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Mother–Child Communication About Location: Giving and Following Directions for Finding Hidden Objects

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We conducted 2 experiments to examine how mothers structure directions to young children for finding hidden objects and how young children use these directions to guide their searches. In Experiment 1, we examined the reference frames mothers use to communicate with their 2.5-, 3-, and 3.5-year-old children about location by asking mothers to verbally disambiguate a target hiding container from an identical nontarget hiding container. We found that mothers' reference frame use was primarily governed by the relative proximity of the target container to the landmark and themselves. Older children were more successful in following directions than were younger children, and children were more likely to search successfully in response to a person than to a landmark frame of reference. In Experiment 2, we further investigated how 3-year-old children follow directions involving person and landmark frames of reference by asking mothers to use either only themselves or only the landmark to describe the target location. Children in the person reference frame condition successfully followed their mother's directions when the target was relatively close to the mother, but not when the target was relatively far from the mother. Children in the landmark reference frame condition were at chance regardless of the relative proximity of the target to the landmark. The discussion focuses on the roles of spatial proximity and reference frames in mother–child spatial communication.

Keywords: spatial communication, maternal input, spatial development, proximity, reference frames

Giving and following directions for finding missing objects are common everyday tasks for children and adults alike. Because children frequently ask parents where things are, many parents spend a good deal of time describing locations for their children. Most research to date, however, has focused on how young children give directions to others (Craton, Elicker, Plumert, & Pick, 1990; Plumert, 1996; Plumert, Ewert, & Spear, 1995; Plumert & Hawkins, 2001; Plumert & Nichols-Whitehead, 2007). Although these studies provide valuable information about the development of young children's direction-giving skills, little is known about how parents give directions to their young children and whether young children can use these directions to locate objects. Of particular interest is whether parents tailor their spatial directions to the age of the child. According to the social-contextual view of development (Gauvain, 2001; Rogoff, 1990; Vygotsky, 1978), children benefit when parents provide input that is appropriately geared to the developmental level of the child. Previous work has shown that when parents serve as listeners in a direction-giving task, they are sensitive to the scaffolding needs of younger and older children (Plumert & Nichols-Whitehead, 1996). However, given that the children (not the parents) were producing the directions in this work, the question of whether parents tailor their spatial directions to the developmental level of the child is left unanswered. Here, we address this issue by examining what information mothers provide in their directions to young children and whether young children can successfully use this information to locate hidden objects.

Whether remembering or communicating about location, locations have to be coded in relation to a reference frame. There are two types of reference systems commonly used for coding location, the viewer-based reference system in which location is coded in relation to the self and the externally based reference system in which location is coded in relation to landmarks or axes (Newcombe & Huttenlocher, 2000). Within the viewer-based system, a simple type of spatial coding is response learning, which involves establishing an association between an object and a specific motor movement or sequence of movements. For example, one might code the location of a computer mouse in terms of a remembered movement toward the right. This system of spatial coding works well except in cases when the position of the self changes with respect to the object location. For example, if the computer mouse is moved to the left side of the computer, one would likely still reach toward the right. Within the externally based system, a simple type of spatial coding is cue learning, which involves establishing an association between an object and a visible landmark, such as remembering that the printer is close to the computer. This type of spatial coding works well when the object is very close to the landmark and more precise spatial relational information is unnecessary.

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Work on children's spatial memory has shown that there are changes in children's use of these reference frames over development. One important change has been characterized as the *egocentric to allocentric shift.* There is general agreement that infants and young children are able to use viewer-based frames of reference before they are able to use externally based frames of reference to code location, though the timing of this shift depends on the task context (e.g., Acredolo, 1978; Acredolo & Evans, 1980; Bremner & Bryant, 1977; Piaget, 1954). For example, in an early study of egocentric versus allocentric spatial coding, Acredolo (1978) developed a paradigm in which she examined how 6-, 11-, and 16-month-olds code the location of an interesting event. Infants were seated at one end of a room with one window on the wall to their left and one on the wall to their right. For half of the infants in each age group, a large yellow star was placed above the target window. Infants were trained to look at the target window to see an interesting event following a buzzer that sounded from a central location. Following training, infants were moved to the opposite end of the room and rotated 180°. When the buzzer sounded, experimenters recorded which way the infants turned. Turning in the direction they were trained to look indicated egocentric responding, whereas turning in the opposite direction they were trained indicated allocentric responding. Six-month-olds exhibited egocentric responding regardless of the presence of the landmark, 11-month-olds exhibited allocentric responding when the landmark was present, and 16-month-olds exhibited allocentric responding even without the landmark. These results suggest that infants as young as 11 months old are able to code the location of an interesting event in relation to salient landmark information.

Another important change has been characterized as the *proximal to distal shift* in externally based coding systems. A large body of work has shown that young children rely on proximal before distal landmarks to remember locations (e.g., Acredolo, 1976; Allen & Kirasic, 1988; Craton et al., 1990; Newcombe, Huttenlocher, Drummey, & Wiley, 1998; Overman, Pate, Moore, & Peuster, 1996; Sluzenski, Newcombe, & Satlow, 2004). For example, Newcombe et al. (1998) found that children ages 22 months and older searched more accurately for a toy that was hidden in a long, narrow sandbox when distal landmarks (e.g., door and windows) were available. The availability of distal landmarks made no difference for children ages 21 months and younger, suggesting that the ability to use distal landmarks is undergoing change in early childhood. In a study with older children, Acredolo (1978) examined how 5- and 10-year-olds coded their starting position in a room when both proximal (table) and distal (door and bookshelf) landmarks were available. Children stood next to a table and then were blindfolded and taken on a disorienting walk. While they were walking, the table was silently moved to a new location. When asked to go back to the place where they started, 5-year-olds went and stood by the table, whereas 10-year-olds went to the correct position within the room. Presumably, the older children's reliance on more distal landmarks allowed them to locate their starting position despite conflicting information.

Everyday spatial communication also involves choosing between alternative reference frames. When asked where something is, a speaker can use a landmark (e.g., "it's next to the chair") or a person (e.g., "it's right in front of me") as a reference point. To date, little is known about how children or adults select reference frames when communicating about location. One exception is a study by Craton et al. (1990) that examined developmental changes in preferences for person (i.e., self or listener) and landmark reference frames when both were available for verbally disambiguating identical locations. In this study, 4-, 6-, and 8-year-old children had to describe the location of a hidden object to a listener who was sitting on the opposite side of a small room. The hiding locations were two or four identical cups placed upside down on a small table in front of the listener. There were landmarks proximal (i.e., colored tape on the edges of the table) and distal (i.e., colored curtains on the walls) to the cup array that could be used to describe the location of the hidden object. Participants had to describe the location of the hidden object with respect to either the left–right dimension, the front–back dimension, or both. Importantly, the 4-year-olds preferred to use person references to differentiate front–back relations (e.g., "it's the cup closest to you"), even when landmarks were available (i.e., the tape on the table and the curtains on the wall). These results suggest young children find it easier to communicate about the front–back dimension using person rather than landmark frames of reference.

