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Research Article

Can Semantic Enrichment Lead to Naming in a Word Extension Task?

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Purpose: This study examined the relationship between semantic enrichment and naming in children asked to extend taught words to untrained exemplars.
Method: Sixteen typically developing children ($M = 32.63$ months, $SD = 4.02$) participated in 3 word learning conditions that varied semantic enrichment via iconic (shape, function) or point gesture. At test, children named taught referents and 2 exemplars of each taught object: shape similar and shape dissimilar. Naming accuracy and errors were analyzed between conditions.
Results: The point condition never outperformed the shape or function conditions. In naming taught words, the shape condition was superior to the point condition, whereas the function condition was only marginally superior to the point condition. However, in naming untrained exemplars, only the shape condition was superior to the point condition, and there were fewer indeterminate errors in the shape condition.
Conclusion: Semantic enrichment supports naming, but shape cues appear to be particularly effective in using words beyond just-taught referents.

Key Words: word learning, word extension, gesture, naming, semantic representation

Models of word retrieval account for word production (e.g., naming) in two broad steps—the first being activation of the semantic representation and the second being activation of the word form (Levelt, 1992). For the purpose of this study, *semantic representation* refers to the meaning of an object in terms of its individual features (Barsalou, Kyle Simmons, Barbey, & Wilson, 2003; Capone & McGregor, 2005; McGregor, Friedman, Reilly, & Newman, 2002; McGregor, Newman, Reilly, & Capone, 2002). Activation of the semantic representation then drives retrieval of the word label. Empirical evidence shows that how richly semantic information is represented in memory influences whether a word will be retrieved for naming (e.g., Capone & McGregor, 2005; McGregor, Friedman, et al., 2002). However, this relationship has been studied only in the context of a single, known referent. Children go on to name multiple exemplars of an object category (e.g., the *cup* category) that have never been named for them. This is referred to as *word extension* and is defined as applying a known name to an unnamed exemplar without direct instruction (Hollich et al., 2000). Word extension also taps semantic representation. What is known about word extension is derived largely from studies that use highly supported test paradigms. Children are asked whether a test object is the same as a just-named referent with that latter object in the child's sight (e.g., Landau, Smith, & Jones, 1988). There is little evidence of how protracted semantic exposure influences word extension under less supported conditions (i.e., to name when the known referent is not in sight). In the present study, semantic enrichment is manipulated as an exposure variable, and its effect on naming is tested in a word extension task. Semantic enrichment is defined as the process of elaborating an existing representation, either through quantity or quality of exposure. Here it is the quality of exposure that is manipulated. What follows is a review of the time course and testing issues of word learning, an overview of word extension, and how the quantity and quality of semantic enrichment influence the retrieval of taught words.

Time Course and Testing Factors of Word Learning

A popular calculation is that children learn eight to 10 new words each day (e.g., Beck & McKeown, 1991; Bloom, 2000). Although a significant feat, this calculation is based on children's fast mapping of a word. *Fast mapping* refers to the initial link made between a word label and its referent after just a brief exposure to them (Carey, 1978). Learning from fast mapping is weak because it is incomplete (Gershkoff-Stowe & Smith, 1997; Horst, McMurray, & Samuelson, 2006). Weak learning may support recognition of the word but not naming of it (Capone & McGregor, 2005; Dollaghan, 1985). In fact, fast mapping a word does not necessarily support retention of it just 5 min later (Horst & Samuelson, 2008).

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Therefore, the lexical representation (i.e., word form), the semantic representation, or the link between the two is not durable with a single exposure. With this incomplete representation, more task support is needed for children to tap what they have retained. For example, an examiner might show the child a just-named object (e.g., "This is a *dax*.") together with a test object and ask, "Is this a *dax*?" or show the child an object array and ask the child to identify it. The response is a yes–no or pointing response, respectively. The child does not need to activate and hold the semantic representation in memory or retrieve or produce the word label. Having the labeled object in view for the child externalizes it from memory. When a representation is externalized from memory, it lightens the task's cognitive load (e.g., Goldin-Meadow, Nusbaum, Kelly, & Wagner, 2001). Word extension has largely been studied under highly supported test conditions.

