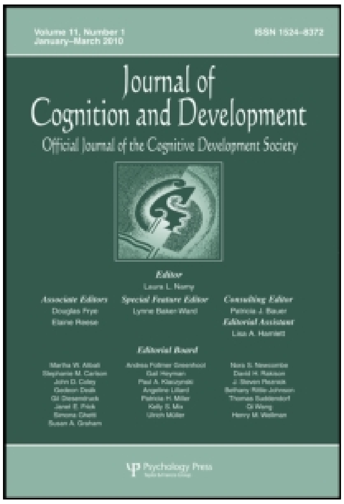

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What Factors Shape *By* Ratings in Relation to Landmarks?

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Two experiments investigated how absolute and relative distance shape adults' and young children's ratings concerning the extent to which the term *by* describes the relation between locations. Three- and 4-year-old children and adults were asked to rate how well the word *by* described the relation between several blocks and a landmark. The blocks were arranged so that their absolute and relative distances from the landmark varied. All ages relied on absolute and relative distance between the blocks and the landmark when making *by* ratings; however, older children and adults showed more differentiated responses. These findings add to our growing understanding of how adults and young children use relative distance to understand the proximity term *by*.

The ability to communicate about locations is central to human functioning. Children and adults often communicate about the locations of objects, such as toys, shoes, and car keys, and doing so skillfully helps to avoid long and tedious searches. Despite years of research demonstrating important changes in language abilities across age (Dromi, 1979; Johnston & Slobin, 1979; Meints, Plunkett, Harris, & Dimmock, 2002; Plumert, Ewert, & Spear, 1995; Plumert & Hawkins, 2001; Weist, Lymburner, Piortowski, & Stoddard, 2000), we know very little about the processes underlying these developmental changes. The purpose of the present investigation was to examine how adults and young children communicate about locations in relation to landmarks. In particular, this project specified how absolute and relative distance affect people's conception of the proximity term *by*.

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In English, we use prepositions or prepositional phrases to convey spatial information (e.g., "The mug is *by* the sink"). Early research focused on the order of acquisition of spatial terms, revealing striking similarities across languages. Children first produce terms such as *in, on*, and *under*, and only later produce terms such as *beside, by, near*, and *next to* (e.g., Clark, 1973, 1980; Dromi, 1979; Johnston & Slobin, 1979). More recently, researchers have sought to specify the factors that influence how adults interpret individual spatial terms (e.g., Carlson-Radvansky, Covey, & Lattanzi, 1999; Carlson-Radvansky & Tang, 2000; Coventry & Prat-Sala, 2001; Crawford, Regier, & Huttenlocher, 2000; Hayward & Tarr, 1995; Meints et al., 2002). Results from these studies have shown that adults use vertical and horizontal reference axes (Coventry & Prat-Sala, 2001; Crawford et al., 2000; Hayward & Tarr, 1995; Meints et al., 1999) and functional relations between objects (Carlson-Radvansky et al., 1999; Carlson-Radvansky & Tang, 2000) to interpret spatial terms such as *above*, *below*, *left*, and *right* (see also Logan & Sadler, 1996; Manning, Sera, & Pick, 2002). For example, Hayward and Tarr examined how reference axes influence the direction and extent of spatial regions denoted by the prepositions *above*, *below*, *left*, and *right*. On each trial, adults viewed two objects (e.g., a computer and a circle) and were asked to rate the acceptability of a linguistic description of the spatial relation between the objects (e.g., "The circle is above the computer"). Acceptability for *above* and *below* was highest when the circle was directly above or below the computer (i.e., along the vertical axis). Similarly, acceptability for *left* and *right* was highest when the circle was directly to the left or right of the computer (i.e., along the horizontal axis). These findings suggest that reference axes play an important role in adults' judgments about spatial prepositions (see also Crawford et al., 2000).

