CHILD DEVELOPMENT

Child Development, January/February 2013, Volume 84, Number 1, Pages 143–153

Young Word Learners' Interpretations of Words and Symbolic Gestures Within the Context of Ambiguous Reference

Sumarga H. Suanda and Laura L. Namy
Emory University

Early in development, many word-learning phenomena generalize to symbolic gestures. The current study explored whether children avoid lexical overlap in the gestural modality, as they do in the verbal modality, within the context of ambiguous reference. Eighteen-month-olds' interpretations of words and symbolic gestures in a symbol-disambiguation task (Experiment 1) and a symbol-learning task (Experiment 2) were investigated. In Experiment 1 (N = 32), children avoided verbal lexical overlap, mapping novel words to unnamed objects; children failed to display this pattern with symbolic gestures. In Experiment 2 (N = 32), 18-month-olds mapped both novel words and novel symbolic gestures onto their referents. Implications of these findings for the specialized nature of word learning and the development of lexical overlap avoidance are discussed.

From the earliest stages of development, words appear to guide human infants' attention in a manner distinct from other auditory signals. Evidence of this early sensitivity to words comes from recent studies demonstrating that very young infants prefer to listen to monosyllabic words compared to complex nonword analogs (Vouloumanos & Werker, 2004, 2007). Further evidence suggests that within the 1st year, words but not nonverbal sounds (e.g., pure tones) promote object categorization (Balaban & Waxman, 1997; Ferry, Hespos, & Waxman, 2010; Fulkerson & Waxman, 2007) and facilitate object individuation (Xu, 2002).

Despite this early sensitivity to the unique role that words play in behaviors such as categorization and individuation, a fully developed understanding of words requires an additional sensitivity to the symbolic capacity of words (Bloom, 2000). A number of scholars have argued that an appreciation of the uniqueness of words in this sense emerges only later in development (Bloom, 2000; Namy, 2001; Woodward, 2000). For example, a handful of studies have demonstrated that hearing children 18 months and younger are equally receptive to learning words and nonverbal sounds as labels for objects (Campbell & Namy, 2003; Hollich et al., 2000; Namy, 2001; Woodward & Hoyne, 1999). Only after 18 months do children develop a priority for words over other auditory signals as the primary form of symbolic reference.

Studies comparing children's early learning, processing, and production of words and symbolic gestures support the notion of an initial flexibility with regards to the form of object labels. Observational studies reveal that in the beginning stages of word learning, children's productive communication consisted not only of words but also of symbolic gestures (e.g., Acredolo & Goodwyn, 1985, 1988). Symbolic gestures, also referred to as ''representational gestures'' (Iverson, Capirci, & Caselli, 1994; Caselli, 1994), are distinct from ''deictic gestures'' such as pointing in that they refer to specific referents or kinds of referents (e.g., extending ones arms out to indicate an airplane in the sky). Extant observational work suggests a number of commonalities between children's early words and symbolic gestures, namely, that words and symbolic gestures show a similar age of onset, they are recruited for similar communicative functions, and they tend to be mutually exclusive in the child's developing lexicon (Acredolo & Goodwyn, 1988; Caselli, 1994;

Portions of this research were presented at the 2010 International Conference on Infant Studies. We thank all the parents and children who participated. We are grateful to members of the Emory Language and Learning Lab, particularly Maggie Dancel, Ann Marie Finley, Jane Fisher, Anna Heilbrun, and Nassali Mugwanya for their assistance with coding and participant recruitment. We thank Robert Hampton, Lynne Nygaard, and three anonymous reviewers for helpful comments and suggestions on earlier versions of this work. This research was supported by an NSF GRF awarded to SHS and in part by NICHD Grant 5-R03-HD058777-02 awarded to LLN.

Correspondence concerning this article should be addressed to Sumarga H. Suanda, Department of Psychology, Emory University, 36 Eagle Row, Atlanta, GA 30322. Electronic mail may be sent to ssuanda@emory.edu.

 0009-3920/2013/8401-0012
DOI: 10.1111/j.1467-8624.2012.01847.x

Iverson et al., 1994; Shore, Bates, Bretherton, Beeghly, & O'Connell, 1994)

These observational findings have received support from experimental investigations comparing children's acquisition of words and gestures. For example, Namy and Waxman (1998) taught 18-month-olds either a novel word (e.g., ''blicket'') or a novel symbolic gesture (e.g., a dropping hand motion) as a label for a familiar category (e.g., vehicles). These children learned both words and gestures with equal facility, and extended both verbal and gestural labels to other members of the category (see also Namy, 2001; Namy, Campbell, & Tomasello, 2004). Furthermore, Graham and Kilbreath (2007) found that words and symbolic gestures similarly guide young word learners' inferences about object properties. Finally, using event related potentials, Sheehan, Namy, and Mills (2007) demonstrated that the semantic processing of words and symbolic gestures show similar patterns of neural activation at 18 months.

Namy and others have taken this flexibility to suggest that the processes underlying early word learning may reflect a more general capacity for symbol learning rather than a dedicated mechanism for word learning (Graham & Kilbreath, 2007; Namy, 2001; Namy & Waxman, 1998; Sheehan et al., 2007; Woodward & Hoyne, 1999). These findings have led some researchers to posit that early on, words and symbolic gestures are equipotential and interchangeable aspects of a common lexicon (Caselli, 1994; Clark, 2003). For example, Clark (2003, p. 96) has suggested that ''gestures and words form a single lexicon.'' Caselli (1994, p. 65) similarly argued that ''there is one lexicon constructed partially from gestures and partially from words.'' The goal of the current experiments was to further examine the commonalities between word and gesture learning in early communicative development. Specifically, we examined whether a specific word-learning strategy, avoidance of lexical overlap, which develops during the 2nd year (Halberda, 2003), is equally evident in the case of gesture learning.