The goals of the present study were to examine how mothers communicate about the locations of hidden objects to young children and to assess how well young children use these directions to find hidden objects. In Experiment 1, mothers were asked to disambiguate two identical hiding locations for their 2.5-, 3-, and 3.5-year-old children. We chose these ages based on pilot testing showing substantial age changes in children's ability to successfully follow simple directions between the ages of 2.5 and 3.5 years. We chose to study only mothers based on research showing differences in how mothers and fathers communicate with young children (e.g., Gauvain, Fagot, Leve, & Kavanagh, 2002). While children were not looking, mothers watched an experimenter hide a toy in one of two identical containers on the floor of the testing room. Throughout the 16 test trials, the containers were placed such that the target and nontarget containers varied with respect to their relative proximity to mother and child and to a landmark on the floor. Mothers were instructed to tell their children where the toy was hidden without pointing. Children then attempted to find the toy on the first try.

Two issues were of particular interest. The first was whether mothers' choice of reference frames (e.g., person or landmark) varied with the age of the child and the location of the target container. One possibility is that mothers may prefer to relate the location of a hidden object to themselves or the child, based on younger children's preferences for egocentric frames of reference. A second possibility is that mothers may prefer to relate the location of a hidden object to whatever is most proximal, based on children's preferences for proximal over distal landmarks. The second issue of interest was how children's success in finding the toy varied with the age of the child and the reference frame mothers used. On the basis of young children's preferences for coding location relative to the self (i.e., the egocentric to allocentric shift), they may be more successful in following directions involving person than landmark references. However, based on their preferences for proximal over distal landmarks, we would also expect that young children would also be better at following directions involving proximal than distal landmarks.

Experiment 1A

Method

Participants. Forty-eight mother–child dyads participated in the study. There were sixteen 2.5-year-olds (mean age: 30 months, 5 days; range: 29 months, 4 days–31 months, 8 days), sixteen 3-year-olds (mean age: 35 months, 28 days; range: 35 months, 4 days–36 months, 26 days), and sixteen 3.5-year-olds (mean age: 41 months, 24 days; range: 41 months, 9 days–42 months, 26 days) and their mothers. There were equal numbers of male and female children in each age group. Fourteen additional participants (six 2.5-year-olds, three 3-year-olds, and five 3.5-year-olds) were not included for the following reasons: (a) came with their fathers, (b) refused to start, (c) did not complete all of the test trials, (d) mother had previously participated with a sibling, and (e) technical problems. Participants were recruited through a child research participant registry maintained by the Department of Psychology at a Midwestern university. Parents received a letter describing the study, followed by a telephone call inviting them to participate. Ninety-eight percent of the children were European American, and 2% were Hispanic/Latino. Two percent of the mothers had completed only their high school education, 21% had completed some college education, and 77% had a 4-year-college education or beyond.

Apparatus and materials. Two identical, opaque Plexiglas containers with opaque lids (3 in. tall, 2.5 in. in diameter) and a circular landmark (8 in. in diameter) made of laminated paper were placed on the floor in a 6.5-ft-wide × 9-ft-long room (see Figure 1). A ceiling-to-floor-length curtain encased the entire perimeter of the room. A chair for the mother was placed approximately 48 in. from the center of the landmark. The chair for the child was placed next to the mother's chair, but behind the curtain. A Sony Handycam DCR-HC96 camcorder was used to record the entire session.

Design and procedure. The session started with two familiarization trials outside of the testing room in which mothers told the children how to find an object hidden in one of two containers. One container was placed on top of a chair that was approximately 48 in. from where the mothers were seated. The second container was located on the floor next to the chair. Both containers were visible at all times, and the toy was hidden in each container one time. Mothers were instructed to watch the experimenter hide the toy and make sure that the child could not see it being hidden. After the toy was hidden, the mothers gave children directions for how to find the hidden object. Mothers were asked to make sure they gave a complete direction, one which provided enough information for the child to find the toy on the first try, before letting the child go search. Mothers were allowed to answer any questions the children asked, but they were not allowed to point. Children were allowed to search until they found the toy.

After the familiarization trials, mothers and children completed 16 test trials in the testing room. During each test trial, one container was located 2 in. from the edge of the circle on one side, and the other container was 12 in. from the edge of the circle on the opposite side, such that the containers were always at unequal distances from the landmark. Figure 2 shows the four trial types (TT1, TT2, TT3, and TT4). Participants completed four blocks of trials, with each trial type presented once in a random order in each block. At the start of each trial, the mother instructed the child to hide behind the curtain, so he or she could not see where the experimenter hid the object. After the toy was hidden, the mother brought the child out from behind the curtain and gave directions (without pointing) for finding the hidden object. Children then searched for the object. Mothers were allowed to interact with their child after giving the initial directions.

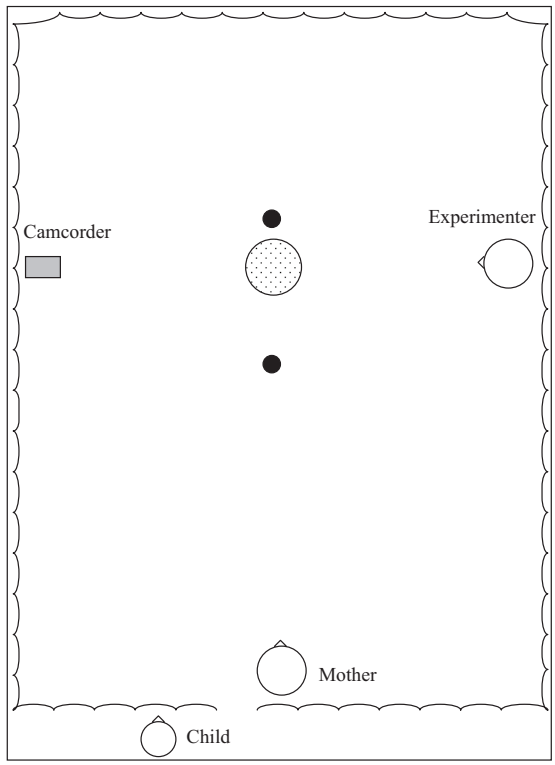

Figure 1. Diagram of testing room.

Coding and measures. Each session was videotaped and transcribed verbatim for coding. Only directions given before the child began to approach the containers were coded. Mothers used a variety of strategies to describe the location of the hidden toy to their children. A coding scheme was developed based on the reference frames, spatial terms, and other strategies that mothers used most frequently to describe the location. Trials were dropped from consideration if mothers pointed at the containers, children searched before mothers gave a direction, children opened both containers simultaneously, or children did not complete a trial. Children who did not have at least two trials of each trial type were excluded from the study. An Age (2.5, 3, and 3.5 years) × Trial Type (TT1, TT2, TT3, TT4) repeated measures analysis of variance (ANOVA) on the number of trials of each type completed yielded no significant effects. The mean number of trials completed for TT1, TT2, TT3, and TT4 was 3.83 (SD = .38), 3.90 (SD = .31), 3.90 (SD = .31), and 3.83 (SD = .43), respectively.