This investigation focused on adults' and young children's understanding of the spatial term *by* to describe the relation between nonlandmark locations and a landmark. Overall, much fewer studies have addressed nearbyness than have addressed other terms, such as *above* and *below*. This paucity of research is one reason further specification is needed. *By* is based on the notion of relative proximity to a reference object (Herskovits, 1986; Landau & Jackendoff, 1993). As such, both relative distance and size affect people's notions of *by*-ness. When deciding whether a target object is *by* a reference object, people consider not only how far the target object is from the reference object (i.e., absolute distance) but also how far the target is from the reference object in relation to the distances between other nontarget objects and the reference object (i.e., relative distance). For example, assume that City Park is five blocks from one's house, and University Park is two blocks from home. The absolute distances between the parks and home are five blocks and two blocks, respectively. Based on these distances, we might judge that the parks are *by* the house. However, we might not judge that City Park is by the house because it is relatively further than the other park. A second factor that affects *by* judgments is the overall size of the layout. People may judge two locations that are at a particular distance apart as by each other when the size of the space is large (e.g., a big city) but not when the size of the space is small (e.g., a small town).

Recently, Hund and Plumert (2007) investigated how relative distance affects *by* judgments. They asked 3- and 4-year-old children and adults to judge whether or not several blocks were *by* a landmark. The blocks were arranged so that their absolute and relative distance from the landmark at the center varied. All three age groups were more likely to judge objects at an intermediate distance as *by* the landmark when intervening objects were absent than when they were present. Nonetheless, reliance on relative distance became more systematic (see also Hund & Naroleski, 2008) and applicable to larger spatial extents across development. These findings suggest that relative distance and size affect children and adults' communicative judgments; however, the nature of the responses required (i.e., a yes-no response) differed from previous adult work using ratings tasks with multiple alternatives (i.e., a Likert-type scale assessing the acceptability of a particular spatial term; see Crawford et al., 2000; Hayward & Tarr, 1995).

One goal of the present study was to examine how the use of relative distance affects *by* ratings using a more sensitive response scale akin to those used in previous research involving other spatial terms (e.g., Crawford et al., 2000; Hayward & Tarr, 1995). Another goal was to specify how such ratings change during the preschool years. Previous research has demonstrated dramatic differences in the ways in which 3- to 5-year-old children make use of relative information (e.g., Gentner & Ratterman, 1991; Hund & Naroleski, 2008; Hund & Plumert, 2007; Huttenlocher, Newcombe, & Vasilyeva, 1999; Plumert et al., 1995; Plumert & Hawkins, 2001; Vasilyeva & Huttenlocher, 2004; see also Uttal, Sandstrom, & Newcombe, 2006). For example, Gentner and Ratterman proposed that children become increasingly able to use relative information in a variety of specific domains during the preschool years, a phenomenon they call the relational shift. Understanding how young children use absolute and relative distance to make judgments about the proximity term *by* has the potential to shed light on the complexities of spatial language and cognitive development during the preschool years and beyond.

It is critical to understand not only when children use specific spatial terms but also the processes by which they make decisions about spatial terms in a variety of settings. Understanding these processes involves careful examination of how children and adults use a variety of cues to facilitate spatial language and thinking across many settings. This assertion is consistent with recent theoretical claims that reweighting mechanisms underlie developmental changes in cognitive and language abilities (Craton, Elicker, Plumert, & Pick, 1990; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Newcombe & Huttenlocher, 2000; Newcombe, Huttenlocher, Drummey, & Wiley, 1998; Sluzenski, Newcombe, & Satlow, 2004). According to this view, as children get older, they use an expanding set of cues to remember and communicate (about locations) in increasingly precise ways. Moreover, the ways in which they combine these cues (e.g., intrinsic and extrinsic reference frames, spatial and functional information, absolute and relative distance) become more finely tuned with task demands over age and experience. As such, it is important for empirical research to specify: 1) when children use particular cues, and 2) how the adaptive combination of multiple cues changes throughout development. This project sought to specify how 3- and 4-year-old children and adults use absolute and relative distance to make *by* ratings in relation to landmarks as one step in this complex process of understanding the mechanisms supporting the development of language and thinking.