The disambiguation task is the classic demonstration of avoidance of lexical overlap. In this task, a child is presented with two objects, one novel (e.g., tongs) and the other familiar (e.g., a cup). An experimenter then elicits a choice between the objects using a novel word (e.g., ''Show me the dax''). Children tend to avoid lexical overlap, reliably selecting the novel object (Diesendruck & Markson, 2001; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992; Graham, Poulin-Dubois, & Baker, 1998; Hutchinson, 1986; Markman & Wachtel, 1988; Merriman & Bowman, 1989; Mervis & Bertrand, 1994; Vincent-Smith, Bricker, & Bricker, 1974). To the extent that the same processes underlie word and gesture learning in the early stages of development, children completing the disambiguation task should select the novel object and avoid the familiar object when the novel label is a symbolic gesture, just as they do when the label is a novel word.

Children's response patterns across words and symbolic gestures in the disambiguation task may also inform the mechanisms underlying lexical overlap avoidance. Traditionally, avoidance of lexical overlap has been assumed to reflect either children's assumption that each referent has only one label (i.e., *mutual exclusivity principle*; Markman & Wachtel, 1988) or that children prefer to attach a novel name onto a novel, nameless object category (i.e., *N3C principle*; Golinkoff, Mervis, & Hirsh-Pasek, 1994). However, there is debate about the specificity of the basis for children's avoidance of lexical overlap. Some scholars (e.g., Bloom, 2000; Diesendruck & Markson, 2001; Grassmann, Stracke, & Tomasello, 2009; but see Scofield & Behrend, 2007) have argued that the phenomenon reflects a more general understanding of the social pragmatics of communication (i.e., that speakers use mutually known labels to refer to familiar objects) rather than a specific word-learning strategy. Others (Jaswal, 2010; Jaswal & Hansen, 2006; Preissler & Carey, 2005) have suggested that the behavior cannot be attributed entirely to sociopragmatic reasoning about speakers' referential intentions but also to specific strategies within the context of word learning. Adherence to avoidance of lexical overlap for both words and symbolic gestures would be consistent with a sociopragmatic account of this phenomenon.

Experiment 1

To compare overlap avoidance within the domain of words and gestures, we adopted a paradigm employed by Diesendruck and Markson (2001) and Scofield and Behrend (2007) who compared overlap avoidance in the domains of words and verbal facts. We tested 18-month-olds because previous research has demonstrated that at this age, children readily map both words and symbolic gestures to objects (Namy, 2001; Namy & Waxman, 1998), and this is the earliest age at which children demonstrate the disambiguation effect using choice measures (Graham et al., 1998; Liittschwager & Markman, 1994; Mervis & Bertrand, 1994) albeit to a lesser degree than older children (Evey & Merriman, 1998).

In the current study, we showed children a pair of novel objects and taught children a novel label (either word or symbolic gesture) for one of the objects. In a subsequent testing phase, we presented children with a disambiguation task in which the experimenter introduced a second novel label from the same modality as the first and asked children to select between the just-labeled object and the unlabeled object as the referent of this second label.

Method

Participants. Thirty-two 18-month-olds (M = 18.3, range = 17.6–20.1) participated (19 male). The sample was 63% White, 24% Black, 8% Asian, and 5% unspecified. Sixteen children were randomly assigned to the word condition and 16 to the gesture condition. Parents completed the MacArthur-Bates Communicative Development Inventory Short Form (Fenson et al., 2000), which measures children's productive vocabulary. We transformed raw scores into percentile rank scores, based on validated age and gender norms (see Fenson et al., 2000). Rank scores did not differ reliably between the word (M = 45.31, SD = 21.53) and gesture (M = 34.83, SD = 26.75) conditions. Data from an additional 15 participants (9 in the gesture condition) were excluded from analysis due to failure to complete at least 8 of 12 trials (8); displaying a side preference on all, or all but one, of the trials (6); or parental interference (1). We suggest that this relatively high attrition rate likely reflects the high task demands of an inference-based disambiguation task for 18-month-olds. Indeed, 18 months represents the lower cusp of when children begin to reliably display disambiguation effects in a forced-choice task (Graham et al., 1998; Mervis & Bertrand, 1994).

Stimuli. Stimuli consisted of three pairs of small plastic objects selected to be unfamiliar to young children including *level–aspirator*, *whisk–garlic press*, and *paint roller–juicer*. The objects in each pair were matched for salience through piloting and thus were fixed across children. Novel words were two-syllable strings that adhered to the phonotactic constraints of English. Novel gestures were arbitrary and unrelated to any of the objects. The gestures were modeled from those used by Namy and Waxman (1998), which were constructed based on the phonological properties (hand shape, hand location, and motion trajectories) of sign language. A complete list of the novel words and novel gestures used is presented in Table 1. For each

Table 1
Novel Words and Novel Gestures Used in Experiments 1 and 2

Novel word	Novel gesture
Blicket	Repeated simultaneous extension of index and middle finger from a closed fist
Daxen	Side-to-side motion, hand extended as if to shake hands
Seebow	Dropping motion with closed fist opening, palm down
Toma	Closed fist, thumb and pinky finger extended, facing down, rocking side-to-side
Riffle	Hand oriented vertically, up-and-down knocking motion facing child
Foppick	Slicing motion with hand extended toward child at a 45° angle

participant, which novel word or gesture was assigned to each object was randomly determined.

Design. Children were randomly assigned to either the word or gesture condition. The experimental procedure was identical in the two conditions, with the exception of the type of novel label employed. Children completed four trials with each pair of objects including two target trials (in which the experimenter asked the child to choose the referent of a second novel label) and two control trials (in which the experimenter asked the child to simply choose ''one''). Children therefore completed a total of 12 trials, including 6 target and 6 control trials. The experimental design was 2 (condition: word vs. gesture) × 2 (trial type: target vs. control), with condition as a between-subject variable and trial type as a within-subject variable.