Reference frames. The overwhelming majority of the reference frames used were landmark and person references. A landmark reference included any reference to the circle, the curtain, or the back wall of the testing room, as well as implicit

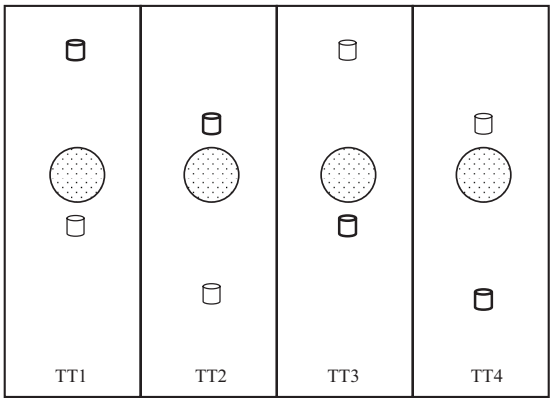

Figure 2. Locations of target and nontarget containers in Experiments 1 and 2. The target container is darkened in this figure for illustration purposes only. TT = trial type.

references to an external landmark, such as "the other side" of the room. A person reference included any reference to "me" (mother) or "Mommy," "you" (child), and "us" (mother and child), as well as implicit references to the mother and child, such as "the close one." (Note that such references were only coded as implicit person references when the target location was close to the mother and the nontarget location was far from the landmark.) We chose to call all of these person references because the mother and child shared the same viewpoint. Scores for each type of reference frame were calculated based on the total number of times that each reference frame was used within each trial type divided by the total number of trials completed of each type. Thus, there were four scores for each reference frame, representing the mean number of landmark and person references per trial for each trial type.

Spatial relational terms. The majority of the spatial relational terms were variants of *close to* (by, near, next to, not far from) and *far from* (away from, not by, not close to). Scores for spatial relational terms were calculated based on the total number of times within each trial type that each spatial term was used divided by the total number of trials completed of each type. Again, there were four scores for each spatial term, representing the mean number of *close to* and *far from* references per trial for each trial type.

Children's search success. We coded whether children searched in the correct container on the first try. If a child approached one container but the mother offered additional information after the approach (e.g., "No, no, not that one") and the child changed his or her mind, we coded the first container approached as the container searched. This occurred on 6% of trials. Scores for correct searches were calculated based on the proportion of trials within each trial type that children searched correctly.

Intercoder reliabilities. Intercoder reliabilities (n = 9) for reference frames and spatial terms were high, ranging between r = .94 and r = .98. Intercoder reliability based on exact percent agreement for search success was 98%.

Results

Preliminary analyses with child gender as a factor revealed no significant main effects or interactions involving gender. Therefore, we collapsed across gender in all of the analyses reported below.

Mothers' reference frame use. We compared mothers' use of the two predominant reference frames to examine whether mothers' use of landmark and person references shifted depending on the child's age and the trial type. (Note that a direct comparison of the two reference frames is possible because mothers were free to use both in a given trial.) The mean number of landmark and person references per trial for each trial type was entered into an Age (2.5, 3, 3.5 years) × Reference Frame (landmark, person) × Trial Type (TT1, TT2, TT3, TT4) mixed model ANOVA with the first factor as a between-subjects variable and the second and third factors as within-subjects variables. This analysis yielded a significant effect of age, $F(2, 45) = 5.97$, $p < .01$, $\eta_p^2 = .21$. Mothers provided more reference frames overall (landmark and person reference frames combined) to 2.5-year-olds (M = .93, SD = .82) than to 3.5-year-olds (M = .61, SD = .56). The 3-year-olds (M = .80, SD = .67) did not differ from the 2.5- and 3.5-year-olds.

There was also an effect of trial type, $F(3, 135) = 13.58$, $p < .0001$, $\eta_p^2 = .23$, that was subsumed under a significant Trial Type × Reference Frame interaction, $F(3, 135) = 32.64$, $p < .0001$, $\eta_p^2 = .42$. As shown in Figure 3, simple effects tests revealed a significant effect of reference frame for TT1, $F(1, 45) = 4.78$, $p < .05$; for TT2, $F(1, 45) = 5.71$, $p < .05$; and for TT4, $F(1, 45) = 54.29$, $p < .0001$; but not for TT3, $F(1, 45) = 0.005$, *ns*. Mothers preferred a person reference frame when the target container was close to them and far from the landmark (TT4). They preferred a landmark reference frame when the target was far from them and far from the landmark (TT1) and when the target was close to the landmark and far from them (TT2). When the target

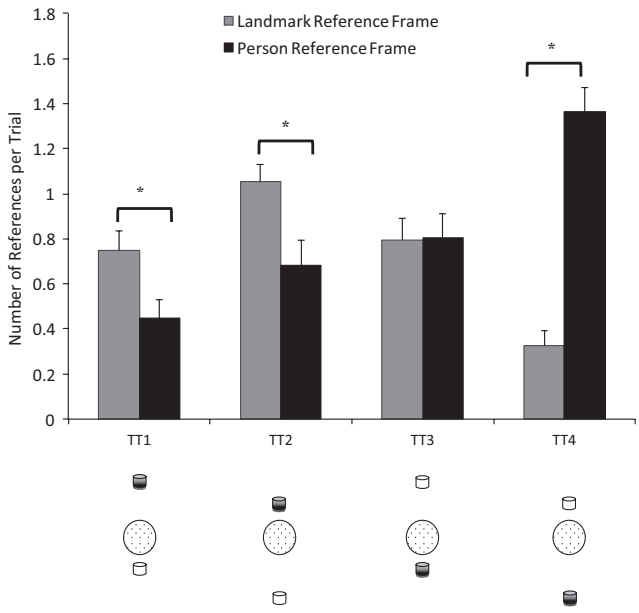

Figure 3. Mean number of landmark and person references per trial by trial type (TT) in Experiment 1. The target container is darkened in this figure for illustration purposes only. Brackets with asterisks represent a significant difference between the pair of means. Error bars represent standard errors.

container was close to the circle and close to them (TT3), they used person and landmark references equally.

Next, we looked more closely at mothers' use of person references to determine whether there were preferences for using the self (e.g., "mommy"), the child (e.g., "you"), or both the self and child (e.g., "us") as a frame of reference. An Age (2.5, 3, 3.5 years) × Reference Frame (self, child, both) × Trial Type (TT1, TT2, TT3, TT4) mixed model ANOVA revealed significant effects of reference frame, $F(2, 90) = 8.25$, $p < .001$, $\eta_p^2 = .15$, and trial type, $F(3, 135) = 44.47$, $p < .001$, $\eta_p^2 = .50$, and a significant Reference Frame × Trial Type interaction, $F(6, 270) = 4.38$, p .001, $\eta_p^2 = .09$. Post hoc tests of the reference frame effect showed that mothers referred significantly more often to the self ($M = .39$, $SD = .59$) and to the self and child ($M = .28$, $SD = .49$) than to just the child ($M = .06$, $SD = .22$). There was no difference in references to the self and to the self and child. Simple effects tests of the Reference Fame × Trial Type interaction revealed that this pattern held across all trial types except that the difference between self and child ($M = .14$, $SD = .35$) and child ($M = .01$, $SD = .06$) was marginally significant for TT2 ($p = .06$).

