The Official Journal of the International Society on Infant Studies
Infancy

Infancy, 1–17, 2013

ISSN: 1525-0008 print / 1532-7078 online
DOI: 10.1111/infa.12031

WILEY Blackwell

Object Locations, Identity and Absent Reference Understanding at 12 Months

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Spatial and contextual information plays an organizing role in many cognitive processes including object individuation and memory retrieval. Recently, attention has been drawn to the fact that changes in an object's location negatively affect infants' learning in different domains. One example is that prestudy exposure to a target object in a nontest location disrupts infants' ability to locate that object when it is hidden in a test room. In the current study, we investigate the possibility that infants' difficulty finding the object is the result of confusion about the identity of the target object. In the current research, infants were familiarized with an object in one room and tested in the other. Infants who were shown a characteristic identifying feature on the object in both locations and who were thus able to track the object identity could later locate the absent referent. In contrast, when infants' attention was drawn to different features on the object in the two locations or to the object itself via pointing, infants were unable to find the object.

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INTRODUCTION

Infants' perception and memory of objects' features and locations have been of considerable interest for developmental researchers. It has been established that for young infants, location information is both easier to perceive and easier to remember than object surface characteristics (Káldy & Leslie, 2003; Krojgaard, 2004; Leslie, Xu, Tremoulet, & Scholl, 1998; Mareschal & Johnson, 2003; Simon, Hespos, & Rochat, 1995; Tremoulet, Leslie, & Hall, 2000; Xu, 1999; Xu & Carey, 1996). The importance of location information may lead to an excessive sensitivity to variations in object locations. In keeping with this, location change sometimes results in impaired learning and test performance (Benitez & Smith, 2012; Saylor & Ganea, 2007; Sommerville & Crane, 2009). In the present study, we investigate the possibility that location changes may present challenges for infants because it makes it more difficult for them to keep track of the identity of an object.

There have been several recent demonstrations that changes in an object's location negatively affect infants' performance on a variety of tasks. In particular, switching objects from right to left, or presenting them at different locations on a stage, or familiarizing infants with objects in a different room before a study can disrupt infants' ability to interpret ambiguous references, to learn new words, and to infer a goal of an action. For example, Saylor and Ganea (2007) demonstrated that between 14 and 17 months, infants rely on an object's prior location when interpreting ambiguous requests for absent objects. In this study, two experimenters sequentially played with infants with a distinctly colored ball (e.g., one experimenter played with the red ball, the other with the blue ball). After the play, the balls were placed in containers: One ball was in a container to the right of the infant and the other one was in a container to the left of the infant. When one of the experimenters came back and asked for "the ball," infants could successfully identify the referent previously associated with the requester only if the balls were in their original locations. If the locations of the containers holding the balls were swapped prior to the request, infants approached the correct object only half of the time. This suggests that stable location information made it easier for infants to identify the referent of an ambiguous verbal request.

Two recent word learning studies demonstrated that the variability of target object locations disrupts infants' ability to associate a word with an object (Benitez & Smith, 2012; Samuelson, Smith, Perry, & Spencer, 2011). In Samuelson et al. (2011), infants from 17 to 19 months of age were presented several times with a target and distracter object on the right and on the left side of a table. Then, the objects were put each in its

own opaque container, and one of the objects was named. Infants' ability to learn a new word was disrupted when the target and the distracter objects were switched from left to right before being put in opaque containers. Similarly, in Benitez and Smith (2012), 16- to 18-month-old infants saw objects appear on a stage, pointed at and named. Each object was prenamed before appearing on the stage. When objects were presented in constant locations, infants were able to anticipate the location of the target after prenaming. When objects appeared at variable locations on the stage, infants were not able to anticipate the location of the prenamed object. Infants learned words more efficiently when names were associated with objects presented at a constant location rather than at variable locations.

Location changes that involve displacements larger than switching objects from right to left (e.g., taking the object to a different room) also affect infants' learning. For example, 10-month-old infants fail to use information about an experimenter's preference to interpret the goal of an ambiguous action sequence if information about the person's preference for an object is delivered in a different room (Sommerville & Crane, 2009). In this study, infants were familiarized with an experimenter preferring one object over another. This happened in the same room they were later tested in or a different room. During testing, infants were habituated to the experimenter reaching for and grabbing the same toy as they did during the familiarization. Then, the locations of the toys were switched. Infants who were familiarized with the experimenter's preference in the same room were surprised when the experimenter reached to the old location with the new object. In contrast, infants who received the goal preview in the other room did not show surprise when the experimenter reached for a new object in the testing room.