In contrast, naming requires a child to activate the existing semantic representation in memory, to activate its connection to the word label, and then to activate the articulatory features needed for production (Levelt, 1992). When asked to extend that word, the child has the added task of making an inference about the object's category. Naming paradigms provide less task support and therefore require richer word representations in memory (e.g., Capone & McGregor, 2005; Gershkoff-Stowe & Smith, 1997; McGregor, Freidman, et al., 2002). A richer word representation is characterized by a more complete and distinct representation as well as stronger links between the semantic representation and its word label. Children accrue rich word representations over time, during the slow mapping phase. Slow mapping is the protracted period of exposure after a word is fast mapped (Carey, 1978). Nuances of the word label, its meaning, and the link between them are strengthened (Bloom, 2000; Carey, 1978; Horst et al., 2006).

The naming paradigm also has functional implications for communication. A key feature of functional communication is that words are used symbolically (Wilkinson & McIlvane, 2001). A word achieves symbolic status if it meets four conditions (e.g., Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Goodwyn & Acredolo, 1993; McGregor & Capone, 2004; Piaget, 1952; Wilkinson & McIlvane, 2001). First, the word is used for naming; second, the child must name multiple exemplars of a known referent; third, the child names them without direct teaching; and fourth, the child names them in the absence of the known referent. Functional word use, then, is characterized by naming under conditions of word extension.

Word Extension: Defining Object Categories

Word extension taps semantic representation. Consider the following example: In the course of a day, a young child encounters a variety of exemplars for an object category, such as *cup*. *Cup* exemplars could include her own sipper cup, mom's tea cup, older brother's juice cup, and the to-go coffee cup held by a passerby. Even though each of these cups functions as a cup, it may look similar or dissimilar to another cup. Also, not all of these cups will be labeled for the child. The child must make inferences about the unlabeled cups she encounters to determine whether they too are referred to as *cup*. Children draw on an existing semantic representation of an object when deciding if a potential exemplar fits the same object category (Barsalou et al., 2003). If yes, it gets the same name. The cup category is formed by including things that are cup-looking (shared shape) or cup-acting (shared function; e.g., Jones, Smith, & Landau, 1991; Kemler Nelson, 1999; Kemler Nelson, Frankenfield, Morris, & Blair, 2000; Landau et al., 1988; Landau, Smith, & Jones, 1998). Children do not discern inanimate object categories by such features as size or texture.

Whether children use object shape or function as a basis for forming an object category may depend on the type of objects being learned and the type of experience children have with them. For example, Landau et al. (1988) labeled a novel object for 2- and 3-year-old children and then asked whether other objects were also called the same name under the highly supported test conditions discussed above. Children recognized untrained exemplars when they matched the original object's shape. These novel objects and untrained exemplars were static and did not have functions (e.g., a circle with a flat edge). However, even when objects were given functions (e.g., absorbing water; Landau et al., 1998), children continued to extend words on the basis of shape. In a slow-mapping study, Smith, Jones, Landau, Gershkoff-Stowe, and Samuelson (2002) provided seven shape-teaching sessions to 17-month-old toddlers over 7 weeks. During teaching, the experimenter labeled two same-shaped objects 10 times in 5 min. A contrasting exemplar was also shown. Children extended words to same-shaped exemplars, whereas a no-teaching group did not. Therefore, labeling of same-shaped exemplars led to word extension on the basis of shape in the slow-mapping period just as in fast mapping. However, objects did not have functions, and children were not asked to name them.

Objects with functions were used by Kemler Nelson (1999), who gave 28-month-old children experience using novel objects and modeled their word label (e.g., *brocket*). Whereas the functions in Landau et al. (1998) tended to be related to the texture of the object, these objects had shape–function relations. After a brief exposure to the word label, children were shown two test objects and asked to find a *brocket*. Children who had an activity session with the objects before learning the name correctly identified brockets that were dissimilar in shape (but shared function) with the original brocket. Naming was not tested.