The present project probed communicative ratings among adults and 3- and 4-year-old children to broaden our understanding of people's conceptions of nearbyness and to specify changes in young children's use of relative and absolute distance. In Experiment 1, adults were asked to rate how well the spatial term *by* described the relation between each of several small blocks surrounding a larger box (i.e., a landmark) using a 5-point Likert-type scale. I focused on participants' responses to target blocks that were always at the same absolute distance from the landmark but were at different relative distances from the landmark. One condition included additional blocks closer to the landmark, making the target blocks relatively far from the landmark. The other condition included additional blocks further from the landmark, making the target blocks relatively close to the landmark. It was expected that adults would systematically use relative distance to interpret the proximity term *by*. That is, they would give higher *by* ratings to the target blocks when other blocks did not intervene than when other blocks intervened. The second experiment was similar, except that 3- and 4-year-old children and adults participated to assess developmental changes in communication concerning nearbyness. Participants again rated how well the word *by* described the relation between each of several blocks and the landmark, this time using a simplified 3-point Likert-type scale. It was expected that 3-year-olds would use relative distance less systematically when making *by* ratings, leading to less differentiation across distances (i.e., lower *by* ratings for close blocks and higher *by* ratings for far blocks when compared with older participants who exhibit very high *by* ratings for close blocks and very low *by* ratings for far blocks). In other words, 3-year-olds would give lower *by* ratings to blocks close to the landmark than would the older children and adults. Moreover, they would give higher *by* ratings to blocks far from the landmark than would the older children and adults.

EXPERIMENT 1

Method

Participants. Thirty-six adults (mean age = 21;0, range = 18;5 to 41;11; 18 women, 18 men) participated. They were recruited from undergraduate psychology courses at a large, public Midwestern university and received extra credit for their participation.

Apparatus and materials. Twenty-six identical small, brown wooden blocks (1.13 in. tall × 2.5 in. wide × 2.5 in. deep; 2.87 cm × 6.35 cm × 6.35 cm) were arranged on a 78 in. long × 48 in. wide (198.1 cm × 122 cm) piece of white vinyl. The vinyl was laid on the floor of the testing room. A larger, blue box (5 in. on all sides; 12.7 cm) at the center of the blocks served as a landmark. The blocks were arranged so that five blocks were 3 in. (7.62 cm) from the blue box in the center, seven blocks were 6 in. (15.24 cm) from the blue box, seven blocks were 12 in. (30.48 cm) from the blue box, and seven blocks were 18 in. (45.72 cm) from the blue box. The blocks were oriented in such a way as to minimize the appearance that they created concentric circles around the landmark (see Figure 1).

Design and procedure. Participants were randomly assigned to one of three conditions: 3 and 6 in., 6 and 12 in., or 12 and 18 in. In the 3- and 6-in. condition, five blocks 3 in. (7.62 cm) from the box and seven blocks 6 in. (15.24 cm) from the box were present. In the 6- and 12-in. condition, seven blocks 6 in. from the box and seven blocks 12 in. (30.48 cm) from the box were present. In the 12- and 18-in. condition, seven blocks 12 in. from the box and seven blocks 18 in. (45.72 cm) from the box were present. Participants were tested individually in a quiet room in the laboratory. They were seated on a chair approximately 28 in. (70 cm) from the edge of the vinyl. The experimenter first marked the location of a block by placing a small (1.25 in. diameter; 3.18 cm) circular marker on one of the blocks. Then, participants were asked, "Rate how well the word *by* describes the relation between each block and the blue box. The description is very poor, poor, fair, good, or very good." The order of blocks was randomized for each participant. The experimenter recorded participants' *by* rating for each block (i.e., very poor = 0, poor = 0.25, fair = 0.5, good = 0.75, very good = 1), and the mean *by* rating for blocks at each distance was calculated.