Procedure. Children were seated either in a booster seat or on their parents' lap across a table from an experimenter. Parents were instructed not to talk to their children and to avoid influencing their children's behavior in any way. The experiment proper consisted of two phases: a labeling phase and a test phase. In the labeling phase, the experimenter presented children with a pair of novel objects. The experimenter held up and drew attention to each object several times. While drawing attention to one object (randomly selected), the experimenter introduced a novel label. In the word condition, the experimenter said for example, ''Look at this! Blicket! See this? Blicket!'' In the gesture condition, the experimenter said, for example, ''Look at this! [dropping gesture]; See this? [dropping gesture].'' Following initial labeling, the experimenter then handed the labeled object to the child. As the child inspected the object, the experimenter repeated the label four more times. When presenting the unlabeled object, the experimenter drew the child's attention to the object an equal number of times as the labeled object, but without labeling it (e.g., ''Look at this one! Do you see this one?''). Order of presentation of the labeled and unlabeled objects was counterbalanced within each condition.

The test phase immediately followed the labeling phase and consisted of a series of four forced-choice trials for each pair including two identical target trials and two identical control trials. In target trials, the experimenter elicited a choice by saying ''Which one can you get? [LABEL] Can you get it? [LABEL].'' The label used was a *different* novel label drawn from the same modality as the one used in the labeling phase. The experimenter then advanced the objects within the child's reach, one on each side, equidistant from the child's midline. While eliciting the choice, the experimenter's gaze was directed at the child's face. In control trials, the experimenter elicited a choice by saying, ''Which one can you get? Can you get one?'' Children were given neutral feedback (e.g., ''thank you'') regardless of which object they chose. Trials were blocked by type, but order of presentation of target and control trials was counterbalanced across children. After completing the labeling and test phases for the first set of objects, the procedure was repeated for the second and third sets.

Coding. A primary coder, blind to the experimental hypotheses, analyzed videotapes of all participants with the sound muted. For each trial, children's choices were characterized as choosing the novel object, the familiar object, or neither. Children were excluded from the analysis if (a) they made a choice on fewer than 8 of the 12 trials (4 of each trial type), or (b) they selected the object placed on the same side on all, or all but one, of the trials. A second blind coder analyzed a randomly selected 25% of sessions in each condition. Intercoder agreement was 98%.

To ensure that the experimenter was not inadvertently cueing the child to select a particular object, an additional coder analyzed differences in (a) how long the experimenter directed attention to the labeled and unlabeled objects during the labeling phase and (b) the proximity of the objects to the child during choice trials. There was no difference in duration of attention allocated between the labeled and unlabeled objects in either the word or gesture condition. Proximity coding was based on still frames of the moment immediately after the experimenter had advanced the two objects within the child's reach. For each trial, the coder indicated which object appeared closer to the child. Across both conditions, the percentage of target (M = 51% and 53% for word and gesture conditions, respectively) and control trials (M = 50% in both conditions) in which the labeled object was rated closer to the child did not differ by condition or trial type.

Results

For each trial type in each condition, we calculated the mean proportion of trials on which children selected the *unlabeled object* during test. A 2 (condition: word vs. gesture) $\times$ 2 trial type: target vs. control) analysis of variance (ANOVA) on children's proportion selecting the unlabeled object, revealed no main effects of condition or trial type. It did, however, reveal a significant interaction between condition and trial type, $F(1, 30) = 18.24$, $p < .001$, $\eta^2_p = .378$. As shown in Figure 1, children in the word condition avoided lexical overlap, selecting the unlabeled object more often on target ($M = .63$, $SD = .23$) than on control trials ($M = .46$, $SD = .16$), $t(15) = 2.90$, $p < .05$. In contrast, children in the gesture condition selected the unlabeled object *less* often on target ($M = .44$, $SD = .19$) than control trials ($M = .59$, $SD = .20$), $t(15) = -3.21$, $p < .01$.

When compared to chance performance (.50), children in the word condition selected the unlabeled object on target trials significantly more often than predicted by chance, $t(15) = 2.22$, $p < .05$. Performance on control trials did not differ from chance. In the gesture condition, responding did not differ from chance performance on either the target or the control trials. Taken together, the nonsignificant differences from chance in conjunction with the difference in response rates on target and control trials render children's performance in the gesture condition difficult to interpret. Nonetheless, the pattern suggests a weak trend toward mapping the gesture to the previously labeled object, clearly

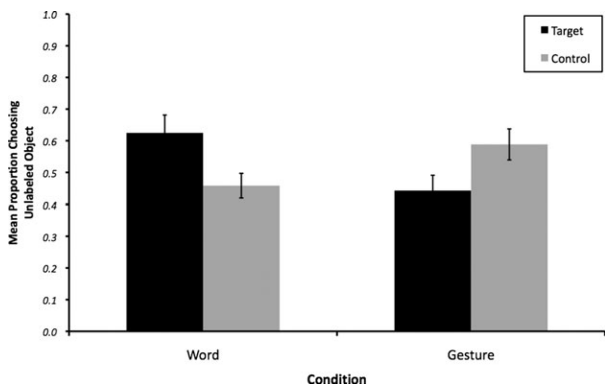

Figure 1. Experiment 1: Mean proportion selecting unlabeled object on target and control trials in each condition.

a different pattern of responding than that in the word condition.

Analysis of individual response patterns. To investigate how representative these group data were of individual children's performance, we examined individual patterns of responding, classifying children as displaying the expected pattern if they selected the unlabeled object more often on target than on control trials. As seen in Table 2, this analysis revealed that most children in the word condition displayed this expected pattern. In contrast, most children in the gesture condition selected the unlabeled object less often on target than on control trials. A chi-square test revealed that these distributions differed by condition, $\chi^2(1, N = 32) = 13.33$, $p < .05$.

