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How do mothers communicate to young children about location

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HOW DO MOTHERS COMMUNICATE TO YOUNG CHILDREN ABOUT LOCATION?

by

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CERTIFICATE OF APPROVAL

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MASTER'S THESIS

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This is to certify that the Master's thesis of

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To Mom and Dad

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ABSTRACT

We conducted three experiments to better understand how mothers structure their input to young children for finding hidden objects and how young children use this input to guide their searches. We examined the reference frames and spatial terms mothers use to communicate with their 2.5-, 3.0-, and 3.5-year-old children about location by asking mothers to verbally disambiguate a target hiding container from an identical non-target hiding container for their child. We varied the relative proximity of the target and non-target containers to a landmark and to the mother and child. The target and non-target containers were on opposite sides of the landmark in Experiment 1 and on the same side of the landmark in Experiments 2 and 3. The absolute distance of the containers from the landmark was increased in Experiment 3, while the relative distance of the containers to the landmark and to the mother and child remained the same. In all of the experiments, mothers' reference frame use was governed by the relative proximity of the target and non-target containers to the landmark and themselves. Older children followed directions more successfully than did younger children. The Discussion focuses on how the age of the child and the characteristics of the task shape maternal spatial communication.

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CHAPTER I

INTRODUCTION

Emergentist views of development emphasize that children's cognitive skills arise out of the interaction of the cognitive system and the surrounding environment, both in the moment and over time (E. J. Gibson, 1988; Gottlieb & Lickliter, 2007; Piaget, 1954; Thelen & Smith 1994; Vygotsky, 1978). A central premise of this approach is that we cannot explain developmental change in children's thinking by focusing only on the cognitive system. Rather, we need to understand how structure offered by the physical, social, or task environment interacts with the developing cognitive system to produce changes in thinking (Plumert, 2008). From this perspective, the environment is not just an "influence" on thinking or development. Rather, the child and the environment are part of a unified system that changes over time. A critical step in determining how these interactions take place both in the moment and over time is understanding both what the child brings to the table and the structure that is available in the environment. To date, a great deal of attention has been devoted to describing the characteristics of the developing cognitive system, particularly in infancy and early childhood. Far less attention has been paid to understanding the characteristics of the social, physical, or task environment. In particular, we are only beginning to understand the role of parental input in cognitive development (e.g., Gauvain, 2001; Hoff-Ginsberg, 1998; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007). A first step in understanding how cognitive skills emerge out of the interaction of the developing cognitive system and the social environment is documenting what this input looks like. Specifically, how does the input vary with respect the age of the child and characteristics of the problem-solving situation? Here, we examine these questions in the context of how mothers give spatial directions to their young children.

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, we know little about how parents communicate spatial information to their young children. 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), skills emerge out of social interactions between the child and more experienced individuals. The primary task for the parent in these interactions is to provide guidance that is appropriately geared to the developmental level of the child. In the case of spatial communication, we presume that very young children require more scaffolding in order to follow even simple spatial directions from parents. An important question this raises is whether parents are aware of the need to provide more scaffolding to support young children's direction-following skills. 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.

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.

Work on children's spatial cognitive development 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 (e.g., Acredolo, 1978; Acredolo & Evans; 1980; Bremner & Bryant, 1977). For example, classic work by Acredolo (1978) showed that around 11 months of age, infants begin to code locations relative to a salient landmark. Prior to this age, infants tend to code locations relative to their own movement (e.g., turning to the left to see an interesting event). As noted above, this leads to errors when the relation between the self and the target changes (e.g., infants are rotated 180 degrees).

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, Craton et al. (1990) found that 4-year-olds were more likely to refer to proximal than distal landmarks when communicating about the location of a hidden object. Newcombe et al. (1998) also found that children aged 22 months and older searched more accurately for a toy that was hidden in a long, narrow sandbox when distal landmarks were available. The availability of distal landmarks made no difference for children aged 21 months and younger, suggesting that the ability to use distal landmarks is undergoing change in early childhood.

The aforementioned "egocentric-to-allocentric" and "proximal-to-distal" shifts refer to the fact that some types of spatial coding appear earlier than others in development, not that the later system of coding supercedes the earlier form of coding. Clearly, adults use both viewer-based and externally-based reference systems and both proximal and distal landmarks. A basic question in the field of spatial cognition is what governs choice of reference frames? Recently, Newcombe and Huttenlocher (2006) proposed the "Adaptive Combination Model" as a way of conceptualizing choice of reference frames. They propose that people's experiences with using various spatial coding systems to remember locations and their observations of the usefulness of those coding systems in different situations lead to adaptive changes in the conditions under which each system is used. Thus, they do not subscribe to the idea of a qualitative "egocentric-to-allocentric" or a "proximal-to-distal" shift in reference frames. Rather, they propose that viewer-based and externally-based or proximal and distal landmarks are weighted differently depending on the situation. In particular, this model suggests that the salience and reliability of spatial information determines how information is weighted. One implication of this model is that people will use reference frames that are most likely to yield successful searches for missing or hidden objects.

Everyday spatial communication often involves choosing between alternative reference frames. When asked where something is, a speaker can use a landmark reference (e.g., "it's next to the chair) or a self reference (e.g., "it's right in front of me").

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. In one condition, the room contained distinctive 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, 6-year-olds preferred to use person over landmark references to differentiate front-back relations (e.g., “it’s the cup closest to you”), but preferred to use landmark over person references to differentiate left-right relations (e.g., “it’s in the cup next to the red tape”). These results suggest that even young children adaptively shift their use of reference frames.

What might govern mothers’ selection of reference frames when communicating about location to their young children? On the one hand, mothers may prefer to relate the location of a hidden object to the self, particularly when they and the child share the same viewpoint. Thus, mothers may consistently try to use a self frame of reference, regardless of proximity of the self to the hidden object. On the other hand, 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. Thus, mothers may be willing to alternate between self and landmark reference frames, depending on the proximity of the self and a landmark to the hidden object. On the surface, such alternation may seem like poor maternal input because the child cannot lock onto a consistent reference frame. According to the Adaptive Combination model, however, mothers’ past experience with

success and failure in communicating about location to their young children may lead them to weight the proximity of the reference object more heavily than the type of reference object. If so, we may be able to see these adaptive choices within the context of a single experimental session as mothers alternate between reference frames in an attempt to emphasize proximity.

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. Mothers were asked to disambiguate two identical hiding locations for their 2.5-, 3.0-, 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 mothers over fathers 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. The containers were placed such that the target container varied in its relative proximity to the self (mother and child) and to a landmark on the floor. There were four trial types defined by the location of the target container: (a) close to the mother/child and far from the landmark; (b) close to the landmark and far from the mother/child; (c) close to the mother/child and close to the landmark; and (d) far from the mother/child and far from the landmark. 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 how mothers' choice of reference frames (e.g., self or landmark) and spatial terms (e.g., "close to" or "far from") varied with the age of the child and the location of the target container. We were especially interested in whether mothers shifted between self and landmark reference frames in an attempt to emphasize proximity. The second issue of interest was how

children's success in finding the toy varied with the age of the child and the location of the target container. We also explored whether children's success depended on the type of reference frame or spatial term mothers used.

CHAPTER II

EXPERIMENT 1

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;4-31;8), sixteen 3-year-olds (mean age: 35 months, 28 days; range: 35;4-36;26), and sixteen 3.5-year-olds (mean age: 41 months, 24 days; range: 41;9-42;26) and their mothers. There were equal numbers of male and female children in each age group. Fourteen additional participants were not included for the following reasons: a) came with their fathers (one 2.5-year-old, one 3.0-year-old, and one 3.5-year-old), b) refused to start (two 2.5-year-olds), c) did not complete all of the test trials (two 2.5-year-olds, two 3-year-olds, and two 3.5-year-olds), d) mother had previously participated with a sibling (one 2.5-year-old), and e) technical problems (two 3.5-year-olds). Participants were recruited through a child research participant database maintained by the Department of Psychology at a Midwestern university. Mothers 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 x 9 ft-long room (Figure A1). 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 3 ft 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 two inches from the edge of the circle on one side, and the other container was twelve inches from the edge of the circle on the opposite side, such that the containers were always at unequal distances from the landmark. Figure A2 shows the four trial types (TT1, TT2, TT3, and TT4). Participants completed four blocks of trials for a total of 16 trials. There was one of each trial type in each block and the four trial types were randomized within blocks. At the start of each trial, the mother instructed the child to hide behind the curtain, so he/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.

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 if children did not finish the last trial or two. An Age (2.5, 3.0, and 3.5 years) x Trial Type (TT1, TT2, TT3, TT4) repeated measures 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. Mothers used a variety of reference frames for describing the location of the hidden toy. The overwhelming majority of the reference frames used were landmark and self references. A *landmark* reference included any reference to the circle, the curtain, or the back wall of the testing room, as well as implicit references to an external landmark, such as “the other side” of the room. A *self* reference included any reference to “me” (mother) or “Mommy,” “you” (child), and “us” (mother and child), as well as implicit references to the self, such as “the close one.” (Note that such references were only coded as implicit self references when the target location was close to the mother and the non-target location was far from the landmark.) We chose to call all of these “self” 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.

Spatial relational terms. We also coded the spatial relational terms that mothers used to describe the target container. 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.

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 child changed his/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 (on 9 participants) for reference frames and spatial terms were very high, ranging between $r = .94$ and $r = .98$. Intercoder reliability based on exact percent agreement for search success was 98%.

Results

We first conducted preliminary analyses with gender as a factor to determine whether mothers' directions or children's search success varied by gender. Because there were no significant effects involving gender, 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 self 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 self references per trial for each trial type were entered into an Age (2.5, 3, and 3.5 years) x Reference Frame (landmark, self) x Trial Type (TT1, TT2, TT3, TT4) repeated measures 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, $p < .01$. Mothers provided more reference frames overall (landmark and self 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, $p < .0001$, that was subsumed under a significant Trial Type x Reference Frame interaction, F (3, 135) = 32.64, $p < .0001$. As shown in Figure A3, 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) = .005, *ns*. Thus, mothers preferred a self reference frame when the target container was close to them and far from the landmark (TT4) and they preferred a landmark reference frame when the target was far from them and far from the landmark (TT1). When the target was close to the landmark but far from them (TT2), they preferred a landmark reference frame, and when the target container was close to the circle and close to them, they used self and landmark references equally.

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 were entered into an Age (2.5, 3, and 3.5 years) x Spatial Relational Term (close to, far from) x 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.) There was no significant effect of age, F (2, 45) =1.24, *ns*, but mothers tended to provide more spatial terms overall to the younger children than to

the older children (for 2.5-year-olds, M = .82, SD = .87, for 3.0-year-olds, M = .75, SD = .78, and for 3.5-year-olds, M = .63, SD = .70).

As with the reference frame analysis, there was a significant Trial Type x Spatial Term interaction, F (2, 90) = 56.20, $p < .001$. 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) = .04, *ns*. As shown in Figure A4, 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

We also examined whether the proportion of correct searches varied by age and trial type. 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, and 3.5 years) x Trial Type (TT1, TT2, TT3, TT4) repeated measures ANOVA. There was a significant effect of age, F (2, 45) = 5.34, $p < .01$. Fisher's PLSD 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. There was no significant effect of trial type, F (3, 135) = .34, *ns*.

