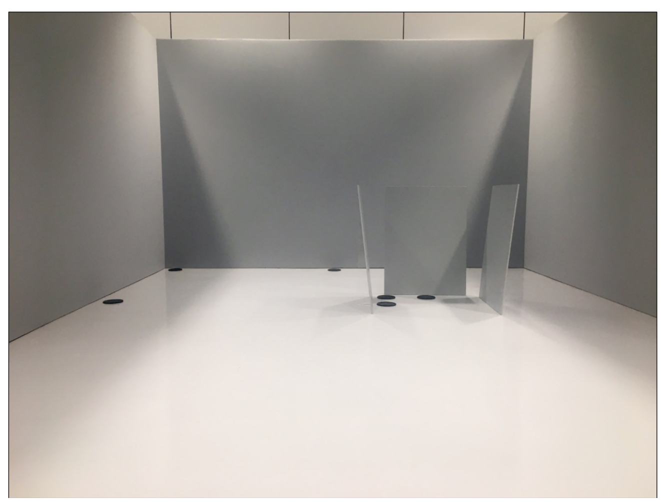

Figure 1: Photograph of the fort with the six possible target locations (black disks) taken from the perspective of a child.

Coding

Online coding. On every trial, the coder, who was in the room for the duration of the experiment, used an iPad to take a photograph of the children's drawing when it was completed or record and transcribe the children's description as it transpired. In the drawing condition, the children were asked to point to each separate thing they drew and in the language condition, they were read aloud their description, with an emphasis put on each noun. The children were then asked to stand up, and the experimenter pointed to or reapeated aloud each element, asking the children to go touch it. The coder recorded what element the children touched. This process continued until all of the identified elements were labeled. The full coding specifications are provided in the study script and preregistration (https://osf.io/6784t/).

Search Accuracy Coding. After each trial, the children left the room, and the research assistant entered the room. The coder either showed the children's drawing or read the children's description to the research assistant and identified for the research assistant each separate element by touching it in the fort. The research assistant then guessed the target location by touching one disk. The coder recorded the research assistant's response and gave no feedback. The script (https://osf.io/5dhvg/) provides additional details.

Results

Preregistered Analyses

The analyses were conducted with the online-coding data only. First, we evaluated which spatial elements children drew and described using a mixed-model Poisson regression with condition (drawing, language), element (wall, object), and target (near a wall, near an object) as fixed effects and participant as a random-effects intercept. We found no main effect of condition (Wald Test, $\chi^2[1] = 1.24$, $p = .265$), but significant main effects of element (Wald Test, $\chi^2[1] = 5.94$, $p = .015$), with more objects included than walls, and of target (Wald Test, $\chi^2[1] = 9.47$, $p = .002$), with more elements included for targets near objects versus walls. These effects were further characterized by a condition * element interaction (Wald Test, $\chi^2[1] = 11.25$, $p < .001$), with more objects than walls included in the drawing versus language condition, and an element * target interaction (Wald Test, $\chi^2[1] = 10.28$, $p = .001$), with more walls included for the targets near walls and more objects included for the targets near objects. Strikingly, we also found a condition * element * target interaction (Wald Test, $\chi^2[1] = 14.25$, $p < .001$), suggesting that children modulated their inclusion of wall or object information based on target location more in the language versus drawing condition (Figures 2 & 3).

We also conducted planned contrasts across condition, element, and target, corrected by Holm's method, although these contrasts may not have had the power to detect pairwise differences given the incomplete sample size. In the drawing condition, children did not draw more walls for wall versus object targets ($p = 1$), but they did draw more objects for object versus wall targets ($p = .037$). In addition, children did not draw more objects than walls for object targets ($p = .222$) or more walls than objects for wall targets ($p = .478$). In the language condition, in contrast, children described more walls for wall versus object targets ($p < .001$) and more objects for object versus wall targets ($p = .002$). In addition, children described more objects than walls for object targets ($p < .001$) and more walls than objects for wall targets ($p = .012$). Finally, there was no differential treatment of walls for wall targets across the drawing and language conditions ($p = 1$) and no differential treatment of objects for object targets across the drawing and language conditions ($p = 1$). These contrasts nevertheless provide additional evidence that children modulated their inclusion of wall or object information based on target location more in the language versus drawing condition.