We also examined individual differences in mothers' use of reference frames. Of particular interest was the extent to which mothers predominantly used landmark, person, or a mixture of landmark and person reference frames. To classify mothers' reference frame use, we looked at the proportion of landmark reference frames out of the total landmark and person reference frames used for each trial type (proportion of landmark references = landmark references/landmark + person references). We classified mothers as using predominantly (a) landmark reference frames if the proportion of landmark reference frames was .66 or greater, (b) person reference frames if the proportion of landmark references was .33 or lower, and (c) a mixture of landmark and person reference frames if the proportion of landmark reference frames was greater than .33 and less than .66. As shown in Table 1, the percentages of mothers who fell into each category for each trial type closely mirrored the analyses above on the mean number of landmark and person reference frames. In addition, 85% of mothers exhibited at least one switch from one strategy to another (landmark, person, or mixture) across trial types. Furthermore, 54% of mothers exhibited at least one switch from a predominantly landmark to a predominantly person reference frame across trial types. Thus, the individual patterns of reference frame use support the conclusion that mothers were alternating between reference frames across trial types.

Mothers' spatial relational term use. We compared mothers' use of the two predominant spatial terms to examine whether mothers' use of *close to* and *far from* references shifted depending on age and the trial type. The mean number of *close to* and *far from* references per trial for each trial type was entered into an Age (2.5, 3, 3.5 years) × Spatial Relational Term (close to, far from) × Trial Type (TT1, TT2, TT4) repeated measures ANOVA with the first factor as a between-subjects variable and the second and third factors as within-subjects variables. (Because mothers never used "far from" for TT3, we excluded this trial type from the analysis.) As with the reference frame analysis, there was a significant Trial Type × Spatial Term interaction, $F(2, 90) = 56.20$, $p < .001$, $\eta_p^2 = .56$. Simple effects tests revealed a significant effect of spatial term for TT1, $F(1, 45) = 63.63$, $p < .001$, and for TT4, $F(1, 45) = 86.05$, $p < .001$, but not for TT2, $F(1, 45) = 0.04$, *ns*. As shown in Figure 4, mothers used *far from* references more often than *close to* references when the target was far from them and far from the landmark (TT1), whereas they used *close to* references significantly more often than *far from* references when the target was close to them and far from the landmark (TT4). The mean number of *close to* and *far from* references was nearly identical when the target was far from them and close to the landmark (TT2). As one would expect, when the target was close to the landmark and close to themselves (TT3), mothers exclusively used *close to* references.

Children's search success. The first analysis examined whether the magnitude of correct searches differed by age or trial type. The mean proportion of correct searches was entered into an Age (2.5, 3, 3.5 years) × Trial Type (TT1, TT2, TT3, TT4) mixed

Table 1
Percentage of Mothers Using Predominantly Landmark, Person, or Mixed Frames of Reference in Experiment 1

	Age group		
Trial type (TT)	2.5 years	3 years	3.5 years
TT1 (far from mother, far from landmark)			
Landmark	56	46	60
Person	25	31	20
Mixed	19	23	20
TT2 (far from mother, close to landmark)			
Landmark	50	44	69
Person	25	12	0
Mixed	25	44	31
TT3 (close to mother, close to landmark)			
Landmark	37	20	56
Person	44	53	38
Mixed	19	27	6
TT4 (close to mother, far from landmark)			
Landmark	6	6	19
Person	75	81	75
Mixed	19	13	6

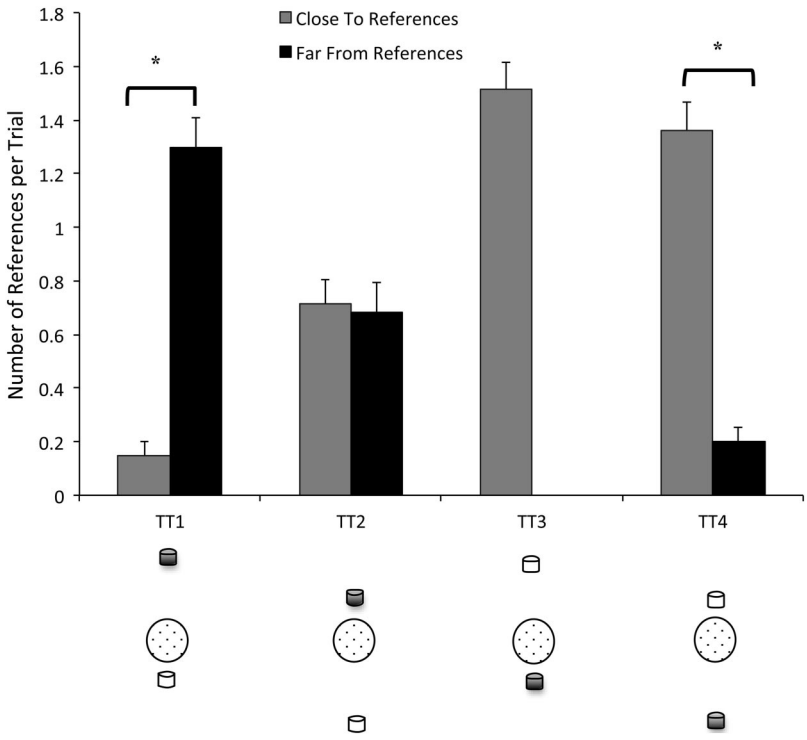

Figure 4. Mean number of *close to* and *far from* references per trial by trial type (TT) in Experiment 1. The target container is darkened in this figure for illustration purposes only. Brackets with asterisks represent a significant difference between the pair of means. Error bars represent standard errors.

model ANOVA. There was only a significant effect of age, $F(2, 45) = 5.34$, $p < .01$, $\eta_p^2 = .19$. Fisher's protected least significant difference follow-up tests indicated that 3.5-year-olds ($M = .80$, $SD = .26$) were more likely to search correctly than both 2.5-year-olds ($M = .61$, $SD = .32$) and 3-year-olds ($M = .68$, $SD = .32$). The two younger age groups did not significantly differ from one another.

The second analysis examined whether the proportion of correct searches on each trial type exceeded that expected by chance (see Figure 5). We used separate one-sample *t* tests for each age group and trial type to compare the proportion of correct searches to the chance value of .50. The 3.5-year-olds were significantly above chance on all trial types, $ts(15) > 3.50$, $p < .01$. In contrast, the 3-year-olds were above chance when the target container was close to the mother and child (TT3 and TT4), $ts(15) > 2.90$, $p < .01$, but not when the target container was far from the mother and child (TT1 and TT2), $ts(15) < 1.90$, $p > .05$. The 2.5-year-olds were at chance for all trial types except when the target was far from the mother and close to the landmark (TT2), $t(15) = 2.63$, $p < .05$.

