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Complex Spatial Language Improves from 3 to 5 Years: The Role of Prompting and Overhearing in Facilitating Direction Giving Using *Between* and *Middle*

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Abstract

The primary goal of this study was to specify age-related improvements in young children's use of the complex spatial terms *between* and *middle* in response to prompting and overhearing supports. Three- to 5-year-old children described the location of a mouse hidden between two furniture items in a dollhouse. Three prompting conditions (Between Directive, Middle Directive, Nondirective) were compared with two overhearing conditions (Overhearing Between, Overhearing Middle). Children's use of *between* and *middle* was much more frequent in response to directive prompting than in response to nondirective prompting or overhearing. Only 4-5-year-old children showed some evidence of using *middle* in response to nondirective prompting and overhearing, demonstrating developmental gains in sensitivity to subtle cues. The secondary goal was to assess young children's production and comprehension of *between* and *middle* using tasks suitable for young children and parent report checklists. As expected, children's spatial language showed strong developmental improvement and was related to direction-giving performance.

Keywords: spatial language, between, middle, scaffolding, overhearing

Complex Spatial Language Improves from 3 to 5 Years: The Role of Prompting and Overhearing in Facilitating Direction Giving Using *Between* and *Middle*

Understanding and communicating about locations is important for children and adults. Young children often give and follow directions to find coats, shoes, and favorite toys. Spatial precision is important in facilitating clear understanding and efficient searches. For example, it is important to determine whether the toy is on the table, under the table, next to the table, or between the table and the chair. Decades of research findings have documented young children's expanding mastery of simple spatial concepts, such as in, on, and under (e.g., Clark, 1973; Dromi, 1978; Jackendoff & Landau, 1991; Johnston & Slobin, 1979). More recently, researchers have begun to focus on more complex concepts, such as nearby, middle, and between (e.g., Foster & Hund, 2012; Hund & Plumert, 2007; Plumert & Hawkins, 2001, Plumert et al., 2012; see also Johnston & Slobin, 1979); however, we still know relatively little about how children understand and use these complex spatial concepts. As such, the primary goal of this study was to specify age-related improvements in young children's use of the complex spatial terms *between* and *middle* in a challenging direction-giving task based on prompting and overhearing supports. The secondary goal was to assess young children's production and comprehension of these spatial terms using tasks suitable for young children and parent report checklists and to link these findings to direction-giving performance. Exploring *between* and *middle* in the same research study was important for comparative purposes given the dearth of research regarding these spatial concepts.

Between is complex for a number of reasons. First, it requires comparison with two reference points (e.g., the cup is between the plates), making it more difficult conceptually than

spatial terms requiring comparison with only one reference point (e.g., the cup is by the plate). In addition, *between* requires complex syntactic constructions (in English) and is infrequent in language corpora (Durkin, 1981, 1983; Weist, Lyytinen, Wysocka, & Atanassova, 1997). As such, it is not surprising that children's comprehension and production of *between* becomes more precise throughout early childhood (Durkin, 1981, 1983; Internicola & Weist, 2003; Johnston & Slobin, 1979; Messick, 1988; Washington & Naremore, 1978; Weist & Lyytinen, 1991; Weist et al., 1997; Weist, Atanassova, Wysocka, & Pawlak, 1999; Weist, Lymburner, Piortowski, & Stoddard, 2000). For instance, Weist et al. (2000) noted that conceptualization of *between* is evident by 4 years 7 months, which is considerably later than simpler spatial concepts. Like *between*, *middle* also is complex. *Middle* requires comparison with (at least) two reference points, making it relatively difficult conceptually. *Middle* also may refer to the center of a region. In precise usage, *middle* may require detailed information about distance, rendering *middle* equidistant from reference points or boundaries. In English, *middle* adheres to complex syntactic constraints, often involving multiple prepositions (e.g., in the *middle of* the trees), and these constraints differ across reference frames. These conceptual and syntactic aspects may pose difficulties for young children.

Previous research investigating when young children understand and produce the spatial terms *between* and *middle* is sparse. In one early study, 3- to 6-year-old children were shown three sets of picture cards. For example, a bird, rabbit, and fish were alternated so that in each picture, each animal had a different position in a straight line. Children were asked to point to the card depicting the scene that the experimenter explained, such as "Which card shows the rabbit *between* the bird and the fish?" Two-thirds of the 3- and 4-year-olds were able to correctly

identify the picture card depicting the appropriate configuration. Five-year-olds were able to correctly identify more pictures than both the 3- and 4-year-olds, and 6-year-olds chose only correct pictures (Durkin, 1983). In another test of comprehension, 3- to 7-year-old children were asked to put a blue brick between two green bricks. Only 25% of 3- to 5-year-old children were successful, whereas 65% of 6- to 7-year-old children were successful, revealing dramatic improvement across childhood (Durkin, 1981). It is interesting to note differences across tasks, suggesting that comprehension across diverse contexts differs from first usage in highly supportive contexts. Overall, these findings reveal improvements in the conceptualization and utilization of *between* in early childhood, particularly between 3 and 5 years (see also Internicola & Weist, 2003; Johnston & Slobin, 1979; Messick, 1988; Washington & Naremore, 1978; Weist & Lyytinen, 1991; Weist et al., 1997, 1999, 2000).

Research findings documenting children's acquisition of the spatial term *middle* are very limited. *Middle* is not included in comprehensive discussions of spatial language acquisition (e.g., Clark, 1973; Johnston & Slobin, 1979; Logan & Sadler, 1996). In one study, Loewenstein and Gentner (2005) tested comprehension by asking young children to point to the spatial position described, probing several spatial terms such as *on*, *in*, *under*, *top*, *middle*, and *bottom*. Their findings revealed that by 3 years 8 months, children were correct on 84% of trials when asked to point to the middle shelf. Another recent study by Simms and Gentner (2008) indicates that some 3- to 5-year-old children understand and produce the spatial terms *middle* and *between*, and that these language skills closely parallel children's search abilities. Although detailed findings from the language production and comprehension tasks were not provided in their brief report, children's spontaneous production of *middle* and *between* during their search task

increased from 3 to 4 and 5 years, consistent with general trends regarding spatial language acquisition (Simms & Gentner, 2008). Similarly, Ankowski, Thom, Sandhofer, and Blaisdell (2012) investigated the interplay of spatial language and search strategies among 2- to 6-year-old children. Although children's searches did not differ as a function of language input, this study documented profound improvement in young children's grasp of the relational concept *middle*. Parents reported that 40% of 2-year-olds, 89% of 3-year-olds, and 100% of 4- to 6-year-olds understood and produced the word *middle*.

