The Role of Social-Referential Context in Verbal and Nonverbal Symbol Learning

Aimee L. Campbell and Laura L. Namy

This study examined the role of social-referential context in 13- and 18-month-olds’ mapping of verbal and nonverbal symbols to object categories. Infants heard either novel words or novel nonverbal sounds in either a referential or nonreferential context. In all conditions, an experimenter engaged in a social-referential interaction and the label was produced while the infant’s attention was directed to the referent. In the referential condition, labels were produced by the experimenter within the context of a familiar naming routine. In the nonreferential condition, labels were emitted from a baby monitor placed near the infant. The study subsequently tested infants’ mapping of the symbols to the referent objects using a forced-choice procedure. Although the results for the 18-month-olds were strongest, infants at both ages showed evidence of learning both words and sounds in the referential condition and failed to learn them in the nonreferential condition. Thus, infants successfully learned both words and sounds under the same circumstances at both ages. These findings suggest that the social-referential context, and not the symbolic form per se, determine infants’ success at symbol learning.

Infants’ emerging symbolic ability is one of the most amazing and most enigmatic phenomena of their early development. Infants as young as 1 year seem to have surprisingly little trouble with the complexity of learning that some symbol (often completely arbitrarily related to an object, action, or event) can be used to stand for, represent, and convey information about that entity. Studies investigating infants’ ability to learn words indicate that by the end of their first year, infants have acquired a keen ability to learn words that stand for things in their environment (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Bloom, 1993). Woodward, Markman, and Fitzsimmons (1994) demonstrated that infants as young as 13 months are able to interpret a novel word as an object name quickly in an experimental setting with limited number of exposures, and will apply the word to other category members.

Recent studies of the mechanisms underlying early word learning reveal evidence consistent with a general symbolic ability supporting word learning. Infants exposed to a spoken language are not only able to learn words, but are also able to acquire nonverbal symbols such as gestures and tones as names for things, and appear to acquire them under the same learning conditions as they do words (Acredolo & Goodwyn, 1985, 1988; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Iverson, Capirci, & Caselli, 1994; Namy, 2001; Namy & Waxman, 1998; Woodward & Hoyne, 1999).

Specifically, observational evidence shows that children exposed exclusively to a vocal language will produce gestural symbols to refer to things in the environment in the same manner that they produce words to refer to things in the environment (Acredolo & Goodwyn, 1985). Acredolo and Goodwyn (1988) found that 87% of the 16- to 18-month-olds they studied had at least one sign in their communicative repertoire. These gestures appear to be acquired at about the same time that the referential use of words begins to occur (Folven & Bonvillian, 1991; Goodwyn & Acredolo, 1993; Meier & Willerman, 1995). There are strong correlations between children’s early gestural production and language development. For example, gestural combinations have been noted to occur at the same time in development as two-word combinations, and the number of symbolic gestures being produced correlates with the rate of vocabulary development (Acredolo & Goodwyn, 1985, 1988). In addition, infants’ use of words and symbolic gestures seems to
be complementary rather than redundant; that is, infants tend not to acquire both a gesture and a word to name the same object (Acredolo & Goodwyn, 1985, 1988; Iverson et al., 1994).

This observational evidence is bolstered by experimental evidence directly comparing infants' acquisition of novel words and novel nonverbal symbols as object names. Namy and colleagues (Namy, 2001; Namy & Waxman, 1998, 2000, 2002) have found that 17-month-olds interpret novel symbols including both words and gestures as well as nonverbal sounds and pictograms as names for object categories. All gestures, words, sounds, and pictograms were novel and arbitrarily related to the objects. Woodward and Hoyne (1999) reported a similar phenomenon for the acquisition of words and nonverbal sounds. Infants as young as 13 months readily accepted either a word or a sound as an object name. Hollich et al. (2000) have also demonstrated that nonverbal mouth noises are readily mapped to object categories as early as 12 months of age.

It is interesting that although the empirical evidence suggests that initially, infants seem to regard words and nonverbal symbols as part of the same symbolic system, a shift seems to take place around 18 months of age (see Volterra & Iverson, 1995). For example, Iverson et al. (1994) reported a shift from an equivalent number of words and gestures at 16 months to a strong preference for the verbal modality at 20 months. Experimental evidence for a shift from a more general, inclusive symbolic ability to a priority for acquiring words is reported by Namy and Waxman (1998, 2002) and Woodward and Hoyne (1999). For example, Namy and Waxman (1998) compared 18- and 26-month-olds' acquisition of a novel word or arbitrary gesture as a name for an object category. Although infants at both ages learned a novel word as a category name, only the 18-month-old infants accepted the novel gesture as standing for the category. In fact, even when the experimenter strongly emphasized the symbolic nature of the gestures by embedding them within a highly familiar and ritualized naming routine, 26-month-old infants did not learn the gesture as representing, or naming, the category. Only when the experimenter provided explicit training and reinforcement for the child’s use of gestures did the 26-month-olds interpret the gestures as standing for the categories. Woodward and Hoyne similarly found that in contrast to 13-month-olds, 20-month-olds failed to interpret nonverbal sounds as object names. Namy and Waxman (1998) interpreted these findings as implying that over time, children begin to discern that words are privileged with respect to object naming as they accrue experience with language. Thus, an initial, general ability to learn symbols gives rise to a more focused tendency to use words as the predominant symbolic modality.

This evidence appears to support the notion that infants begin word learning with no clear priority for words over other types of symbols. The expectation that words are the predominant form of symbolic reference appears to emerge out of infants’ experience with symbols more generally. Although the evidence in support of this account is compelling, there is some evidence that appears to challenge this developmental account.

Two findings in particular challenge the notion that infants’ early symbolic abilities are general. These studies suggest that words hold a privileged status in the symbolic repertoire from the onset of communicative development. In fact, these studies suggest that words have taken on a privileged status with respect to symbolic reference even before the onset of productive language in infancy. These two studies are similar in that they each pit words against nonverbal sounds in prelinguistic infants.

Balaban and Waxman (1997) looked at the use of a noun phrase (e.g., “a bird”) versus a duration-matched sine tone to facilitate perceptual categorization and category discrimination in 9-month-old infants. In their procedure, Balaban and Waxman habituated infants to categories of objects presented on a screen that were accompanied by either the label or tone. If words and tones both facilitate attention to objects, infants in both conditions should show evidence of forming object categories by preferring to look at an object from a novel object category following habituation. Results indicated that infants who had heard the novel word during the habituation phase looked reliably more at the object from the new category during the test. In contrast, infants who had heard the novel tone as a name for the category showed no preference for the object from the new category. The authors interpreted this finding as suggesting that infants have certain expectations that words refer to object categories, and on hearing a word, they were more likely to form a category for the objects. This finding implies that infants do not have the same expectation for a novel tone as they do for a novel word.