A recent study has provided evidence for a strong effect of contextual change on 12-month-olds' ability to comprehend a reference to an absent object (Osina, Saylor, & Ganea, 2013). In this study, infants played with a toy and saw it being hidden in an ottoman (that they could see and approach easily). After a short delay, the experimenter talked to infants about the absent thing. Infants who had first been introduced to the toy in the experimental room responded to hearing a reference to the hidden toy by searching for the toy at its location. In contrast, infants who had been introduced to the toy outside of the experimental room (either at home or in an adjacent room) did not indicate they understood the experimenter's references by searching for the toy at its new location. In the latter case, infants did not have a continuous exposure to the object because they did not witness the object being transferred from one room to the other. Rather, the object was introduced in the reception room and then

reintroduced in the experimental room where it was hidden and later referred to in its absence.

One reason why changes in an object's location interfere with infants' learning or responses may have to do with the fact that when objects are introduced in one context and then reintroduced in another context, young infants cannot establish the identity of the object. Such difficulty may affect infants' attentiveness during the study and disrupt their performance on subsequent tasks.

To test this possibility, we adapted the paradigm used by Osina et al. (2013) to ask whether providing children with cues about the identity of the object would enable them to more easily recognize the test object when it reappeared in the experimental room. In one condition, infants were introduced to an object and its characteristic feature in the reception room and were reminded about the same, characteristic feature in the experimental room. The identifying feature provided infants with unambiguous evidence that the familiar object was the same one seen in the reception room. If infants' difficulty locating the referent in Osina et al. (2013) was the result of their confusion about the object identity, highlighting the identifying feature in both locations should make it easier for infants to locate the referent when they hear it mentioned again.

Two additional conditions were included to control for the possibility that highlighting the characteristic feature on the object simply made infants' representation of the object richer and stronger and that this alone made it easier for them to respond to the request for the absent thing. In one condition, different features on different parts of the object were highlighted for infants in the reception and the experimental rooms. In the other condition, infants' attention was drawn to the object in both locations by verbal and gestural means without a single, specific feature being highlighted. Such manipulations served to enhance infants' representation of the object without helping them track the object's identity across its dislocations. If infants' difficulty responding to absent reference is caused by their confusion about object identity, they should only find the object in the condition in which the same feature is highlighted in both rooms. On the other hand, if infants simply need a stronger and richer representation of the target object, they should locate the hidden object in all three conditions.

METHOD

Participants

Fifty-six 12-month-olds participated (M = 12 months 15 days; range 11 months 23 days—12 months 29 days; 28 girls). Seven additional infants

were omitted because of parental interference (2), failure to attend to the target objects (2), lost videotape (2), and sibling interference (1). Participants were primarily Caucasian and from middle-class families. They were recruited from a city area by phone from a database of interested families and were full-term at birth, normally developing and hearing, with English as their primary language.

Materials

Two ottomans that were identical in shape and size (one brown, one black) were used as hiding locations. Target objects were two stuffed animals from the laboratory. One stuffed animal (a pig) was shown to infants before the experiment and thus was familiar when the experiment started. The other stuffed animal (a dog) was not shown to infants before the experiment and thus was new when the experiment started. Infants in a previous study using the same test objects were equally likely to respond to the dog and pig.

The toy pig had two characteristic features. First, there were yellow threads on the side that had remained after a label was cut off. Second, yellow threads were attached to the back of the neck for the purposes of the study. During the experiment, the researcher directed infants' attention to these features in different conditions.

Procedure and design

Every infant participated in a *new toy* and *familiar toy* condition. The *familiar toy* condition will be described first.

There were three between-subjects variants of the *familiar toy* condition: *identifying feature, nonidentifying feature,* and *no feature*. The three conditions varied according to which feature of the familiar object the experimenter highlighted during familiarization.