What factors facilitate young children's emerging understanding and usage of complex spatial language? There is no doubt that children's conceptual understanding is linked with language development, and that concepts and language grow in scope and complexity across infancy and early childhood. Moreover, there is little doubt that contextual supports, social interactions, and cultural beliefs shape emerging language proficiency. Focusing on child factors points out the central notion that children's competence is important for linguistic development. In contrast, focusing on sociocultural factors shifts the emphasis to children's performance evident in interactions with others, which varies over contexts and with experience. In particular, adopting a sociocultural perspective leads to a focus on the zone of proximal development, which represents the set of activities a child cannot accomplish on his or her own but can complete with support from someone with more expertise (Vygotsky, 1978). Support can take many forms, including scaffolding and overhearing, which are the supports we tested in this study. Scaffolding is the process by which adults provide supportive strategies to children by guiding parts of the interaction that are too complex for children to complete individually, adjusting support as needed to match children's zone of proximal development (Wood, Bruner,

& Ross, 1976). We know that scaffolding supports children's ability to solve everyday problems such as building with blocks (Gregory, Kim, & Whiren, 2003), solving math problems (Stevenson & Baker, 1987), and understanding science concepts (Fender & Crowley, 2007).

Scaffolding also supports young children's spatial language. For example, Plumert and Nichols-Whitehead (1996) found that parents adjusted the amount of support they provided to their 3- and 4-year-old children to help them provide complete descriptions of objects hidden in, on, or nearby furniture items in a dollhouse. In particular, they provided more directive support for 3-year-olds, especially early in the session, providing specific spatial language options. Results from a second study showed that initially 3-year-olds had difficulty using nondirective prompts—which pointed out ambiguity but did not offer potential solutions—but their performance improved throughout the session to become indistinguishable from 4-year-olds, demonstrating the importance of appropriate supports. Foster and Hund (2012) extended this line of research by examining how parents and their 4- and 5-year-old children use more complex spatial language in a similar direction-giving task. They found that parents provided more directive support early in the direction-giving session. Moreover, children who received directive prompts that included the spatial terms *between* or *middle* incorporated these specific spatial terms into their directions much more often than did children who received nondirective prompts or no prompts. These findings indicate that directive prompting using complex spatial language is a powerful cue for 4- and 5-year-old children; however, developmental sensitivity to such prompting support has not been tested with younger children. Given that previous research findings demonstrate emerging understanding and usage of *between* and *middle* by 3 years, it is important to test the extent to which 3-year-old children benefit from adult scaffolding support.

Moreover, it is important to include *between* and *middle* in the same study to provide a more complete understanding of these complex spatial terms.

We know that overhearing also facilitates children's language acquisition. For example, toddlers can learn object labels, facts, and verbs via overhearing adult conversations (Akhtar, Jipson, & Callanan, 2001; Floor & Akhtar, 2006; Gampe, Liebal, & Tomasello, 2012; Martínez-Sussmann, Akhtar, Diesendruck, & Markson, 2011), even in the face of distraction (Akhtar, 2005, see Akhtar, 2014 for a recent summary). Overhearing also facilitates understanding of complex aspects of language that can pose difficulties for young children. For example, personal pronouns such as *you* and *me* are difficult for young children to understand and to use correctly in conversations, likely due to the contextual nature of deictic relations. We know that young children benefit from overhearing personal pronouns (Oshima-Takane, 1988; Oshima-Takane, Goodz, & Derevensky, 1996). Similarly, complex spatial language can be difficult for young children to master, likely due, at least in part, to incomplete usage of spatial reference frames. Interestingly, Foster and Hund (2012) showed that overhearing can facilitate complex spatial language for 4- and 5-year-old children. That is, children who overheard adult conversations containing the terms *between* or *middle* evinced some evidence of using these terms when giving directions, but not nearly as frequently as when they received directive prompting. These findings suggest that overhearing is subtler than directive prompting, leaving open the question of whether younger children would benefit from overhearing complex spatial language. Again, including *between* and *middle* is important to provide a more complete understanding of the development of complex spatial language during the preschool years.

The Present Study

The primary goal of this study was to specify age-related improvements in 3- to 5-year-old children's use of the complex spatial terms *between* and *middle* in a direction-giving task based on prompting and overhearing supports. Children described the location of a mouse hidden between two furniture items in a dollhouse, and their usage of *between* and *middle* were coded. Three prompting conditions (Between Directive, Middle Directive, Nondirective) were compared with two overhearing conditions (Overhearing Between, Overhearing Middle). We expected that 4- and 5-year-old children would benefit greatly from directive prompting using *between* and *middle*, replicating the pattern of findings from Foster and Hund (2012). We also expected some benefit of nondirective prompting and overhearing for 4- and 5-year-old children, though we predicted that the magnitude would be much less pronounced than directive prompting, again replicating the pattern of findings from Foster and Hund (2012).

Importantly, this study is the first to test developmental changes in complex spatial language that result from prompting and overhearing supports starting at 3 years of age. Three years is a time of rapid growth in complex spatial language, so it is a critical time period for investigation. We expected that 3-year-olds would benefit from directive prompting containing *between* and *middle*, though less strongly than would older children given their limited understanding of these complex spatial terms. In contrast, we did not expect that 3-year-old children would benefit from nondirective prompting or overhearing, given the demanding nature of the spatial language context coupled with quite subtle supports. These findings would provide important details about the ways in which scaffolding and overhearing contexts facilitate spatial language during the preschool years.

The secondary goal of this study was to assess young children's production and comprehension of the complex spatial terms *between* and *middle* using tasks suitable for young children and parent report checklists. Inclusion of new measures of spatial language comprehension and production that included both *between* and *middle* was important because further specificity is needed with regard to the developmental trajectories of spatial language acquisition during early childhood. We predicted that our measures would reveal strong developmental improvement in children's understanding and usage of *between* and *middle* from 3 to 5 years. Moreover, we expected that the spatial language measures would be correlated across informants and types of tasks. Although we predicted similar patterns of findings for both spatial terms (i.e., *between* and *middle*), documenting their developmental trajectories in one study was important given the dearth of research related to these complex spatial terms. Similarly, it was important to document developmental trajectories for girls and boys.