Contingencies between mothers' reference frame use and children's search success. We also explored whether the proportion of correct searches on each trial in response to mothers' use of person and landmark reference frames exceeded that expected by chance. We calculated the proportion of trials in which children searched correctly in response to landmark reference frames and to person reference frames. We excluded trials in which mothers used a mixture of landmark and person reference frames or another type of reference frame (41% of trials). We used separate one-sample *t* tests for each age to compare children's success in response to a landmark versus person reference frame to the chance value of .50. The 2.5-year-olds were not above chance in response to landmark references, $t(9) = 0.59$, *ns* ($M = .55$, $SD = .28$), but they were above chance in response to person references, $t(14) = 3.65$, $p < .01$ ($M = .72$, $SD = .23$). Likewise, the 3-year-olds were not above chance in response to landmark references, $t(10) = -0.56$, *ns* ($M = .44$, $SD = .37$), but they were above chance in response to person references, $t(14) = 2.45$, $p < .05$ ($M = .69$, $SD = .30$). The 3.5-year-olds were above chance in response to both landmark, $t(13) = 3.66$, $p < .01$ ($M = .78$, $SD = .29$), and person references, $t(15) = 2.31$, $p < .05$ ($M = .71$, $SD = .36$).

Experiment 1B

Method

Participants. Eight adults participated in a follow-up study designed to test the adequacy of the directions mothers gave to their children. There were five males and three females (mean age: 19 years, 6 months; range: 18 years, 3 months–22 years, 10 months). The adult participants were recruited through an elementary psychology course and received course credit for their participation. Eighty-eight percent were European American, and 12% identified themselves as mixed race.

Procedure. We asked the adult participants to try to locate the correct container on the basis of the directions mothers gave to

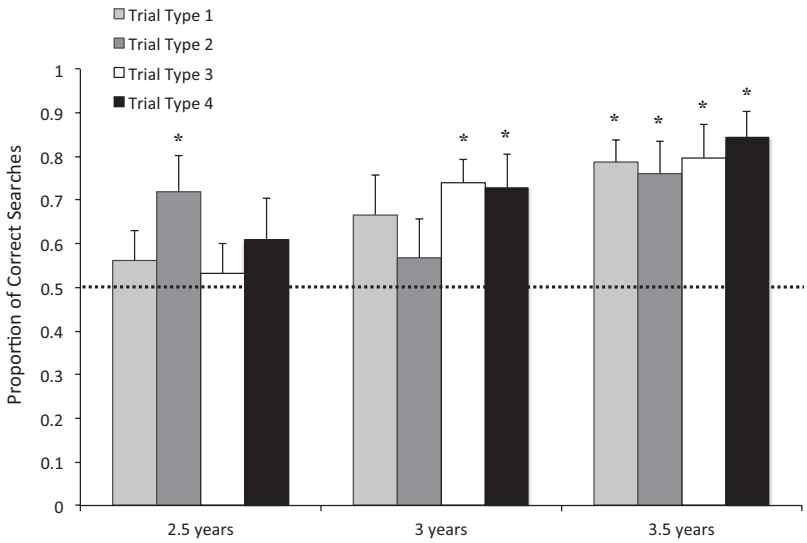

Figure 5. Proportion of correct searches by age and trial type in Experiment 1. The dotted line represents chance performance. Asterisks represent performance that is significantly above chance. Error bars represent standard errors.

their children. Each adult heard the directions given to six children (two in each age group). The experimenter first showed them the setup and explained the procedure that was used during the mother–child study. The experimenter and adult then sat side by side at a table in the testing room, viewing the setup from the same perspective as the mother and child. The four trial types were depicted on four 8.5-in. × 11-in. cards showing the relative locations of the blue circle and the two identical containers (as in Figure 2). For each of the 16 trials, the experimenter placed the card depicting the trial type used for that particular trial in front of the participant. The experimenter then read the mother's directions verbatim (only the directions given before the child began to approach the containers were used). Participants were instructed to point to the target container if they thought they knew where the toy was hiding or to answer, "I don't know," if they could not ascertain where the toy was hiding. The "I don't know" option was made available to reduce the likelihood of inflating correct answers through guessing. The recorded answers were later coded as correct or incorrect, based on the actual location of the target container. The "I don't know" answers were coded as incorrect.

Results

Adults located the correct container on 98% of trials on average. They were 98%, 99.5%, and 96% correct on directions given to 2.5-year-olds, 3-year-olds, and 3.5-year-olds, respectively. Thus, the initial directions that mothers gave to their children were clearly sufficient for finding the hidden toy.

Discussion of Experiments 1A and 1B

Mothers clearly adjusted their choice of reference frames and spatial terms depending on the target location. They were more likely to use landmark than person reference frames when the target was close to the landmark and far from them (TT2) and far from the landmark and far from them (TT1). They were more likely to use person reference frames to describe the location close to them and far from the landmark (TT4) and equally likely to use landmark and person references when the target was close to the landmark and close to them (TT3). This pattern of reference frame use indicates that mothers based their choices on spatial proximity. Mothers' use of spatial terms also varied depending on the target location. They were more likely to use "far from" when the target location was farthest from them (TT1), and they were more likely to use "close to" to describe the two locations that were closest to them (TT3 and TT4). Mothers were equally likely to use "close to" and "far from" to describe the location that was far from them and close to the circle (TT2). Overall, mothers showed strong systematicity in their use of both reference frames and spatial terms.

Children across the 2.5- to 3.5-year-old age range studied here varied considerably in their success in using mothers' directions to find the hidden object, even though naïve adults had no problem in following the mothers' directions. The 3.5-year-olds performed significantly better than the 2.5- and 3-year-old children and showed levels of search success that were above chance on all trial types. The 2.5-year-olds had difficulty following their mothers' directions, exhibiting levels of search success that were at chance on all trial types except TT2. In keeping with 2.5-year-olds' difficulty with following directions, mothers also provided more reference frames overall to the 2.5-year-olds than to the 3.5-year-olds. This often took the form of repeating the same reference frame (e.g., "It's close to the circle and close to us, close to the circle and close to us"). Moreover, mothers provided the highest number of references overall to 2.5-year-olds on TT2, which may explain why 2.5-year-olds' search performance was above chance on this trial type. The 3-year-olds fell between the other two age groups, performing above chance on the two target locations closest to the mother (TT3 and TT4). Interestingly, the analyses of

the contingencies between mothers' reference frame use and children's search success revealed that 2.5- and 3-year-olds were more successful using person than landmark reference frames. Together, these results suggest that younger children found it easier to follow directions relating a location to a proximal person than object.

We conducted a second experiment to directly test this hypothesis. We wanted to retain the basic mother–child communication task, but we also wanted to control the reference frames children experienced. Therefore, we used the same procedure as before, except that we asked mothers to use either only themselves or only the circle as a reference point when giving directions to their 3-year-old children. We chose mothers rather than children as reference points because almost all of the person references in Experiment 1 involved the mother's location (e.g., "the one closer to mommy" or "the one close to us"). We focused on the 3-year-olds because they were a transitional age group, exhibiting successful searches only at the two target locations closest to the mother.