Xu (1998) has made similar arguments about the privileged status of words in the formation of object sortals. She examined whether providing distinct labels (e.g., “a ball” and “a duck”) for two distinct
objects facilitated infants’ ability to individuate the two objects. In the two-word condition, infants were familiarized with two objects emerging from either side of an occluder. During the presentation of each of the objects, they received a label that was produced by a loudspeaker. For example, the infant heard “Look, a duck” or “Look, a ball.” In the one-word condition, infants also saw two objects emerging from either side; however, both objects received the same label, “Look, a toy.” Next, the occluder was lowered to reveal either the expected outcome of two different objects resting behind the occluder, or the unexpected outcome of a single object. Results indicated that infants in the two-word condition looked longer at the unexpected outcome, indicating their expectation that there would be two objects behind the screen, whereas infants in the one-word condition did not show this trend. Xu interpreted this finding as indicating that the presence of the label for each of the objects encouraged infants to recognize them as distinct. In an important manipulation, Xu performed the same procedure using either two distinct words or two tones as labels for the objects. If infants interpret the tones, which were an octave apart, in the same manner that they interpret the words, as indicating distinct objects, the presence of tones should facilitate their performance on the task as well. Results showed that infants looked longer at the unexpected outcome when they heard two words labeling the objects but looked longer at the expected outcome when they heard two tones labeling the object. This finding suggests that although hearing two different words for the objects facilitated their ability to discriminate two distinct objects, hearing two different tones did not affect their performance. In this case, then, infants did not use words and tones as similar cues to object individuation.

These two studies seem to suggest that words are already a privileged form of reference for infants at 9 to 10 months of age. Infants appear to expect words to name objects in a way that other arbitrary signals do not. This raises the possibility that the similar performance of slightly older children on verbal versus nonverbal symbol-learning tasks does not imply a general symbolic ability from the onset of communicative development. Perhaps the similar performance observed for words versus nonverbal symbols does not reflect similar processing mechanisms. For example, perhaps the task is eliciting symbolic mapping in the case of word learning but merely paired association in the case of nonverbal symbols, with no real appreciation of the referential or representational nature of the signal.

There are two reasons to believe this is not the case. First, the two studies that challenge the equipotentiality of verbal and nonverbal symbols are visual attention tasks, not symbolic-mapping tasks such as those used by Namy (2001; Namy & Waxman, 1998) and Woodward & Hoyne (1999). It may be that the privileged influence of words on infants’ visual discrimination is by virtue of the fact that one stimulus involves a human voice whereas the other does not. We know from the literature on infant attention that from birth, visual orienting is heightened by the human voice (e.g., see Ecklund-Flores & Turkewitz, 1996). This heightened attention might, by itself, lead to superior category discrimination or object discrimination, independent of any expectations infants might have about the communicative function of language. Second, the verbal and nonverbal stimuli employed in the studies by Balaban and Waxman (1997) and Xu (1998) were not necessarily matched for salience and complexity. When a similar paradigm was employed using instrumental Raffi music, similar visual attention and category discrimination were found for a verbal versus a nonverbal task (Roberts, 1995; Roberts & Jacob, 1991).

Nonetheless, it is a clear possibility that the learning processes for words versus nonverbal symbols may differ, despite the similar performance in the range of symbol-learning tasks employed thus far. If words are interpreted symbolically and nonverbal symbols hold some more associative and less representational status, we should be able to reveal different learning conditions for words and other symbols. Namy and Waxman (2000) have already revealed one such distinction that may indicate different learning contexts, namely, the role of sentence context in word versus gesture learning. Specifically, Namy and Waxman found that 17-month-olds will interpret gestures as object names regardless of whether they are presented within familiar naming phrases such as “Look at the …” In contrast, infants more readily interpreted words as object names when they were embedded in naming phrases than when they were presented in isolation. In the current study, we went one step further—we attempted to ascertain the symbolic nature of infants’ mapping of verbal and nonverbal signals to objects by examining the social-referential cues to naming inherent in a typical naming context.

We know from studies by Baldwin, Tomasello, and colleagues that children as young as 12 months and certainly by 18 months appreciate that pointing and eye gaze are important cues to naming, lending strong support to the claim that children appreciate the referential and representational nature of words.
For example, Baldwin (1991, 1993) found that 18-month-olds are able to determine the appropriate referent of a novel word by following the attention of the experimenter. Tomasello and colleagues (Tomasello & Barton, 1994; Tomasello, Strosberg, & Akhtar, 1996) have found that 18- and 24-month-old children are able to use information gained from an experimenter’s behavior in determining the appropriate referent for a word under even more complicated or subtle circumstances.

In perhaps the most direct test of infants’ appreciation of social-referential cues versus paired association as a mechanism for word learning, Baldwin et al. (1996) compared infants’ acquisition of words when they were introduced to novel words produced either with or without cues to referential intent. In this study, infants were presented with a novel word in either a coupled or decoupled condition. In the coupled condition, the novel word was produced by the experimenter who was engaged in a joint-attention episode with the child. In the decoupled condition, the novel word was produced by a confederate who was out of sight and pretending to talk on a telephone. However, the presentation of the word by the confederate was contingent on the child’s attention; the word was produced only when the child was engaged with the object. Mapping of the novel word to the target object was tested by a forced-choice paradigm requiring the child to select the object from a tray containing both the target and a distractor toy. Results indicated that 18- and 20-month-old infants were more likely to select the target toy in the coupled condition. The researchers concluded that infants as young as 18 months of age understand that the speaker identifies the referent of a word, and if cues to referential intent are lacking, no symbolic mapping should be made. In a similar study, Fulkerson, Shull, and Haaf (2002) recently demonstrated that infants as young as 15 months of age are able to use an object label to aid categorization when it is presented by the experimenter in the context of an interaction, but not when it is played by a tape recorder placed at a distance from the experimenter, suggesting a sensitivity to context at an even earlier age.

Our primary question of interest in this study was whether social-referential cues similarly facilitate nonverbal symbol learning. If infants acquire nonverbal object names via associative principles, the social-referential context should not influence infants’ success at symbol-to-referent mapping. If, however, infants appreciate the symbolic and representational nature of the nonverbal, as well as the verbal, signals, they should show the same sensitivity to social-referential cues in a symbol-learning task for both verbal and nonverbal stimuli.