The second analysis examined whether the proportion of correct searches on each trial type exceeded that expected by chance (Figure A5). We used separate one-sample t-tests for each age group and trial type to compare the proportion of correct searches to an expected chance value of .50. The 3.5-year-olds were significantly above chance on all

trial types, *t's* (15) > 3.50, $p < .01$. In contrast, the 3-year-olds were above chance on the two trial types closest to the mother and child, *t's* (15) > 2.90, $p < .01$, but not on the two trial types farthest from the mother and child, *t's* (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 a particular reference frame exceeded that expected by chance. We calculated the proportion of trials in which children searched correctly in response to landmark reference frames and to self reference frames. We excluded trials in which mothers used a mixture of landmark and self 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 vs. self reference frame to an expected value of .50. The 2.5-year-olds were not above chance in response to landmark references, t (9) = .59, *ns*, (M = .55, SD = .28), but they were above chance in response to self references, t (14) = 3.65, $p < .01$, (M = .72, SD = .23). Likewise, the 3.0-year-olds were not above chance in response to landmark references, t (10) = -.56, *ns* (M = .44, SD = .37), but they were above chance in response to self 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 self references, t (15) = .2.31, $p < .05$, (M = .71, SD = .36).

Contingencies between Mothers' Spatial Term Use and Children's Search Success

We also explored whether the proportion of correct searches on each trial in response to a particular spatial term exceeded that expected by chance. We calculated the proportion of trials in which children searched correctly in response to "close to" and "far from" references. We excluded trials in which mothers used a mixture of "close to" and "far from" spatial terms, or another spatial term (41.2% of trials). We used separate one-sample t-tests for each age to compare children's success in response to "close to" vs.

"far from" references to an expected value of .50. The 2.5-year-olds were not above chance in response to "close to" references, t (13) = 1.64, *ns*, (M = .64, SD = .31), but they were above chance in response to "far from" references, t (9) = 2.48, $p < .05$, (M = .70, SD = .26). The 3.0-year-olds were not significantly above chance in response to either "close to", t (9) = 1.46, *ns*, (M = .64, SD = .30), or "far from" references, t (8) = 1.58, *ns*, (M = .72, SD = .42). As expected, the 3.5-year-olds were above chance in response to both "close to", t (15) = 7.65, $p < .001$, (M = .86, SD = .19) and "far from" references, t (15) = 3.10, $p < .01$, (M = .76, SD = .33).

Discussion

Mothers clearly adjusted their use of reference frames and spatial terms depending on the target location. They were more likely to use landmark references to describe locations that were relatively far from them, and they were more likely to use self references to describe the location closest to them. Mothers were equally likely to use landmark and self references when the target was close to the landmark and close to them. 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, and they were more likely to use "close to" to describe the two locations that were closest to them. 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. Overall, mothers showed strong systematicity in both their use of reference frames and spatial terms.

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."). Based on our observations of the sessions, mothers seemed to be giving more information to the youngest children in response to their difficulty with searching the correct container. This observation is born out in the age differences in children's search success. The 2.5- and

3-year-olds were less successful than the 3.5-year-olds, who were above chance on all trial types. The 3-year-olds were above chance on TT3 and TT4, and the 2.5-year-olds were only above chance on TT2. 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 self than landmark reference frames. The 2.5-year-olds were also above chance in response to "far from" but not above chance in response to "close to." The 3-year-olds were not above chance in response to either spatial term. These results must be treated with caution, however, because the sample size was low in some cases and performance was averaged over trial types.

Given that the order of trial types was randomized, mothers were often switching between reference frames from trial to trial. On the surface, this alternation may seem like poor scaffolding because the child could not lock onto a consistent reference frame from trial to trial. However, it appears that mothers were using the most salient information available to describe the location of the hidden toy. When the target container was closer to the landmark than to the mother, mothers used the landmark as a reference, and when the target container was closer to the mother than to the landmark, mothers used themselves or the child as a reference. These results suggest that mothers were sensitive to the context and alternated reference frames based on the proximity of the target container to either the landmark or the self.

One question that remains unanswered is how the location of the non-target container influenced mothers' choice of reference frames. In this experiment, relative proximity was defined in two ways. The first was through the positions of the target and non-target containers relative to the landmark and the mother. For each trial type, a container could be close to (or far from) the mother and close to (or far from) the landmark relative to the other container. The second way was through the positions of the target and non-target containers relative to the near and far sides of the space. That is, the landmark on the floor bisected the space into a near and far side as seen from the

mother's perspective. Because the target and non-target containers were always on opposite sides of the circle, the locations on the near side were all relatively close and the locations on the far side were relatively far. To further examine how the location of the non-target container influenced mothers' choice of reference frames, we conducted a second experiment in which the target and non-target container were always on the same side of the circle. The location of the target container remained the same for the four trial types as in Experiment 1, but the non-target container was placed on the same side of the circle as the target container. This change meant that the relative proximity of the target container to the landmark and mother remained the same for TT1 (far from landmark and far from mother) and TT4 (far from landmark and close to mother). For TT2 and TT3, however, the relative proximity of the target container to the mother was reversed. Of particular interest was whether mothers' choice of reference frames changed for these two trial types.

CHAPTER III

EXPERIMENT 2

Method

Participants

Forty-eight mother-child dyads participated. There were sixteen 2.5-year-olds (mean age: 30 months, 2 days; range: 28;22-31;9; seven females), sixteen 3-year-olds (mean age: 36 months, 13 days; range: 35;18-37;11; eight females), and sixteen 3.5-year-olds (mean age: 42 months,16 days; range: 41;20-43;9; eight females) and their mothers. Seventeen additional participants were not included for the following reasons: a) came with their fathers (two 2.5-year-olds, two 3-year-olds, and one 3.5-year-old), b) refused to start (one 2.5-year-old, two 3-year-olds, and one 3.5-year-old), c) did not complete the task (five 2.5-year-olds and one 3.0-year-old), d) mother did not speak English (one 2.5-year-old) and e) technical problems (one 2.5-year-old). Participants were recruited in the same manner as Experiment 1. Ninety-six percent of the children were European American, and 4% were Asian American. Two percent of the mothers had completed only their high school education, 15% had completed some college education, and 83% had a 4-year college education or beyond.

Apparatus and Materials

The apparatus and materials were the same as those used in Experiment 1.

Design and Procedure

All aspects of the design and procedure were the same as in Experiment 1 with the exception of the placement of the hiding containers during the test trials (Figure A6). For each test trial, one container was placed two inches from the edge of the circle and the other container was twelve inches from the edge of the circle such that both containers were always on the same side of the landmark.

Coding and Measures

The coding and measures were identical to those used in Experiment 1. 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 2.4% of trials, we coded the first container approached as the container searched. The number of trials of each type completed was entered into an Age (3) x Trial Type (4) repeated measures ANOVA. There was a significant effect of age, F (2, 45) = 3.91, $p < .05$. Follow-up tests indicated that 2.5-year-olds completed fewer trials than did 3.5-year-olds. The mean number of trials per type completed for 2.5-, 3.0-, and 3.5-year-olds was 3.53 (*SD* = .59), 3.72 (*SD* = .45), and 3.81 (*SD* = .39), respectively. The mean number of trials completed for TT1, TT2, TT3, and TT4 was 3.60 (*SD* = .49), 3.73 (*SD* = .54), 3.67 (*SD* = .52), and 3.75 (*SD* = .44), respectively. Intercoder reliabilities (on 9 participants) for reference frames and spatial terms were very high, ranging between r = .97 and r = .99. Intercoder reliability based on exact percent agreement for search success was 99%.

Results

We first conducted preliminary analyses with gender as a factor to determine whether mothers' directions or children's search success varied by child gender. Although there were no significant main effects involving gender, there was one significant 2-way interaction involving gender. Given the fact that we had no predictions about the effect of child gender in this investigation, we decided to collapse across gender in all of the analyses reported below.

Mothers' Use of Reference Frames

As in Experiment 1, mothers primarily used landmark and self reference frames to describe the target container to their children. The mean number of landmark and self references per trial for each trial type was entered into an Age (3) x Reference Frame (2) x Trial Type (4) repeated measures ANOVA. There was a significant main effect of age, F (2, 45) = 4.83, $p < .05$, and a significant Age x Trial Type interaction, F (6, 135) =

2.52, $p < .05$. Mothers again provided more reference frames overall (landmark and self reference frames combined) to 2.5-year-olds ($M = .73$, $SD = .87$) than to 3.5-year-olds ($M = .49$, $SD = .52$). The difference between 2.5-year-olds and 3-year-olds ($M = .58$, $SD = .63$) approached significance ($p = .058$). There was no significant difference between the 3- and 3.5-year-olds, however. Follow-up tests of the Age x Trial Type interaction indicated that this pattern held for all trial types except TT1 (far from mother, far from landmark). There were no age differences in mothers' overall reference frame use for TT1.

There were also significant effects of trial type, F (3, 135) = 16.45, $p < .0001$, and reference frame, F (1, 135) = 27.57, $p < .0001$. These main effects, however, were subsumed under a significant Trial Type x Reference Frame interaction, F (3, 135) = 109.29, $p < .0001$. Simple effects tests revealed a significant effect of reference frame for TT1, F (1, 47) = 14.84, $p < .001$, for TT2, F (1, 47) = 70.43, $p < .0001$, for TT3, F (1, 47) = 168.53, $p < .0001$, and for TT4, F (1, 47) = 108.83, $p < .0001$. As shown in Figure A7, mothers used landmark references more often than self references for TT1, TT2, and TT3, and they used self references more often for TT4. A significant Age x Trial Type x Reference Frame interaction, F (6, 135) = 2.59, $p < .05$, additionally revealed that for TT3 (far from mother, close to landmark) mothers gave significantly more landmark references to 2.5-year-olds ($M = 1.69$, $SD = .73$) than to 3-year-olds ($M = 1.03$, $SD = .54$) and 3.5-year-olds ($M = 1.02$, $SD = .36$).

Mothers' Use of Spatial Relational Terms

Mothers again primarily used variants of "close to" and "far from" references to describe the target container to their children. The mean number of "close to" and "far from" references per trial for each trial type were entered into an Age (3) x Spatial Relational Term (2) x Trial Type (TT1, TT3, 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 TT2, we excluded this

trial type from the analysis.) This analysis yielded a significant main effect of age, F (2, 45) = 6.65, $p < .01$. As with reference frame use, mothers provided more spatial terms overall to the 2.5-year-olds (M = .84, SD = .91) than to either the 3-year-olds (M = .63, SD = .66) or the 3.5-year-olds (M = .54, SD = .57).

There was also a main effect of spatial term, F (1, 45) =33.48, $p < .0001$. This effect was subsumed under a significant Trial Type x Spatial Term interaction, F (2, 90) = 89.70, $p < .0001$. Simple effects tests revealed a significant effect of spatial term for TT1, F (1, 45) = 23.75, $p < .0001$, for TT3, F (1, 45) = 146.02, $p < .0001$, and for TT4, F (1, 45) = 119.04, $p < .0001$. As shown in Figure A8, mothers used "far from" references significantly more often than "close to" references when the target was far from the mother and far from the landmark (TT1), whereas they used "close to" references significantly more often than "far from" references for TT3 and TT4. No other differences were significant. As would be expected, when the target was close to the landmark and close to themselves (TT2), mothers exclusively used "close to" references.

Children's Search Success

We also examined whether the proportion of correct searches varied by age and trial type. As in Experiment 1, we first entered the mean proportion of correct searches into an Age (3) x Trial Type (4) repeated measures ANOVA. There was a significant main effect of age, F (2, 45) =13.64, $p < .0001$. Follow-up tests indicated that 3.0- (M = .85, SD = .23) and 3.5-year-olds (M = .95, SD = .14) searched correctly more often than did 2.5-year-olds (M = .67, SD = .31). The 3- and 3.5-year-olds did not significantly differ from one another. There was also a significant effect of trial type, F (3, 135) = 3.20, $p < .05$. Follow-up tests indicated that children searched correctly on TT2 more often than on TT1. No other differences were significant. The mean proportion of correct searches was .75 (SD = .31) for TT1, .88 (SD = .22) for TT2, .83 (SD = .25) for TT3, and .83 (SD = .25) for TT4. To compare performance across experiments, we conducted a separate Age (2) x Trial Type (4) x Experiment (2) repeated measures ANOVA. There

was a significant effect of experiment, F (1, 90) = 15.55, $p < .001$, indicating that children in Experiment 2 (M = .82, SD = .26) searched successfully more often than did children in Experiment 1 (M = .69, SD = .31).