This pattern of performance raises interesting possibilities for how 3-year-olds might respond to directions that exclusively rely on either a landmark or a person frame of reference, particularly those involving the spatial relational term *close.* One possibility is that 3-year-olds can successfully follow directions involving closeness to either a person or a landmark, but only when they do not need to bypass the nontarget container to reach the target container. In this case, children receiving person directions should search successfully in the two locations closest to the mother (TT3 and TT4), and children receiving landmark directions should search successfully when the location is close to the circle and close to the mother (TT3), but not when the location is close to the circle and far from the mother (TT2). This hypothesis rests on the idea that 3-year-olds can follow directions involving either proximal person or landmark references, but only when they do not need to inhibit searching the first container they encounter (for a review of executive function in young children, see Garon, Bryson, & Smith, 2008). A second possibility is that 3-year-olds can successfully follow directions involving closeness to a person but not to a landmark. In this case, children receiving person directions should search successfully in the two locations closest to the mother (TT3 and TT4), and children receiving landmark directions should not search successfully even when the location is close to the circle (TT2 and TT3). This hypothesis rests on the idea that young children use person before landmark reference frames to communicate about the location of a hidden object (Craton et al., 1990).

Experiment 2A

Method

Participants. Thirty-two mother–child dyads participated. There were sixteen 3-year-olds (eight females) in the person reference frame condition and sixteen 3-year-olds (six females) in the landmark reference frame condition (mean age: 34 months, 13 days; range: 33 months, 0 days–37 months, 28 days). Participants were recruited in the same manner as Experiment 1. Six additional child participants were not included because they refused to start or did not complete the task. Ninety-one percent of the children were European American, and 9% were multiracial. Sixteen percent of the mothers had completed some college education, and 84% had a 4-year college education or beyond.

Apparatus and materials. The apparatus and materials were the same as those used in Experiment 1. A second Handycam DCR-HC96 camcorder was placed at the back of the room to provide another camera angle for coding purposes.

Design and procedure. The session again started with two familiarization trials outside of the testing room in which mothers told the children how to find an object hidden in one of the two identical containers. The circular landmark was placed on the floor approximately 48 in. from the mother's chair. One container was placed close to the mother's chair, and the other container was placed close to the circle. Each container served as the target for one familiarization trial. While the child was turned away, the experimenter hid a toy in one of the containers. In the landmark condition, the experimenter gave the following instructions to the mother: "I'd like you to tell [child's name] where the toy is in relation to the circle. When we play for real we're going to ask that you only give directions that involve the circle as a reference point." In the person condition, the experimenter gave the following instructions to the mother: "I'd like you to tell [child's name] where the toy is in relation to you. When we play for real we're going to ask that you only give directions that involve you as a reference point." The experimenter answered any questions from the mother but avoided giving specific examples of directions involving each reference frame.

After the familiarization trials, mothers and children completed 16 test trials in the testing room. All aspects of the procedure were identical to that used in Experiment 1 except for the instructions regarding use of reference frames to describe the location of the target container. Once the mother and child were settled in the testing room, the experimenter said, "OK, now we're going to do the same thing. I'll hide the toy in one of the two containers while [child's name] is behind the curtain. Then, you'll tell [child's name] where the toy is in relation to [blue circle, yourself]. Just like we did during the practice ones." If a mother inadvertently used the wrong reference frame for a trial, the experimenter reminded her at the beginning of the next trial "to tell the child where the toy was hiding in relation to [blue circle, yourself]."

Coding and measures. The coding and measures were identical to those used in Experiment 1. Trials were dropped from consideration if mothers pointed at the containers, mothers used the wrong reference frame (13 mothers, 17 trials total), children searched before mothers gave a direction, children opened both containers simultaneously, or children did not complete a trial. Again, only directions given before the child approached the containers were coded. We again coded whether children searched in the correct container on the first try. On 4% of trials, we coded the first container approached (but not physically searched) as the container searched. The number of trials of each type completed was entered into a Condition (person, landmark) × Trial Type (TT1, TT2, TT3, TT4) mixed model ANOVA. There were no significant effects. The mean number of trials per type completed was 3.58 (SD = .61) in the person condition and 3.33 (SD = .67) in the landmark condition. The mean number of trials completed for TT1, TT2, TT3, and TT4 was 3.41 (SD = .67), 3.53 (SD = .57), 3.50 (SD = .67), and 3.38 (SD = .71), respectively. Intercoder reliabilities (n = 6) for reference frames and spatial terms were high, ranging between r = .94 and r = .97. Intercoder

reliability based on exact percent agreement for search success was 99%.

Results

Preliminary analyses with gender as a factor showed no significant main effects or interactions involving gender. Therefore, we collapsed across gender in all of the analyses reported below.

Mothers' use of reference frames. We first analyzed mothers' use of reference frames to determine whether the amount of information they gave varied across conditions. Table 2 shows that the quantity of landmark references in the landmark condition was very similar to the quantity of person references in the person condition. A Condition (2) × Trial Type (4) mixed model ANOVA confirmed that the mean number of references per trial did not differ across the person ($M = 1.82$, $SD = .80$) and landmark ($M = 1.92$, $SD = .88$) conditions, $F(1, 30) = 0.15$, *ns*. Neither the effect of trial type nor the interaction of condition and trial type was significant. This indicates that any differences in children's search success across conditions were due to the type and not to the quantity of reference frames mothers provided.

Mothers' use of spatial relational terms. We also analyzed mothers' use of spatial relational terms to determine whether their use of spatial relational terms differed across conditions. As in Experiment 1, mothers primarily used variants of "close to" and "far from" to describe the location of the target container to their children. Table 3 shows that mothers in the two conditions chose spatial terms that were appropriate for the trial type. For example, mothers in both conditions used "far" when the target container was both far from the landmark and far from themselves (TT1) and "close" when the target container was both close to the landmark and close to themselves (TT3). To examine whether the quantity of spatial terms differed across conditions, we conducted a Condition (2) × Trial Type (4) mixed model ANOVA on the mean number of spatial terms per trial. There was no main effect of condition, but there was a significant Condition × Trial Type interaction, $F(3, 90) = 4.37$, $p < .01$. Simple effects tests showed that mothers provided significantly more spatial relational terms in the person than in the landmark condition for TT1 (far from the mother and far from the landmark), $F(1, 30) = 7.31$, $p < .05$. However, there was no significant difference between the person and landmark conditions for the other three trial types, indicating that the quantity of spatial terms was similar across conditions for the majority of trial types.