Correlations between task performance and vocabulary development. Finally, we explored whether children's performance in either condition varied as a function of vocabulary size. To test the correlation between vocabulary and avoidance of lexical overlap, we calculated a difference score between proportion choosing the unlabeled object in target trials and proportion choosing the unlabeled object in control trials (hereafter overlap avoidance [OA] score; see also Byers-Heinlein & Werker, 2009; Halberda, 2003). A high-positive OA score reflects strict avoidance of lexical overlap. For children in the word condition we found a positive correlation between productive vocabulary and OA score, $r = .54$, $p < .05$. This finding is consistent with previous work (Graham et al., 1998; Lederberg, Prezbindowski, & Spencer, 2000; Mervis & Bertrand, 1994) reporting that the strength of children's adherence to lexical overlap avoidance as a word-learning strategy increases as a function of vocabulary size. In contrast, children's verbal productive vocabulary in the gesture condition was not correlated with their OA scores, $r = -.23$, *ns*.

Discussion

The results of this experiment revealed significant differences in children's mapping of novel words and novel gestures within the context of the disambiguation task. When presented with a novel word, children reliably selected the previously unlabeled object, a pattern of behavior consistent with previous findings that even young word learners map a novel word onto a novel object as opposed to a familiar one (Byers-Heinlein & Werker, 2009; Graham et al., 1998; Halberda, 2003; Houston-Price, Caloghiris, & Raviglione, 2010; Liittschwager & Markman, 1994; Mervis & Bertrand, 1994). In contrast, when presented with a novel gesture, children did not demonstrate a reliable preference. The fact that children systematically avoided overlap between two words but not two gestures suggests that at least some principles underlying the mapping of words have diverged from those that underlie the mapping of symbolic gestures. These findings are surprising given both previous behavioral observations (Acredolo & Goodwyn, 1988; Caselli, 1994; Iverson et al., 1994; Shore et al., 1994; but see Petitto, 1992) and experimental evidence suggesting that words and symbolic gestures are equipotential forms of symbolic reference (Graham & Kilbreath, 2007; Namy, 2001; Namy et al., 2004; Namy & Waxman, 1998; Sheehan et al., 2007).

Although this outcome suggests that words and symbolic gestures follow distinct learning patterns, it is also possible that children's failure to map novel gestural labels to unlabeled objects was due to a baseline difference in children's receptivity to gestures as symbolic forms. That is, perhaps children failed to map the initial label onto the labeled object; in this case, they would be expected to respond at chance in the target trials because they would regard both objects as unlabeled. Although the ability to map novel labels onto objects has been established in 18-month-olds for both words (Waxman & Hall, 1993; Woodward, Markman, & Fitzsimmons, 1994) and symbolic gestures (Namy, 2001; Namy et al., 2004; Namy & Waxman, 1998), it is important to replicate this finding using the current experimental setting to rule out failure to map the first gestural label to the labeled object as a basis for children's failure to map the second label to the unlabeled object.

Table 2
Distribution of Individual Patterns of Behavior in Each Condition Across Both Experiments

Pattern of selecting target object across trial types	Experiment 1		Experiment 2	
	Word	Gesture	Word	Gesture
Target trials > control trials	11	1	13	9
Target trials = control trials	2	6	1	5
Target trials < control trials	3	9	2	2

Experiment 2

This experiment replicates the finding that 18-month-olds are able to map both novel words and novel gestures to labeled objects. The paradigm is identical to that used in Experiment 1 with the exception that children were tested on their interpretation of the first label introduced during the labeling phase, rather than a second novel label. We expected that children would reliably select the labeled object in both the word and gesture condition.

Method

Participants. Thirty-two 18-month-olds (M = 18.4, range = 17.5–19.3) participated in this study (16 male). The racial composition of the sample was 75% White, 21% Black, 2% Asian, and 2% Native Hawaiian or Other Pacific Islander. Children's productive vocabulary rank scores in the word (M = 34.44, SD = 25.77) and gesture (M = 34.00, SD = 27.00) conditions did not differ reliably. Data from an additional 5 participants (2 from the gesture condition) were excluded from the analysis due to failure to complete at least 8 of 12 trials (4) or displaying a side bias (1).

Stimuli, Design, Procedure, and Coding. Stimuli, design, procedure, and coding were identical to those in Experiment 1 with one exception. In the test phase of Experiment 2, the experimenter elicited a choice on target trials using the *same* label used during the introduction phase. Thus, whereas Experiment 1 tested the extent to which children would map a second novel label onto a previously unlabeled object, Experiment 2 tested the extent to which children successfully mapped the initial label (word or gesture depending on condition) to the labeled object.

As in Experiment 1, one coder analyzed all sessions and a second coder reviewed a random selection of 25% of sessions in each condition. Intercoder agreement was 97%. There were no differences between conditions in either the duration of the experimenter's interaction with the objects during the labeling phase or the proximity of the objects to the child during the testing phase.

Results and Discussion

For each trial type in each condition, we calculated the mean proportion of trials on which children selected the *labeled* object. A 2 (condition: word vs. gesture) × 2 (trial type: target vs. control) ANOVA revealed a main effect of trial type, $F(1, 30) = 13.92$, $p < .01$, $\eta^2_p = .317$. There was no effect of condition and no interaction. Planned comparisons revealed that children in both the word and gesture conditions selected the labeled object more often in target trials than control trials (see Figure 2), ts(15) = 3.28 and 2.15, for the word ($M_{target} = .62$, $SD_{target} = .21$; $M_{control} = .44$, $SD_{control} = .15$) and

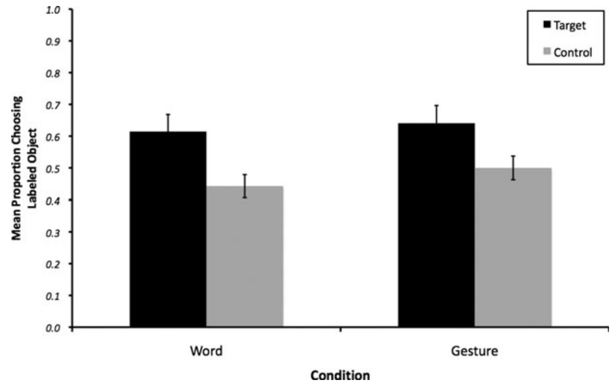

Figure 2. Experiment 2: Mean proportion selecting labeled object on target and control trials in each condition.

gesture ($M_{target} = .64$, $SD_{target} = .22$; $M_{control} = .50$, $SD_{control} = .15$) conditions, respectively, both ps < .05.