The second analysis examined whether the proportion of correct searches on each trial type exceeded that expected by chance (.50). As shown in Figure A9, separate one-sample *t*-tests revealed that both 3-year-olds, *t's* (15) > 3.90, $p < .01$, and 3.5-year-olds, *t's* (15) > 7.3, $p < .0001$, were significantly above chance on all trial types. The 2.5-year-olds were significantly above chance on TT2 and TT3, *t's* (15) > 2.8, $p < .05$, and marginally above chance on TT4, t (15) = 2.09, $p = .054$. However, they were no better than chance on TT1, t (15) = .82, *ns*.

Contingencies between Mothers' Reference Frame Use and Children's Search Success

Again, we explored whether the proportion of correct searches on each trial in response to a particular reference frame exceeded that expected by chance (.50). We again excluded trials in which mothers used a mixture of landmark and self reference frames, or another type of reference frame (24% of trials). One-sample t-tests showed that the 2.5-year-olds were above chance in response to landmark references, t (13) = 2.13, $p = .05$, (M = .67, SD = .30), but not in response to self references, t (12) = .91, *ns*, (M = .59, SD = .37). The 3.0-year-olds were above chance in response to both landmark references, t (14) = 5.21, $p < .001$ (M = .84, SD = .25), and self references, t (14) = 5.54, $p < .0001$, (M = .87, SD = .26). Likewise, the 3.5-year-olds were above chance in response to both landmark, t (15) = 9.68, $p < .001$, (M = .92, SD = .17) and self references, t (13) = 8.57, $p < .0001$, (M = .91, SD = .18).

Contingencies between Mothers' Spatial Term Use and Children's Search Success

We also explored whether the proportion of correct searches on each trial in response to a particular spatial term exceeded that expected by chance (.50). We again excluded trials in which mothers used a mixture of "close to" and "far from" spatial terms, or another strategy (20% of trials). One-sample t-tests showed that the 2.5-year-

olds were above chance in response to "close to" references, t (15) = 2.63, $p < .05$ (M = .70, SD = .30), but not in response to "far from" references, t (7) = -.34, *ns*, (M = .45, SD = .43). Likewise, the 3.0-year-olds were above chance in response to "close to" references, t (15) = 13.04, $p < .001$, (M = .91, SD = .13), but not in response to "far from" references, t (11) = 1.78, $p = .10$, (M = .69, SD = .38). As expected, the 3.5-year-olds were above chance in response to both "close to", t (14) = 46.19, $p < .001$, (M = .98, SD = .04) and "far from" references, t (12) = 8.95, $p < .001$, (M = .93, SD = .17).

Discussion

The results of this experiment again demonstrate that mothers adjusted their use of reference frames and spatial terms depending on the trial type. As in Experiment 1, mothers were more likely to use a landmark than a self reference frame when the target location was far from them and far from the landmark (TT1) and they were more likely to use a self than landmark reference frame when the target container was close to them and far from the landmark (TT4). Unlike Experiment 1, however, mothers relied almost exclusively on landmark references when the target container was close to both the landmark and themselves. Mothers again were more likely to use landmark references when the target was close to the landmark and far from the mother, though their preference for landmark frames of reference appeared stronger than in Experiment 1. These results clearly show that the placement of the non-target container also played an important role in mothers' choice of reference frames.

We again found that mothers used more reference frames and spatial terms overall with the 2.5-year-olds than with the 3.5-year-olds. This mirrored age differences in children's search success, suggesting that mothers were providing additional information to the youngest children in response to their difficulty with the task. We also found that children's search success improved in Experiment 2. Both 3- and 3.5-year-olds were better than chance on all four trial types, and 2.5-year-olds were better than chance on

TT2 and TT3. In Experiment 1, 3-year-olds were only above chance on the two locations closest to them, and 2.5-year-olds were only above chance on TT2. One explanation for this difference between the two experiments is that children found it easier to focus their attention on one side of the space than to spread their attention across both sides of the space. Another possible explanation is that children in Experiment 2 benefited from mothers' more consistent reference frame use within particular trial types. Further research is needed to evaluate these two possibilities.

One question that remains unanswered is how the absolute distance of the containers from the landmark and the mother influenced mothers' choice of reference frames. In Experiment 1 and 2, the absolute distance of the containers was always two inches and twelve inches from the edge of the circle. To further examine how the location of the target and non-target containers influenced mothers' choice of reference frames, we conducted a third experiment in which the absolute distance of the containers was always 12 inches from the edge of the circle, and 22 inches from the edge of the circle. As in Experiment 2, both containers were always on the same side of the circle and the relative proximity of the target and non-target containers to the landmark and the mother remained the same for the four trial types. Of particular interest was whether mothers' choice of reference frames changed for these depending on the absolute distance of the target container from the landmark and the mother.

CHAPTER IV

EXPERIMENT 3

Method

Participants

Forty-eight mother-child dyads participated. There were sixteen 2.5-year-olds (mean age: 30 months, 5 days; range: 29;17-31;5; 8 females), sixteen 3-year-olds (mean age: 36 months, 16 days; range: 35;13-37;29; 9 females), and sixteen 3.5-year-olds (mean age: 42 months, 17 days; range: 41;17-43;12; 8 females) and their mothers. Thirty-two additional participants were not included for the following reasons: a) came with their fathers (one 2.5-year-olds), b) refused to start (one 2.5-year-old and one 3.5-year-old), c) did not complete enough trials (eight 2.5-year-olds, two 3.0-year-olds, and one 3.5-year-old), d) English was child's second language (one 2.5-year-old), e) technical problems (two 3.0-year-olds), f) child's behavior (four 2.5-year-olds), g) mother had previously participated with a sibling (one 2.5-year-old, two 3-year-olds, two 3.5-year-olds), h) sibling was in the room (one 2.5-year-old and one 3.5-year-old) i) subject was past eligibility (three 3.0-year-olds and one 3.5-year-old). Participants were recruited in the same manner as Experiments 1 and 2. Ninety-six percent of the children were European American, 2% were Hispanic/Latino, and 2% were Asian American. Twenty percent had completed some college education, and 80% had a 4-year-college education or beyond.

Apparatus and Materials

The apparatus and materials were the same as those used in Experiments 1 and 2.

Design and Procedure

All aspects of the design and procedure were the same as in Experiment 2 with the exception of the placement of the hiding containers during the test trials (Figure A10). For each test trial, one container was placed 12 inches from the edge of the circle and the

other container was 22 inches from the edge of the circle such that both containers were always on the same side of the landmark.

Coding and Measures

The coding and measures were identical to those used in Experiments 1 and 2. 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 7.1% of trials, we coded the first container approached as the container searched. The number of trials of each type completed was entered into an Age (3) x Trial Type (4) repeated measures ANOVA. The analysis yielded no significant effects. The mean number of trials completed for TT1, TT2, TT3, and TT4 was 3.42 (*SD* = .74), 3.42 (*SD* = .74), 3.50 (*SD* = .58), and 3.50 (*SD* = .62), respectively. Intercoder reliabilities (on 9 participants) for reference frames and spatial terms were very high, ranging between *r* = .94 and *r* = .99. Intercoder reliability based on exact percent agreement for search success was 99%.

Results

In order to directly compare whether altering the absolute distance of the containers from the reference frames influenced mothers' use of reference frames and spatial terms, we conducted cross-experiment analyses between Experiments 2 and 3. We compared mothers' use of the two predominant reference frames to examine whether mothers' use of landmark and self references shifted depending on the child's age, the trial type, and the experiment. We first conducted preliminary analyses with gender as a factor to determine whether mothers' directions or children's search success varied by child gender. There were no significant effects of gender, thus we collapsed across gender in all of the analyses reported below.

Mothers' Use of Reference Frames

As in Experiments 1 and 2, mothers primarily used landmark and self reference frames to describe the target container to their children in Experiment 3. The mean

number of landmark and self references per trial for each trial type was entered into an Age (3) x Reference Frame (2) x Trial Type (4) x Experiment (2) repeated measures ANOVA. There was a significant Age x Experiment interaction, F (2, 90) = 4.99, $p < .01$. Simple effects tests revealed a significant effect of age for Experiment 2, F (2, 45) = 4.83, $p < .05$, but not for Experiment 3, F (2, 45) = 1.61, *ns*. Follow-up tests of the age effect for Experiment 2 revealed that mothers provided significantly more references for 2.5-year-olds (M = .73, SD = .87) than for 3.5-year-olds (M = .49, SD = .52), $p < .01$. Mothers also provided more references to 2.5- than to 3.0-year-olds (M = .58, SD = .63), although the difference did not quite reach significance, $p = .06$. There was no significant difference in the mean number of references given to 3.0- and 3.5-year-olds. In Experiment 3, the mean number of references given to 2.5-year-olds (M = .51, SD = .69), 3.0-year-olds (M = .70, SD = .73), and 3.5-year-olds (M = .69, SD = .69) did not differ significantly.

As in previous experiments, there was also a Reference Frame x Trial Type interaction, F (3, 270) = 136.08, $p < .0001$. Simple effects tests revealed a significant effect of reference frame for TT1, F (1, 90) = 11.03, $p < .01$, for TT2, F (1, 90) = 62.12, $p < .0001$, for TT3, F (1, 90) = 115.17, $p < .0001$, and for TT4, F (1, 90) = 230.43, $p < .0001$. Follow-up tests of the reference frame effect revealed that mothers provided significantly more landmark than self references on TT1 (M = .69, SD = .81 vs. M = .31, SD = .54), TT2 *(*M = .94, SD = .60 vs. M = .30, SD = .44) and TT3 (M = 1.14, SD = .63 vs. M = .28, SD = .47), while mothers provided significantly more self references (M = 1.22, SD = .67) than landmark references (M = .06, SD = .22) on TT4. In addition, there was a significant Reference Frame x Trial Type x Experiment interaction, F (3, 270) = 3.36, $p < .05$. Simple effects tests revealed a significant Reference Frame x Experiment effect for TT2, F (1, 90) = 13.80, $p < .00$, and TT3, F (1, 90) = 15.14, $p < .001$, but not for TT1, F (1, 90) = .98, *ns,* or TT4, F (1, 90) = .06, *ns*. To determine the source of this interaction, we examined whether there was an effect of experiment for landmark

references and self references in TT2 and TT3. Simple effects tests revealed a significant effect of experiment for landmark references in TT2, F (1, 90) = 11.61, $p < .01$, and a marginal effect of experiment for landmark references in TT3, F (1, 90) = 3.48, $p = .07$. In addition, simple effects tests revealed a significant effect of experiment for self references in both TT2, F (1, 90) = 6.15, $p < .05$, and TT3, F (1, 90) = 20.26, $p < .0001$. As seen in Figure A11, mothers' use of landmark references in TT2 and TT3 was higher in Experiment 2 than in Experiment 3. In contrast, mothers' use of self references in TT2 and TT3 was higher in Experiment 3 than in Experiment 2 (See Figure A12).