To examine this question, we developed a procedure similar to that used by Baldwin et al. (1996). Infants were assigned to one of two conditions, either the referential or nonreferential condition. In both conditions, infants engaged in an interactive play session with an experimenter who was seated across the table from them, and in both conditions the production of a novel symbol was entirely contingent on and associated with infants’ visual attention to the target object being labeled. In the referential condition, the experimenter, who was engaged with the infant in a socially dynamic interaction, produced the symbol as part of that interaction. In the nonreferential condition, the experimenter was also engaged with the infant; however, the symbol was not produced as part of this interaction, but rather originated from an external source and was not contingent on the experimenter’s social-referential cues. In each condition, half of the infants were introduced to novel words and the other half were introduced to novel nonverbal sounds as names for object categories.

All infants were subsequently tested on their mapping of the symbol (word or sound) to the target object, as well as their extension of the symbol to additional members of the target category that had not been explicitly labeled. The difference between the referential and nonreferential conditions was a subtle manipulation because, from the infants’ perspective, the only difference was the source and the timing of the symbol. As a result, this manipulation provided a strong test of infants’ sensitivity to the social-pragmatic factors that accompany symbols.

To examine the development of infants’ emerging symbolic ability, both 13- and 18-month-olds’ performance on this symbol-learning task was examined. Although a good amount of evidence has been accrued supporting the idea that 18-month-olds are proficient and flexible symbol learners, less is known about symbol acquisition at 13 months. By examining the performance of infants at these ages, a developmental picture examining the emergence of a symbolic ability can be formed. This also allows us to test the possibility that the equipotentiality of words and nonverbal symbols observed at 18 months in previous studies has emerged over the first several months of word learning, with a priority for words evident at the very onset of communicative development.
Method

Participants

Participants in this experiment consisted of sixty-four 13-month-old infants (age: $M = 13.57$ months; range = 12.70–14.74 months) and sixty-four 18-month-old infants (age: $M = 17.82$ months; range = 17.04–19.18) who were recruited via direct mailings. Participants were from predominantly White or Black middle-class families.

A stringent inclusion criterion was imposed, in that only children who made a clear choice on at least 13 of the 16 trials presented (discussed later) were included in the analysis. Fifteen additional infants were excluded (six 13-month-olds and nine 18-month-olds), 6 for failing to make a choice on at least 13 trials, 7 for failing to complete the task, and 1 for exhibiting a side preference on all 16 trials. The number of infants excluded did not differ systematically by condition or symbol type learned.

Materials

Stimuli consisted of 10 small, manipulable toy replicas of objects that were used in the context of a game with the experimenter. All of the objects were selected to be common and familiar to infants at these ages. Two of the objects, a rabbit and a spoon, were used in a warm-up trial to teach the infant the “finding” game. The remaining eight objects were used in the experimental portion of the procedure. The eight objects consisted of two visually discriminable examples from each of four categories: apples, cups, planes, and horses.

The experimental session was taped by a video camera situated to record the ongoing interaction between the experimenter and the infant. This interaction was transmitted by live video feed to a television monitor outside the testing room, where a confederate viewed the interaction. Placed near the confederate was the transmitting end of a baby monitor. The receiving end of the baby monitor was positioned over the experimenter’s left shoulder. The receiving end of the baby monitor was positioned on a window sill to the right of the infant. The infants were able to see the monitor if they turned their heads to the right. The procedure was composed of three phases: a warm-up phase, an introduction phase, and a test phase.

Warm-Up phase. The procedure began with a warm-up phase designed to introduce the child to the finding game that was used to assess symbol interpretation. This phase was identical across all ages and conditions. The infants were shown two familiar objects (e.g., a rabbit and a spoon) one at a time and were allowed to play freely with each of them. During play, the experimenter called the infant’s attention to each toy six times. For one of the two objects, designated the target object, the experimenter labeled the toy with its familiar basic-level name (i.e., bunny or spoon) by saying, for example, “Look at what you have ... bunny! You see that? ... bunny! Do you like that one? ... bunny!” For the remaining toy, designated the distractor, the experimenter drew similar attention to the toy omitting only the label, saying, for example, “Look at what you have! You see that? Do you like that one?” Thus, the two toys received equal attention from the experimenter, but only one was labeled. Assignment of the target and distractor object and order of presentation of the two objects was randomly determined for each infant.

After the experimenter referred to each object six times, she administered a series of four forced-choice trials during which the infants were presented with both toys and were asked to choose one. Two of the choice trials were target trials and two of the choice trials were control trials. On the target trials, the experimenter asked for the toy that had been named and a rising glissando. The nonverbal sounds were produced by a battery-operated, hand-held device that could be hidden out of view of the infant, on the experimenter’s lap.

Procedure

Infants at each age were randomly assigned to either the referential or nonreferential condition and to either the word or sound group within each condition. Each infant was seated in a booster seat across a table from the experimenter, with the parent seated next to the infant. Parents were instructed not to speak during the procedure. Where infants were uncomfortable sitting by themselves in the booster seat, they were transferred to their parent’s lap during the procedure. The video camera was positioned over the experimenter’s left shoulder. The receiving end of the baby monitor was positioned on a window sill to the right of the infant. The infants were able to see the monitor if they turned their heads to the right. The procedure was composed of three phases: a warm-up phase, an introduction phase, and a test phase.

Warm-Up phase. The procedure began with a warm-up phase designed to introduce the child to the finding game that was used to assess symbol interpretation. This phase was identical across all ages and conditions. The infants were shown two familiar objects (e.g., a rabbit and a spoon) one at a time and were allowed to play freely with each of them. During play, the experimenter called the infant’s attention to each toy six times. For one of the two objects, designated the target object, the experimenter labeled the toy with its familiar basic-level name (i.e., bunny or spoon) by saying, for example, “Look at what you have ... bunny! You see that? ... bunny! Do you like that one? ... bunny!” For the remaining toy, designated the distractor, the experimenter drew similar attention to the toy omitting only the label, saying, for example, “Look at what you have! You see that? Do you like that one?” Thus, the two toys received equal attention from the experimenter, but only one was labeled. Assignment of the target and distractor object and order of presentation of the two objects was randomly determined for each infant.