Method

Participants

Seventy-eight 3-year-old children (*M* = 3 years 7 months, range = 3 years 0 months to 3 years 11 months; 34 girls, 44 boys) and 100 four- to five-year-old children (*M* = 4 years 9 months, range = 4 years 0 months to 5 years 7 months; 46 girls, 54 boys; 72 4-year-olds, 28 5-year-olds) participated.[1] One hundred two parents completed parent ratings of child language and family demographics, representing 57% of the total sample who returned these forms in person or via the mail.[2] Eighty-seven children identified as White non-Hispanic (85%), 7 identified as Asian (7%), four identified as Hispanic/Latino (4%), and four identified as Other (4%). Six parents had completed high school or GED (6%), four parents had completed an associate's

degree (4%), 46 had completed an undergraduate degree (45%), and 46 had completed a graduate degree (45%). Data from 23 additional children were omitted from analyses due to equipment problems (n = 1), prompting errors by experimenters (n = 15), difficulty understanding the tasks (n = 4), and incomplete sessions (n = 3). Participants were recruited via local preschools and childcare centers and via a department child participant database. Children received a small gift. Children in each age group were randomly assigned to one of five conditions (described below): Between Directive (n = 45, 20 3-year-olds, 16 4-year-olds, and 9 5-year-olds), Middle Directive (n = 36, 15 3-year-olds, 13 4-year-olds, and 8 5-year-olds), Nondirective (n = 32, 14 3-year-olds, 16 4-year-olds, and 2 5-year-olds), Overhearing Between (n = 34, 16 3-year-olds, 15 4-year-olds, and 3 5-year-olds), or Overhearing Middle (n = 31, 13 3-year-olds, 12 4-year-olds, and 6 5-year-olds).

Apparatus and Materials

Direction-giving task. The experimental space was a one-room dollhouse with a clear Plexiglas cover. The cover was used to ensure children did not point to or retrieve the hidden object before giving directions. The dollhouse was decorated to look like a living room, and it contained four pairs of identical furniture items: two chairs, two tables, two couches, and two floor lamps. Four pairs of identical small objects served as hiding locations: two pillows, two paper bags, two towels, and two baskets. A miniature mouse served as the hidden object, and two small dolls were used to elicit directions. Boys gave directions to the boy doll, and girls gave directions to the girl doll (see Figure 1, for a complete description, see Foster & Hund, 2012).

Child language production task. The booklet included 15 laminated pages containing simple pictures. There were three practice pictures (a cup on a table, a ball by a chair, a dog

between two trees) followed by 12 test pictures. Test pictures included a yellow smiley face (1 inch diameter) and two blue squares (2 x 2 inches each, spaced 2 inches apart, adapted from Dessalegn & Landau, 2008). The placement of the face relative to the squares varied across pictures. The face was placed on top of the left square twice, on top of the right square twice, on the outside edge of the left square twice, on the outside edge of the right square twice, and in between the squares four times. As such, the spatial terms *on, by,* and *between* (or equivalents) could be used to describe four trials each. The pictures were presented in one of two random orders, counterbalanced across participants, using this basic prompt, "This face is where?" Please see the Procedure section for more details about the prompts.

Child language comprehension task. The booklet included 13 laminated pages with simple pictures. There was one practice picture (a door) and 12 test pictures (two 2 x 2 inch blue squares spaced 2 inches apart, adapted from Dessalegn & Landau, 2008). Children used dry erase markers to indicate their responses following a simple prompt: "Put an X ___ the squares." The descriptive spatial terms tested were under, above, next to, over, on the left of, on top of, by, in the middle of, between, below, on the right of, and on the bottom of, presented in one of two random orders.

Design and Procedure

This research study was approved by the university Institutional Review Board and each childcare center or preschool. Parents first provided written permission for their children's participation and consent for their own participation. Then children provided verbal assent. Each child was tested individually in a quiet room. A digital camcorder was used to record

interactions. Parents were asked to complete the language checklist and demographic form and return them to the researcher in person or via the mail.

Direction-giving task. The dollhouse was placed on a low table, and children were seated directly in front of it. The experimenter sat to the children's right. The pairings of small objects and furniture items were randomized across participants. In all cases, one small object was placed between identical furniture items, while the other small object was placed by one of the furniture items (i.e., one basket was between the couches and one basket was by a couch). Four hiding locations were used during the session—always the "between" location. These hiding locations were presented in random orders during the first four and last four trials with the constraint that the fourth and fifth trial could not be identical. Comparison across the two trial blocks facilitated analysis of changes in child language over time.

Children were told they would be playing a hiding and finding game in which they would hide a mouse in the dollhouse while the doll was not looking and then give directions so the doll could find the mouse. Children were familiarized with all the objects in the dollhouse by asking the children to name each item. The experimenter pointed to the objects in a random order and ensured that children saw all identical pairs of objects. The experimenter helped children if they had trouble naming an item, and that item was noted again to make sure children remembered it.

At the beginning of each trial, the doll was placed behind the dollhouse so that he/she did not "see" where the children and experimenter hid the mouse. Then, the mouse was hidden in a small object (e.g., a bag) directly between two furniture items (e.g., chairs). An additional identical object (e.g., another bag) was located by one of the furniture items (e.g., chair). After the mouse was hidden, the doll came out from behind the dollhouse, and children were instructed

to tell the doll exactly where the mouse was hiding without pointing to its location (i.e., "Can you tell the doll where the mouse is hiding?"). Children were reminded not to point if they had difficulty abiding by this instruction, and the experimenter/doll used only the children's language and ignored pointing when locating the hidden mouse. Following children's initial verbal response, the experimenter provided prompting that varied depending on the three prompting conditions (see below for details), and children were allowed to provide one set of additional verbal information in response. Children in the overhearing conditions received no prompting but rather overheard two conversations (see below for details).

In the Between Directive condition, children received directive prompts containing the term *between* when more spatial information was needed based on their original response. For example, if children told the doll that the mouse was in the basket, the doll responded, "I see two baskets. Is the mouse in the basket *between* the couches or in the basket *by* the couch?" In the Middle Directive condition, children received directive prompts containing the term *middle* when more spatial information was needed based on their original response. For example, if children told the doll that the mouse was under the towel, the doll responded, "I see two towels. Is the mouse under the towel in the *middle* of the tables or under the towel *by* the table?" In the Nondirective condition, children received less specific prompting when more spatial information was needed based on their original response. For example, if children told the doll that the mouse was in the bag, the doll responded, "I see two bags. Can you tell the doll anything more?"

In the Overhearing Between condition, the two adult experimenters engaged in two brief conversations (following familiarization and following the fourth trial) describing the dollhouse set up to one another so that children overheard their conversations before the first and fifth

trials. Children overheard the spatial term *between* eight times throughout these conversations. That is, the secondary experimenter said, "Oh, ___ [primary experimenter's name], do you have the dollhouse set up for today's game? Remember that one __ is between the couches and the other ___ is by the couch. One ___ is between the tables and the other ___ is by the table. One ___ is between the chairs and the other ___ is by the chair. One ___ is between the lamps and the other ___ is by the lamp." The primary experimenter responded, "Yes, the dollhouse is set up just right." before telling the child that they were ready to play the game. A similar exchange was repeated following Trial 4. The Overhearing Middle condition was identical except that it included eight instances of *middle* in the adult conversations. No prompting was used in the overhearing conditions.

In all trials where children did not provide enough information for the doll to find the mouse, the doll walked to the incorrect small object and simply stated that there was no mouse there and that they would try again. In all trials where children provided enough information for the doll to find the mouse, the doll walked to the correct small object and retrieved the mouse.