Mothers' Use of Spatial Relational Terms

Mothers again primarily used variants of "close to" and "far from" references to describe the target container to their children. The mean number of "close to" and "far from" references per trial for each trial type were entered into an Age (3) x Spatial Relational Term (2) x Trial Type (TT1, TT3, TT4) x Experiment (2) repeated measures ANOVA. (Because mothers never used "far from" for TT2, we excluded this trial type from the analysis.) This analysis yielded a significant main effect of spatial term, F (1, 90) = 36.12, $p < .0001$. There was also a significant Trial Type x Spatial Term interaction, F (2, 180) = 139.67, $p < .0001$. Simple effects tests revealed a significant effect of spatial term for TT1, F (1, 90) = 46.58, $p < .0001$, for TT3, F (1, 90) = 78.04, $p < .0001$, and for TT4, F (1, 90) = 241.71, $p < .0001$. Follow-up tests of the spatial term effect revealed that mothers provided significantly more "far from" references (M = 1.09, SD = .82) than "close to" references (M = .29, SD = .54) on TT1, while mothers provided significantly more "close to" than "far from" references on TT3 (M = 1.02, SD = .58 vs. M = .30, SD = .49) and TT4 (M = 1.22, SD = .63 vs. M = .06, SD = .26). There was also a significant Trial Type x Spatial Term x Experiment interaction, F (2, 180) = 5.40, $p < .01$. Simple effects tests revealed a significant Spatial Term x Experiment interaction for TT3, F (1, 90) = 17.01, $p < .0001$, but not for TT1, F (1, 90) = .01, *ns*, or TT4, F (1, 90) = .04, *ns.* To determine the source of this interaction, we examined whether there was an

effect of experiment for “close to” and “far from” references in TT3. Simple effects tests revealed a significant effect of experiment for “close to” references, F (1, 90) = 6.07, p < .05, and “far from” references, F (1, 90) = 17.75, p < .0001. As shown in Figure A13, mothers’ use of “close to” references in TT3 was significantly higher in Experiment 2 than in Experiment 3, and their use of “far from” references in TT3 was significantly higher in Experiment 3 than in Experiment 2 (See Figure A14). No other differences were significant. As would be expected, when the target was close to the landmark and close to themselves (TT2), mothers exclusively used “close to” references.

Children’s Search Success

To compare performance across experiments, we conducted a separate Age (2) x Trial Type (4) x Experiment (2) repeated measures ANOVA. There was a significant main effect of age, F (2, 90) = 30.49, p < .0001. Follow-up tests indicated that 3.5-year-olds (M = .89, SD = .20) searched correctly more often than did 2.5-year-olds (M = .58, SD = .33), and 3.0-year-olds (M = .77, SD = .30). Three-year-olds searched correctly more often than did 2.5-year-olds. There was also a significant main effect of trial type, F (3, 270) = 3.39, p < .05. Follow-up tests indicated that children searched successfully more often on TT2 and TT3 than TT1. No other differences were significant. Mean number of correct searches were .69 (SD = .33) for TT1, .80 (SD = .27) for TT2, .76 (SD = .31) for TT3, and .74 (SD = .32) for TT4. There was also a significant main effect of experiment, F (1, 90) = 20.95, p < .0001. Follow-up tests indicated that children in Experiment 2 (M = .82, SD = .26) searched successfully more often than did children in Experiment 3 (M = .67, SD = .33)

The second analysis examined whether the proportion of correct searches on each trial type exceeded that expected by chance (.50) in Experiment 3. As shown in Figure A15, separate one-sample t-tests revealed that 3.5-year-olds, t’s (15) > 4.4, p < .001, were significantly above chance on all trial types. The 3-year-olds were above chance on TT2, TT3, and TT4, t’s (15) > 3.90, p < .01, but they were no better than chance on TT1, t (15)

= .66, *ns*. The 2.5-year-olds were no better than chance on any of the trial types, t (15) < 1.0, *ns*.

Contingencies between Mothers' Reference Frame Use and Children's Search Success

Again, we explored whether the proportion of correct searches on each trial in response to a particular reference frame exceeded that expected by chance (.50) in Experiment 3. We again excluded trials in which mothers used a mixture of landmark and self reference frames, or another type of reference frame (31% of trials). One-sample t-tests showed that the 2.5-year-olds were no better than chance in response to landmark references, t (14) = .11, *ns* (M = .51, SD = .36), or self references, t (14) = .02, *ns*, (M = .50, SD = .33). The 3.0-year-olds were no better than chance in response to landmark references, t (15) = .75, *ns*, (M = .56, SD = .32), but they were above chance in response to self references, t (15) = 7.04, p < .0001, (M = .88, SD = .21). The 3.5-year-olds were above chance in response to both landmark, t (14) = 7.96, p < .0001, (M = .88, SD = .18) and self references, t (13) = 4.32, p < .001, (M = .79, SD = .25).

Contingencies between Mothers' Spatial Term Use and Children's Search Success

We also explored whether the proportion of correct searches on each trial in response to a particular spatial term exceeded that expected by chance (.50) in Experiment 3. We again excluded trials in which mothers used a mixture of "close to" and "far from" spatial terms, or another strategy (24% of trials). One-sample t-tests showed that the 2.5-year-olds were no better than chance in response to "close to" references, t (15) = .91, *ns*, (M = .57, SD = .28), or "far from" references, t (9) = -.35, *ns*, (M = .46, SD = .38). The 3.0-year-olds were above chance in response to "close to" references, t (15) = 4.48, p < .001, (M = .75, SD = .22), and in response to "far from" references, t (12) = 2.24, p <.05, (M = .73, SD = .37). As expected, the 3.5-year-olds were above chance in response to both "close to", t (14) = 5.24, p < .0001, (M = .83, SD = .24) and "far from" references, t (14) = 2.18, p < .05, (M = .71, SD = .38).

Discussion

The results of this experiment again demonstrate that mothers adjusted their use of reference frames and spatial terms depending on the trial type. More interestingly, the results indicate that adjusting the absolute distance of the containers from the landmark and the mother affected mothers' use of reference frames and spatial terms when compared to Experiment 2. While mothers' in Experiment 3 exhibited a similar pattern of reference frame and spatial term use as that in Experiment 2, the magnitude of their use of particular reference frames and spatial terms differed between experiments. More specifically, mothers used fewer landmark references when the target location was close to them and close to the landmark (TT2) in Experiment 3 as compared to Experiment 2. Mothers used more self references when the target container was close to them and close to the landmark (TT2) and when the target container was far from them and close to the landmark (TT3) in Experiment 3 as compared to Experiment 2. Mothers used fewer "close to" references and more "far from" when the target container was far from them and close to the landmark (TT3) in Experiment 3 as compared to Experiment 2. These results clearly show that the absolute distance of the containers from the landmark and the mother also played an important role in mothers' choice of reference frames. More specifically, increasing the absolute distance of the target container from the landmark on TT2 and TT3 lead mothers to use more self references and adjust their use of "close to" and "far from" references from Experiment 2 to Experiment 3.

Unlike Experiments 1 and 2, we did not find any age differences in the number of references mothers provided in their directions. This might be due to the perceived difficulty of the task. Based on children's search success, Experiment 3 appeared to be more challenging for 2.5- and 3.0-year olds than Experiment 2. While 3.5-year-olds were better than chance on all four trial types, 3.0-year-olds were only better than chance on TT2, TT3, and TT4, while they were no better than chance on the trial type that was farthest from them and the circle (TT1). The 2.5-year-olds had a particularly difficult

time with Experiment 3. They were no better than chance on any of the four trial types. Thus, it appears that increasing the absolute distance of the containers from the landmark made the task more challenging for the younger children.

CHAPTER V

GENERAL DISCUSSION

The current investigation set out to address two questions about how mothers communicate to young children about location. The primary question was how mothers' choice of reference frames (i.e., self and landmark) and spatial terms (i.e., "close to" and "far from") varied with the location of the target container and the age of the child. Mothers' use of frames of reference was governed by the relative and absolute proximity of the target and non-target containers to the landmark and the mother. In all of the experiments, mothers preferred a self frame of reference when the target container was in the location closest to them (TT4) and they used more landmark references when the target container was in the location farthest from them (TT1). When the target was in either of the two locations close to the landmark (TT2 and TT3), the placement of the non-target container on either the same (Experiments 2 and 3) or opposite (Experiment 1) side of the landmark as the target container influenced mothers' relative use of self and landmark frames of reference. For TT2, mothers preferred a landmark frame of reference in all three experiments, though their preference for a landmark over a self frame of reference appeared to be strongest in Experiment 2. For TT3, mothers used landmark and self reference frames equally in Experiment 1, but showed a preference for a landmark reference frame in Experiments 2 and 3. While the pattern of reference frame use was similar in Experiments 2 and 3, the magnitude of reference frame use differed across experiments. Increasing the distance of the containers from the landmark in Experiment 3 lead mothers to use fewer landmark references on TT2 and TT3 when compared to Experiment 2. These results indicate that increasing the absolute distance between the containers and the landmark decreased the salience of the landmark, thus mothers were more likely to use the self on TT2 and TT3 in Experiment 3 when compared to Experiment 2. In Experiment 2, mothers used landmark references more frequently when

the absolute distance of the containers from the landmark was very close (i.e., two inches from the edge of the circle), but when the distance was increased in Experiment 3, mothers decreased their use of landmark references. In Experiment 2, the relative and absolute distance of the target container from the landmark on TT2 and TT3 was close, while the relative distance of the target container was close on these two trial types, the absolute distance was not. Mothers still used the relative proximity of the containers to guide there reference frame use in Experiment 3, but they gave less weight to the landmark in their choice of reference frames.

Mothers' use of spatial terms closely paralleled their choice of reference frames in all three experiments. This underscores the fact that mothers preferred to relate the target container to whatever was closer, the landmark or themselves. Only in the case where the target container was both far from them and far from the landmark (TT1) did mothers show a preference for "far from." In the case where the target container was close to the mother and far from the landmark, mothers overwhelmingly relied on the term "close to." Likewise, in the two cases where the target was close to the landmark and close to the mother (TT3 in Experiment 1 and TT2 in Experiments 2 and 3), mothers exclusively used "close to" to describe the target location. (This makes sense since the target was not "far from" either the landmark or the mother.) Only in the case where the target was close to the landmark and far from the mother (TT2 in Experiment 1 and TT3 in Experiment 2) did mothers vary across experiments in their use of "close to" and "far from." When the target and non-target were on opposite sides of the landmark (Experiment 1), mothers used the two terms equally. But when the target and non-target were on the same side of the landmark (Experiment 2), mothers overwhelmingly preferred "close to" (e.g., "it's close to the blue circle"). This is noteworthy since mothers could easily have used "far from" (e.g., "it's the one farther from us"), which they did more of in Experiment 3 when compared to Experiment 2.

The picture that emerges from the patterns described above is that mothers were highly attuned to relative proximity. As noted earlier, relative proximity could be defined in two ways. The first was the positions of the target and non-target containers relative to the landmark and the mother. The second way was through the positions of the target and non-target containers relative to the near and far side of the space. This distinction was useful when the target and non-target containers were on opposite sides of the landmark (Experiment 1), but not when they were on the same side of the landmark (Experiment 2). On the other hand, increasing the distance of the containers from the landmark lead mothers to use more self references in Experiment 3 compared to Experiment 2.

The differences between mothers' directions in the three experiments illustrate how both of these senses of relative proximity contributed to reference frame choices. First, mothers' overall use of self references was higher in Experiment 1 than in Experiments 2 and 3, suggesting that the added distinction of the near and far sides of the space (from the mother's perspective) increased the likelihood of self references. Second, different patterns of reference frame use across the three experiments for specific trial types suggest that both aspects of relative nearbyness influenced mothers' choice of reference frames. In particular, the target container was close to both the landmark and the mother and the non-target container was far from both the landmark and the mother in TT3 in Experiment 1. The same was true of TT2 in Experiments 2 and 3. However, the two containers were on opposite sides of the landmark in Experiment 1 and on the same side of the landmark in Experiments 2 and 3. In Experiment 1, mothers chose self and landmark frames of reference equally, but relied more on landmark references in Experiments 2 and 3. Thus, mothers were more likely to use self frames of reference when the target container was "close" to them both in terms of the side of the space and the near to far ordering of the containers.