After the experimenter referred to each object six times, she administered a series of four forced-choice trials during which the infants were presented with both toys and were asked to choose one. Two of the choice trials were target trials and two of the choice trials were control trials. On the target trials, the experimenter asked for the toy that had been named
in the warm-up. For example, the experimenter placed both of the toys in front of the child, one on each side of the table, and said, “Which one can you get? Can I have the bunny?” While requesting the toy, the experimenter placed her hand, with the palm up, at the infant’s midline to indicate her desire for the infant to choose one of the toys. During the request, her eyes remained focused on the child’s face or her own hand rather than the toys. During the target trials of the warm-up phase, the infants were reinforced for choosing the correct toy to convey to the child the goal of the game. If the child selected the target toy, the experimenter cheered and said, for example, “That’s right! That’s the bunny! You’re doing such a good job!” If the child failed to select the target toy, the experimenter highlighted his or her mistake by saying, for example, “That’s not the bunny! Look, this one is the bunny!” The control trials proceeded in exactly the same fashion as the target trials; however, the infant was simply asked to choose one of the objects. Again, the experimenter presented the infant with both of the toys. However, in the control trials, the experimenter said, “Which one can you get? Can you pick one?” During the control trials, the infant was positively reinforced for choosing either toy. The purpose of the control trials was to insure that the infants were attending to the instructions and were not consistently selecting the target object regardless of the instructions, simply because labeling heightened their attention to that object.

Pilot testing suggested that when infants received the target trials first, they were more likely to choose the target toy during the control trials, which defeated the purpose of this training phase. However, when control trials were presented first, infants appeared to understand that either choice was acceptable when neither object was explicitly named during the questioning. For this reason, we consistently presented the two control trials first for all infants during the warm-up phase. The side presentation of the objects was randomly determined for each trial.

*Introduction phase.* Following the practice trials, the experimenter administered the experiment proper. The child was introduced to two sets of objects, each presented in a manner similar to the warm-up phase. Within each set, there were two pairs of objects, a mapping pair (e.g., a red apple and a blue cup) and an extension pair (e.g., a green apple and a silver cup). The pairing of the toys and the order of presentation of the pairs were randomly assigned. Within each pair, one of the toys was randomly designated the target object. As in the warm-up phase, the infants were introduced to each toy one at a time in a random order. While the target toy was presented and the child was attending to it, a symbolic form (either word or nonverbal sound) was produced. The key manipulation of social context involved how the symbol was introduced to the infant. In the referential condition, the experimenter presented the target toy to the infant and labeled it six to eight times in the context of their interaction just as she had during the warm-up phase. The labels were specifically produced when both the child and the experimenter were looking at the object. In the word condition, the experimenter verbalized the word. In the tone condition, the nonverbal sound was produced by the experimenter by activating a hand-held device during the interaction. The sound-producing device was held in the experimenter’s lap and was not visible to the child. For example, in both the word and sound condition, the experimenter said, “Look at what you have! [symbol] That’s what we call that one. Do you see what you have there? [symbol] That’s what that is! Do you like that one? [symbol]” This is similar to the technique employed successfully by Namy (2001).

In presenting the distractor toy, the experimenter behaved identically in both the word and sound conditions. Specifically, the experimenter paid equal attention to the distractor as she did to the target toy during the familiarization phase, saying, “Look at what this is! See what you have? Do you like that one?” However, the distractor object never received a label of any kind.

In the nonreferential condition, when the experimenter presented the target toy, she interacted with the infant in a similar manner, saying, for example, “Look at what this is! Do you like that one? Look at what you have!” However, the symbol (either the word or the nonverbal sound) was not presented by the experimenter in the context of the interaction, but rather was emitted from the baby monitor. Although the symbols were produced when the infant was looking at the object, the production of the symbol was not contingent on the actions of the experimenter, as it was during the referential condition. For example, the symbol did not always directly follow one of the experimenter’s phrases or points, but rather simply occurred when the infant’s attention was focused on the object. The nonreferential manipulation was accomplished by having a confederate view the child’s interactions with the toys from an adjoining room on a television monitor transmitting a live feed from the video camera. The confederate watched the interaction without sound, ensuring that the symbol production was contingent on child gaze but was not explicitly contingent on the
experimenter’s speech or social-referential cues. This confederate then produced the appropriate symbol via the baby monitor at the appropriate time (i.e., when the infant was looking at the target object).

When presenting the distractor object, the experimenter’s behavior was identical to that in the referential condition. The experimenter drew attention to the object without labeling it.

The experimental set-up minimized the possibility of the confederate’s producing the symbols in conjunction with the experimenter’s referential acts. First, the confederate could see but not hear the experimental session on the video monitor. Second, the positioning of the camera provided the confederate with a clear view of the infant and the table, but did not clearly display the experimenter’s movements. Although the experimenter’s hands occasionally came into view on the video monitor, this did not occur with sufficient frequency to cue consistently the confederate as to the experimenter’s referential acts. In addition, the confederate was instructed to focus exclusively on the child’s visual attention to the object, not on the experimenter. Finally, the confederate was blind to the experimental hypotheses.

From the infants’ perspective, the only element that differed between the referential and nonreferential conditions was the source and the timing of the symbol presented with the target object. The experimenter who was interacting with the infant behaved identically in all other respects, drawing the infants’ attention to the object by pointing and directing her gaze at the objects.

Test phase. As during the warm-up phase, the experimenter then administered a series of four forced-choice trials including two target trials and two control trials. The infants were first tested on their mapping of the symbol to the objects that had been presented during the introduction phase, and then were tested again with an extension pair on two target trials and two control trials.

For both mapping and extension, the presentation of the target and control trials was blocked, in that the child either received the two control trials first or the two target trials first. The presentation order of the blocks was randomized. Test trials were identical across age, symbol type, and condition. During target trials, the experimenter placed both toys in front of the child, on each side of the table, and requested the target object by producing either the word or the nonverbal sound. For example, the experimenter would say, “Which one can you get? [symbol] Can you get it? [symbol]” During the test phase for either condition, the symbol was always produced by the experimenter, by verbalizing the word or by using the hand-held sound-producing device. The control trials were identical to those during the warm-up phase. The experimenter presented the child with both of the toys and said, “Which one can you get? Can you pick one?”

Following the mapping and extension trials for the first stimulus set, the introduction phase and the test phase (mapping and extension) were repeated for the second set of objects. Thus, there were a total of four target and four control trials assessing the infants’ mapping of the symbol onto the original target object and an equal number of observations per child for the extension trials.