Overextension of Names

Gershkoff-Stowe and colleagues (Gerskoffe-Stowe, 2001; Gershkoff-Stowe, Connell, & Smith, 2006; see also Plunkett, Sinha, Moller, & Strandsby, 1992) have provided evidence that the mechanism driving word retrieval to name known objects is also engaged when naming unknown objects. Gershkoff-Stowe (2001) studied young toddlers' errors when naming pictures of known entities (i.e., animals) and when naming unknown objects (e.g., tea strainer). Children were neither taught anything about these objects nor prompted to name them. As a result, none of the unknown objects were named correctly by the children. Therefore, this was a study of how children overextend words. Overextension refers to a child's error in thinking a word's meaning reaches farther than it should (Clark, 1973). Gershkoff-Stowe (2001) found that the naming errors of known words and overextensions shared the same developmental trajectory. Of relevance is that over 93% of the overextensions reflected shared shape with the unknown object (e.g., saying *hat* to name a *tea strainer*). However, did children think that the tea strainer was a hat? It is not clear whether children believed these objects were part of the named object category because there was no exposure to the object category of tea strainer.

Gershkoff-Stowe et al. (2006) also studied overextension by manipulating physical similarity between known pictures (e.g., snake) that were used to prime children's naming of novel test pictures (e.g., a coil-shaped picture). Children extended prime words most often to the novel picture when they were highly similar in shape. However, richness of semantic learning for the known words was not tapped or controlled, functions were not primed, and, in fact, children had to rely on shape in selecting a word for naming because the novel exemplars were pictures of shapes that did not have functions.

To sum, young children have a bias toward shared shape when extending names to novel objects, although with exposure, children may override the reliance on shared shape toward shared function in highly supported test contexts. Word extension has only been studied in highly supported tests, and studies of overextended names are of names extended only in error. That is, overextension errors do not reflect what happens during accurate word extension. The current study highlights object shape and function in the same study. The effect is tested on naming in a word extension task where children have knowledge of the object category. The study builds on what is known about semantic learning and its effect on naming a single known referent.

Semantic Learning and the Naming of Known Words

Richness of semantic representation influences whether a word will be retrieved to name a known referent (e.g., McGregor, Friedman, et al., 2002; McGregor, Newman, et al., 2002). For example, McGregor, Friedman, et al. (2002) asked 5-year-olds to name pictures and then define and draw those words. Definitions and drawings served as measures of semantic representation. Children stated more units of semantic information in their definitions and rendered more semantically specific drawings (i.e., rich representations) for accurately named target words than for those words named in error. Words named with semantic errors were associated with fewer semantic information units and semantically vague drawings (i.e., weak representations; see also McGregor, Newman, et al., 2002). Semantically related errors are more common in children than are other error types (e.g., phonologically related, visual misperception; Gershkoff-Stowe, 2001; Gershkoff-Stowe & Smith, 1997; McGregor, 1997; McGregor, Friedman, et al., 2002; McGregor, Newman, et al., 2002). Semantic errors reflect a still evolving semantic representation or link between word label and semantic representation. Another common error type that illustrates the graded nature of word learning is the indeterminate error. Indeterminate errors (e.g., saying "I don't know" or no response) are indicative of missing representations or a missing (or weakest) link between label and meaning.

It is the quantity and the quality of exposure to each word that makes the difference in representational richness (e.g., Bjorklund & Schneider, 1996; Dell, 1990; Gershkoff-Stowe, 2002). Quantity of exposure refers to the frequency of encounters. The more encounters with a word the more will be mapped about it (e.g., McGregor, Sheng, & Ball, 2007). A child knows little about a newly or infrequently encountered word. Semantic enrichment can enhance the quality of word learning exposure even when the frequency of exposure is controlled. For example, Capone and McGregor (2005) taught children word labels by modeling words and used iconic gestures to highlight the shape (shape condition) or the function (function condition) of the object; these were compared with a no-gesture (control) condition. Iconic gestures convey semantic information in their form, path, or movement. For example, holding two fingers in a V can represent a rabbit's ears by highlighting the shape of them (Acredolo & Goodwyn, 1996). Children were tested for their semantic knowledge of taught words by the experimenter asking them to state the function of each object. Children also named pictures of taught objects and identified them from a picture array. Each word was then categorized by the least amount of task support needed to demonstrate learning: uncued picture naming, gesture-cued picture naming, or picture recognition.