Comparisons to chance were consistent with this pattern. In both conditions, children selected the labeled object on target trials significantly more often than predicted by chance performance, ts(15) = 2.13 and 2.52 for word and gesture condition, respectively, both, ps < .05. The proportion on control trials did not differ from chance in either condition.

Analysis of individual response patterns. Individual patterns analysis was consistent with the group-level analysis. As seen in Table 2, most children in both the word and gesture conditions selected the labeled object more often on target than control trials. A chi-square test revealed no effect of condition on the distributions of individual response patterns.

Correlations between task performance and vocabulary development. We examined whether children's symbol mapping was correlated with their verbal vocabulary size. As a measure of task performance, we calculated a difference score between proportion choosing the labeled object in target trials and proportion choosing the labeled object in control trials (hereafter *mapping score*). In neither the word (r = .38) nor the gesture condition (r = −.14) did children's mapping score significantly correlate with their productive verbal vocabulary.

Importantly for the purposes of the current endeavor, results from Experiment 2 replicate previous findings suggesting that 18-month-olds readily learn both words and gestures as object labels (Namy, 2001; Namy et al., 2004; Namy & Waxman, 1998). This outcome rules out failure to learn the initial gesture as a basis for the condition difference observed in Experiment 1. Cross-experiment comparisons of the age and vocabulary size of the gesture conditions revealed no differences, ruling out sample differences as an alternative basis for the differences in performance of children in the gesture condition between the two experiments.

General Discussion

The current findings indicate that children interpret words and symbolic gestures differently within the context of the disambiguation task. When presented with two objects, one previously labeled and one previously unlabeled, 18-month-olds reliably mapped a novel word onto the unlabeled object, avoiding lexical overlap. In contrast, 18-month-olds showed no consistent mapping of a novel gesture, exhibiting a marked difference between children's inferences about novel words and novel symbolic gestures. These findings are unexpected given the existing evidence suggesting that words and symbolic gestures are equipotential forms of symbolic reference that are part of an integrated lexicon early in development.

Existing empirical findings have revealed that 14- to 18-month-olds map words and symbolic gesture onto objects (Namy, 2001; Namy et al., 2004; Namy & Waxman, 1998), display similar extension of words and symbolic gestures onto other members of the object's category (Namy & Waxman, 1998), and use both common words and common symbolic gestures as a basis for inductive inference (Graham & Kilbreath, 2007). These findings led us to predict similar rather than dissimilar mapping patterns for words and symbolic gestures in the current study. The differences observed here suggest that, at least by 18 months of age, words and symbolic gestures are guided, at least in part, by divergent learning principles.

Although unexpected, the current research is not the first to report different patterns of word and gesture mapping at this age. Namy and Waxman (2000) also reported a divergent pattern in the conditions under which children interpreted words versus gestures as object names. In their study, an experimenter introduced 17-month-olds to words or symbolic gestures either embedded in a typical naming phrase (e.g., ''Look at this [symbol]! ''Can you find another [symbol]?''), or stripped of any sentential context (e.g., ''Look! [symbol];'' ''What else can you find? [symbol].'' They found that 17-month-olds learned gestures regardless of the sentential context. In contrast, they mapped words to objects more readily when they were presented within the typical naming phrase. This outcome, like the present results, indicate that although children are equally willing to learn words and symbolic gestures as object labels, there are nonetheless differences in the range of contexts in which children map words and symbolic gestures. The extent to which these cases of divergence are evident earlier in development may shed light onto the effects of experience with language on the early differential learning patterns of words and symbolic gestures.

The Specialized Nature of Children's Early Word Learning

Why do some word-learning phenomena (e.g., mapping, extension, inductive inference) also apply to gesture learning while others (e.g., avoiding lexical overlap, use of sentential context to constrain reference) do not? We speculate that the point in development at which the learning phenomena emerge *within the word domain* may be one way to differentiate phenomena that are shared between word and gesture learning with those that are not.

A comparison of the emergence of generalized (mapping, extension, and inductive inference) and apparently word-specific (avoidance of lexical overlap, use of sentential context to constrain reference) learning phenomena suggests that those behaviors that also extend to symbolic gestures are the same ones that emerge within the *word* domain at an earlier age. Children display an ability to reliably map words (Hollich et al., 2000; Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006; Schafer & Plunkett, 1998; Werker, Cohen, Lloyd, Casasola, & Stager, 1998; Woodward et al., 1994), extend words to new category members (Booth & Waxman, 2009; Waxman & Booth, 2001), and use words to guide inferences about nonobvious object properties (Graham, Kilbreath, & Welder, 2004) from the very onset of word learning. These early-onset behaviors are precisely those that have also been shown for nonverbal symbols, including symbolic gestures (Graham & Kilbreath, 2007; Namy & Waxman, 1998), nonverbal sounds (Campbell & Namy, 2003; Hollich et al., 2000; Namy, 2001), and printed symbols (Namy, 2001). In contrast, word-learning phenomena that do not extend to symbolic gestures, such as avoidance of lexical overlap and sensitivity to syntactic context, emerge slightly later in development within the word domain. For example, Liittschwager and Markman (1994) and Markman, Wasow, and Hansen (2003) have demonstrated the emergence of overlap avoidance-like behaviors at 15–16 months but not younger. In addition, although some looking-time studies have revealed a prelinguistic tendency to adhere to a one-to-one correspondence between words and objects (Pruden et al., 2006; Xu, Cote, & Baker, 2005), Halberda (2003), and others have revealed that infants do not demonstrate success in a preferential-looking version of the disambiguation task until 17 months of age (Byers-Heinlein & Werker, 2009; Houston-Price et al., 2010). Furthermore, although differentiation of syntactic contexts appears early in development (Booth & Waxman, 2009; Waxman & Booth, 2001), reliable mapping of different lexical form classes to different types of meaning (e.g., nouns to object kinds, adjectives to object properties) only emerges toward the end of the 2nd year (Waxman & Markow, 1998).