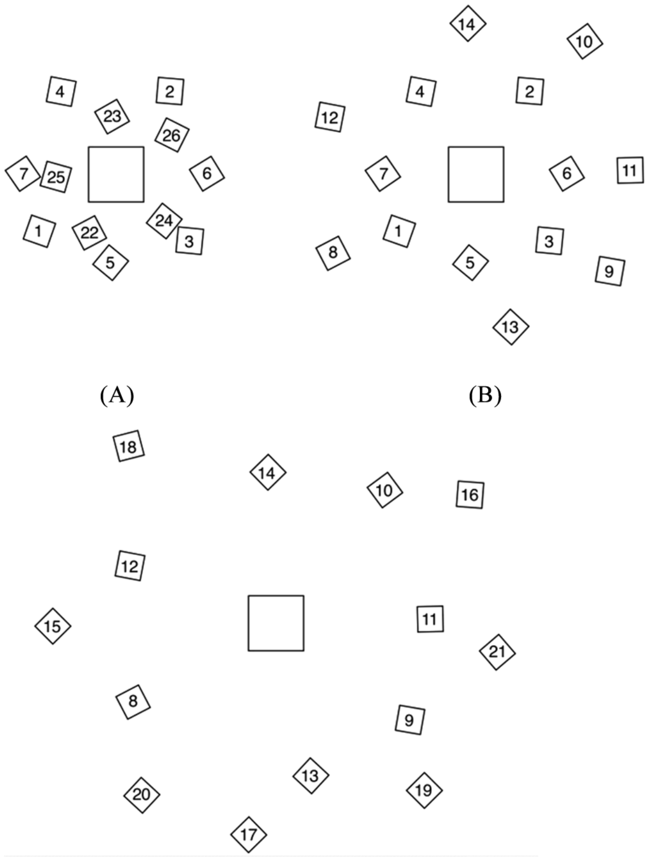

FIGURE 1 Diagram of the landmark and block layouts used in the 3- and 6-in. condition (Panel A), the 6- and 12-in. condition (Panel B), and the 12- and 18-in. condition (Panel C). Block numbers are for illustration only.

Results

One question of interest was how adults' *by* ratings differ across absolute and relative distances. Mean by ratings for blocks at each distance were entered into separate one-way analyses of variance (ANOVAs) for each condition. As expected, all three analyses yielded significant main effects of distance—3- and 6-in. condition, $F(1, 11) = 156.25$, $p < .001$; 6- and 12-in. condition, $F(1, 11) = 182.21$, $p < .001$; and 12- and 18-in. condition, $F(1, 11) = 103.03$, $p < .001$—indicating that *by* ratings were higher for the blocks

TABLE 1
Mean *By* Ratings for Blocks at Each Distance in Experiment 1

	Block location	
Condition	*Close*	*Far*
3 and 6 in.	0.85 (0.11)	0.29 (0.11)
6 and 12 in.	0.80 (0.11)	0.20 (0.15)
12 and 18 in.	0.63 (0.18)	0.19 (0.16)

Note. Standard deviations are listed in parentheses.

closer to the landmark than for the blocks further from the landmark (see Table 1).

A second set of analyses focused on specifying the impact of relative distance on *by* ratings. In particular, ratings for the 6-in. blocks were compared across the 3- and 6-in. and the 6- and 12-in. conditions. Note that these blocks occupied the same absolute locations in relation to the landmark. Nonetheless, their relative distances varied across conditions such that several blocks intervened in the 3- and 6-in. condition and no other blocks intervened in the 6- and 12-in. condition. The ANOVA yielded a main effect of condition, $F(1, 22) = 129.66$, $p < .001$. Ratings were significantly higher when no other blocks intervened ($M = 0.80$, $SD = 0.11$) than when other blocks intervened ($M = 0.29$, $SD = 0.11$), indicating that relative distance impacts adults' *by* ratings. Similarly, the analysis of ratings for the 12-in. blocks across the 6- and 12-in. and 12- and 18-in. conditions revealed a main effect of condition, $F(1, 22) = 38.89$, $p < .001$. Again, ratings were significantly higher when no other blocks intervened ($M = 0.63$, $SD = 0.18$) than when other blocks intervened ($M = 0.20$, $SD = 0.15$), indicating that relative distance strongly impacts adults' *by* ratings.

Discussion

The goal of this experiment was to investigate whether adults' *by* ratings depend on absolute and relative distance. As predicted, adults gave higher *by* ratings to blocks 3 in. from the landmark than those 6 in. from the landmark. Similarly, their ratings were higher for the 6-in. blocks than for the 12-in. blocks, and their ratings were higher for the 12-in. blocks than for the 18-in. blocks. These findings confirm that absolute distance plays an important role in adults' conception of nearbyness. To investigate the role of relative distance in greater detail, *by* ratings for target blocks were compared across conditions in which other blocks were present in intervening locations or in nonintervening locations. As expected, adults' *by* ratings were significantly higher when no other blocks intervened than when other blocks intervened, indicating that they relied on relative distance when communicating about locations.