Results were that richer semantic knowledge occurred in the iconic gesture conditions than in the no-gesture condition, with more object functions stated even though they were never labeled. Naming paralleled these results, with more taught referents named (uncued and cued) under the shape and function conditions than under the no-gesture condition. Learning in the no-gesture condition was evident only in the picture recognition test. To sum, iconic gestures enriched semantic learning above that provided by frequency of exposure. Rich semantic learning supported two levels of naming, uncued and cued, whereas words learned in the no-gesture condition required the most task support for retrieval.

Current Study

This study attempted to fill several gaps in the word learning literature but did so by converging two relatively disparate aspects of it. First, studies that have examined the relationship between semantic representation and naming have tested only a single, known referent. An important aspect of functional word use is that words be extended to name multiple exemplars of an object category, yet naming tests are underused within the context of word extension. Naming in the context of overextension does not necessarily reflect how children accurately extend names when they have knowledge of an object category. Second, both the naming of known words and the decision to extend a word draw on semantic representations, yet little is known of the effect an existing semantic representation has on word extension. In addition, if some aspect of a newly fast-mapped word is not retained into the slow-mapping period, then studies of word extension just after fast mapping may not be representative of the slow-mapping period. Finally, there has been a failure to compare the effect of shape and function exposure on naming under word extension conditions in the same study.

To address these gaps, I manipulated semantic enrichment as an exposure variable and tested its effect on naming in a word extension task. As in Capone and McGregor (2005), I gave semantic enrichment a boost via gesture cues to shape or function of the taught objects. A pointing gesture was used (point condition) as a control. Pointing is a sociopragmatic cue (Booth, McGregor, & Rohlfing, 2008). This latter condition constituted an added level of control over the no-gesture condition in Capone and McGregor (2005). It equates the conditions for presence of gesture, yet the point does not embody a semantic feature. Children were then tested for the naming of taught words as well as two untrained exemplars: a shape-similar exemplar and a shape-dissimilar exemplar. Testing both types of exemplars accounts for children's functional communication in everyday contexts (Kemler Nelson, 1999).

To be conservative, the naming analysis of the untrained exemplars uses a two-step procedure. First, children completed a category test for each untrained exemplar. The purpose of the category test was to ensure that untrained exemplars were correctly categorized with the taught object. Extension of the name in the naming test was analyzed only if it was supported by correct categorization in the category test. The naming analysis also taps a slightly wider learning space by including both uncued and cued naming, to be consistent with Capone and McGregor (2005). Cued naming is meant to reflect richer semantic representations that are just on the cusp of activation. Whereas Capone and McGregor (2005) tapped weak or missing word representations with a recognition task, the current study focused on naming. Therefore, an error analysis was used to characterize still evolving (semantic error) or missing (indeterminate error) representations.

The child's gesture to a naming query was tallied in the error analysis because, like spoken circumlocutions, gestured circumlocutions can reflect an evolving representation. For example, if a child fails to say /kof/, she can say "roll it" or gesture a rolling motion (see *Stimuli* section below). Spoken and gestural modalities tap the same representational space for a variety of concepts, including math, science, and language (e.g., Alibali & Goldin-Meadow, 1993; Bello, Capirci, & Volterra, 2004; Church & Goldin-Meadow, 1986). There is a significant literature that analyzes gesture as well as speech as an index to transitions (i.e., evolutions) in learning, including word learning (e.g., Capone, 2007). To ignore a child's gesture is to ignore what he or she knows.

Study Questions and Predictions

The study asked (a) whether children will retrieve words to name untrained exemplars more often in the shape and function conditions than in the point condition and (b) whether there will be more semantic errors but fewer indeterminate errors in the shape and function conditions than in the point condition. I predicted that children would name more untrained exemplars and produce fewer indeterminate errors but perhaps more semantic errors in the shape and function conditions than in the point condition. The prediction is based on previous findings that semantic enrichment strengthens semantic learning. Word extension taps a semantic representation, and an enriched semantic representation supports retrieval of the word label for naming.