Based on these patterns, we suggest that age of acquisition may be diagnostic of the degree of experience and expertise required for behaviors to emerge within a domain. Thus, mapping, extension, and inductive inference may have low experience thresholds, leading to both early acquisition within the verbal domain and more evidence of generalization to other symbolic domains. In contrast, avoidance of lexical overlap and sensitivity to syntactic context may require greater exposure to systematic input within a particular domain, and thereby only emerge with experience and exclusively for words. The current finding that avoidance of lexical overlap is correlated with productive vocabulary size in the word condition (see also Graham et al., 1998; Lederberg et al., 2000; Mervis & Bertrand, 1994) but not the gesture condition is consistent with this argument. Future research that examines infants with extensive gestural experience on this task may shed further light on the effects of experience on the development of the above learning patterns. The notion that experience drives the emergence of lexical overlap avoidance as a word-learning strategy is also consistent with previous theoretical (Hirsh-Pasek, Golinkoff, & Hollich, 2000), as well as computational (Frank, Goodman, & Tenenbaum, 2009; Merriman, 1999; Regier, 2005) accounts of this behavior.

Although we have argued that the differential patterns of word and gesture mapping in the current study are due to children's extensive experience with words, this outcome may also be attributable to a relative *lack* of experience in the gesture domain. For example, hearing 18-month-olds may have generated weak representations of the visual symbolic forms employed (e.g., Baker, Golinkoff, & Petitto, 2006), which could have resulted in a failure to recognize that the second gesture was novel and distinct from the first. One way to investigate the nature of children's gestural representations would be to test children's ability to map two distinct gestural labels when each is introduced ostensively. An ability to map and retain in memory two different gestures as labels for two different objects would imply that the effect found here is not due purely to fragile gestural representations.

Implications for Mechanisms Underlying Avoidance of Lexical Overlap

The finding that words and symbolic gestures invoke different patterns within the disambiguation task is inconsistent with the argument that lexical overlap is attributable exclusively to domain-general sociopragmatic abilities (see also Scofield & Behrend, 2007; Jaswal, 2010; Jaswal & Hansen, 2006; Preissler & Carey, 2005), given that the sociopragmatic context in which we introduced words and gestures was identical. These findings do not, however, rule out sociopragmatic abilities as a contributing factor in lexical disambiguation. Given children's apparent sensitivity to sociopragmatic cues to reference for both verbal and nonverbal symbol learning from an early age (e.g., Campbell & Namy, 2003), we consider it likely that sociopragmatic inferences guide mapping in both the word and gestural domains. However, we suggest that children's extensive experience in the verbal domain has given rise to more elaborate knowledge of the conventions by which words map onto referents that would help guide their interpretation in cases of ambiguous reference (for discussion on the role of conventions in the disambiguation task, see Diesendruck, 2005; Sabbagh & Henderson, 2007). In contrast, although children *can* interpret symbolic gestures as labels when they are introduced ostensively (as demonstrated in Experiment 2), children may lack experience inferring the referent of symbolic gestures in ambiguous labeling situations.

Thus, although the current data are consistent with a domain-specific account of avoidance of lexical overlap, these findings do not directly challenge either young children's receptivity of symbolic gestures as object labels or a domain-general account of avoidance of lexical overlap. That is, a potentially domain-general mechanism that emerges in specific domains (e.g., words) as a function of elaborated experience within those particular domains is also consistent with these results.

Conclusions

In conclusion, we found that novel words and novel symbolic gestures elicited different mapping patterns within the context of ambiguous reference. These results highlight that although a number of commonalities exist between the mechanism underlying word and gesture learning at 18 months of age, word learning appears to be diverging from more general symbolic processing at this point in development. We suggest that the domain-specific pattern observed in this study originated from domain-general learning processes that are elaborated upon through domain-specific experiences in the verbal domain.

References

Acredolo, L. P., & Goodwyn, S. W. (1985). Symbolic gesturing in language development: A case study. *Human Development*, *28*, 40–49. doi:10.1159/000272934

Acredolo, L. P., & Goodwyn, S. W. (1988). Symbolic gesturing in normal infants. *Child Development*, *59*, 450–466. doi:10.1111/1467-8624.ep8589377

Baker, S. A., Golinkoff, R. M., & Petitto, L. A. (2006). New insights into old puzzles: From infants' categorical discrimination of soundless phonetic units. *Language Learning and Development*, *2*, 147–162. doi:10.1207/s15473341lld0203_1

Balaban, M. T., & Waxman, S. R. (1997). Do words facilitate object categorization in 9-month-old infants? *Journal of Experimental Child Psychology*, *64*, 3–26. doi:10.1006/jecp.1996.2332

Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.

Booth, A. E., & Waxman, S. R. (2009). A horse of a different color: Specifying with precision infants' mappings of novel nouns and adjectives. *Child Development*, *80*, 15–22. doi:10.1111/j.1467-8624.2008.01242.x

Byers-Heinlein, K., & Werker, J. F. (2009). Monolingual, bilingual, trilingual: Infants' language experience influences the development of a word-learning heuristic. *Developmental Science*, *12*, 815–823. doi:10.1111/j.1467-7687.2009.00902.x

Campbell, A. L., & Namy, L. L. (2003). The role of social-referential context in verbal and nonverbal symbol learning. *Child Development*, *74*, 549–563. doi:10.1111/1467-8624.7402015

Caselli, M. C. (1994). Communicative gestures and first words. In V. Volterra & C. J. Erting (Eds.), *From gesture to language in hearing and deaf children* (pp. 56–67). Washington, DC: Gallaudet University Press.

Clark, E. V. (2003). *First language acquisition*. New York: Cambridge University Press.