The fact that mothers emphasized proximity in their directions is consistent with 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). More recent work has shown 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). Together, these studies suggest that young children are more successful at using landmarks that are very close to target objects. The results of the present study are consistent with those of Hund and Plumert (2007), in which 3- and 4-year-olds, and adults were asked to judge the distance of several blocks as "by" or "not by" a larger landmark. Results of this study indicate that children and adults use relative distance to make judgments about nearbyness, and children undergo developmental changes in the use of relative distance between 3- and 4-years-old. Children were more reluctant than adults to judge blocks that were relatively close but somewhat distant from the landmark as "by" the landmark, and 3-year-olds required the blocks to be extremely close to the landmark in order to judge them as "by" the landmark as compared to 4-year-olds. These results indicate that 3-year-olds have more difficulty using relative distance to make judgments about nearbyness at larger distances.

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. Or, mothers may have simply chosen 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.

More generally, mothers' shifting use of reference frames depending on the trial type is consistent with Newcombe and Huttenlocher's (2006) Adaptive Combination Model. They propose that people's experiences with using various spatial coding systems to remember or communicate about location and their observations of the usefulness of

those coding systems in different situations lead to adaptive changes in the conditions under which each system is used. In particular, the salience and reliability of spatial information determines how information is weighted. In the context of our investigation, mothers likely chose the frame of reference they felt would most reliably lead to a correct search. As noted above, mothers' everyday observations of young children's greater success with proximal than distal landmarks may have led them to emphasize proximity in their directions. Although speculative at this point, the present investigation offers an interesting demonstration of the Adaptive Combination Model within the context of a single testing session.

The second issue we addressed in this study was whether children's success in following their mother's directions varied by the location of the target container and the age of the child. In Experiment 1, 3.5-year-olds were significantly more likely to search the correct container on the first try than were the 2.5- and 3.0-year-olds. In Experiment 2, 3- and 3.5-year-olds were more likely to search the correct container on the first try than were 2.5-year-olds. In Experiment 3, 3.5-year-olds were more likely to search the correct container on the first try than were the 2.5- and 3.0-year-olds, and the3.0-year-olds were more likely to search correctly on the first try than the 2.5-year-olds. Together, these results indicate that children's ability to make use of mothers' spatial directions is undergoing significant developmental change during early childhood. Importantly, we found that mothers in Experiments 1 and 2 provided more information (reference frames and spatial terms) to the youngest than to the oldest children. Often this took the form of repeating information, but sometimes mothers added new information (e.g., "It's close to mommy and far from the circle, close to mommy."). Viewed alongside the age differences in search success, this suggests that mothers tailored their directions to the needs of the children. Anecdotally, mothers appeared to adopt this "kitchen sink" strategy as a response to the youngest children's substantial difficulty with searching the correct container. However, this interpretation should be viewed with caution because we have

no way of knowing whether more information actually helped or hurt the youngest children. Further work is needed in which the amount of information is experimentally manipulated to determine whether more information is better than less information.

We also examined the contingencies between mothers' reference frame use and children's search success. These analyses generally revealed that children responded successfully to both self and landmark references, although there was some variation across experiments. One limitation of these analyses, however, is that there were not always enough observations to reasonably examine contingencies between mothers' reference frame use and children's search success separately for each age. A second limitation is that we could only look at trials in which "pure" reference frames or spatial terms were used (i.e., not those in which mothers combined the two reference frames or the two spatial terms). This necessarily meant that a large number of trials were excluded. A third limitation is that the analyses of reference frames and spatial terms were not independent of each other. That is, particular reference frames and spatial terms were commonly used in combination for particular trial types. Future work should experimentally manipulate children's experience with particular combinations of reference frames and spatial terms to determine whether some combinations are more effective than others for given age groups and trial types.

In closing, this investigation represents a first step in understanding the role of parental input in the development of children's spatial communication, and adds to the body of literature on the role of caregiver input in children's language development (e.g., Hoff-Ginsberg, 1998; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002; Huttenlocher et al., 2007). Most noteworthy, 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. However, it is important to note that the direction-

giving task used here was quite simple and that the mothers in this study were highly educated. More research is needed to determine how parents structure their directions in naturalistic settings and what role parental education plays in giving directions.

APPENDIX

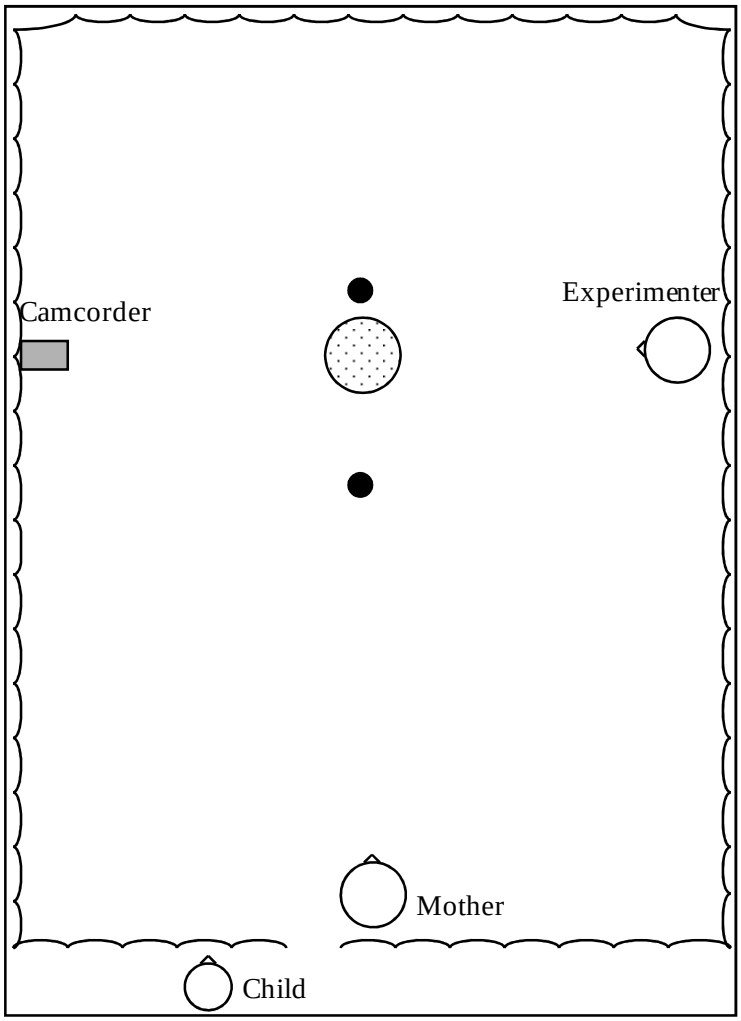

Figure A1. Diagram of testing room.

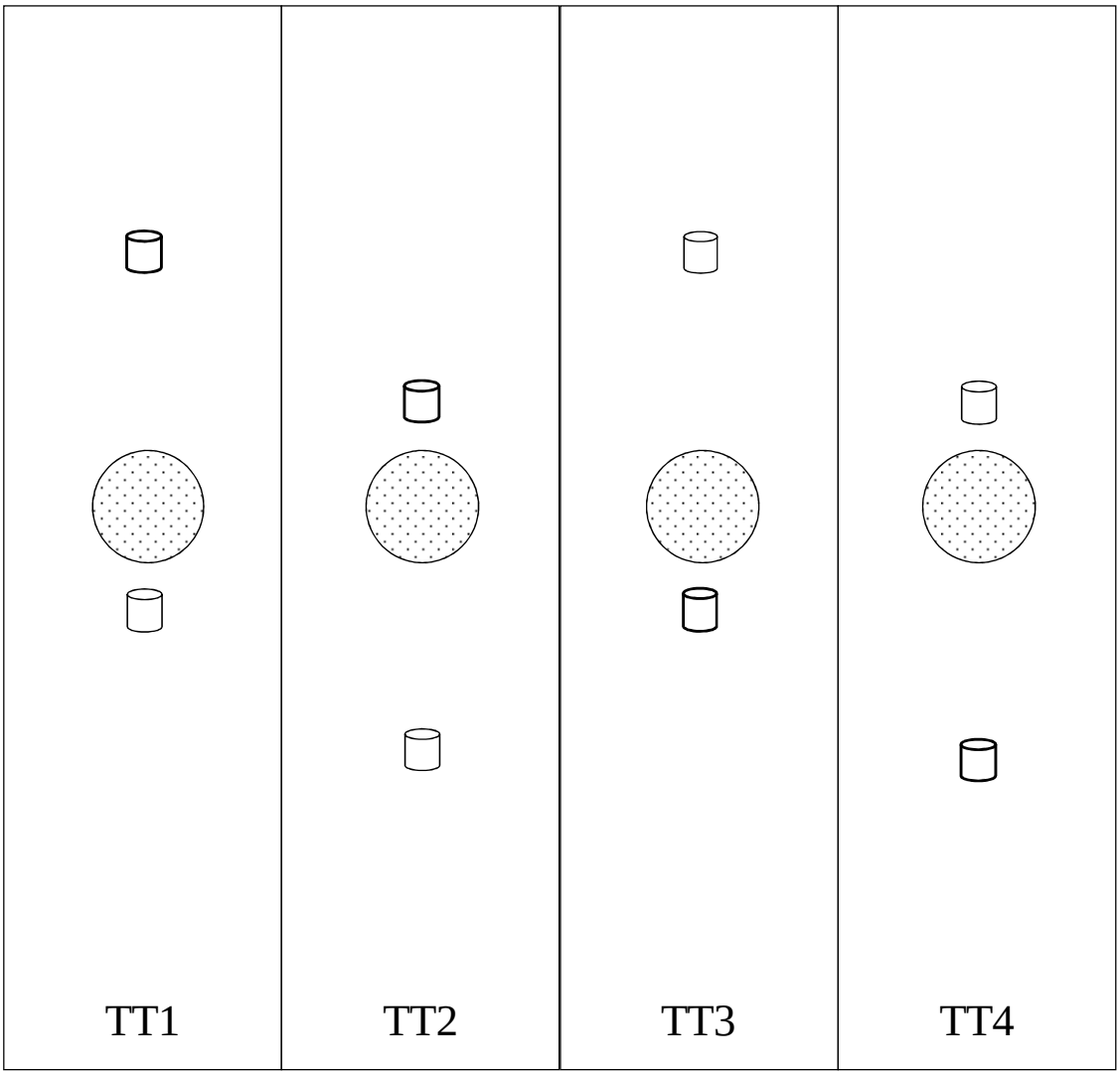

Figure A2. Locations of target and non-target containers in Experiment 1.

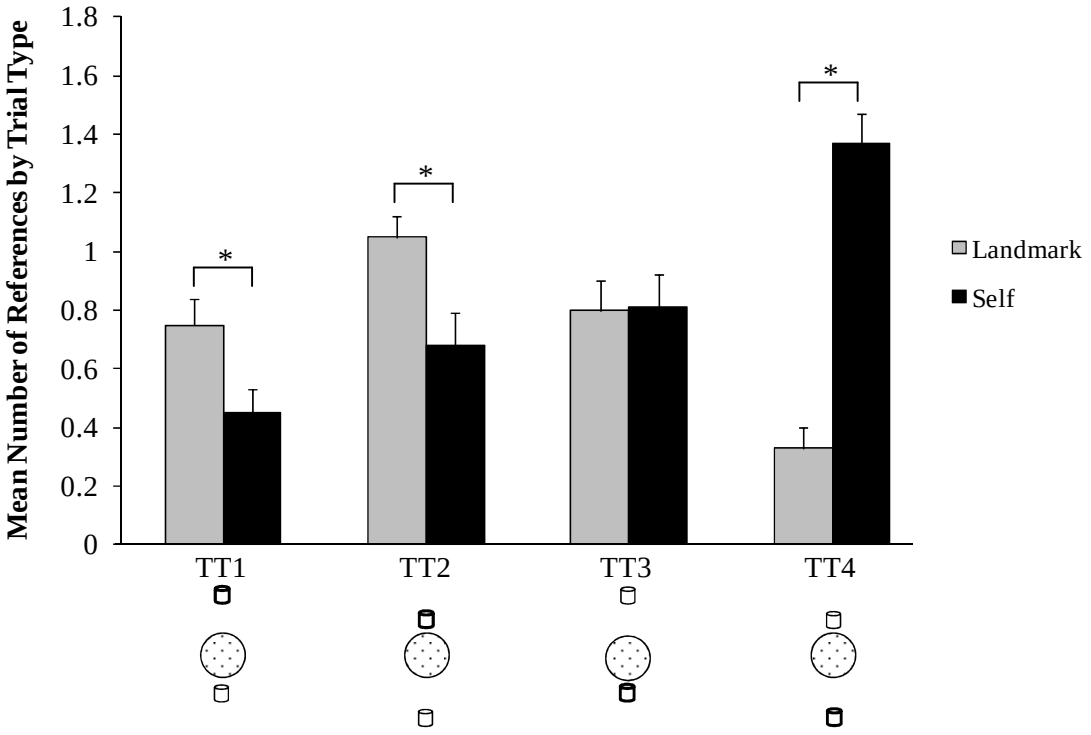

Figure A3. Mean number of landmark and self references per trial by trial type in Experiment 1.