Method

Participants

Sixteen children (M = 32.63 months, SD = 4.02, range = 27–42 months) were recruited from advertisements in a parent magazine for northern New Jersey. Participants were monolingual English-speaking children (8 boys, 8 girls). They were of African American (6%), Asian American (13%), Caucasian (50%), Hispanic (6%), and a variety of unreported (25%) backgrounds. The participants were included if (a) their expressive vocabulary scores fell above the 10th percentile (M = 65th percentile, SD = 26.56, range = 20th–99th) according to the MacArthur Communicative Development Inventories: Words and Sentences form (MCDI; Fenson et al., 1993) or the Expressive Vocabulary Test (EVT; Williams, 1997) and (b) they had a negative history of developmental delay, speech-language impairment, and hearing impairment. For children 27 to 30 months of age, parents completed the MCDI. For children over 30 months, the experimenter administered the EVT. Maternal education ranged from 12 to 20 years (M = 17.25, SD = 1.84).

Stimuli

All stimuli are presented in Table 1. Three distinct teaching objects were chosen from the six teaching objects used by Capone and McGregor (2005). For each teaching object, there was a picture of it to test learning and there was a shape-similar exemplar and a shape-dissimilar exemplar to test word extension. Pictures were 5" × 7" color photographs of the taught objects. Shape-similar exemplars were objects that were similar in appearance to the taught objects. Shape-dissimilar exemplars did not share overall shape with the taught objects. Both objects shared the same function. Shape-similar and shape-dissimilar exemplar objects were determined to be valid representations of the taught object by adult raters.

The decision to use the three teaching objects (of the original six) from Capone and McGregor (2005) was guided by adult ratings. Using a categorical rating scale, 15 adults rated the similarity between the taught object and several possible object exemplars. Rating categories were as follows: same (foil), similar, dissimilar, and out-of-object category. For each object, a variety of untrained exemplars and out-of-object-category objects were rated. Out-of-object-category objects were objects from the other five untrained object categories and random objects not intended to be part of the study. Adult raters had experience enacting functions before rating the objects. A criterion of at least 85% agreement across raters was set to include objects in the study. That is, 13 of the 15 raters had to agree on the object's rating as similar for the shape-similar exemplars, as dissimilar for the shape-dissimilar exemplars, and as out-of-object category

TABLE 1. Study stimuli: Words, objects, gestures, and functions.

	/pin/	/kof/	/wæt/
Trained objects			
Shape-similar			
Shape-dissimilar			
Shape gesture			
Function gesture			
Function of the object	Push down onto flattened Play-Doh, leaving a distinct imprint	Roll across flattened Play-Doh, leaving a distinct imprint	Form a dumpling-shaped mass when moved from open to closed position

for those objects. The three objects (and their untrained exemplars) were judged to be distinct from each other (i.e., out-of-object-category ratings when tested against each other). The shape-similar and shape-dissimilar exemplars used here met the criterion for visual similarity and dissimilarity to the taught object, respectively.

Gestures were iconic or pointing gestures. One iconic gesture highlighted the shape of the taught referent, and another iconic gesture highlighted the object's function. Iconic gestures were those used in Capone and McGregor (2005) and were determined to be valid representations of the object's shape and function by a group of adult raters in that study. Pointing was a prototypical extension of the arm from the body and the index finger from a fisted hand in the direction of the referent.

Words were consonant–vowel–consonant nonce words from Storkel (2001), because they were comparable in high phonotactic probabilities. Phonotactic probability refers to the frequency with which a sound sequence occurs in a language and has been shown to influence word learning. Objects and word labels were counterbalanced between teaching conditions by child but remained consistent across visits with any given child.

Procedure

The study used a within-subject, repeated measures design because children participated in each of the three word learning conditions: shape, function, and point. Stimuli were counterbalanced between children for condition and presentation order of each condition. Therefore, the procedures used here were comparable between the three conditions and the objects.

The experimenter visited each participant at home on 4 separate days. The procedures were of three types: teaching procedures (Visits 1, 2, 3), exemplar experience (Visits 2, 3), and testing (Visit 4). Figure 1 illustrates these procedures over time. Figure 2 illustrates the steps of the teaching procedure and the exemplar experience. Children were taught objects under the shape, function, and point conditions at each of Visits 1, 2, and 3. This schedule resulted in three teaching sessions for each object. Participants were also exposed to the shape-similar and the shape-dissimilar exemplars at both Visits 2 and 3 after the teaching procedures. At Visit 4, children were asked to name taught words and to then complete a category test and the naming test of the untrained exemplars.