Familiarization phase

The *familiar* toy was introduced to infants in a *familiarization* phase. This phase was held in the reception room and started after infants were acquainted with the experimenter and felt comfortable. During *familiarization*, the experimenter and baby played with the pig for 3–4 min. The infants did not see the pig before the familiarization. The experimenter did not label the toy, but instead referred to it as "a toy", "this one", or "it". Soon after the pig had been shown to the infant, the experimenter drew their attention to a feature on the toy or the toy itself by pointing at it

several times and saying "Look! See this? Do you want to touch this? See this?" In the *identifying feature* condition, the experimenter pointed at the yellow threads on the side of the pig. In the *nonidentifying feature* condition, the experimenter pointed at the yellow threads at the back of the pig's neck. In the *no feature* condition, the experimenter pointed at the pig's back where there were no features. This information was offered to the infants approximately in the middle of the familiarization phase while the infants were attending to the object.

At the end of the *familiarization phase,* the pig was put out of sight. Approximately 10 min later, the parent and the infant were taken to an adjacent room for the *experimental phase*. The pig was taken to the room unbeknownst to the infants and put out of sight until the participants settled down for the next phase of the experiment.

Experimental phase

The room where participants were taken for the experimental phase was approximately three times as small as the reception room with no furniture except for two cabinets between which the camera was positioned. The parent was positioned on the floor by the opposite wall from the camera.

The *experimental phase* consisted of three phases: *play, time delay,* and *test*. The purpose of the *play phase* was to give participants experience with the stimulus object and its label and to highlight the relevant feature. In the beginning of the play phase, the experimenter showed the toy to the infants and said "Ready to play? Look what I have for you! It's a pig!" After that, in the familiar toy *identifying feature* condition, the researcher pointed at the threads on the pig's side while saying "See this?"—the threads were the same feature that infants saw during the *familiarization*. In the *nonidentifying* feature condition, she also pointed at the threads on the pig's side saying "See this?", but this feature was different from what infants saw during the *familiarization* (the threads on the back of the pig's neck). In the *no feature* condition, the experimenter pointed at the pig's front with no features saying "See this?" Next, in all conditions, she mentioned the toy eight times using infant appropriate speech (e.g., "Look, it's a pig! Do you like pigs? I like pigs!"). Infants were free to move around the room and to handle the toy. The play phase lasted about 70–75 sec.

At the end of the play phase, the infant was placed on her parent's lap. The experimenter clapped her hands and called the infant's name to attract her attention and then hid the toy in an ottoman saying to the child, "Look! It's going right here! Bye!" The ottoman was on the floor 7.5 feet away from the baby, either to the left or to the right of the infant.

The purpose of the *time delay phase* was to divert infants' attention from the hiding location so that they would not react reflexively to the researcher's request in the test phase. The experimenter sang "Twinkle, Twinkle, Little Star" and pointed to decals on the ceiling. The time delay phase lasted for 40–45 sec. Infants continued to stay on their parents' lap during this time.

In the *test phase,* infants were verbally cued to search for the hidden toy. After attracting the infant's attention, the experimenter asked about the hidden toy eight times, first in a hint-like manner (e.g., "What about the pig? Have you seen the pig?") and then directly (e.g., "Where is the pig? Could you find the pig?"). Hint-like requests were necessary to avoid infants' search behavior in response to "where" questions per se. If infants looked and/or pointed at the toy's location, the researcher continued with the prompts. If infants approached the ottoman at any time the researcher stopped talking, because they terminated the test session naturally by finding the target. Infants usually responded to the hint-like requests with several exceptions: 1 in the *identifying* feature condition, 4 in the *no feature* condition, and 6 in the *nonidentifying* feature condition.

The experimenter retrieved the toy from the ottoman for all infants at the end of the test phase or when the infant approached it and allowed the infant to play with it while she took the ottoman out of the room and brought in a differently colored one. She then repeated the *play,* the *delay,* and the *test* phases for the other object.

The *new* toy condition was identical to the three conditions described above except that there was no *familiarization* phase and the researcher did not draw infants' attention to any feature during the *play* phase. The administration of the *new* toy condition was the same for infants in the *identifying feature, nonidentifying feature,* and *no feature* conditions. The *new* toy condition served as a baseline comparison for each of the three variants of the *familiar toy* conditions. Experimental design is summarized in Table 1.

The order of the *new* and *familiar* toy conditions and the side where each toy was hidden were counterbalanced.

Coding

Infants' memory of the object's current location and its name was measured by whether infants responded to the experimenter's verbal prompt for the hidden object by looking at, pointing at, or approaching the ottoman where the object was located. If infants showed any of these behaviors, they were given a score of 1, and if they did not, they were given a score of 0.