The second experiment sought to extend these findings by specifying how absolute and relative distance affect young children's *by* ratings. Toward that end, 3- and 4-year-old children and adults were asked to rate how well the spatial term *by* described the relation between each of several blocks and a larger landmark box. The design was identical to Experiment 1, except that participants used a simplified 3-point Likert-type scale for their ratings. It was predicted that 3-year-olds' use of relative distance when rating nearbyness would be less differentiated than would the other ages (i.e., lower *by* ratings for close blocks and higher *by* ratings for far blocks when compared with older participants who exhibit very high *by* ratings for close blocks and very low *by* ratings for far blocks).

EXPERIMENT 2

Method

Participants. Thirty-six 3-year-olds (mean age = 3;7, range = 3;2 to 3;11; 23 girls, 13 boys), thirty-six 4-year-olds (mean age = 4;8, range = 4;0 to 4;12; 21 girls, 15 boys), and 36 adults (mean age = 23;0, range = 18;2 to 41;9; 18 women, 18 men) participated. One additional 3-year-old who did not provide verbal assent for participation and one additional 3-year-old who did not complete the task were omitted from analyses. Most children were from middle- to upper-middle-class European American families. They were recruited from area preschools and day care centers, as well as from the community. Parents received a letter explaining the study, and only those children whose parents gave written consent and who gave verbal assent were included in the study. Children received a small gift for participation. Adults were recruited and compensated in the same manner as in Experiment 1.

Apparatus and materials. The same small wooden blocks, blue landmark box, and white vinyl surface were used as in the previous experiment.

Design and procedure. As in Experiment 1, participants were randomly assigned to one of three conditions: 3- and 6-in., 6- and 12-in., or 12- and 18-in. conditions. Participants were asked to rate how well the word *by* described the relation between each block and the landmark using three choices (i.e., *not by, sort of by, by*). Participants were given a small sheet of paper that included a frowning face, a straight face, and a smiling face to help them understand the rating scale. As in Experiment 1, the experimenter noted each rating (i.e., frowning face = 0, straight face = 0.5, smiling face = 1) and later calculated the average *by* rating for blocks at each distance.

Results

The central question of interest was how preschool-aged children's and adults' *by* ratings differ across absolute and relative distances. Mean *by* ratings for blocks at each distance were entered into separate age × distance ANOVAs for each condition. As expected, the analysis for the 3- and 6-in. condition yielded a significant main effect of distance, $F(1, 33) = 114.36$, $p < .001$, and a significant age × distance interaction, $F(2, 33) = 6.65$, $p < .005$. Simple effects tests revealed significant differences across distances for all three age groups: 3-year-olds, $F(1, 11) = 7.66$, $p < .05$; 4-year-olds, $F(1, 11) = 38.64$, $p < .001$; and adults, $F(1, 11) = 216.95$, $p < .001$. All three ages produced higher ratings for the 3-in. blocks than for the 6-in. blocks (see Table 2), indicating that absolute distance impacts *by* ratings for all three ages. Additional simple effects tests were conducted to examine whether *by* ratings for each distance differed across age, thereby providing additional details about developmental changes in rating differentiation. These tests yielded a significant difference across age groups for

TABLE 2
Mean *By* Ratings for Blocks at Each Distance in Experiment 2

	Block location	
Condition and age group	*Close*	*Far*
3 and 6 in.		
3 years	0.65 (0.26)	0.35 (0.33)
4 years	0.85 (0.16)	0.30 (0.22)
Adults	0.93 (0.10)	0.20 (0.18)
6 and 12 in.		
3 years	0.79 (0.23)	0.33 (0.36)
4 years	0.78 (0.26)	0.36 (0.29)
Adults	0.86 (0.16)	0.05 (0.09)
12 and 18 in.		
3 years	0.43 (0.40)	0.37 (0.35)
4 years	0.52 (0.33)	0.27 (0.31)
Adults	0.69 (0.19)	0.05 (0.09)

Note. Standard deviations are listed in parentheses.

ratings of the 3-in. blocks, $F(2, 33) = 7.45$, $p < .005$, but not for ratings of the 6-in. blocks, $F(2, 33) = 1.26$, *ns*. Three-year-olds' ratings of the 3-in. blocks were significantly lower than were the ratings from the 4-year-olds and adults, which did not differ from one another. These findings indicate less differentiation in ratings (i.e., lower *by* ratings for close blocks) among 3-year-olds.