Child language production task. Following the direction-giving task, children were asked to produce spatial language by looking at the pictures in the booklet one at a time and answering simple questions about where things were located. When looking at the first practice picture, children were asked, "See this cup? This cup is where?" This general procedure was repeated for each practice picture depicting familiar objects in increasingly complex spatial arrangements to ensure that children understood the task and to support their language production. Many children produced at least some spatial language during these practice trials. During the test phase, children were shown a series of pictures of two squares with a smiley face and were asked to

describe the location of the smiley face relative to the squares. For the first test trial, children were asked, "See this face? See these squares? This face is where to the squares?" For each additional test trial, they were asked, "This face is where?" Trials were presented in one of two random orders (see *Apparatus and Materials* for details). This task was adapted from one used by Dessalegn and Landau (2008).

Child language comprehension task. Following the language production task, children were asked to make marks on pictures after listening to directions one at a time. For the practice trial, children were asked to put an X on the door. Again, a familiar object and a relatively simple spatial term were used to help ensure that children understood the task and could make appropriate markings. All children were able to draw a suitable marking on the door, demonstrating adequate understanding and motor control. Directions for the test trials were given as, "Put an X ___ the squares." The descriptive spatial terms used for placement included under, above, next to, over, on the left of, on top of, by, in the middle of, between, below, on the right of, and on the bottom of, presented in one of two random orders (see *Apparatus and Materials* for details). All children completed the direction-giving task first, the language production task second, and the language comprehension task last.

Coding and Measures

Direction-giving task. Sessions were transcribed verbatim from video recordings. Children's use of *between*, *middle*, and other spatial language (i.e., disambiguating spatial terms other than *between* or *middle*, such as *by, left, right,* or *front*) before and after prompting was coded for each trial and converted to proportion scores for each trial block (Foster & Hund, 2012). Although inclusion of more than one spatial term in a single trial was very rare, all

instances were coded. Inter-coder reliability was calculated by having two coders independently assess 36 randomly selected transcripts (20% of sample). Intraclass correlations for coding of children's use of *between*, *middle*, and other spatial language were 1.0, .98, and .88, respectively.

Although memory for hiding locations was not assessed in this study, anecdotal evidence suggests that children very rarely forgot the hiding location. They almost always provided details about the small object in/under which the mouse was hiding, indicating they remembered important information about the hiding location. Moreover, they often attempted to direct the doll toward the correct location at the conclusion of the trial, especially in cases where the doll went to the incorrect location following incomplete or incorrect spatial descriptions from the child. These details lead us to believe that children frequently had difficulty explaining the spatial details of the hiding locations with reference to other items (e.g., *between* the couches), rather than forgetting the locations per se.

Child language production task. The proportion of correct verbal responses to the four between trials was used in our analyses. Two researchers independently coded responses from 33 children (19% of sample) for reliability purposes. The intraclass correlation was 1.0.

Child language comprehension task. The proportion of correct markings on the between and middle trials was used in our analyses. Two researchers independently coded responses from 33 children (19% of sample) for reliability purposes. The intraclass correlation was 1.0.

Parent report checklist. Parents were asked to indicate which spatial terms their children produced and understood using a list containing 14 prepositions (above, below, top, bottom, over, under, next to, by, right, left, between, middle, in, and on). The proportion of between and middle indications was used in our analyses.

Results

The primary goal was to determine the effectiveness of prompting and overhearing in eliciting *between* and *middle* from young children in our direction-giving task. First, the proportion of trials in which children used the spatial term *between* was entered into an Age (3 years, 4-5 years) x Gender (boys, girls) x Condition (Between Directive, Middle Directive, Nondirective, Overhearing Between, Overhearing Middle) x Trial Block (1, 2) mixed model ANOVA with the first three factors as a between-subjects variables and the fourth as a within-subjects variable.[3] This analysis yielded a significant main effect of condition, F (4, 158) = 48.37, $p < .001$, $\eta_p^2 = .55$, and a significant main effect of age, F (1, 158) = 7.45, $p < .01$, $\eta_p^2 = .05$. These main effects were subsumed by a significant Age x Condition interaction, F (4, 158) = 5.12, $p < .01$, $\eta_p^2 = .12$ (see Figure 2). Simple effects tests revealed a significant main effect of condition for 3-year-olds, F (4, 73) = 8.94, $p < .001$, $\eta_p^2 = .33$, and for 4-5-year-olds, F (4, 95) = 54.30, $p < .001$, $\eta_p^2 = .70$. Although the magnitude of difference across conditions was stronger for the older children, Least Significant Difference (LSD) follow-up tests revealed that children in both age groups used the spatial term *between* in a much higher proportion of trials when provided with between directive prompts than when provided with nondirective prompts, as well as when provided with middle directive prompts, overhearing between conversations, or overhearing middle conversations.[4] These findings indicate that children as young as 3 years incorporated *between* in their directions when prompted using this term, though the magnitude of responsiveness increased from 3 to 4-5 years. The analysis also revealed a significant main effect of trial block, F (1, 158) = 11.23, $p < .01$, $\eta_p^2 = .07$. Children used *between* more frequently in

the second trial block (M = .20, SE = .02) than in the first trial block (M = .14, SE = .02), indicating that task experience was beneficial in this challenging direction-giving situation.

Next, to determine how children used the term *middle* to describe locations, the proportion of trials in which children used the spatial term *middle* was entered into an Age (2) x Gender (2) x Condition (5) x Trial Block (2) mixed model ANOVA. This analysis yielded a significant main effect of condition, F (4, 158) = 58.00, $p < .001$, $\eta_p^2 = .60$, and a significant main effect of age, F (1, 158) = 20.70, $p < .001$, $\eta_p^2 = .12$. These main effects were subsumed by a significant Age x Condition interaction, F (4, 158) = 3.88, $p < .01$, $\eta_p^2 = .09$ (see Figure 3). Simple effects tests revealed a significant main effect of condition for 3-year-olds, F (4, 73) = 20.89, $p < .01$, $\eta_p^2 = .53$, and for 4-5-year-olds, F (4, 95) = 43.19, $p < .01$, $\eta_p^2 = .65$. LSD follow-up tests revealed that 3-year-olds used *middle* in a much higher proportion of trials when provided with middle directive prompts than when provided with nondirective prompts, as well as when provided with between directive prompts, overhearing between conversations, or overhearing middle conversations, indicating that they were able to incorporate *middle* in their directions when they were prompted using this term. LSD follow-up tests revealed that 4-5-year-olds used *middle* in a much higher proportion of trials when provided with middle directive prompts than when provided with nondirective prompts, as well as when provided with between directive prompts, overhearing between conversations, or overhearing middle conversations, indicating that they were able to incorporate *middle* in their directions when they were prompted using this term. In addition, 4-5-year-old children used *middle* more often when provided with nondirective prompts and when overhearing middle conversations than when overhearing between conversations, demonstrating some utility for less direct prompting and overhearing for older preschoolers.