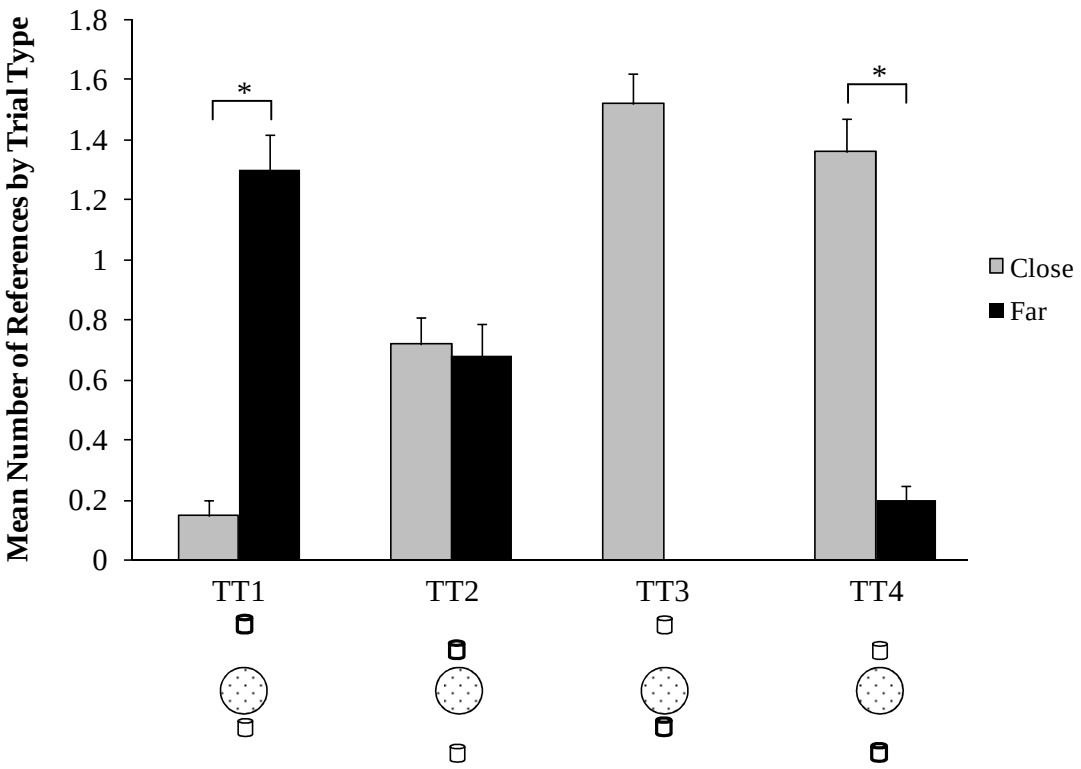

Figure A4. Mean number of "close to" and "far from" references per trial by trial type in Experiment 1.

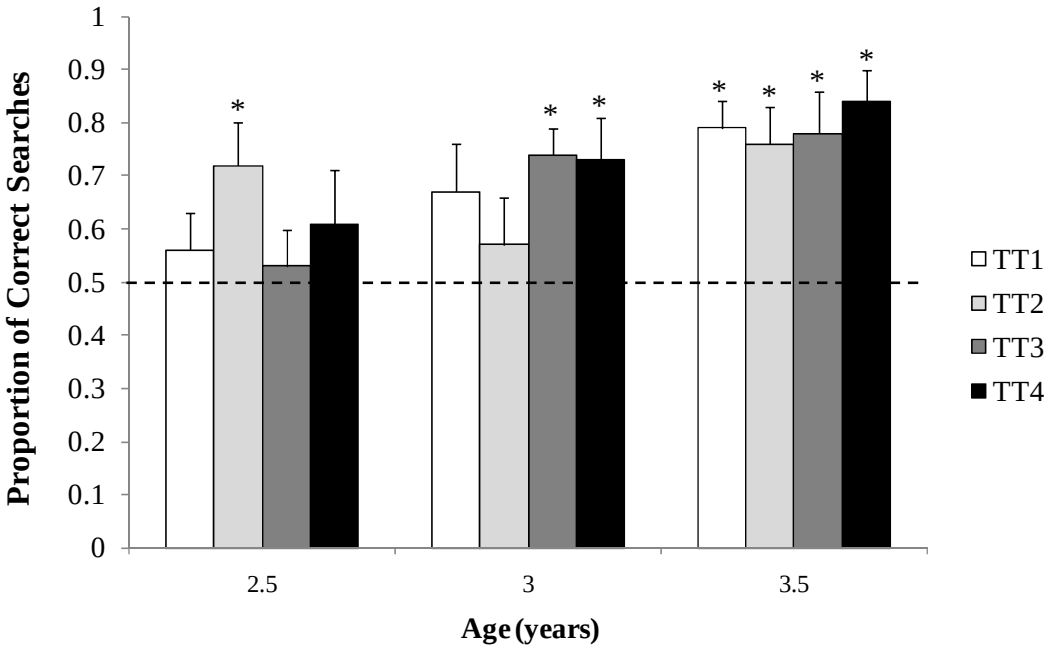

Figure A5. Proportion of correct searches by age and trial type in Experiment 1.

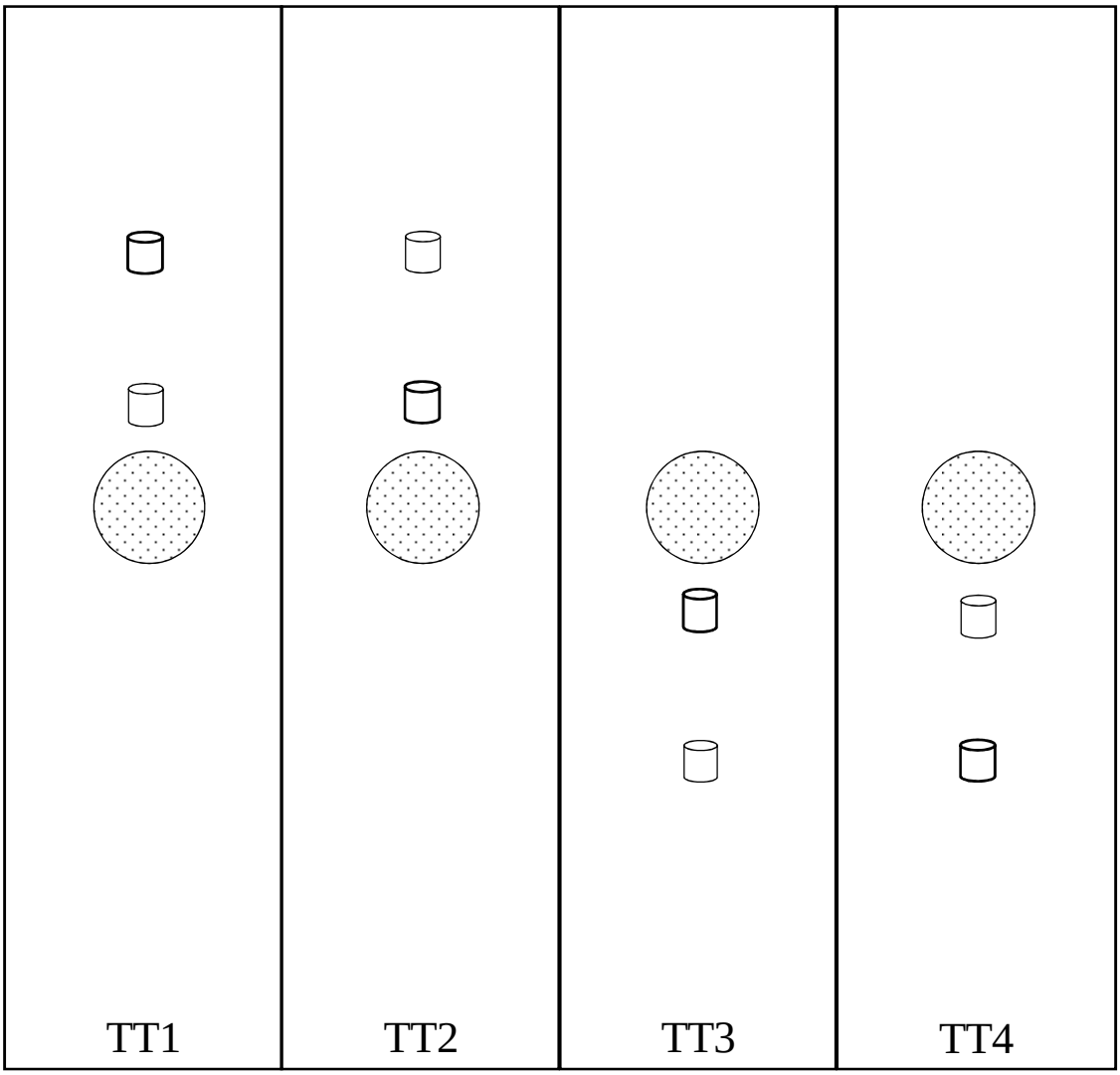

Figure A6. Locations of target and non-target containers in Experiment 2.

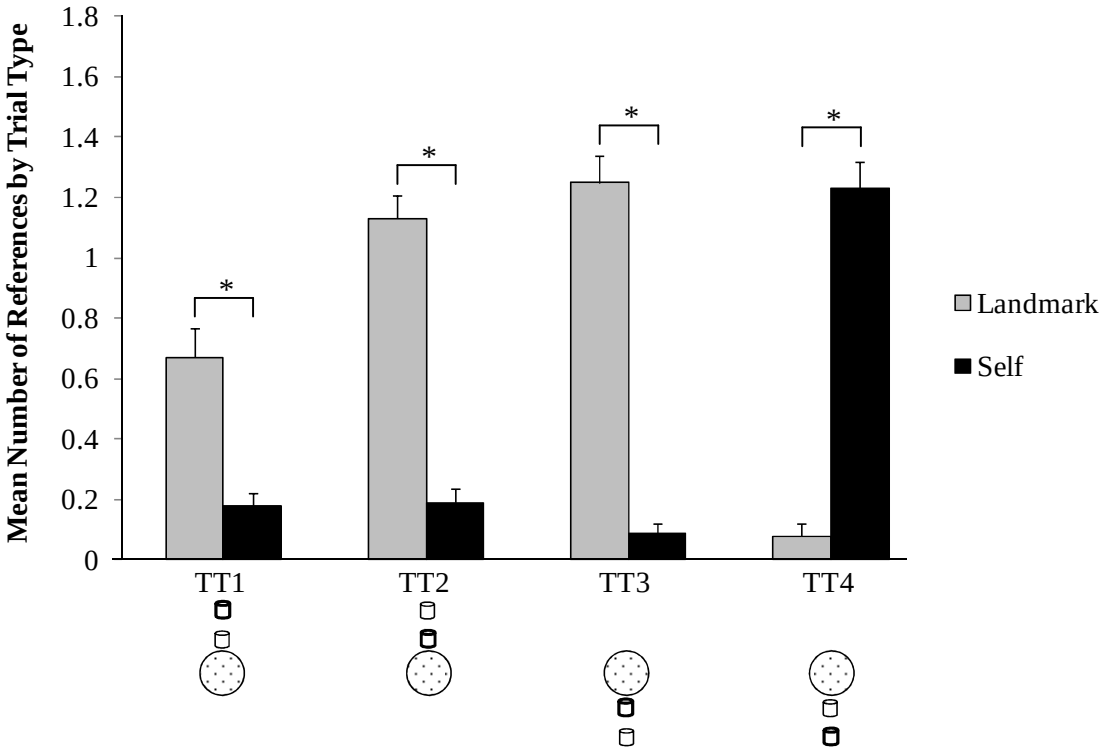

Figure A7. Mean number of landmark and self references per trial by trial type in Experiment 2.