Similarly, the analysis for the 6- and 12-in. condition yielded a significant main effect of distance, $F(1, 33) = 99.51$, $p < .001$, and a significant age × distance interaction, $F(2, 33) = 4.82$, $p < .05$. Simple effects tests revealed significant differences across distances for all three age groups: 3-year-olds, $F(1, 11) = 15.19$, $p < .005$; 4-year-olds, $F(1, 11) = 13.85$, $p < .005$; and adults, $F(1, 11) = 319.74$, $p < .001$. All three ages produced higher ratings for the 6-in. blocks than for the 12-in. blocks (see Table 2), indicating an important influence of absolute distance. Again, a second set of simple effects tests was conducted to examine changes in rating differentiation across age. These tests yielded a significant difference across age groups for ratings of the 12-in. blocks, $F(2, 33) = 4.74$, $p < .05$, but not for ratings of the 6-in. blocks, $F(2, 33) = 0.43$, *ns*. Adults' ratings of the 12-in. blocks were significantly lower than were the ratings from the 3- and 4-year-olds, indicating greater differentiation (i.e., lower *by* ratings for far blocks) for adults.

The analysis for the 12- and 18-in. condition yielded a significant main effect of distance, $F(1, 33) = 60.42$, $p < .001$, and a significant age × distance interaction, $F(2, 33) = 17.52$, $p < .001$. Simple effects tests revealed significant differences across distances for the 4-year-olds, $F(1, 11) = 7.52$, $p < .05$, and for the adults, $F(1, 11) = 191.11$, $p < .001$, but not for the 3-year-olds, $F(1, 11) = 0.81$, *ns*. Four-year-olds and adults produced higher ratings for the 12-in. blocks than for the 18-in. blocks (see Table 2), indicating a powerful influence of absolute distance for the older ages. The difference in ratings was in the same direction for the 3-year-olds but was not large enough to reach conventional levels of statistical significance. A second set of simple effects tests yielded a significant difference across age groups for ratings of the 18-in. blocks, $F(2, 33) = 4.13$, $p < .05$, but not for ratings of the 12-in. blocks, $F(2, 33) = 2.08$, *ns*. Three-year-olds' ratings of the 18-in. blocks were significantly higher than the ratings from the adults, again revealing less differentiation (i.e., higher *by* ratings for far blocks) among the youngest age group.

Another set of analyses focused on specifying the impact of relative distance on *by* ratings. In particular, ratings for the 6-in. blocks were compared across the 3- and 6-in. and the 6- and 12-in. conditions. Note that these blocks occupied the same absolute locations in relation to the landmark. Nonetheless, their relative distances varied across conditions such that several blocks intervened in the 3- and 6-in. condition and no other blocks intervened in the 6- and 12-in. condition. The age $\times$ condition ANOVA yielded a main effect of condition, $F(1, 66) = 88.64$, $p < .001$. Ratings were significantly higher when no other blocks intervened ($M = 0.81$, $SD = 0.11$) than when other blocks intervened ($M = 0.29$, $SD = 0.11$), indicating that relative distance impacts *by* ratings. Similarly, the analysis of ratings for the 12-in. blocks across the 6- and 12-in. and 12- and 18-in. conditions revealed a main effect of condition, $F(1, 66) = 17.87$, $p < .001$, as well as an age $\times$ condition interaction, $F(2, 66) = 6.01$, $p < .005$. Simple effects tests revealed that ratings differed across distances for the adults, $F(1, 22) = 108.29$, $p < .001$, but not for the 3-year-olds, $F(1, 22) = 0.37$, *ns*, and not for the 4-year-olds, $F(1, 22) = 1.49$, *ns*. Adults' ratings were higher when no blocks intervened than when other blocks intervened, indicating their systematic use of relative distance to rate the acceptability of the spatial proximity term *by*. Children's use of relative distance was less systematic overall.