Teaching procedures. In teaching, the experimenter first showed each teaching object, then demonstrated its function, and subsequently allowed the child to manipulate it. Children enacted each object function for 20–30 s with Play-Doh. This procedure ensured familiarity with both shape and function of the object prior to labeling it. The experimenter then placed the object on the table and stated "It's a [label]!" Labels were *word* + *gesture*. For example, one participant heard "It's a /pin/" + shape gesture, "It's a /kof/" + function gesture, and "It's a /wæt/" + a point gesture in the shape, function, and point conditions, respectively. Children again manipulated the object. The experimenter labeled the object two additional times with *word* + *gesture,* ensuring that gestures were within the child's visual attention. Each object was labeled three times during each teaching session, summing to nine exposures by the study's end.

Exemplar experience procedures. Participants had exposure to shape-similar and shape-dissimilar exemplars at Visits 2 and 3 to ensure familiarity with object shape and function and to eliminate novelty effects that could arise at testing. Untrained exemplars were presented individually after the teaching object was placed to the side. The untrained exemplars were never labeled or paired with a gesture. The experimenter stated, "Here's another one." The child manipulated each of the objects for 20–30 s with Play-Doh. The experimenter modeled an object's function if a child did not use it. Presentation of shape-similar exemplars and shape-dissimilar exemplars was counterbalanced such that half the children experienced the shape-similar exemplar first (and shape-dissimilar exemplar second) and half the children experienced the shape-dissimilar exemplar first (and shape-similar exemplar second).

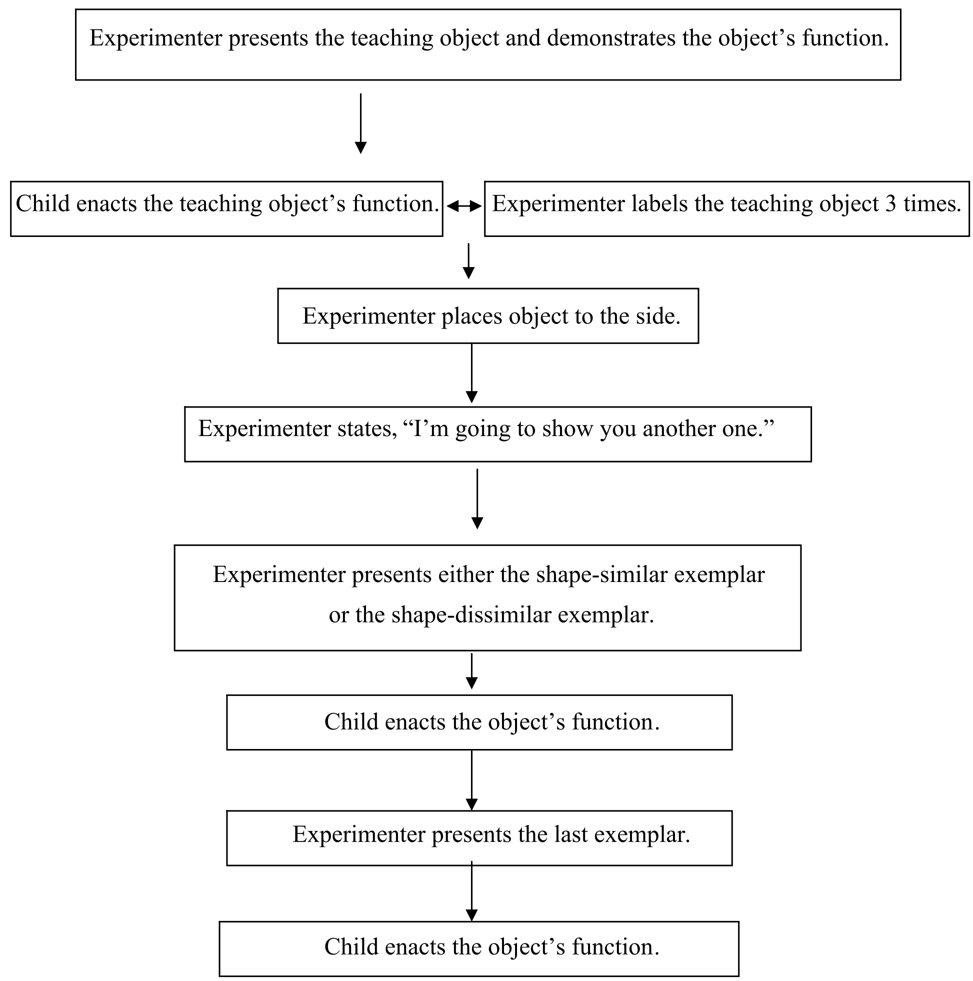
Testing procedures. At Visit 4, children named taught words and untrained exemplars, but naming of the untrained exemplars was tested in two steps. First, children were asked to identify objects as a test of object categorization (category test). Second, children were asked to name the untrained exemplars. Only uncued and cued naming responses supported by a correct categorization response were included in the naming analysis.