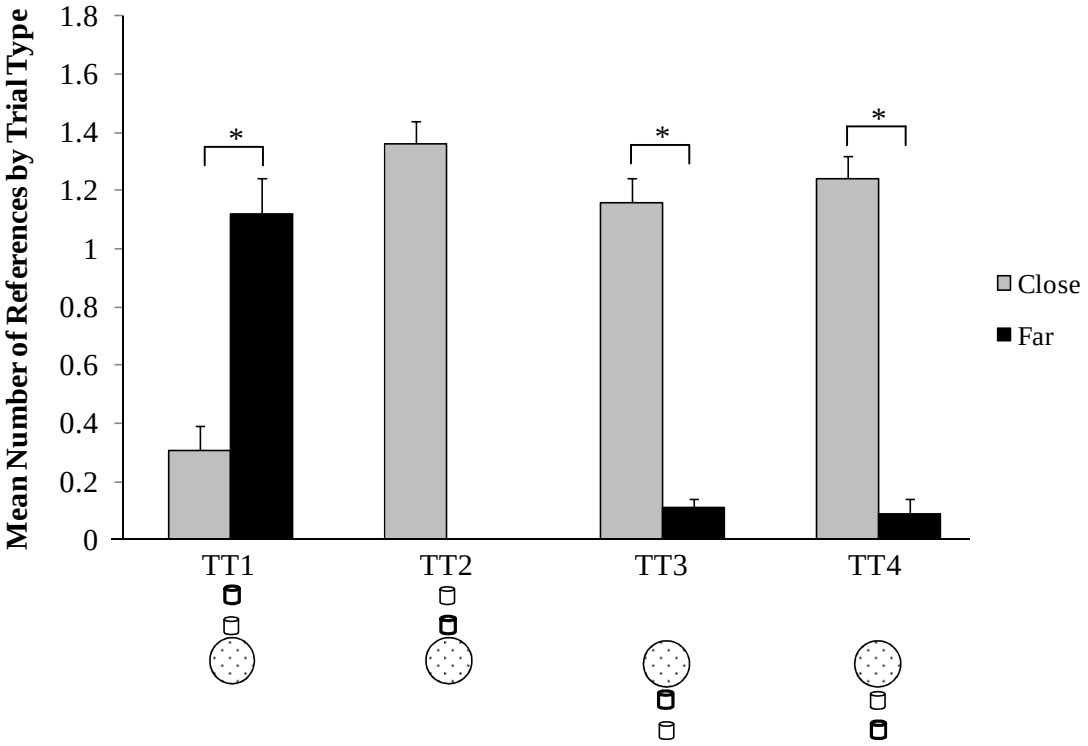

Figure A8. Mean number of "close to" and "far from" references per trial type in Experiment 2.

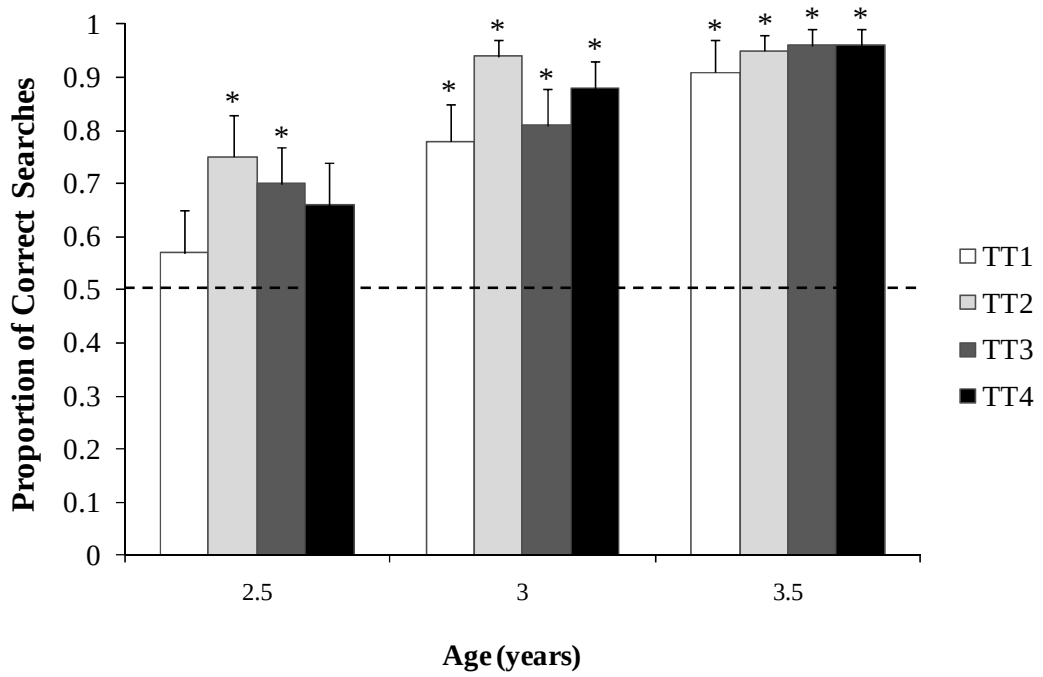

Figure A9. Proportion of correct searches by age and trial type for Experiment 2.

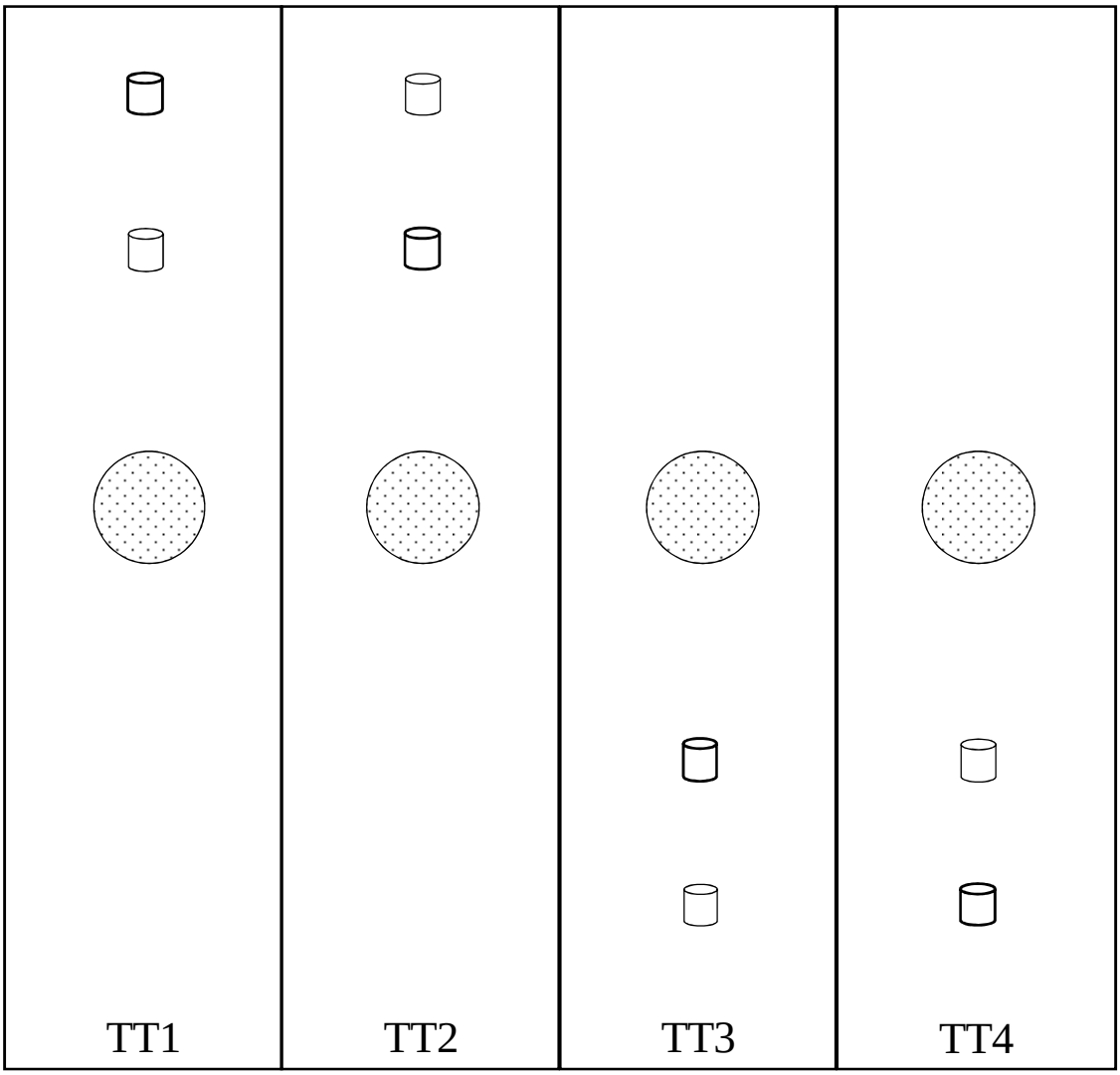

Figure A10. Locations of target and non-target containers in Experiment 3.

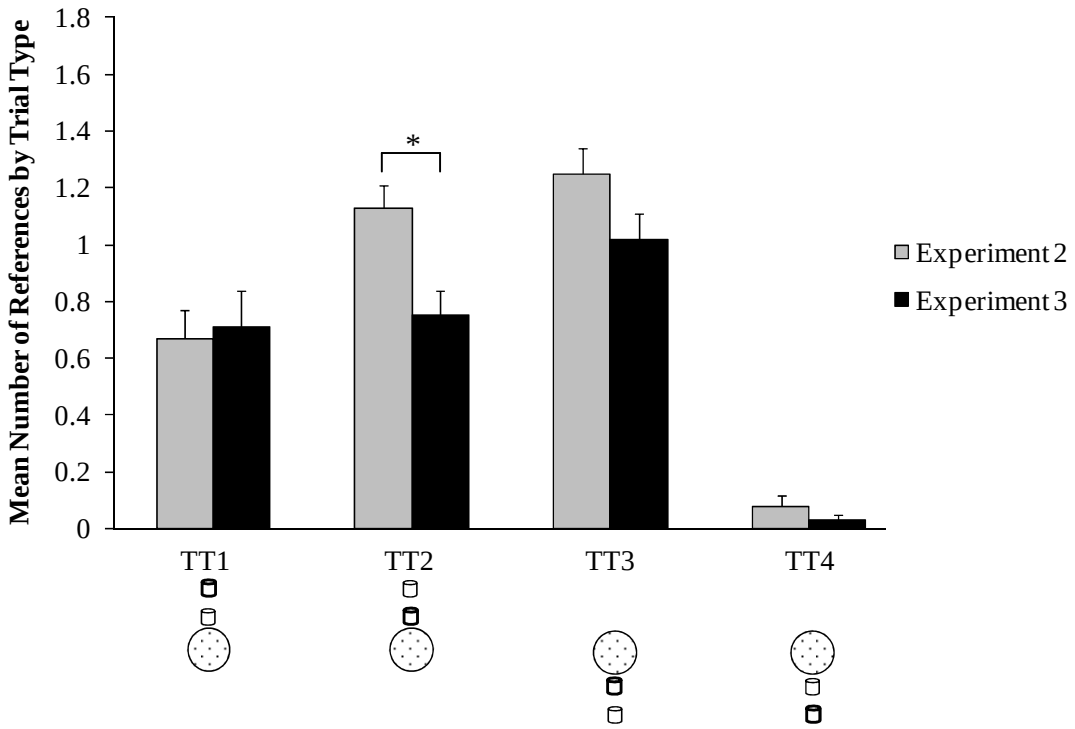

Figure A11. Mean number of landmark references by trial type in Experiments 2 and 3.