Discussion

The goal of Experiment 2 was to examine how *by* ratings change during the preschool years. As expected, *by* judgments differed across distances for all age groups. Nonetheless, 3-year-olds' ratings were less differentiated across distances than were the ratings from older children and adults. In particular, the 3-year-old children gave lower acceptability ratings to the 3-in. blocks and higher acceptability ratings to the 18-in. blocks compared with the other ages. Together, these findings indicate that 3-year-olds' *by* ratings are less differentiated across distances than are those of older children and adults.

I also sought to specify how young children use relative distance to rate the acceptability of the spatial proximity term *by*. As in Experiment 1, *by* ratings were compared across distances and at a given distance across two conditions in which other blocks were present in intervening locations or in nonintervening locations. Participants used a simplified 3-point Likert-type scale. It was hypothesized that the 3-year-old children would use relative distance in a less differentiated fashion than the 4-year-old children and adults. *By* ratings for the 6-in. blocks differed significantly across conditions for all three age groups, suggesting that the relative distance between the target blocks and the landmark affected these acceptability ratings. Interestingly, *by* ratings for the 12-in. blocks differed across conditions only for the adults, not for the children, indicating that the systematicity with which people use relative distance to rate the acceptability of *by* increases during development (especially when the distances involved are larger). These findings generally confirm the predictions regarding developmental changes in acceptability ratings.

GENERAL DISCUSSION

The present results clearly show that adults use absolute and relative distance to rate the acceptability of the spatial proximity term *by.* In particular, *by* ratings declined as distance from the landmark increased. Moreover, the presence of objects at an intervening distance led to significantly lower *by* ratings relative to the ratings with blocks at a nonintervening distance. Although these findings are consistent with previous results demonstrating the effects of relative distance on adults' nearbyness judgments (Hund & Naroleski, 2008; Hund & Plumert, 2007), they are in sharp contrast with other findings showing that the presence of distractor items has little effect on ratings of *above* (Carlson & Logan, 2001). For instance, although adults were slower to verify relations (e.g., "L is *above* X") when distractors were present than when they were absent, the location of the distractor relative to the target object did not affect *above* ratings. In contrast, the location of "distractor" objects in this task had a major impact on how adults interpreted the term *by.* Clearly, additional research is needed to investigate how a variety of factors influence people's interpretation of different spatial terms, perhaps focusing on comparisons of several terms within a single task.

Interestingly, the present results confirm that differentiated use of relative distance increases across development. Adults systematically used relative distance when making *by* ratings. Thus, they gave very high acceptability ratings to blocks when no intervening blocks were present and very low acceptability ratings to the same blocks when intervening blocks were present. In contrast, 3-year-olds were less systematic in their use of relative distance to make *by* ratings. Together, these patterns of responding underscore two points about the developmental trajectory of *by* ratings. First, children and adults use relative distance to rate the acceptability of the spatial term *by*. Second, there are developmental changes in the use of relative distance during the preschool years. In particular, judgments based on relative distance become more differentiated throughout development (see also Hund & Naroleski, 2008; Hund & Plumert, 2007).

The idea that young children might have difficulty with the spatial term *by* is consistent with research investigating young children's referential communication. This work has shown that preschool children have difficulty using proximity terms to disambiguate identical hiding locations even after they can produce the terms successfully (Plumert et al., 1995; Plumert & Hawkins, 2001). For example, Plumert and Hawkins compared young children's use of *in* and *by* to disambiguate identical hiding locations. In one study, 3- and 4-year-olds described the location of a miniature mouse hidden in a one-room model house. Several pairs of identical small objects (e.g., bags, pillows, hats) served as hiding locations. These small objects were always placed either *in* or *next to* (and touching) a piece of furniture (e.g., a crib). Thus, to unambiguously describe the location of the mouse, children needed to refer to the relation between the mouse and the small object and to the relation between the small object and the furniture landmark (e.g., "The mouse is *under* the pillow *in* the crib"). Both 3- and 4-year-olds' descriptions almost always included a reference to the small object (e.g., "The mouse is under the pillow"), but children were more likely to provide a reference to the furniture landmark when the small object was *in* the furniture item than when the small object was *by* the furniture item. In a similar study, 3- and 4-year-old children searched for the hidden mouse using a description provided by the experimenter (e.g., "The mouse is in the bag *next to* the crib"). Three-year-olds took longer to find the mouse when it was hidden in a small object next to a landmark than when it was in a small object that was in a landmark (e.g., "The mouse is in the bag *in* the crib"). Search latencies did not differ across spatial relations for the 4-year-olds (Plumert & Hawkins, 2001). Together, these findings suggest that children's use of proximity terms is undergoing change during early childhood.