We next evaluated the research assistants' search accuracy. A binominal mixed-model logistic regression with participant as a random-effect intercept revealed that the research assistant's search accuracy was above chance in both conditions ($M_{\text{accuracy, drawing}} = 0.42$, $M_{\text{accuracy, language}} = 0.61$, *chance* = 0.17, *p*s < .001). A second binominal mixed-model logistic regression on search accuracy with condition (drawing, language) and target (near a wall, near an object) as fixed effects and participant as a random-effects intercept revealed no main effect of condition (Wald Test, $\chi^2[1] = 0.84$, $p = .359$), despite the large numerical difference in search accuracy favoring the language condition. This analysis did reveal a significant main effect of target (Wald Test, $\chi^2[1] = 6.78$, $p = .009$), with searches for targets by walls more accurate than searches for targets by objects. There was no significant condition * target interaction (Wald Test, $\chi^2[1] = 0.65$, $p = .419$). Holm-corrected planned contrasts revealed a significant difference in search accuracy at wall versus object targets in both the drawing ($p = .037$) and language conditions ($p = .015$) and no significant difference in search accuracy at wall targets ($p = .229$) or object targets ($p = .587$) between conditions.

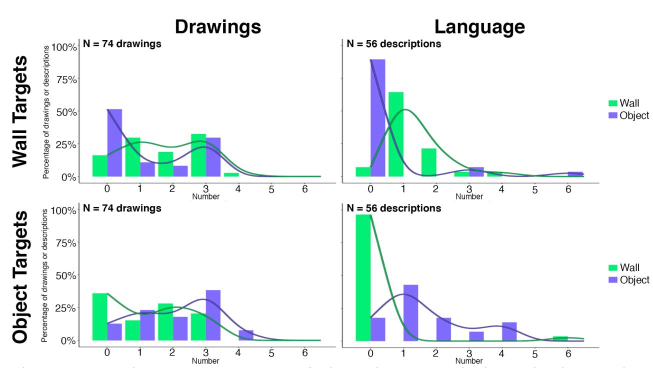

Figure 2: The percentage of drawings and descriptions that include a given number of wall or object elements for wall and object targets.

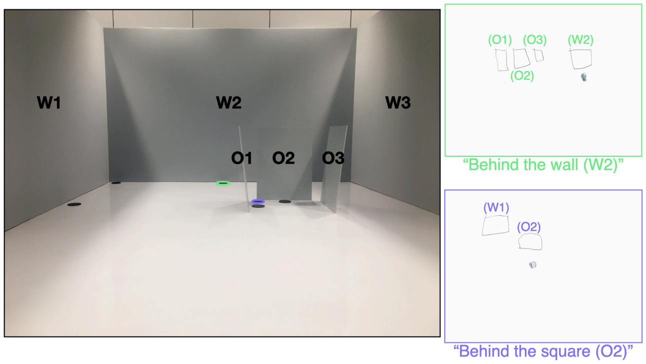

Figure 3: Example drawings and descriptions of a wall (green) and object (purple) target by one child in each condition. Children in the language condition tended to include the one or two most relevant elements to the target location and children in the drawing condition tended to be less concise in their inclusion if the relevant elements.

Discussion

Previous work on young children's drawing production revealed their tendency to include objects and omit layouts when depicting navigable spaces (Dillon, 2021). In the present study, we investigated whether introducing a communicative goal to a similar drawing task and contrasting drawings with language could help reveal why children tend to draw objects but not layouts.

First, consistent with these results as well as decades of findings suggesting that infants and children are biased to attend to and learn about objects more generally (Booth & Waxman, 2002; Feigenson & Carey, 2005; Feigenson, Carey & Hauser, 2002; Gershkoff-Stowe & Smith, 2004; Landau, Smith, & Jones, 1988; Machón, 2013; Piaget & Inhelder, 1967; Waxman & Markow, 1995), we found that overall children drew and described more object information than layout information and they produced more elements when drawing or describing targets by objects than those by walls. Children's object bias may therefore carry through to their early symbolic productions across mediums.

Strikingly, however, we also found that children drew and described both layout and object information when that information was relevant to their communicative goal. If a target location was close to an object, children drew and described more objects, but if it was close to a wall, children drew and described more walls. This flexibility, moreover, was more pronounced in language versus drawings. While no previous work to our knowledge has directly compared the communicative efficiency of language versus drawings, previous cross-linguistic research suggests that language is shaped by pressures of efficient communication (Rubio-Fernandez & Jara-Ettinger, 2020; Rubio-Fernandez, Mollica, & Jara-Ettinger, 2020). Future research may thus directly compare both adults' and children's drawings and descriptions of navigable environments given either communicative or descriptive goals.

Overall, our findings suggest that attention may affect what children include in symbolic communication, like drawings and language. As communicative tools, drawings and language more generally may prioritize those elements in the navigable environment that naturally elicit our explicit attention. Future studies may investigate how attention not only to layouts and objects but also to other agents and social partners in our environment may contribute to our uniquely human symbolic expressions.

Acknowledgements

This work was supported by a National Science Foundation CAREER Award (DRL-1845924 to M.R.D.). Thanks to P. Chan, A. Bachrach, and I. Cekici for assistance with data collection and coding and E. Mitnick and S. Yasuda for assistance with data analysis.

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