These findings highlight important developmental changes in sensitivity to contextual supports for complex spatial language. The analysis also yielded a significant main effect of trial block, F (1, 158) = 8.41, $p < .01$, $\eta_p^2 = .05$, and a significant Trial Block x Gender interaction, F (5, 158) = 6.20, $p < .05$, $\eta_p^2 = .04$. Tests of simple effects indicated that children's use of *middle* increased significantly over trial blocks for girls, F (1, 79) = 12.15, $p < .01$, $\eta_p^2 = .13$ (Trial Block 1: $M = .20$, $SE = .04$; Trial Block 2: $M = .27$, $SE = .05$), but not for boys, F (1, 97) = .07, *ns* (Trial Block 1: $M = .19$, $SE = .03$; Trial Block 2: $M = .20$, $SE = .04$).

To determine how children used other spatial language to describe locations, the proportion of trials in which children used disambiguating spatial terms other than *between* or *middle* was entered into an Age (2) x Gender (2) x Condition (5) x Trial Block (2) mixed model ANOVA. This analysis yielded a significant main effect of condition, F (4, 158) = 3.52, $p < .01$, $\eta_p^2 = .08$, and a significant Age x Condition interaction, F (4, 158) = 2.60, $p < .05$, $\eta_p^2 = .06$ (see Figure 4). Simple effects tests revealed a significant main effect of condition for 3-year-olds, F (4, 73) = 2.92, $p < .05$, $\eta_p^2 = .14$, and a marginally significant effect for 4-5-year-olds, F (4, 95) = 2.43, $p = .053$, $\eta_p^2 = .09$. LSD follow-up tests revealed that 3-year-olds used other spatial language in a higher proportion of trials when provided with between directive or middle directive prompts than when overhearing between conversations or overhearing middle conversations. Responses to nondirective prompts did not differ from the other conditions. Inspection of individual transcripts revealed that the most common other spatial term used in response to directive prompting was *by*, indicating that 3-year-olds responded to a directive prompt such as, "I see two bags. Is it in the bag in the middle of the tables or in the bag by the

table?" by responding, "*by* the table," demonstrating their incomplete grasp of the complex terms *between* and *middle*. LSD follow-up tests revealed that 4-5-year-olds used other spatial language in a higher proportion of trials when provided with nondirective prompts than when provided with middle directive prompts, overhearing between conversations, or overhearing middle conversations. Responses to between directive prompts did not differ from the other conditions. Inspection of individual transcripts revealed a wide variety of spatial terms (e.g., *left, right, next to, front, back, first, second*) in the nondirective condition, suggesting that 4-5-year-old children were doing their best to provide disambiguating spatial language when prompted about ambiguity, but there was great variability in their responses. Together, these findings reveal important developmental changes in children's complex spatial language.

To provide additional details about the acquisition of the spatial terms *between* and *middle*, we analyzed language production and comprehension data using separate Age (2) x Gender (2) ANOVAs. For the child language production task, we analyzed the proportion of trials in which young children said *between* or *middle* when asked, "The face is where to the squares." This analysis revealed a significant main effect of age, F (1, 173) = 25.65, $p < .01$, $\eta_p^2 = .13$. As expected, 4-5-year-old children produced *between* and *middle* more often ($M = .76$, $SE = .04$) than did 3-year-olds ($M = .42$, $SE = .05$). The main effect of gender also was significant, F (1, 173) = 4.50, $p < .05$, $\eta_p^2 = .03$, indicating that girls used these terms more often ($M = .66$, $SE = .05$) than did boys ($M = .52$, $SE = .04$). Analysis of children's comprehension of the terms *between* and *middle* revealed a significant main effect of age, F (1, 173) = 26.32, $p < .01$, $\eta_p^2 = .13$. As expected, 4-5-year-old children correctly indicated that they understood the terms *between* and *middle* more often ($M = .85$, $SE = .04$) than did 3-year-olds ($M = .58$, $SE = .04$).

Parent reports of child production and comprehension were analyzed in separate Age (2) x Gender (2) ANOVAs. It is important to note that parent reports were available for only a subset of the child participants, limiting the generalizability of these findings. Nonetheless, given the dearth of research in this arena, we chose to include the findings to provide a more complete assessment of young children's spatial language development. As expected, parent reports of production revealed a significant main effect of age, F (1, 98) = 15.95, $p < .01$, $\eta_p^2 = .14$. Overall, parents reported that their 4-5-year-old children produced *between* and *middle* more often ($M = .84$, $SE = .04$) than did 3-year-olds ($M = .55$, $SE = .06$). Similarly, parent reports of comprehension revealed a significant main effect of age, F (1, 98) = 12.62, $p < .01$, $\eta_p^2 = .11$. As expected, parents reported that 4-5-year-old children comprehended *between* and *middle* more often ($M = .95$, $SE = .03$) than did 3-year-olds ($M = .79$, $SE = .04$). The percentage of parents who reported that their children produced and comprehended *between* and *middle* can be seen in Table 1. Visual inspection reveals remarkable improvement in production (especially for *between*) between 3 and 4 years with very little change from 4 to 5 years. Comprehension also improved from 3 to 4 years, with little change thereafter. As noted above, this pattern of findings motivated our decision to analyze responses for 4- and 5-year-old children as one group in the other analyses reported. Together, these findings provide strong support for pronounced developmental gains in children's production and comprehension of *between* and *middle* from 3 to 4 years of age.

Our final set of analyses examined whether spatial language measures were correlated across informants and contexts. First, as expected, child age in months was correlated with all language measures, with the exception of children's use of other spatial language that varied in

type not amount, *r*s (102) > .16, $p < .05$, again demonstrating strong developmental gains. As a result, we used partial correlations to control for the known effects of age in the analyses that followed. First, we demonstrated that parent measures of comprehension and production were correlated, r (97) = .51, $p < .01$. Next, we showed that child comprehension and production measures were correlated, r (97) = .48, $p < .01$. Importantly, child production also was correlated with their use of *middle* in the direction-giving task, r (97) = .21, $p < .05$, though not with their use of *between, r* (97) = .09, $p = .41$. Third, we demonstrated that parent reports of production were correlated with child production, r (97) = .21, $p < .05$, though not with child language in the direction-giving task, *r*s (97) < .06, $p > .59$. Finally, parent reports of comprehension were correlated with child comprehension, r (97) = .36, $p < .01$.