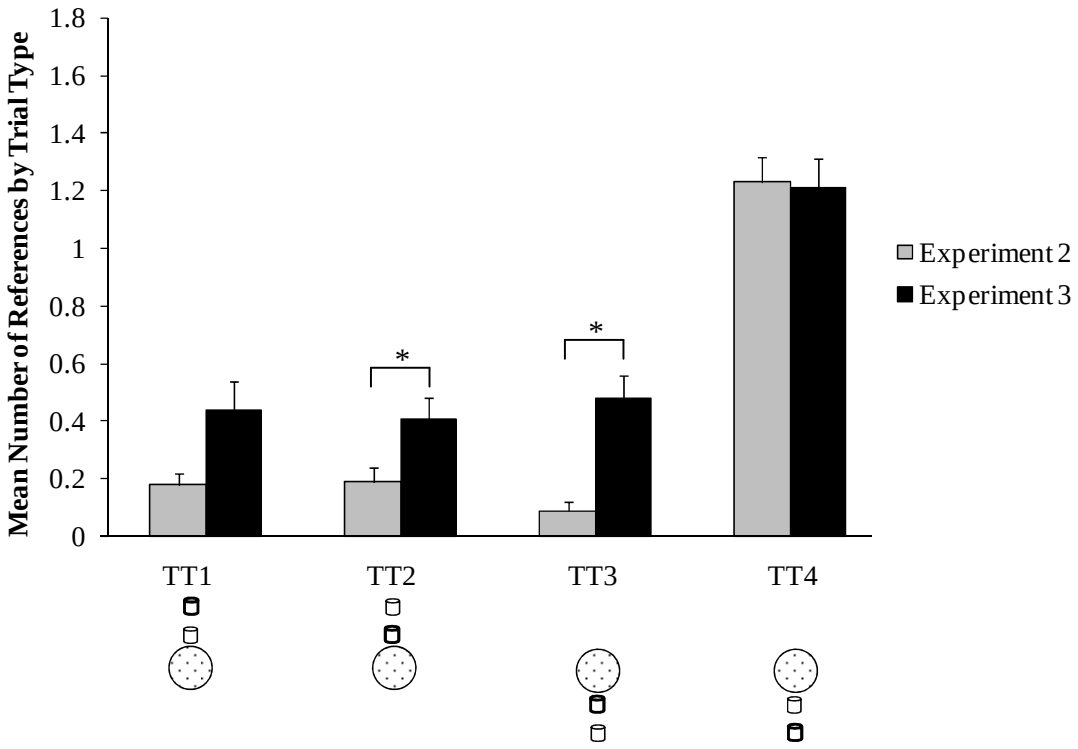

Figure A12. Mean number of self references by trial type in Experiments 2 and 3.

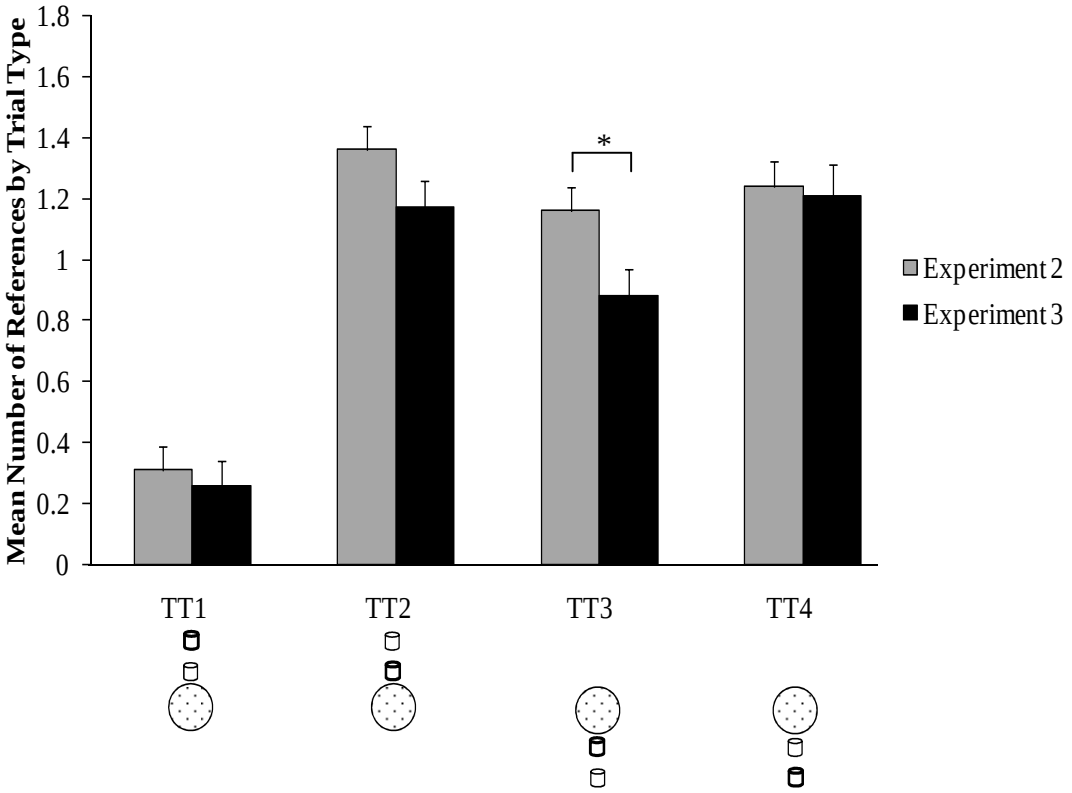

Figure A13. Mean number of "close to" references by trial type in Experiments 2 and 3.

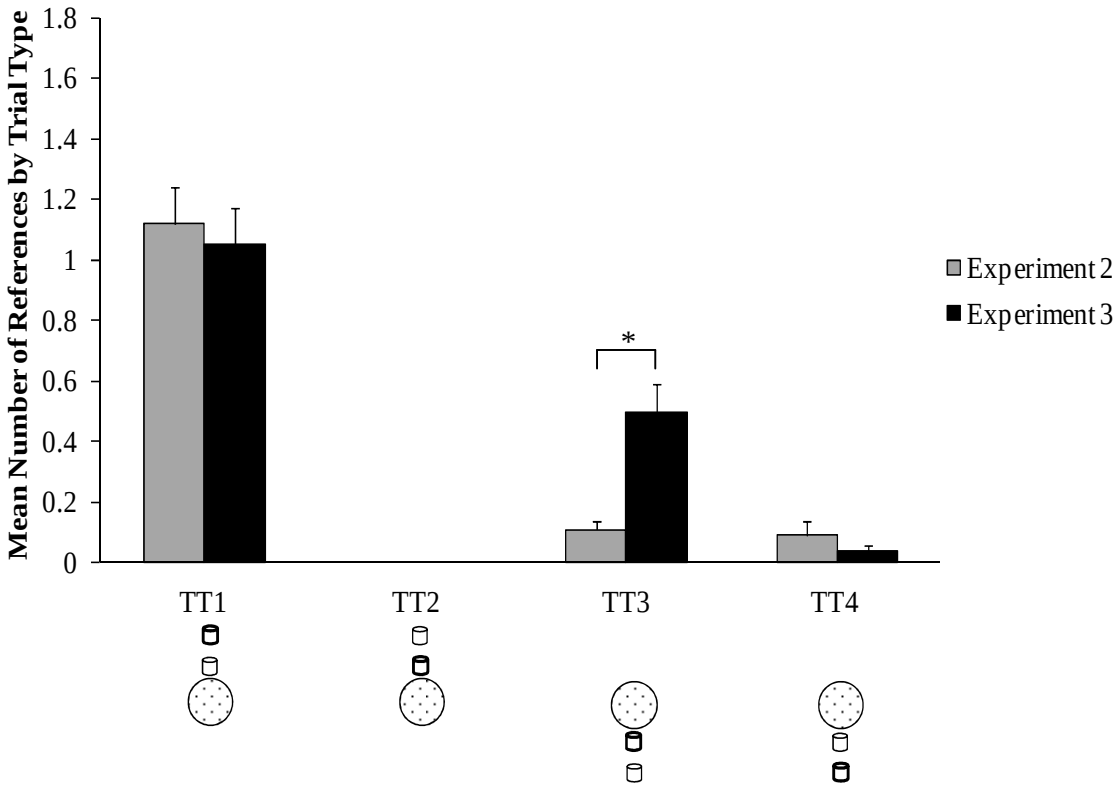

Figure A14. Mean number of "far from" references by trial type in Experiments 2 and 3.

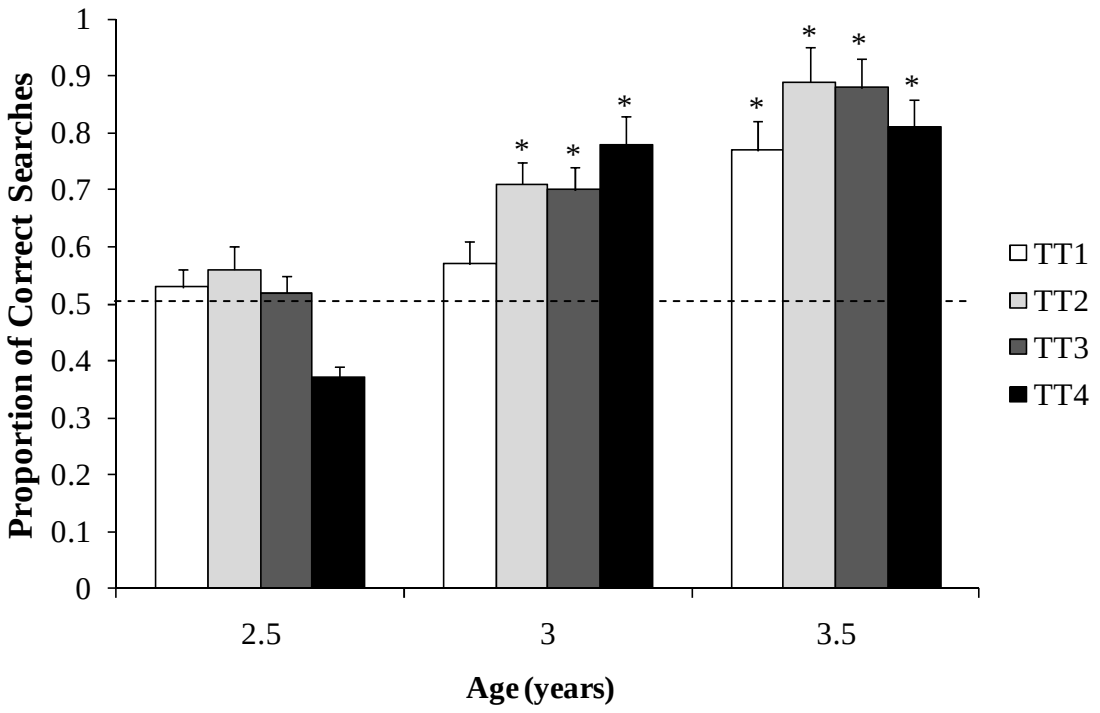

Figure A15. Proportion of correct searches by age and trial type in Experiment 3.

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