Why might young children's use of relative distance when making proximity judgments be less differentiated than adults' usage? One possibility is that changes in children's use of relative distance parallel changes in their understanding of relative information more generally. Although Piaget and Inhelder (1948/1967) proposed that children's understanding of relative information (i.e., proportional reasoning) emerges during the formal operational stage, contemporary researchers have challenged this notion, suggesting instead that young children can use relative coding in rudimentary ways but that this ability becomes more sophisticated with age (Huttenlocher, Duffy, & Levine, 2002; Huttenlocher et al., 1999; MacDonald, Spetch, Kelly, & Cheng, 2004; Vasilyeva & Huttenlocher, 2004). For example, Huttenlocher et al. (1999) asked 3- and 4-year-old children to use a dot marked on a map to find a disk hidden in a long, narrow sandbox. Overall, the 4-year-olds were quite successful in finding the hidden disk. In contrast, only about half of the 3-year-olds were successful. The remaining 3-year-olds were unable to find the disk, instead responding randomly or perseveratively. It is possible that increases in young children's differentiated use of relative distance are related to changes in analogical reasoning abilities. According to Gentner (1988), children between the ages of 3 and 5 years become increasingly likely to use relational similarity to solve analogical reasoning tasks in a variety of specific domains (see also Gentner & Ratterman, 1991; Goswami, 1989; Ratterman & Gentner, 1998). For example, when shown two arrays of objects that differ in size and identity (e.g., a small car, a medium mug, and a large house; a small mug, a medium house, and a large flower pot) and asked to select the object that is the same as the marked one in the first array (e.g., the medium mug), 3-year-olds have difficulty choosing the relational match (i.e., the *medium* house), preferring to use object identity matches instead (i.e., the small *mug*). When object similarity and relational similarity are not in conflict, 3-year-olds are much more likely to succeed in making relational matches. In contrast, 5-year-olds are likely to use relational similarity in analogical reasoning tasks regardless of other available cues. These findings suggest that developmental improvements in relational thinking may underlie the increased differentiation in the use of relative distance observed here.

Halford and colleagues claim that increases in working memory capacity underlie young children's emerging abilities to use relational information (Andrews & Halford, 2002; Halford, Andrews, Dalton, Boag, & Zielinski, 2002; Halford, Wilson, & Phillips, 1998). In particular, they assert that the number of relations children can hold in working memory increases throughout development, thereby facilitating domain-general changes in their ability to handle increasingly complex relational cues. Although the present research does not settle the debate between Gentner's domain-specific view and Halford's domain-general view of relational coding, it does highlight the increasingly differentiated use of relational cues in the spatial domain, providing additional support for the overall notion that preschool-aged children become increasingly adept at using relative cues.

In conclusion, the results of the present investigation clearly show that young children and adults use absolute and relative distance when rating the acceptability of the spatial proximity term *by*. Nonetheless, their ratings based on relative distance become increasingly differentiated across development. These findings are broadly consistent with recent theoretical claims regarding reweighting mechanisms underlying developmental changes in location coding and language abilities (e.g., Hollich et al., 2000; Newcombe & Huttenlocher, 2000; Sluzenski et al., 2004). As such, the present findings add to a growing body of research specifying when children use particular cues and how their adaptive combination of such cues might change across age and experience. Together, these findings offer rich details about the dynamics of spatial language during early childhood.

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