Discussion

The primary goal of this study was to specify age-related improvements in young children's use of the complex spatial terms *between* and *middle* in response to sociocultural supports such as prompting and overhearing. The present findings reveal that 3- and 4-5-year-old children benefitted from directive prompting. In general, children receiving between directive prompts used this term to describe the mouse's location with greater frequency than did children receiving any other prompt type or overhearing adult conversations. Similarly, children receiving middle directive prompts used *middle* in their directions with greater frequency than did children receiving any other prompt type or overhearing adult conversations. Importantly, these patterns replicate those found for 4- to 5-year-old children in Foster and Hund's (2012) study and extend the findings to 3-year-old children. As such, the present findings confirm that directive prompting can facilitate the production of complex spatial terms for children as young as 3 years.

Interestingly, the magnitude of difference with which children used *between* across conditions was more pronounced for older children, demonstrating that children's responsiveness to directive prompting improves over development. Moreover, 4-5-year-old children used *between* and *middle* more often in the direction-giving task than did 3-year-olds, demonstrating developmental gains in spatial language production. In addition, 4-5-year-old children who overheard conversations containing *middle* or who received nondirective prompting evinced some evidence of using *middle*—using it more frequently in these conditions than in the condition where they overheard conversations containing *between*—but not nearly as frequently as in the middle directive condition. It is interesting to note that the older children benefitted more from overhearing *middle* than *between*, perhaps suggesting *middle* is an easier spatial term in this context. In contrast, 3-year-old children showed no clear benefits from overhearing adult conversations or nondirective prompting with regard to using *between* or *middle* in direction giving. These findings provide important details about developmental sensitivity to overhearing as a mechanism for facilitating children's language: 4- and 5-year-old children, but not 3-year-old children, evince some benefit from overhearing complex spatial language. Moreover, 4- and 5-year-olds benefitted somewhat from nondirective prompting highlighting ambiguity in their directions, whereas 3-year-olds did not show any benefit. In general, this pattern of findings confirms our predictions that 3-year-olds, like older children, would benefit from salient, directive prompting using *between* and *middle*, but unlike older children, they would not benefit from less directive prompting or overhearing of complex spatial language in our challenging direction-giving context.

Although the complex spatial terms *between* and *middle* were the main focus of this study, we also were interested in other spatial terminology young children employed in the direction-giving task. Previous studies using similar designs shared our enthusiasm for broad investigation of spatial language beyond the specific terms being studied, but noted that statistical analyses were beyond the scope of their work (Foster & Hund, 2012). Analysis of children's use of other spatial language was included here, revealing that usage varied for younger and older children. In particular, 3-year-old children used other spatial language more often in conjunction with directive prompting relative to overhearing conversations. What types of other spatial language did 3-year-olds produce, and why would they use other language when provided with directive prompts? The most common other spatial term for 3-year-olds was *by*. Note that our directive prompting asked children whether the mouse was hiding in the small object *between* the furniture items or in the small object *by* the furniture. Three-year-old children responded by saying that the mouse was hiding in the small object *by* the furniture with noticeable frequency. This description was imprecise in our direction-giving context, because more than one small object was by each furniture type. It is possible that these findings demonstrate 3-year-olds' emerging understanding of nearbyness, as well as their fragile understanding of *between* and *middle*. It is also possible that these findings stem, at least in part, from 3-year-old children's uncertainty regarding the researcher's questioning, selecting the last option with noticeable frequency.

For 4-5-year-old children, in contrast, other spatial language was more frequent in the nondirective condition than in the two overhearing conditions or the middle directive condition. These findings suggest that older children appreciated the need for additional spatial details when prompted regarding the ambiguity of their initial directions using a nondirective prompt ("I

see two [small objects]. Can you tell the doll anything more?"). However, the spatial language these children selected to resolve the ambiguity varied widely (e.g., *left, right, next to, front, back, first, second*). It is interesting to note that many of these terms are quite complex in nature. Their usage by the older children in our sample is consistent with other literature demonstrating the protracted development of complex spatial and ordinal labeling during the preschool years (e.g., Johnston & Slobin, 1979; Miller, Marcovitch, Boseovski, & Lewkowicz, 2015). This developmental shift in other spatial language from reliance on *by* (an imprecise spatial descriptor in this context) in response to directive prompting at 3 years to more sophisticated reliance on a variety of complex spatial and ordinal terms at 4 years and beyond parallels the developmental improvements noted above, suggesting powerful changes in young children's spatial conceptualization from 3 to 4 years. Future research should probe children's understanding of a wide variety of complex spatial and ordinal concepts and qualitative aspects of children's language production, which were beyond the scope of this study.

Analysis of parent report measures and child production and comprehension responses demonstrated clear developmental improvement in children's production and comprehension of *between* and *middle* from 3 to 5 years, with the most pronounced differences emerging between 3 and 4 years. These age differences were consistent with and linked to those revealed in the direction-giving task, providing further support for the notion that the development of complex spatial language increases dramatically during the preschool years. Our findings underscore the notion that although substantial understanding of spatial concepts is evident by age 3, considerable improvement continues in the ensuing year, with subtle yet protracted improvements in the years that follow. Specifying developmental trajectories was an important

motivation for this study, so these findings are central to our understanding of the development of spatial language during early childhood. Overall, the results of this study help specify when young children produce and comprehend the spatial terms *between* and *middle* using converging evidence from multiple measures. Our findings add to a small but growing body of literature suggesting that, due to their complexity, *between* and *middle* are two of the last spatial prepositions that children produce and comprehend with consistency and precision. Moreover, our findings are consistent with the general progression of understanding simpler spatial concepts before more complex spatial concepts (e.g., Johnston & Slobin, 1979; Quinn, Adams, Kennedy, Shettler, & Wasnick, 2003; Weist et al., 1999). In addition to clear developmental improvement, wide individual variation also was evident. Production of bi-referential spatial terms is especially challenging for English-speaking preschool-aged children (Weist et al., 1999), so more research is needed to understand the processes by which children come to produce complex spatial language that is precise and consistent and the implications of spatial language for other aspects of development (Miller, Patterson, & Simmering, 2016).

Visual inspection of comprehension and production results suggests that comprehension outpaced production across the parent ratings and the child responses, as would be expected overall (Fenson et al., 1993) and in the spatial language domain (Weist et al., 1999). Moreover, visual inspection suggests that parent reports were higher than child responses, indicating the importance of considering task demands when assessing language concepts, especially when conceptualization is fragile (e.g., Ankowski, Vlach, & Sandhofer, 2013; Hadley, 1998; Marinellie, 2004; Masterson & Kamhi, 1991). In general, spatial language measures were correlated across informants and contexts.