Diesendruck, G. (2005). The principles of conventionality and contrast in word learning: An empirical examination. *Developmental Psychology*, *41*, 451–463. doi:10.1037/0012-1649.41.3.451

Diesendruck, G., & Markson, L. (2001). Children's avoidance of lexical overlap: A pragmatic account. *Developmental Psychology*, *37*, 630–641. doi:10.1037/0012-1649.37.5.630

Evey, J. A., & Merriman, W. E. (1998). The prevalence and the weakness of an early name mapping preference. *Journal of Child Language*, *25*, 121–147. doi:10.1017/S0305000997003336X

Fenson, L., Pethick, S., Renda, C., Cox, J. L., Dale, P. S., & Reznick, J. S. (2000). Short-form versions of the MacArthur Communicative Development Inventories. *Applied Psycholinguistics*, *21*, 95–116. doi:10.1017/S0142716400001053

Ferry, A. L., Hespos, S. J., & Waxman, S. R. (2010). Categorization in 3- and 4-month-old infants: An advantage of words over tones. *Child Development*, *81*, 472–479. doi:10.1111/j.1467-8624.2009.01408.x

Frank, M. C., Goodman, N. H., & Tenenbaum, J. B. (2009). Using speakers' referential intentions to model early cross-situational word learning. *Psychological Science*, *20*, 578–585. doi:10.1111/j.1467-9820.2009.02335.x

Fulkerson, A. L., & Waxman, S. R. (2007). Words (but not tones) facilitate object categorization: Evidence from 6- and 12-month-olds. *Cognition*, *150*, 218–228. doi:10.1016/j.cognition.2006.09.005

Golinkoff, R. M., Hirsh-Pasek, K., Bailey, L. M., & Wenger, N. R. (1992). Young children and adults use lexical principles to learn new nouns. *Developmental Psychology*, *28*, 99–108. doi:10.1037/0012-1649.28.1.99

Golinkoff, R. M., Mervis, C. B., & Hirsh-Pasek, K. (1994). Early object labels: The case for a developmental lexical principles framework. *Journal of Child Language*, *21*, 125–155. doi:10.1017/S0305000900008692

Graham, S. A., & Kilbreath, C. S. (2007). It's a sign of the kind: Gestures and words guide infants' inductive inferences. *Developmental Psychology*, *43*, 1111–1123. doi:10.1037/0012-1649.43.5.1111

Graham, S. A., Kilbreath, C. S., & Welder, A. N. (2004). Thirteen-month-olds rely on shared labels and shape similarity for inductive inferences. *Child Development*, *75*, 409–427. doi:10.111/j.1467-8624.2004.00683.x

Graham, S. A., Poulin-Dubois, D., & Baker, R. K. (1998). Infants' disambiguation of novel object words. *First Language*, *18*, 149–164. doi:10.1177/014272379801805302

Grassmann, S., Stracke, M., & Tomasello, M. (2009). Two-year-olds exclude novel objects as potential referents of novel words based on pragmatics. *Cognition*, *112*, 488–493. doi:10.1016/j.cognition.2009.06.010

Halberda, J. (2003). The development of a word-learning strategy. *Cognition*, *87*, B23–B34. doi:10.1016/S0010-0277(02)00186-5

Hirsh-Pasek, K., Golinkoff, R. M., & Hollich, G. (2000). An emergentist coalition model for word learning: Mapping words to objects is a product of the interaction of multiple cues. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward,

N. Akhtar, et al. (Eds.), *Becoming a word learner: A debate on lexical acquisition* (pp. 136–164). Oxford, UK: Oxford University Press.

Hollich, G. J., Hirsh-Pasek, K., Golinkoff, R. M., Brand, R. J., Brown, E., Chung, H. L., et al. (2000). Breaking the language barrier: An emergentist coalition model for the origins of word learning. *Monographs of the Society for Research in Child Development*, *65*(3, Serial No. 262). doi:10.1111/1540-5834.00090

Houston-Price, C., Caloghiris, Z., & Raviglione, E. (2010). Language experience shapes the development of the mutual exclusivity bias. *Infancy*, *15*, 125–150. doi:10.111/j.1532-7078.2009.00009.x

Hutchinson, J. E. (1986). Children's sensitivity to the contrastive use of object category terms. *Papers and Reports in Child Language Development*, *25*, 49–55.

Iverson, J. M., Capirci, O., & Caselli, M. C. (1994). From communication to language in two modalities. *Cognitive Development*, *9*, 23–43. doi:10.1016/0885-2014(94)90018-3

Jaswal, V. K. (2010). Explaining the disambiguation effect: Don't exclude mutual exclusivity. *Journal of Child Language*, *37*, 95–113. doi:10.1017/S0305000909009519

Jaswal, V. K., & Hansen, M. B. (2006). Learning words: Children disregard some pragmatic information that conflicts with mutual exclusivity. *Developmental Science*, *9*, 158–165. doi:10.1111/j.1467-7687.2006.00475.x

Lederberg, A. R., Prezbindowski, A. K., & Spencer, P. E. (2000). Word-learning skills of deaf preschoolers: The development of novel mapping and rapid word-learning strategies. *Child Development*, *71*, 1571–1585. doi:10.1111/1467-8624.00249

Liittschwager, J., & Markman, E. M. (1994). Sixteen- and 24-month-olds' use of mutual exclusivity as a default assumption in second-label learning. *Developmental Psychology*, *30*, 955–968. doi:10.1037/0012-1649.30.6.955

Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology*, *20*, 121–157. doi:10.1016/0010-0285(88)90017-5

Markman, E. M., Wasow, J. L., & Hansen, M. B. (2003). Use of the mutual exclusivity assumption by young word learners. *Cognitive Psychology*, *47*, 241–275. doi:10.1016/S0010-0285(03)00034-3

Merriman, W. E. (1999). Competition, attention, and young children's lexical processing. In B. MacWhinney (Ed.), *The emergence of language* (pp. 331–358). Mahwah, NJ: Erlbaum.