TABLE 1
Experimental Design

Condition	*Object type*	*Familiarization phase*	*Experimental phase*
Identifying feature	Familiar	Room A Pointing to feature 1	Room B Pointing to feature 1
	New		Room B No features
Nonidentifying feature	Familiar	Room A Pointing to feature 2	Room B Pointing to feature 1
	New		Room B No features
No feature	Familiar	Room A Pointing at the back	Room B Pointing at the front
	New		Room B No pointing

In this and all subsequent studies, the initial judgments about the presence of a behavior were made by the experimenter and recorded for each participant right after the study. A look was coded if infants looked at the ottoman following the mention of a hidden object. A point was coded if infants looked and raised their arm in the direction of the ottoman. Both index finger and full-hand pointing were considered. Approaching the ottoman was coded if the baby looked at the ottoman and moved their body toward the ottoman. Videotapes of the sessions (representing 71% of the sessions) were then coded by a second coder who was blind to the hypothesis of the study and to the condition. The coder was not blind to the position of the ottoman because it was partially visible on the tapes. Overall agreement on the presence or absence of target behaviors was high (94%, Cohen's kappa 0.88). Disagreements were resolved via discussion, and the experimenter's initial judgments were used in the analyses below.

RESULTS

The purpose of this experiment was to investigate why infants have difficulty orienting to a hidden toy's location after having seen this toy in an adjacent room. We predicted that infants would perform at similarly high levels with the *new* and a *familiar* toy in the *identifying feature* condition. In the *nonidentifying feature* and the *no feature* conditions, we predicted high performance with the *new* toy and poor performance with the *familiar* toy. Results are displayed in Figure 1.

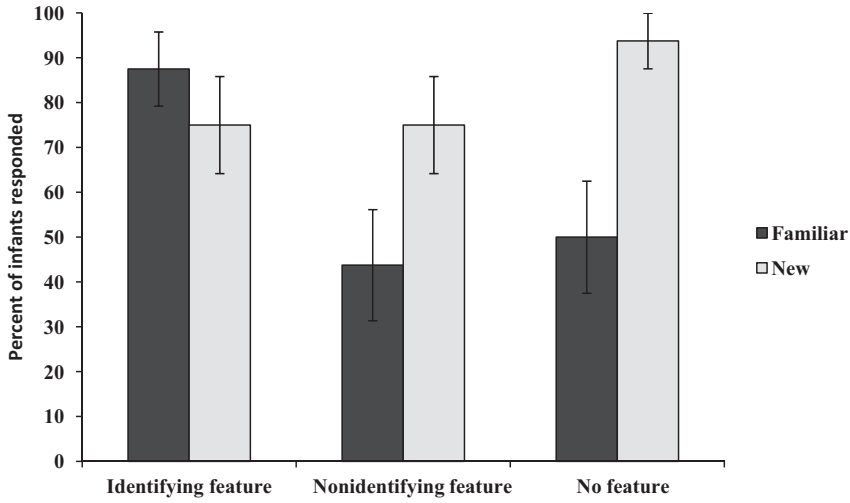

Figure 1 Percentage of infants displaying target behaviors toward hidden familiar and new objects.

As a first step, to ensure that infants were equally attentive in the three *familiar* toy conditions, we analyzed the time they looked at the object when the experimenter highlighted the object or its feature during the *familiarization* phase. Data from one participant in the *identifying feature* condition were excluded from this and all other analyses because the infant focused on the object more than 2.5 standard deviations longer than average. A one-way Welch ANOVA[1] revealed no difference in how long infants looked at the object across the three conditions during the feature introduction, F (2, 28.65) = 1.97, p = 0.16, (*identifying feature:* M = 9.53 sec, SE = 1.06, *nonidentifying feature:* M = 9.25 sec, SE = 0.71, *no feature:* M = 7.58 sec, SE = 0.64). Importantly, how long infants looked at the object during the *familiarization* did not predict whether infants responded or not to the *familiar* toy in the *test phase* (logistic regression, β = 0.003, p = 0.43). This suggests that any differences in infants' responses to a *familiar* object across conditions cannot be explained by differences in their attention during the *familiarization* phase.

Further analyses of infants' responses in the test phase revealed no effects of gender, side, or toy order. Boys were as responsive as girls, and neither the side where a toy was hidden, nor the order of the *familiar* and

[1]The reason for performing Welch ANOVA was because of unequal variances in the duration of object encoding across the three conditions.

the *new* toy conditions mattered for infants' ability to respond. There was also no interaction between condition and order.