As is true of all empirical studies, our findings were limited by the set of measures included here and their particular task demands. Although the measures were adapted from others used in the literature with preschool-aged children, the language demands and prompts provided were quite prescribed and perhaps somewhat difficult for young children. Developing easy to use spatial language production and comprehension assessments suitable for children across the preschool years (and beyond) is an important arena for future research and practice. Broad assessments would facilitate our understanding of developmental trajectories, including the determination of age norms. It is important to note that the overhearing conditions did not include prompting, and we did not include a no prompt control condition in this study (unlike Foster and Hund [2012]). These design details may have limited the interpretation of the overhearing results, most likely by underestimating potential effects of overhearing. Future research could add clarity with regard to these issues. Of course, limiting attrition for parent report and child measures also is important in future studies.

Although gender was not a major focus of this study, understanding language patterns for girls and boys is important, especially in our quest for developing spatial language norms. The parent report measures used here revealed no gender differences. The child production task yielded an advantage for girls, whereas the child comprehension task revealed no gender differences. Overall, these findings suggest that gender differences in complex spatial language are not widespread, but favor girls when evident, which was in the challenging production task in our case (Huttenlocher et al., 1991).

Children's use of *between* and *middle* in the direction-giving task increased with task experience, demonstrating the importance of context in shaping spatial discourse. Children's use

of other spatial language increased with task experience only when they overheard conversations containing *middle*. The direction-giving results did not differ as a function of gender, except that only girls evinced increased usage of *middle* across trial blocks. Overall, the lack of widespread gender differences in direction giving proficiency is consistent with results from Foster and Hund (2012), as well as the general patterns from our production and comprehension measures, demonstrating few gender differences in complex spatial language.

Finding that children as young as 3 years benefit from directive prompting and children as young as 4 years benefit from overhearing (albeit to a lesser extent relative to directive prompting) are consistent with broader sociocultural notions that children learn language and many skills through didactic activities and keen observation/listening (Correa-Chávez & Rogoff, 2009; López, Correa-Chávez, Rogoff, & Gutiérrez, 2010; Morelli, Rogoff, & Angelillo, 2003). Documenting children's socialization experiences and their attention to contextual facets is an important arena for further research. One limitation of the present study is that we did not capture specific details about children's attention during our tasks. In particular, we did not record direction-giving sessions in such a way that children's visual attention could be coded with fidelity, and coding auditory attention is difficult under even the best of circumstances. Nonetheless, anecdotal evidence suggests that there was wide variability in children's focused attention during the direction-giving task, especially during the overhearing segments. Moreover, we suspect that some variability in responding following overhearing was related to variability in attention during the adult conversation that children purportedly "overheard." This notion would be consistent with recent findings showing that attention to the overhearing context influences the effectiveness of learning via overhearing (Shneidman, Buresh, Shimpi, Knight-Schwarz, &

Woodward, 2009). Although it remains to be seen whether variability in attention during overhearing indeed is linked with spatial language outcomes, we suspect that keen attention is one important mechanism by which children benefit from overhearing. In addition, children's appreciation of (shared) intentions likely is important (Tomasello, 2003). These notions suggest that overhearing is necessary, but not sufficient, for facilitating successful locative communication for young children. Clearly, future research is needed to clarify the mechanisms that support the development of spatial communication during childhood, as well as the mechanisms by which spatial language supports other aspects of development (Miller et al., 2015; Pruden, Levine, & Huttenlocher, 2011).

In conclusion, our findings indicate that the ability to communicate about locations is an important skill that emerges early but shows protracted improvement across early childhood. As expected, we found that 3-year-olds benefited from directive prompting but not from nondirective prompting or overhearing, indicating that younger children may require strong support to succeed in challenging direction-giving situations. In contrast, 4- and 5-year-old children showed even stronger benefits from directive prompting and also showed some benefit from nondirective prompting and overhearing to facilitate complex spatial language in our direction-giving task. These findings are the first to demonstrate the extent to which sociocultural supports aid 3-year-old children's use of complex spatial language during direction giving. Our findings also help specify age-related gains in young children's production and comprehension of complex spatial language, an important goal given the sparse literature in this domain. As predicted, children's comprehension and production of *between* and *middle* improved with age, especially from 3 to 4 years. In sum, the present findings demonstrate strong effects of

prompting for children as young as 3 years, and to a lesser extent overhearing for children as young as 4 years, in facilitating complex spatial language during early childhood, thereby adding to our understanding of sociocultural aspects of cognitive and linguistic development.

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Footnotes

[1] We combined the 4- and 5-year-old children into one group when describing our sample to be consistent with the main analyses that follow. The decision to combine the older children into one group for analysis purposes was based on nearly identical outcomes from parent reports of 4- and 5-year-old children's comprehension and production of the complex spatial language used here (see Table 1).

[2] We acknowledge the high attrition rate for parent reports of demographics and child language comprehension and production. We provided the forms once with postage-paid return envelopes but made no further attempts to follow up with parents who did not return the forms. We have no reason to believe systematic factors in our control affected return rate. Moreover, comparison of child language outcomes for children whose parents did vs. did not return the parent forms indicated no differences in child language production, comprehension, or usage of *between* or other spatial language during direction-giving, all $|t|$s $(176) < 1.30$, $p > .19$. Children whose parents returned the forms used *middle* in the direction-giving task more often than did children whose parents did not return the forms, $t\ (176) = 2.55$, $p < .05$. Overall, these findings indicate that children whose parents completed the forms were similar to those whose parents did not complete the forms.

[3] We acknowledge that analyzing proportion scores derived from dichotomous responses (i.e., children produced or did not produce the target spatial word for each trial) using an ANOVA framework requires robustness with regards to potential violations of assumptions. We chose to maintain this analytic framework rather than using logistic regression based on precedence in the

literature and alignment with our design overall. Replicating the pattern of findings evident here using another analytic framework is important for future research.

[4] Comparing responses to the nondirective (baseline) condition was most important, especially for the spatial terms that matched those included in directive prompts or overheard conversations; however, we included all pair-wise comparisons for completeness.

Table 1

Percentage of Parents Who Reported Their Children Comprehend and Produce *Between* and *Middle*

Age Group	Comprehension		Production	
	Between	Middle	Between	Middle
3 years	74	84	39	71
4 years	90	98	76	90
5 years	95	100	77	91
Overall	85	93	63	83

Note. $N = 102$ (3 years: $n = 38$; 4 years: $n = 42$; 5 years: $n = 22$).