Assessment of context manipulation. To confirm that the referential and nonreferential conditions were roughly equated with respect to the nature of the experimenter interaction, a group of six naive coders viewed a randomly selected 12 children’s experimental sessions from each condition (equally distributed among the two ages and symbol types) and rated the experimenter’s enthusiasm and engagement with the toys and the choosing game. The 24 sessions were viewed in a random order. Coders were told nothing about the nature of the study except that we were interested in the ways children learn names for objects. They were also explicitly instructed to “ignore the exact details of the procedure and focus only on the experimenter and her overall level of enthusiasm” for the objects and the game. Coders assigned an enthusiasm score to each session using a 7-point scale with 1 labeled as “completely unenthusiastic,” 4 as “moderately enthusiastic” and 7 as “extremely enthusiastic.” The range of scores varied from 4 to 7, with an average enthusiasm rating of 5.97. To ensure that the experimenter was generating as much enthusiasm for the objects and the game in the nonreferential condition as in the referential condition, we conducted a t test comparing the ratings for the referential ($M = 5.88, SD = .34$) and nonreferential ($M = 6.07, SD = .31$) conditions. This analysis indicated that the experimenter was actually rated as slightly but significantly more enthusiastic in the nonreferential condition, $t(5) = 2.62, p < .05$. This heightened enthusiasm toward the objects and the game in the nonreferential condition, while unexpected, is valuable in that it biases the outcome, if at all, against our hypothesis in favor of the learning of symbols in the nonreferential condition and not in the referential condition.

In addition, we confirmed that infants in both context conditions received equal numbers of clear presentations of the label (word or sound) while attending to the target object. This was a concern.
because the confederate could not hear the experimenter and might have occasionally produced the symbols while the experimenter was talking, resulting in a smaller number of clear exposures to the symbols in the nonreferential condition. For a randomly selected 16 children’s sessions in each condition (equally distributed among the two ages and two symbol types), we tabulated the number of times the label was presented clearly while the infant was attending to the object in each session (including both Set 1 and Set 2). Labeling instances in which the child was looking away from the object or when the confederate’s production of the label was eclipsed by the experimenter speaking to the child were not included in the tally. This analysis indicated that the experimenter produced symbols an average of 6.4 times per set in the referential condition, and the confederate produced the symbols clearly (without vocal competition from the experimenter) an average of 6.8 times per set. A \( t \) test comparing the number of clear labels produced in the two conditions was not significant, suggesting no systematic difference in the number of presentations of the labels by condition.

Choice coding. Infants’ choices on each trial were coded from videotape. On each trial, infants could select the target object, the distractor, or make no clear choice between the two objects. A choice was defined as the first object a child touched. If the child touched both toys simultaneously and then proceeded to hand one to the experimenter, this toy was considered the choice. Any child who failed to make a clear choice on more than two target trials, more than two control trials, or more than three trials overall was excluded from the experiment.

One primary coder analyzed all of the videotapes and a secondary coder who viewed only the test phase and coded with the sound off (and was therefore blind to target object assignment, symbol type, and condition) analyzed a randomly selected 25% of the videos of the infants in each condition. Intercoder agreement on individual trials was 95%.

If the infants are mapping the symbols to the target object, they should choose the target object at above-chance rates in the target trials and select the target object significantly more in the target trials than in the control trials. If the infants fail to map the symbols to the object, they should respond at chance in both the target and control trials, yielding no reliable differences between trial types.

Results

The mean proportion of trials on which the infants in each group selected the target toy in both the target and control trials is presented in Table 1. We assessed infants’ performance on the task in three ways: (a) by examining group effects of condition, (b) by comparing infants’ performance to chance, and (c) by examining individual patterns. In all analyses, we compared the proportion of the trials on which infants chose the target object for the target versus control trials. Success on this symbol-learning task was defined as heightened selection of the target object on target trials relative to control trials and relative to chance responding. We first assessed whether there were a priori differences in infants’ success on the task attributable to a clearer understanding of the finding game. To assess this possibility, we examined infants’ performance on warm-up trials. We tested infants’ ability to find objects corresponding to familiar basic level object labels (e.g., bunny).

Warm-Up Trials

To examine any systematic variation in performance related to the infants’ understanding of the finding game, we conducted a four-way ANOVA on infants’ performance on the warm-up trials with age (2: 13-month-olds vs. 18-month-olds), symbol (2: word vs. sound), and context (2: referential vs.

<table>
<thead>
<tr>
<th>Age</th>
<th>Referential</th>
<th>Nonreferential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target trials</td>
<td>Control trials</td>
<td>Target trials</td>
</tr>
<tr>
<td>13-month-olds</td>
<td>Word: 0.601 (0.258), 0.503 (0.240), 0.548 (0.199), 0.468 (0.199)</td>
<td>Sound: 0.599 (0.174), 0.479 (0.189), 0.409 (0.214), 0.473 (0.236)</td>
</tr>
<tr>
<td>18-month-olds</td>
<td>Word: 0.619 (0.207), 0.454 (0.203), 0.471 (0.195), 0.513 (0.264)</td>
<td>Sound: 0.661 (0.195), 0.498 (0.192), 0.519 (0.222), 0.538 (0.217)</td>
</tr>
</tbody>
</table>
nonreferential) as between-subject factors, and trial type (2: target vs. control) as a within-subject factor. As expected, the analysis revealed a main effect of trial, $F(1, 109) = 9.44, p < .01$. Infants were more likely to choose the target object in the target trials ($M = 0.59, SD = 0.42$) than in the control trials ($M = 0.47, SD = 0.42$). However, there was also an unanticipated trial by context interaction, $F(1, 109) = 3.98, p < .05$. On practice trials, infants in the referential condition were more likely to choose the target object in the target trials ($M = 0.65, SD = 0.42$) than they were in the control trials ($M = 0.45, SD = 0.42$). However, performance in the nonreferential condition did not differ by trial type ($M = 0.53, SD = 0.42$ for the target trials and $M = 0.49, SD = 0.42$ for the control trials), Tukey’s HSD, $p < .01$. That is, infants randomly assigned to the referential condition tended to perform better on the practice trials than those in the nonreferential condition. There were no other main effects or interactions. We accounted for these sample differences in the basic comprehension of the finding game by conducting two types of subsequent analyses.

In one set of analyses, we calculated a difference score on infants’ performance in the warm-up phase (number of target choices on target trials minus number of target choices on control trials) and entered it as a covariate in subsequent analyses. This approach is imperfect because the warm-up trials were actually intended to teach infants the game rather than to index their a priori understanding of it. That they received feedback during the warm-up trials renders it likely that many of the children who did poorly overall on the warm-up trials had, in fact, learned the game by the time the experiment proper commenced. However, this covariate offers the advantage of allowing us to include performance for all participants while mathematically controlling for any variance in the experiment proper accounted for by initial comprehension of the task. For 11 infants, a warm-up difference score could not be calculated because they did not make a clear choice on either of the practice control trials, on either of the practice target trials, or both. The mean difference score was calculated for the other 117 infants ($M = 0.12$), and this value was entered as the estimated difference score for the 11 missing values.