A generalized estimating equation (GEE) model with condition as the between variable and type of toy as the within variable was conducted to examine the effect of object recognition on infants' responses during test. Predictor variables were dummy-coded with the *identifying feature* condition and the *new toy* as reference categories. Condition, object type, and their interaction were entered in the model simultaneously.

First, we analyzed infants' baseline performance with the *new toy* across conditions. Next, we compared the differences in infants' performance with the *new* and *familiar* objects across conditions (the interaction effect). Finally, by coding the *familiar toy* instead of the *new toy* as a reference category, we compared infants' performance with the *familiar* object in the *identifying feature* condition to their performance with the *familiar* object in two other conditions.

Infants' baseline performance with the *new* object was high, and there were no significant differences across the three groups of participants. Infants were highly likely (75%) to respond to the *new toy* in the *identifying feature* condition ($B_0 = 0.67$, $\chi^2(1) = 3.92$, $p < 0.05$, 95% CI [0.01, 1.34]). There were no significant differences in the rate of their responding to the *new toy* in the *identifying feature* condition compared to the *nonidentifying feature* (75%) and the *no feature* conditions (94%) (*nonidentifying* versus *identifying:* $B_1 = 0$, $\chi^2(1) = 0$, $p = 1$, 95% CI [−0.94; 0.94]; *no feature* versus *identifying:* $B_2 = 0.86$, $\chi^2(1) = 1.89$, $p = 0.17$, 95% CI [−0.36, 2.08]). This suggests that there were no overall differences in responsiveness between the three groups of infants.

Next, there were no significant differences in infants' likelihood to respond to *the new toy* and the *familiar toy* in the *identifying feature* condition ($B_4 = 0.48$, $\chi^2(1) = 0.67$, $p = 0.41$, 95% CI [−0.66; 1.61]). However, there was a significant condition by object type interaction (likelihood ratio test, $\chi^2(2) = 6.61$, $p < 0.05$). This suggests that the effect of object type on infants' responses varied across conditions. Infants in the *nonidentifying feature* and in the *no feature* conditions were more likely to show higher performance with the *new toy* relative to the *familiar* one than were infants in the *identifying feature* condition (*nonidentifying:* $B_5 = -1.31$, $\chi^2(1) = 3.86$, $p < 0.05$, 95% CI [−2.61; −0.003]; *no feature:* $B_6 = -2.01$, $\chi^2(1) = 6.4$, $p < 0.05$, 95% CI [−3.57; −0.45]). These findings suggest that infants perform worse with a familiar object encountered before the study in a different location than with a new object and that this effect holds unless the object has a characteristic identifying feature on it.

Finally, there were significant differences in infants' performance with the *familiar* object across the three conditions. Infants in the *identifying*

feature condition were highly likely (87.5%) to search for *the familiar* toy ($B_0 = 1.15$, $\chi^2(1) = 8.2$, $p < 0.01$, 95% CI [0.36; 1.94]). Infants in the *non-identifying feature* condition were 43.8% less likely to search for the *familiar toy* than infants in the *identifying feature* condition ($B_1 = -1.31$, $\chi^2(1) = 6.57$, $p = 0.01$, 95% CI [−2.31; −0.31). Infants in the *no feature* condition were 37.5% less likely to search for the *familiar toy* than infants in the *identifying feature* condition ($B_2 = -1.15$, $\chi^2(1) = 4.97$, $p < 0.05$, 95% CI [−2.16; −0.139]). This comparison demonstrates that infants' enhanced performance with the object that had identifying feature on it cannot be explained by infants' generally stronger and richer representation of the object. It also suggests that the effect of prior location of the target object cannot be ameliorated by providing infants with nonidentifying information about the object or simply by drawing their attention to it.

All together, the analyses revealed no differences in infants' performance with the *new toy* across the three groups and better performance with the *familiar toy* in the *identifying feature* condition than in the two control conditions. These results show that infants have difficulty tracking object identity when an object is moved from room to room. The findings are consistent with the proposal that infants' confusion about the object identity resulting from such location changes disrupts infants' ability to reveal understanding of absent reference.