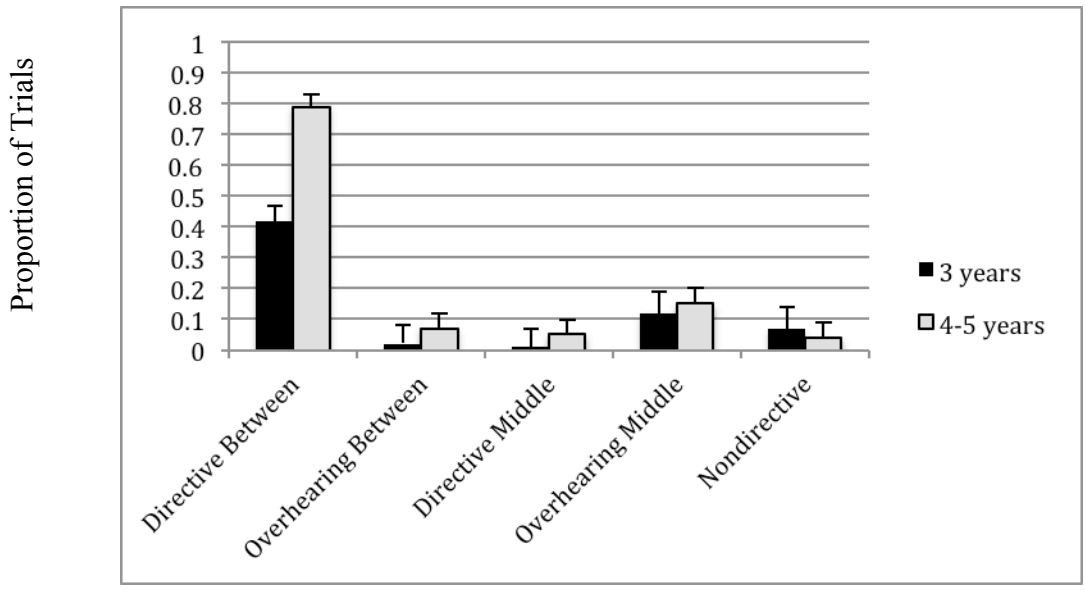
Figure Captions

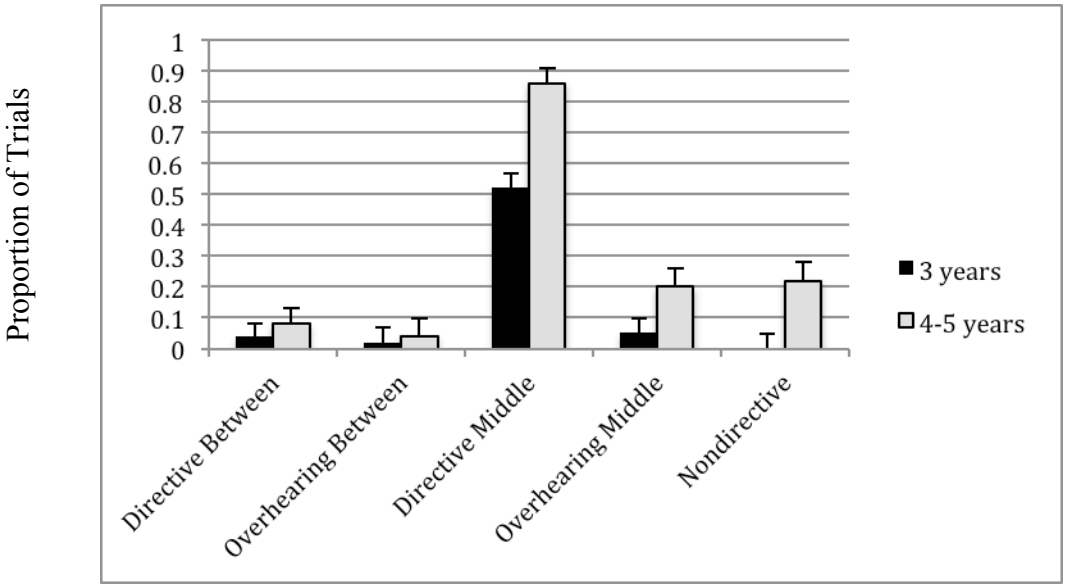
Figure 1. Picture of the dollhouse used during the direction-giving task. Note that the pairing of small objects with furniture items was randomized across participants; however, the placements were identical.

Figure 2. Proportion of trials on which 3- and 4-5-year-old children produced *between* across conditions in the direction-giving task.

Figure 3. Proportion of trials on which 3- and 4-5-year-old children produced *middle* across conditions in the direction-giving task.

Figure 4. Proportion of trials on which 3- and 4-5-year-old children produced other spatial language across conditions in the direction-giving task.


Proportion of Trials
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Directive Between
Overhearing Between
Directive Middle
Overhearing Middle
Nondirective
3 years
4-5 years


Proportion of Trials
1
0.9
0.8
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0.6
0.5
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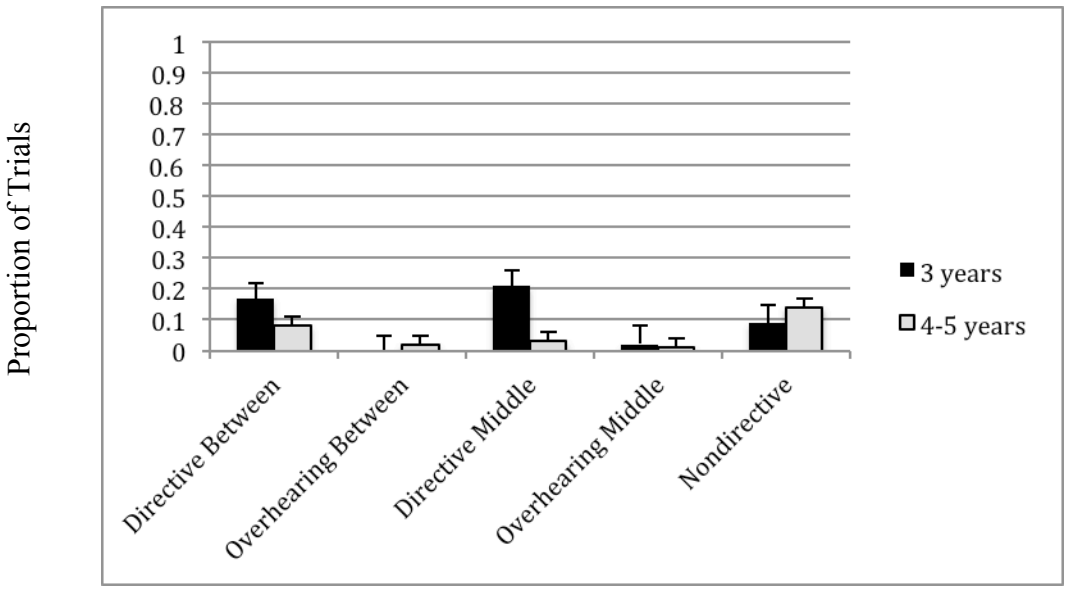
0.2
0.1
0
Directive Between
Overhearing Between
Directive Middle
Overhearing Middle
Nondirective
3 years
4-5 years


Proportion of Trials
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0.8
0.7
0.6
0.5
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0.3
0.2
0.1
0
Directive Between
Overhearing Between
Directive Middle
Overhearing Middle
Nondirective
3 years
4-5 years