In our second set of analyses, we re-conducted the statistics including only those infants whose difference scores were greater than zero. Although this approach eliminated many of the infants from the analysis (including many who performed well in the experiment proper, further challenging the validity of the warm-up measure), it offers the advantage of eliminating any possible effects of task comprehension on performance. Conducting the analyses both ways provides the most comprehensive characterization of the phenomena by seeking converging findings across these two approaches.

**Effects of Condition**

We assessed the effects of several factors on infants’ performance, the form of the symbol (word vs. sound), the context in which the symbol was presented (referential vs. nonreferential), the age of the infant (13 months vs. 18 months), and mapping vs. extension as well as trial type (target vs. control). We first performed a five-way ANCOVA with age (2), symbol type (2), and context (2) as between-subject factors and trial (target vs. control) and type (mapping vs. extension) as within-subject factors, using warm-up scores as a covariate. This analysis yielded a main effect of trial, $F(1, 119) = 7.49, p < .01$, indicating that overall, infants were more likely to choose the target toy in the target trials ($M = 0.54, SD = 0.21$) than in the control trials ($M = 0.49, SD = 0.21$). This main effect was mediated by a Trial × Context interaction, $F(1, 119) = 8.75, p < .01$. Infants who were presented with the symbols in the referential context were more likely to choose the target toy in the target trials ($M = 0.60, SD = 0.22$) than they were in the control trials ($M = 0.49, SD = 0.22$). However, performance in the nonreferential condition did not vary as a function of trial type ($M = 0.48, SD = 0.22$ for the target trials and $M = 0.49, SD = 0.22$ for the control trials), Tukey’s HSD, $p < .01$. This interaction reveals that infants more readily mapped symbols to their referents in the referential than in the nonreferential condition.

Additionally, the analysis revealed a main effect of type (mapping vs. extension), $F(1, 119) = 6.61, p < .05$. We were surprised to find that infants were more likely to choose the target toy during the extension trials ($M = .54, SD = 0.21$) than during the mapping trials ($M = .49, SD = 0.21$). This effect may be driven by a relative novelty preference for the distractor object during the mapping trials after increased attention to the target object during the introduction phase. The effect of the mapping versus extension did not interact with trial (target vs. control), suggesting that the finding reflects more of an attentional component of the infants’ behavior in this task rather than their symbolic understanding. A similar effect of type (mapping vs. extension) has been reported by Namy and Waxman (2000) using a similar type of paradigm.
There were no main effects or interactions involving symbol type. In fact, the \( F \) value for the main effect of symbol type was less than 1, hinting that the social-referential context had a similar influence on both word and sound learning. This was confirmed by effect size analyses. Using the \( \omega^2 \) statistic, we calculated that at 18 months, the effect of context on performance was medium to large for both words and sounds (\( \omega^2 = .048 \) and .097 for words and sounds, respectively; see Cohen, 1977, for a discussion of magnitude of effects). At 13 months, there was a medium to large effect for sounds (\( \omega^2 = .049 \)); however, the \( F \) value of the context effect was less than 1 for words, indicating a null effect of context in this condition. Thus, the effect of context on sound learning was at least equal in magnitude to the effect on words at both ages.

Next, we conducted a 2 (age) \( \times \) 2 (symbol type) \( \times \) 2 (context) \( \times \) 2 (trial) \( \times \) 2 (type) ANOVA including only those children who succeeded on the warm-up trials (difference score > 0, \( N = 39 \)). This analysis yielded only a Context \( \times \) Trial Type interaction, \( F(1, 31) = 6.52, \ p < .05 \). Post hoc analysis indicates that, as in the ANCOVA, children in the referential condition selected the target object reliably more often on the target trials (\( M = 0.61, \ SD = 0.22 \)) than on the control trials (\( M = 0.45, \ SD = 0.20 \)), but did not do so in the nonreferential condition (\( M = 0.47 \) and 0.57 for the target and control trials, respectively, \( SD = 0.16 \) and 0.24). Performance on the target trials was reliably higher for the referential condition than for the nonreferential condition, but there was no difference between the two conditions for the control trials.

**Comparisons With Chance**

We augmented these group comparisons by comparing performance with chance in each cell. All comparisons were one-tailed, assessing whether the means exceeded chance performance.

As earlier, we conducted the analyses separately for the entire sample and for only those children who succeeded on the warm-up trials. However, the small sample size for the set of children succeeding on the warm-up trials offered limited power, yielding sample sizes ranging from 2 to 8 per cell at each age. As a result, we used a marginal criterion (\( p < .10 \)) for these reduced samples and interpreted the outcomes with caution, seeking only to bolster or confirm the full-sample analysis rather than draw strong conclusions from those analyses alone. Infact the reduced sample analyses closely mirrored the analyses from the full sample at each age.

The 18-month-old infants showed clear patterns that were consistent with the findings from the AN(C)OVAs. Those in the referential condition selected the target object at a rate significantly higher than chance for the target trials in both the sound and word conditions using the full sample in each group, \( t(15) = 4.37 \) and 2.27, respectively, both \( ps < .01 \), and were marginally above chance in the reduced sample of those succeeding on the warm-up trials for both symbol types, \( t(7) = 1.51, \ p = .087 \) for the word condition, and \( t(8) = 1.83, \ p = .063 \) for the sound condition. Performance did not differ from chance on control trials for either symbol type, using either measure. The 18-month-olds in the nonreferential condition failed to choose the target object at a rate significantly higher than chance for either trial type in either the word or sound condition, using either measure. These results confirm that at 18 months, a symbol-to-object mapping is evident only in the target trials of the referential condition, and that words and sounds follow a similar pattern.

In general, 13-month-olds revealed a similar but less robust pattern. The 13-month-old infants in the referential condition who were learning words selected the target object at a rate significantly higher than chance in the target trials using the full sample, \( t(15) = 1.92, \ p < .05 \), but failed to exceed chance using the reduced sample that succeeded on the warm-up trials. Both samples failed to exceed chance performance on the control trials. The 13-month-old infants learning sounds in the referential condition failed to exceed chance responding for either target and control trials using the full sample, but reached marginal significance for the target trials using the reduced sample, \( t(4) = 1.596, \ p = .093 \). In the nonreferential condition, the 13-month-old infants failed to choose the target object at a rate significantly higher than chance for either trial type in either the word or sound condition, using either measure.