DISCUSSION

In the current study, we investigated the possibility that infants' difficulty locating a hidden object encountered in a different context before the study is related to their difficulty establishing the object's identity across multiple contexts. To facilitate infants' ability to track objects across large-scale spatial displacements in this research, we highlighted the same, characteristic feature of the object in both locations where infants encountered the object. This manipulation facilitated infants' subsequent ability to find the object in response to a verbal request. When two different features were highlighted or pointed at, infants were less likely to locate the object based on a verbal request for it. When an object was not introduced before the experimental phase, infants had no difficulty locating the object when it was hidden. Together these findings suggest that large-scale spatial displacements may disrupt infants' ability to locate verbal referents, but that they can be released from this difficulty if attempts are made to clarify that the referent is the same object as the one that they had recently seen in a different context.

A limitation of the current study is that toy type was confounded with toy familiarity: The dog was always new to infants, and the pig was always familiar. However, the condition differences found for the familiar toy suggest that the current results cannot be explained by infants' preference to one toy over the other. If a toy preference were the only factor guiding infants' responses, they should not have searched for the (familiar) pig in any of the conditions.

Previous research on infants' absent reference understanding has shown that at 12 months, infants' ability to react to the experimenter's mention of a hidden object by locating it is very fragile and context specific and that infants' ability to represent the referent and its location at the time of the request is critical for their comprehension (Ganea, 2005; Saylor & Baldwin, 2004). One possible reason why infants' confusion about the identity of the target object disrupts their performance is that such confusion affects infants' ability to allocate resources to encoding the name and location of the object during the play phase in the test room. This account has much in common with the effect of divided attention on memory retrieval in adult subjects. It has been shown that introducing concurrent tasks during encoding, independently of their domain, significantly impairs long-term and short-term, episodic, recall, or recognition memory (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Fernandes & Moscovitch, 2000; Naveh-Benjamin, Craik, Guez, & Dori, 1998). Therefore, it is possible that in the current study, the target object's ambiguous identity affected infants' attention in the play phase during their encoding of the information (i.e., object name and location) critical for the subsequent task of locating the object based on a verbal request. When such ambiguity was removed, by drawing the child's attention to the object's identifying feature in both locations, infants could successfully respond to the mention of the hidden object by locating it.

Several lines of research support our interpretation that infants have difficulty recognizing an object in the test room after having seen it in the reception room. First, the object individuation literature highlights the primacy of spatiotemporal information for young infants' object tracking ability (Káldy & Leslie, 2003, 2005; Leslie et al., 1998; Mareschal & Johnson, 2003; Simon et al., 1995; Tremoulet et al., 2000; Wilcox & Baillargeon, 1998). When unambiguous spatiotemporal information is not provided, infants have difficulty establishing the number of objects based on their surface characteristics alone (Xu, 1999; Xu & Carey, 1996). Second, the literature on memory development has established that infants' memories are strongly associated with the initial context of encoding (Butler & Rovee-Collier, 1989; Hartshorn et al., 1998; Hayne, Macdonald, & Barr, 1997). During the second encounter with an object in a new location, infants lack contextual

retrieval cues that can help them fully recognize the familiarly looking object. Finally, one study provides direct evidence that encountering a familiar object in a new location confuses infants as to whether it is the same object or not (Moore & Meltzoff, 2004). In this study, 14-month-old infants saw a bell hidden in a cabinet. When they returned to the lab 24 h later, they saw the bell lying on the floor. They approached the cabinet to verify whether the original bell was still there and the one on the floor was an identical but numerically distinct bell.

Importantly, at 12 months, infants already have enough mental capacity to retain at least some features of a single object over occlusion (Tremoulet et al., 2000; Xu, 1999; Xu & Carey, 1996; Xu, Carey, & Quint, 2004). Therefore, when an object disappears and then reappears later in a different location, infants at 12 months should encode that they had seen that object before. However, although the object may look familiar to them, they still may experience difficulty recognizing it as the one they had previously encountered in a different location.

An alternative explanation for why infants fail to search for an object in the current research is that infants associate an object with its location during the initial familiarization with the object and then this association *directly* interferes with their ability to bind a new location to the object (its hiding location in the experimental room). This process is similar to proactive interference, where the learning of new information is impaired by the existence of similar information in memory (Greenberg & Underwood, 1950; Keppel & Underwood, 1962). This explanation is unlikely for the following reasons.