Children's search success. Of primary interest was whether children's search success varied by condition and trial type. To examine this question, we first entered the mean proportion of correct searches into a Condition (2) × Trial Type (4) mixed model ANOVA. The main effects of condition and trial type were not significant, but there was a highly significant Condition × Trial Type interaction, $F(3, 90) = 8.08$, $p < .001$, $\eta_p^2 = .21$. Simple effects tests broken down by condition revealed that there was a significant effect of trial type for the person condition, $F(3, 45) = 8.49$, $p < .001$, $\eta_p^2 = .36$, but not for the landmark condition, $F(3, 45) = 2.03$, $p = .12$. Additional simple effects tests broken down by trial type revealed a significant effect of condition for TT3, $F(1, 30) = 15.95$, $p < .001$, $\eta_p^2 = .35$, and for TT4, $F(1, 30) = 7.84$, $p < .01$, $\eta_p^2 = .21$, but not for TT1, $F(1, 30) = 1.89$, $p = .18$, or TT2, $F(1, 30) = 1.05$, $p = .31$. As shown in Figure 6, children in the person condition performed significantly better on TT3 and TT4 (when the target container was relatively close to the mother) than on TT1 and TT2 (when the container was relatively far from the mother). Children in the landmark condition performed equally poorly on all trial types. Likewise, children in the person condition performed significantly better than children in the landmark condition on TT3 and TT4, but not on TT1 and TT2.

The second analysis examined whether the proportion of correct searches on each trial type exceeded that expected by chance (.50). As shown in Figure 6, separate one-sample *t* tests revealed that children in the person condition were significantly above chance on TT3, $t(15) = 9.43$, $p < .001$, and TT4, $t(15) = 3.02$, $p < .01$, but not on TT1 and TT2, $ts(15) < -0.66$, *ns*.

Table 2
Mean Number of Landmark and Person References Per Trial for Each Condition and Trial Type in Experiment 2

Trial type (TT)	Condition: Landmark	Condition: Person
TT1 (far from mother, far from landmark)		
Landmark references	1.80 (.82)	0.00
Person references	0.00	2.02 (.82)
TT2 (far from mother, close to landmark)		
Landmark references	1.94 (.94)	0.00
Person references	0.00	1.84 (.99)
TT3 (close to mother, close to landmark)		
Landmark references	1.90 (.85)	0.00
Person references	0.00	1.67 (.75)
TT4 (close to mother, far from landmark)		
Landmark references	2.03 (.98)	0.00
Person references	0.00	1.73 (.60)

Note. Standard deviations are given in parentheses.

Table 3
Mean Number of Close and Far References Per Trial for Each Condition and Trial Type in Experiment 2

Trial type (TT)	Condition	
	Landmark	Person
TT1 (far from mother, far from landmark)		
Close references	0.00	0.06 (.25)
Far references	1.17 (.91)	2.02 (.86)
TT2 (far from mother, close to landmark)		
Close references	1.22 (1.00)	0.00
Far references	0.00	1.96 (1.20)
TT3 (close to mother, close to landmark)		
Close references	1.57 (.86)	1.65 (.80)
Far references	0.00	0.00
TT4 (close to mother, far from landmark)		
Close references	0.00	1.61 (.78)
Far references	1.18 (1.00)	0.00

Note. Standard deviations are given in parentheses.

Children in the landmark condition were not above chance on any of the trial types, ts(15) < 1.34, *ns*.

Experiment 2B

Method

Participants. Six adults participated in a follow-up study designed to test the adequacy of the directions mothers gave to their children. There were three males and three females (mean age: 21 years, 6 months; range: 18 years, 1 month–28 years, 11 months). The adult participants were recruited in the same manner as in Experiment 1B. Eighty-three percent were European American, and 17% were Asian American.

Procedure. The procedure and coding used with the adult participants to test the adequacy of mothers' directions were identical to that used in Experiment 1. Four adults heard the directions

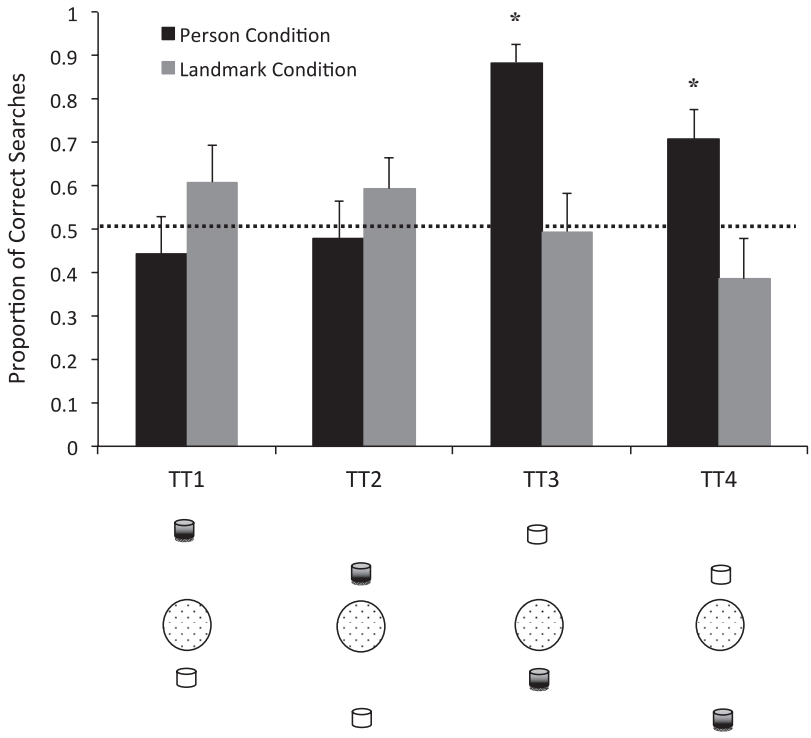

Figure 6. Proportion of correct searches by condition and trial type (TT) in Experiment 2. The target container is darkened in this figure for illustration purposes only. The dotted line represents chance performance. Asterisks represent performance that is significantly above chance. Error bars represent standard errors.

given to six children, and two adults heard the directions given to four children.

Results

Adults located the correct container on 97.6% of trials on average. They were 98% and 97% correct on directions given in the landmark and person conditions, respectively. As in Experiment 1B, the initial directions that mothers gave to their children were clearly sufficient for finding the hidden toy.

Discussion of Experiments 2A and 2B

The results of this experiment point to two main conclusions. The first is that young children have difficulty following directions involving the relation *far from.* Neither children in the person condition nor children in the landmark condition were successful in locating the correct container when mothers described the target container as "far from" either themselves or the circle. Given that it is somewhat unusual to describe the location of an object as far from something else, young children may have had little experience with following directions involving the relation of *far from.* In fact, their performance in this experiment suggests that children of this age may not even comprehend the term *far from.* This is in keeping with other research showing that 3-year-olds have difficulty with making judgments about relative proximity (Hund & Plumert, 2007).

The second conclusion is that young children are more successful in following directions involving closeness to a person than to a landmark. Children in the person condition were above chance in following mothers' directions when the target container was relatively close to the mother and child (TT3 and TT4), but children in the landmark condition were not above chance when the target container was relatively close to the circle (TT2 and TT3). Children's performance on TT3 was particularly telling. Even though the target container was relatively close to both the mother and the circle and was the first container children encountered as they began to search, only children in the person condition exhibited above-chance search success. In addition, a cross-experiment comparison revealed that 3-year-olds in the person condition in Experiment 2 ($M = .89$, $SD = .16$) performed significantly better than 3-year-olds in Experiment 1 ($M = .74$, $SD = .21$) on TT3, $t(30) = 4.92$, $p < .05$. This suggests that 3-year-olds' search success in Experiment 1 was hindered by mothers' use of landmark references. (Recall that mothers used landmark and person frames of references equally for TT3 in Experiment 1). This also fits with the results of the contingency analyses in Experiment 1 showing that 2.5- and 3-year-olds exhibited above-chance search success in response to person reference frames, but not in response to landmark reference frames. Overall, the results of Experiment 2 provide strong evidence that young children are able to follow directions involving proximal person frames of reference before they are able to follow directions involving proximal landmark frames of reference.