Thus, comparisons with chance largely mirror the findings of the AN(C)OVAs at 18 months, revealing above-chance performance in the referential but not the nonreferential condition for both symbol types. These analyses reveal a similar, but more variable pattern for the 13-month-old infants. In the referential condition, 13-month-olds exceeded chance performance for the word condition using one measure and for the sound condition using the other. In the nonreferential condition, 13-month-olds did not differ from chance for either symbol type.
Individual Patterns of Performance

To examine how the performance of the individual infants related to the group trends, we compared the number of infants in the referential and nonreferential conditions who chose the target object more often on the target trials than they did on the control trials, collapsed across mapping and extension trials. This criterion is liberal in that it includes even children who selected the target only once more in the target than in the control trials. However, it is useful in bolstering our claims to the extent that it captures individual patterns consistent with group performance. Tables 2 and 3 depict the proportion of children adhering to this criterion for the full and reduced samples, respectively. Given the small sample sizes in each cell of the design for the reduced sample, we do not attempt to analyze these smaller samples statistically, performing quantitative analyses for the full sample only. However, we report them to demonstrate that the trends found for the full sample are fully replicated by the reduced sample and, in fact, tend to appear even more robust within the selected sample.

For the 18-month-olds overall, significantly more infants showed the targeted pattern of success (that is, more target choices on target trials than on control trials) in the referential condition than in the nonreferential condition, Fisher’s exact test, \( p = .005 \). Collapsing across conditions, we found no difference in the number of infants choosing the target object more in the target trials in the word versus the sound condition, Fisher’s exact test, \( p = .19 \), consistent with the similar performance for the two symbol types in the ANOVAs. When comparing the referential condition with the nonreferential condition for each symbol type, we found that more 18-month-olds learning sounds in the referential condition demonstrated this pattern of success than did those learning sounds in the nonreferential condition, Fisher’s exact test, \( p = .002 \). However, the number of infants learning words who chose the target more in the target trials than in the control trials did not differ between the referential condition and the nonreferential condition, Fisher’s exact test, \( p = .22 \).

At 13 months, we found similar patterns. A greater number of infants succeeded in the referential condition than in the nonreferential condition, Fisher’s exact test, \( p = .044 \). In addition, the 13-month-olds did not differ in their likelihood of choosing the target more in the target trials by symbol type, Fisher’s exact test, \( p = .19 \). When examining effects of condition separately for each symbol type, a marginally significantly greater number of infants learning sound showed this pattern of success in the referential condition than in the nonreferential condition, Fisher’s exact test, \( p = .06 \). However, no difference in responding was found for the word condition, Fisher’s exact test, \( p = .22 \). Infants’ performance seems to be more robustly affected by the context (referential vs. nonreferential) in the sound condition than in the word condition at this age.

Looking Behavior of Infants

As a supplementary analysis, we examined the number of times infants looked to the monitor and to the experimenter during the labeling events. We interpreted looks to the monitor as an index of interest and attention to the novel source of the
auditory stimulus. In contrast, we interpreted looks to the experimenter as social-referencing acts, bids for information about the meaning of the auditory stimulus. The configuration of the camera relative to the child did not lend itself to accurate and reliable duration measures; therefore, we employed the number of looks as a cruder measure of attention and social reference.

We examined the number of looks to the monitor for infants in the nonreferential condition using a 2 (age) × 2 (symbol type) × 2 (set) ANOVA. This analysis yielded no effect of age or symbol type but a main effect of set, \( F(1, 60) = 30.19, p < .001 \). This effect indicates that infants looked to the monitor signiﬁcantly more often on the ﬁrst set (\( M = 2.91, SD = 2.26 \)) than on the second set (\( M = 1.48, SD = 1.93 \)). This pattern reﬂects the relative novelty of the sound source in set 1, revealing that infants became more accustomed to the experience by the second set. This conﬁrms that infants were indeed attending to the monitor, especially during their ﬁrst encounter with sounds emitted from the monitor. This suggests that infants’ lack of mapping of the symbols in the nonreferential condition was not due to failure to notice or attend to the sounds emanating from the monitor.

Next, we performed an analysis of the number of looks to the experimenter’s face during labeling, using a 2 (age) × 2 (symbol type) × 2 (context) × 2 (set) ANOVA. This analysis yielded no effect of age, context, or symbol. There was a main effect of set, \( F(1, 120) = 10.13, p < .005 \), revealing that infants looked signiﬁcantly more often to the experimenter during the ﬁrst set (\( M = 4.21, SD = 2.90 \)) than during the second set (\( M = 3.38, SD = 2.48 \)). This effect was mediated by an interaction between set and symbol type, \( F(1, 120) = 7.31, p < .01 \). Post hoc analyses (Tukey’s HSD) revealed that infants looked reliably more often to the experimenter during Set 1 than during Set 2 in the sound condition (\( M = 4.53 \) and 3.00, \( SD = 2.88 \) and 2.36 for Sets 1 and 2, respectively) but did not demonstrate a decline in experimenter looks in the word condition (\( M = 3.89 \) and 3.77, \( SD = 2.91 \) and 2.56 for Sets 1 and 2, respectively). Despite this pattern, the number of looks did not differ reliably between the word and sound condition during either set. This ﬁnding suggests that children were frequently consulting the experimenter’s face for cues to help interpret the novel symbolic input, regardless of the context of symbol type. However, by the second set, children seem to respond differently to words and sounds, orienting less toward the experimenter’s face as a source of information about the sound, but maintaining orientation toward the experimenter as an information source in the word condition.

Discussion

These data provide clear evidence that 18-month-old infants map both words and nonverbal sounds to objects when the symbols are presented in a referential context. However, when these symbols are presented in a nonreferential context, infants fail to learn them as names of objects. The data from the 13-month-old infants are similar to those for the older children, but less consistent. There is a general trend toward more successful symbol learning in the referential condition than in the nonreferential condition for both symbol types at both ages. However, comparisons with chance and analyses of individual patterns indicate more robust effects of context at 18 months than at 13 months for both symbol types. Overall, these ﬁndings imply that the driving force behind infants’ interpretation of a symbol as an object name is not the form of the symbol per se, but rather the context in which the symbol is presented.

These ﬁndings are striking for two reasons. First, infants resist interpreting nonreferential symbols as object names, even when the availability of social-referential cues during the naming episodes is held constant. Consistent with work by Baldwin et al. (1996), we ﬁnd that as early as 13 months, infants discriminate between labeling (those contexts in which the symbols originated from the same animate source as the social-referential cues) and nonlabeling contexts (those in which the symbols were produced by an inanimate source that functioned independently from the social-referential cues available). Second, we ﬁnd no systematic difference between the conditions under which infants map words versus other nonverbal symbols to object categories. This suggests that infants are using cues to intentionality rather than expectations about a particular modality or symbol type to determine symbolic mappings.