First, the magnitude of interference from previous associations depends on the strength of the existing memory trace. For example, Greenberg and Underwood showed that proactive interference is stronger when the amount of prior information learned is increased (Greenberg & Underwood, 1950). At the same time, proactive interference in subsequent learning can be significantly reduced if participants are cued to *not* memorize the items they are currently encoding (Turvey & Wittlinger, 1969). Applying this to our study, the stronger the memory of the initial object location infants had during the experiment, the worse their search performance should be. Pointing out the object's identifying feature in the play phase should have reminded infants of the previous context where the same episode had happened—familiarization with object in the reception room. The reactivation of the previous object–location association should have impaired infants' encoding and retention of the object's new location. Therefore, infants should have failed to locate the hidden object when they were reminded about the characteristic feature on the object in the *identifying feature* condition. However, this did not happen.

Second, deeper processing of the focal cue suppresses the encoding of the immediate environment and decreases contextual effects on retrieval (Jones & Herbert, 2006, 2008; Smith & Vela, 2001). In the context of our study, infants were encouraged to pay closer attention to the object and process it more deeply in the *nonidentifying feature* and the *no feature* conditions. This may have enabled them to disregard the surrounding context. Therefore, the object–location association should have been weaker, and infants' test performance in these conditions should have improved as a result (by a proactive interference account). However, infants did not successfully search for the object in the *nonidentifying feature* and the *no feature* conditions, suggesting that the confusion about the target object identity is a more likely explanation of the location change effect.

In the absent reference comprehension literature, there is growing evidence that infants' ability to locate the absent referent depends on various spatial factors. Some of the factors are the accessibility of the hiding location (Ganea, 2005), its proximity to the infant (Ganea & Saylor, 2013; Saylor & Baldwin, 2004) and, most central to the present discussion, the stability of object location (Huttenlocher, 1974; Saylor & Ganea, 2007). The current study shows that location information may affect infants' absent reference comprehension indirectly through affecting their object representation. Encountering an object several times across different locations affects infants' understanding of the object identity, and this impairs their ability to locate the hidden object upon the experimenter's verbal request. An interesting question for future research is whether this effect can be extended to other types of referents that are less likely to have duplicates, for example to people or objects that infants know are unique. Another question is whether highly salient features that naturally help infants identify objects can release them from the location change effect. Finally, it would be interesting to know when in development such type of location change stops interfering with infants' performance and to understand what cognitive factors lead to such improvement.

Previous research has shown that infants are able to individuate objects based on featural information before 12 months, at 4.5–10 months depending on the procedure (McCurry, Wilcox, & Woods, 2009; Wilcox, 1999; Wilcox & Baillargeon, 1998; Wilcox & Woods, 2009; Xu & Carey, 1996). In the current study, 12-month-old infants were confused about the number of objects when not given consistent spatiotemporal information and when their attention was not deliberately drawn to surface features. Several aspects of the current study design might have contributed to this. First, the time lag between the two object presentations was much larger (10 min) in this study than in object individuation studies (a few seconds). Second, infants in this research had not only to individuate an object

(establish its representation as a distinct solid entity in space), but also to identify it (that is, bind different object features together that define its identity and hold them in memory throughout occlusion for future retrieval). It is known that object identification is a more challenging task than object individuation (Tremoulet et al., 2000). Third, in the current study, infants' object recognition was assessed in response to a verbal request for the object when it was absent. Presumably this is a more demanding test situation.

An interesting aspect of infants' behavior in the current study is that although the toy in all three conditions was the same, infants could recognize the familiar object only in the *identifying feature* condition, when they were shown an identity carrying feature across locations. This means that minor details on the surface of objects are not something that infants at 12 months may reliably use to individuate objects. Nevertheless, if a feature is pointed to them, then it helps them keep track of the referent across multiple contexts and time periods.

In conclusion, this study demonstrates that infants' understanding of an object's identity as they encounter it in multiple contexts affects their comprehension of references to that object when absent. When infants saw an object in two different locations providing them with identifying information, but not other kind of information, helped them respond to absent reference by locating the object. This finding highlights the relationship between early cognitive and language development: The way infants perceive and conceptualize objects and space affects their comprehension of speech about the absent.

ACKNOWLEDGMENTS

We thank all families who participated. We also thank Amy Needham and Daniel Levin for helpful advice. We thank Maria Vázquez, Hannah Suchy, Michelle Doscas, and Bronwyn Backstrom for their help with data collection and coding.

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