General Discussion

The current investigation set out to address two main questions about mother–child spatial communication. One was how mothers' choice of reference frames (i.e., person and landmark) varied with the proximity of the target and nontarget containers relative to themselves and the landmark. The other was how young children's success in following directions varied with the reference frames their mothers used. When mothers were free to choose a frame of reference in Experiment 1, their choices were primarily governed by the relative proximity of the target container to the landmark and themselves. In short, they preferred to relate the target container to whatever was closer, the landmark or themselves. Although the 3.5-year-olds were successful in following directions for all target locations regardless of the reference frame mothers used, 3-year-olds' success depended on the target location and the reference frame. Specifically, they were only successful in following directions when the target was relatively close to the mother and when mothers used a person frame of reference. We confirmed 3-year-olds' preference for person over landmark reference frames in Experiment 2 by asking mothers to only use either the circle or themselves as a frame of reference. Again, 3-year-olds were successful when mothers described the target container as close to themselves but at chance when mothers described the target container as close to the circle.

What do these results tell us about the extent to which mothers tailored their directions to the developmental level of their child? Overall, it appears that mothers weighted spatial proximity more heavily than the reference frame when communicating to their young children about the location of the hidden toy. Given the fact that the 3-year-olds in Experiment 2 exhibited chance levels of search success when mothers described the target as far from themselves or the circle, mothers' preference in Experiment 1 for describing the target in relation to whatever was closer suggests some sensitivity to children's skills. Their preference for spatial proximity is also consistent with earlier work showing that young children rely on proximal landmarks to remember and communicate about locations (Acredolo, 1978; Acredolo & Evans, 1980; Allen & Kirasic, 1988; Craton et al., 1990; Newcombe et al., 1998; Overman et al., 1996; Sluzenski et al., 2004) and with more recent work showing that 3-year-olds are better able to make judgments about the relative nearbyness of objects to a landmark when the distances between the objects and the landmark are small (Hund & Naroleski, 2008; Hund & Plumert, 2007). In our investigation, mothers' everyday observations of young children's difficulty with relating locations to more distal landmarks may have led them to emphasize proximity in their directions. However, it is also possible that mothers simply chose to provide the most salient information in this situation, regardless of the age of their listener. Further work is needed to determine whether mothers' choice of reference frames would differ if their listener were an adult rather than a young child.

Mothers' choice of reference frames in Experiment 1 when the target container was close to themselves and close to the circle (TT3) also suggests that there may have been individual differences in mothers' sensitivity to children's direction-following skills. For 3-year-olds, 53% of the mothers relied predominantly on person frames of reference, 20% relied predominantly on landmark frames of reference, and 27% exhibited mixed use of person and landmark frames of reference for this trial type (see Table 1). Interestingly, 3-year-olds searched successfully on 83% of trials in which mothers used only a person frame of reference, whereas they searched successfully on only 46% of trials in which mothers

used only a landmark frame of reference. Choosing a person frame of reference for this trial type was clearly a strategy that better fit 3-year-olds' direction-following skills. Further research is needed to better understand possible individual differences in mothers' sensitivity to young children's ability to follow directions.

What do young children's patterns of search success tell us about the roles that spatial proximity and reference frames play in how they respond to spatial directions? The fact that the 3.5-year-olds in Experiment 1 were successful on all trial types indicates that they are adept at following simple spatial directions involving either a person or landmark reference frame and either a *close to* or *far from* relation. In fact, some of the 3.5-year-olds found the task boring because it was so easy. This is reminiscent of developmental shifts seen in other tasks around this age range such as the ramp task (Berthier, Deblois, Poirier, Novak, & Clifton, 2000) and the scale model task (DeLoache, 1987). The fact that 2.5-year-olds were not above chance on any of the trial types except TT2 suggests that they generally have difficulty using a simple verbal description of a location to find a hidden object. This contrasts with their ability to remember the locations of hidden objects in search tasks (e.g., Bushnell, McKenzie, Lawrence, & Connell, 1995). The 3-year-olds' performance suggests that they are transitional with respect to following simple spatial directions. As such, their patterns of search success are most revealing about developmental changes in direction-following skills. They were able to locate the toy on the basis of their mother's directions when mothers described the target container as close to themselves, but not when they described it as close to the circle. Three-year-olds were at chance in locating the toy when mothers described the target container as far from themselves or far from the circle. These results clearly show that 3-year-olds' ability to follow simple spatial directions depends both on spatial proximity and on the reference frame.

Why were 3-year-olds able to use proximal person references before they were able to use proximal landmark references to locate a hidden object? This pattern of performance may be another manifestation of the egocentric to allocentric shift, the idea that young children can code locations in relation to the self before they can code locations in relation to external landmarks. Although mothers in Experiment 1 rarely used the child alone as a reference point and mothers in the person condition in Experiment 2 used only themselves as the reference point, young children may readily translate between references to themselves and others, particularly when they share the same spatial viewpoint. A related explanation is that person frames of reference have a special status for young children. In other words, the similarity between self and other may lead young children to treat people as a special type of landmark. In the developmental shift from coding location relative to the self to coding location relative to external landmarks, young children may be able to use people as landmarks before they use objects as landmarks. This is consistent with earlier work by Craton et al. (1990) showing that 4-year-olds preferred to describe the location of a target container in relation to the listener rather than a landmark even when they and their listener did not share the same viewpoint. Further work on young children's direction following should examine whether the preference for person over landmark frames of reference persists even when the child and mother do not share the same viewpoint.

In closing, this investigation represents a first step in understanding mother–child communication about location and adds to a small but growing body of literature on the role of caregiver input in children's spatial development (e.g., Cartmill, Pruden, Levine, & Goldin-Meadow, 2010; Plumert & Nichols-Whitehead, 1996; Szechter & Liben, 2004). We found that mothers' directions were highly systematic, emphasizing the relative proximity of the target container to the landmark and themselves. This systematicity may play a significant role in teaching young children to emphasize proximal reference points when describing locations to others, though it appears that young children are likely to use people before objects as proximal reference points. However, some caution is warranted in generalizing the results of this study to naturalistic situations and to other populations. In particular, it is not known what role maternal education or cultural context played in the pattern of results, particularly the findings regarding young children's preferences for proximal person reference frames. Other research has shown that socioeconomic status is related to the kinds of linguistic input that children receive (Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002) and that there is cultural variation in the reference frames used to remember and communicate about locations (Haun, Rapold, Janzen, & Levinson, 2011). More research is needed to determine the extent to which these results reflect universals in mother–child spatial communication.

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