The ﬁnding that infants are able to discriminate between labeling and nonlabeling contexts strongly suggests that infants interpret these words and sounds as symbolic, mapping them to object categories only when appropriate cues to naming are present. Infants’ sensitivity to the intentional, communicative nature of symbols argues against a more associative, stimulus–response learning process as accounting for early symbol learning. This ﬁnding does not, of course, imply that infants are
unable to associate a novel symbol with an object category in the absence of referential cues by way of associative learning. However, the results suggest that infants more readily learn the association in referential (naming) contexts and that it is not simply a stimulus–response pairing but rather a symbolic and referential mapping for both words and nonverbal sounds.

Although 13-month-olds do not show any evidence of learning either symbol in the nonreferential condition and do show evidence of learning both symbols in the referential condition, it is clear that the context effect is weaker for infants at this age than at 18 months. There are several possible reasons we might expect to find weaker results in such a task with these younger infants. First, we might expect any symbol-learning task to be more challenging for children at such a young age who are on the cusp of word learning. Second, this forced-choice paradigm (requiring children to demonstrate their understanding of the symbol by choosing the target object during the target trials) is a particularly demanding task requiring significant attention and memory resources. Although looking-time measures have been used successfully with children this age, we felt that a more stringent criterion of whether a symbolic mapping has been made, even if it results in less consistent performances, was an important component of the study. Although a small number of studies have successfully elicited symbolic mapping using a forced-choice paradigm with this age (in particular, see Woodward & Hoyne, 1999; Woodward et al., 1994), the dynamics of our tasks may not have been as well suited to this younger population as to the 18-month-olds.

The results of this study conflict with Balaban and Waxman’s (1997) and Xu’s (1998) findings. In particular, the infants in this study failed to map words to objects in the nonreferential condition. A methodological difference between this study and those of Balaban and Waxman and of Xu may account for the discrepant findings. In particular, the testing measures were distinct. The aforementioned studies recorded looking times of infants and used this information to infer their understanding of words and sounds. The current study required that the infants actively map the symbol onto the referent and to demonstrate this knowledge by reliably choosing the target object in target trials. Although the looking-time measure reflects infants’ decreased attention to category instances and increased attention to novel objects as a function of exposure to a label, this measure may not accurately reflect the extent to which the infants understand the symbolic relationship between the word and the object.

The use of a habituation method may also account for the different performance in the word versus sound condition in these other studies. It may be that infants’ attention is more readily directed to objects by words than by nonverbal sounds, given the greater history of exposure to words as referential symbols. However, the familiar naming context in which the sounds were embedded in our referential condition was apparently sufficient to override any implicit preference for words as symbols. Such social-referential cues to naming were absent in Balaban and Waxman’s (1997) and Xu’s (1998) studies. The degree of discrepancy between the patterns of findings reported for looking-time versus choice measures suggests that the two methods may be tapping different processes.

**Implication for Our Model of Word Learning**

The finding that infants learn both words and nonverbal sounds in similar contexts is consistent with the findings of Roberts (1995; Roberts & Jacob, 1991), Namy and Waxman (1998; Namy, 2001), and Woodward and Hoyne (1999). These results suggest that, initially, infants are willing to accept a variety of symbol forms as object names when these symbols are presented in the appropriate social-referential context. It is important to note that not only did infants succeed at learning both the word and the sound in the referential condition, they showed similarly robust effect sizes in the two symbol-learning tasks. In other words, infants appeared to interpret words and sounds as equipotential symbolic forms. This suggests that the mechanisms driving word learning are not specific to words but rather imply a general symbolic ability early in development.

Of course, there are limits to the degree to which one can infer common process from common behavior. However, evidence from a wide range of measures and methodologies including naturalistic production (Acredolo & Goodwyn, 1985, 1988; Goodwyn & Acredolo, 1993; Iverson et al., 1994), experimental comprehension studies (Hollich et al., 2000; Namy, 2001; Namy & Waxman, 1998; Woodward and Hoyne, 1999), and experimental production (Namy & Waxman, 2002) converge on the conclusion that words and nonverbal symbols are equipotential forms of symbolic reference in infants. That infants successfully learn multiple symbolic forms under the same learning conditions and, perhaps even more telling, fail to learn multiple
symbolic forms under the same learning conditions (as the current experiment shows) lends even stronger support to this conclusion.

**Implications for Our Understanding of Infants' Social-Referential Sensitivity**

The findings in this study replicate Baldwin et al.'s finding that infants fail to interpret a label as an object name when it is produced by a source that does not embed the label in a social-referential routine. This implies a fairly subtle appreciation of how social-referential cues signal naming events, because in both conditions the social-referential cues were present during labeling, and the label was produced concurrent with infants' attention to the same object toward which the referential cues are oriented. Thus, infants understand not only that social-referential cues were reliable indices of naming but also that the social-referential cues must originate from the same source as the label.

In one sense, the manipulation between the referential and nonreferential conditions was subtle, in that the only difference was the source and the timing of the symbol. However, in another sense, the manipulation could be seen as obvious. In one condition, the symbol was presented by the person with whom the child was interacting. In the other condition, the symbol originated from a mechanical object placed to the side of the infant that seemed unrelated to the ongoing interaction. In future work, it will be important to explore whether it is possible to elicit symbolic mappings in the absence of social-referential cues, given sufficient alternative indicators that the symbols are being produced with the intention of labeling. Put differently, it may be that social-referential cues are sufficient but not necessary to elicit symbolic mapping, provided that other reliable cues to intentional naming are present. Indeed, studies by Balaban and Waxman (1997), Schafer and Plunkett (1998), and Werker, Cohen, Lloyd, Casasola, and Stager (1998) have demonstrated, using looking-time paradigms, that children readily associate novel words with their referents even in the absence of social-referential cues. However, it is unclear from these passive looking paradigms whether these associations are symbolic in nature. We propose that the appreciation that social-referential behaviors signal naming is acquired because social-referential behaviors emerge as a reliable set of cues to reference over time. This implies that infants should be able to use alternative cues to reference when those cues are established as reliable indicators as well. A test of this hypothesis will provide important insight into the origins and acquisition process of social-referential understanding.

**Conclusions**

The results from the current study provide several key insights into the symbol-acquisition process. First, this study joins a growing body of research indicating that infants' early word-learning ability is not driven by a word-specific mechanism but rather by a general symbolic ability. Infants, at least until the age of 18 months, accept a variety of symbolic forms as object names. Second, this study confirms that a driving factor behind whether infants will learn a symbol as an object name is the context in which the symbol is presented. Infants show impressive sensitivity to subtle referential cues and reveal the ability to use this information to make appropriate symbolic mappings as well as avoid making inappropriate symbolic mappings. Results from this study suggest that the mechanisms driving early symbol learning are those that take into account the social and referential nature of symbols and are not initially limited to a particular symbolic medium.

**References**