Merriman, W. E., & Bowman, L. (1989). The mutual exclusivity bias in children's word learning. *Monographs of the Society for Research in Child Development*, *54*(3, 4, Serial No. 220). doi:10.2307/1166130

Mervis, C. B., & Bertrand, J. (1994). Acquisition of the novel name-nameless category (N3C) principle. *Child Development*, *65*, 1646–1662. doi:10.2307/1131285

Namy, L. L. (2001). What's in a name when it isn't a word? 17-month-olds' mapping of non-verbal symbols to object categories. *Infancy*, *2*, 73–86. doi:10.1207/S15327078IN0201_5

Namy, L. L., Campbell, A. L., & Tomasello, M. (2004). The changing role of iconicity in non-verbal symbol learning: A u-shaped trajectory in the acquisition of arbitrary gestures. *Journal of Cognition & Development*, *5*, 37–57. doi:10.1207/s15327647jcd0501_3

Namy, L. L., & Waxman, S. R. (1998). Words and gestures: Infants' interpretations of different forms of symbolic reference. *Child Development*, *69*, 295–308. doi:10.2307/1132165

Namy, L. L., & Waxman, S. R. (2000). Naming and exclaiming: Infants' sensitivity to naming contexts. *Journal of Cognition and Development*, *1*, 405–428. doi:10.1207/S15327647JCD0104_03

Petitto, L. A. (1992). Modularity and constraints in early lexical acquisition: Evidence from children's early language and gestures. In M. R. Gunnar & M. Maratsos (Eds.), *Modularity and constraints in language and cognition: The Minnesota Symposia on Child Psychology* (Vol. 25, pp. 25–58). Hillsdale, NJ: Erlbaum.

Preissler, M. A., & Carey, S. (2005). The role of inferences about referential intent in word learning: Evidence from autism. *Cognition*, *97*, B13–B23. doi:10.1016/j.cognition.2005.01.008

Pruden, S. M., Hirsh-Pasek, K., Golinkoff, R. M., & Hennon, E. A. (2006). The birth of words: Ten-month-olds learn words through perceptual salience. *Child Development*, *77*, 266–280. doi:10.1111/j.1467-8624.2006.00869.x

Regier, T. (2005). The emergence of words: Attentional learning in form and meaning. *Cognitive Science*, *29*, 819–865. doi:10.1207/s15516709cog0000_31

Sabbagh, M. A., & Henderson, A. M. E. (2007). How an appreciation of conventionality shapes early word learning. *New Directions for Child and Adolescent Development*, *115*, 25–37. doi:10.1002/cd.180

Schafer, G., & Plunkett, K. (1998). Rapid word learning by fifteen-month-olds under tightly controlled conditions. *Child Development*, *69*, 309–320. doi:10.2307/1132166

Scofield, J., & Behrend, D. A. (2007). Two-year-olds differentially disambiguate novel words and facts. *Journal of Child Language*, *34*, 875–889. doi:10.1017/S0305000907008100

Sheehan, E. A., Namy, L. L., & Mills, D. L. (2007). Developmental changes in neural activity to familiar words and gestures. *Brain and Language*, *101*, 246–259. doi:10.1016/j.bandl.2006.11.008

Shore, C., Bates, E., Bretherton, I., Beeghly, M., & O'Connell, B. (1994). Vocal and gestural symbols: Similarities and differences from 13 to 28 months. In V. Volterra & C. J. Erting (Eds.), *From gesture to language in hearing and deaf children* (pp. 79–91). Washington, DC: Gallaudet University Press.

Vincent-Smith, L., Bricker, D., & Bricker, W. (1974). Acquisition of receptive vocabulary in the toddler-age child. *Child Development*, *45*, 189–193. doi:10.2307/1127767

Vouloumanos, A., & Werker, J. F. (2004). Tuned to the signal: The privileged status of speech for young infants. *Developmental Science*, *7*, 270–276. doi:10.1111/j.1467-7687.2004.00345.x

Vouloumanos, A., & Werker, J. F. (2007). Listening to language at birth: Evidence for a bias for speech in neonates. *Developmental Science*, *10*, 159–164. doi:10.1111/j.1467-7687.2007.00549.x

Waxman, S. R., & Booth, A. E. (2001). Seeing pink elephants: Fourteen-month-olds' interpretations of novel nouns and adjectives. *Cognitive Psychology*, *43*, 217–242. doi:10.1006/cogp.2001.0764

Waxman, S. R., & Hall, D. G. (1993). The development of a linkage between count nouns and object categories: Evidence from 15- to 21-month-old infants. *Child Development*, *64*, 1224–1241. doi:10.2307/1131336

Waxman, S. R., & Markow, D. B. (1998). Object properties and object kind: Twenty-one-month-old infants' extension of novel adjectives. *Child Development*, *69*, 1313–1329. doi:10.2307/1132268

Werker, J. F., Cohen, L. B., Lloyd, V. L., Casasola, M., & Stager, C. L. (1998). Acquisition of word-object associations by 14-month-old infants. *Developmental Psychology*, *34*, 1289–1309. doi:10.1037/0012-1649.34.6.1289

Woodward, A. L. (2000). Constraining the problem space in early word learning. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, et al. (Eds.), *Becoming a word learner: A debate on lexical acquisition* (pp. 81–114). Oxford, UK: Oxford University Press.

Woodward, A. L., & Hoyne, K. L. (1999). Infants' learning about words and sounds in relation to objects. *Child Development*, *70*, 65–77. doi:10.1111/1467-8624.00006

Woodward, A. L., Markman, E. M., & Fitzsimmons, C. M. (1994). Rapid word learning in 13- and 18-month-olds. *Developmental Psychology*, *30*, 553–566. doi:10.1037/0012-1649.30.4.553

Xu, F. (2002). The role of language in acquiring object concepts in infancy. *Cognition*, *85*, 223–250. doi:10.1016/S0010-0277(02)00109-9

Xu, F., Cote, M., & Baker, A. (2005). Labeling guides object individuation in 12-month-old infants. *Psychological Science*, *16*, 372–377. doi:10.1111/j.0956-7976.2005.01543.x