The category test was an object identification task. Children were presented an array of three objects: the two exemplar objects (shape-similar, shape-dissimilar) and an unlabeled

FIGURE 1. Schedule of procedures over time.

Visit 1	Visits 2 and 3	Visit 4
Teaching procedure—Object 1	Teaching procedure—Object 1	Naming of taught object
↓	↓	↓
Teaching procedure—Object 2	Exemplar experience—Object 1	Category test
↓	↓	↓
Teaching procedure—Object 3	Teaching procedure—Object 2	Naming of exemplars
	↓	
	Exemplar experience—Object 2	
	↓	
	Teaching procedure—Object 3	
	↓	
	Exemplar experience—Object 3	
	↓	

FIGURE 2. Teaching procedures and exemplar experience.



exemplar of the practice object. Identification of shape-similar exemplars was tested separately from the shape dissimilar exemplars, but presentation order was counterbalanced between children; half the children were tested on the shape-similar exemplars first, and half the children were tested on the shape-dissimilar exemplars first. Children were shown a taught object and prompted, "Let's find another one of these." No objects were named or paired with gesture during this assessment, so as to avoid priming naming of the exemplars in the naming test. Presentation of individual objects was random. The array was covered with a blanket after each trial and rearranged to accommodate changing test objects and to differentiate trials from one another.

Naming was assessed via picture naming of taught objects and object naming of shape-similar and shape-dissimilar exemplars. The naming of taught referents was tested separately from the naming test of the untrained exemplars. This decision was made for two reasons. First, the interest and attention of these young children was maintained by using the different tasks. Second, it ensured that the taught objects were not in sight when children named the untrained exemplars. A practice trial in which the experimenter referred to a familiar object (*cup*) preceded each test task. For all tests, noncontingent praise was provided for any response.

Picture naming of taught objects was embedded in a mailing game. The mailing game was used to engage young children in the repeated task of naming. It was used successfully in Capone and McGregor (2005). In addition, to engage children in the repeated task of naming the untrained exemplars, children were told they were going to make a pile of objects for themselves ("Let's see what to put in your pile."). Pictures and objects were presented individually and randomly, and the experimenter elicited naming by asking, "What are we mailing?" or "What is this?" If the child did not accurately name a picture or object, then the experimenter provided a gesture cue ("It's a *gesture.*"). Gesture cue was determined by the teaching condition of the object. The untrained exemplars were presented randomly, but the three shape-similar exemplars were presented separately from presentation of the shape-dissimilar exemplars. Presentation order of the untrained exemplars was counterbalanced so that half the children were tested on the shape-similar exemplars first and the other half of the children were tested on the shape-dissimilar exemplars first. Taught objects and their pictures were not in sight during testing of the untrained exemplars.

The fourth visit occurred, on average, 12.73 days (SD = 3.79) after the first visit and 4.13 days (SD = 2.29) after the third visit. The mode was 9 days between first and fourth visit and 5 days between third and fourth visit.

Dependent Variables and Analysis

The dependent variables were (a) the number of taught words named in each condition, (b) the number of shape-similar exemplars categorized and named in each condition, (c) the number of shape-dissimilar exemplars categorized and named in each condition, and (d) the number and type of naming errors on uncued naming trials in each condition (collapsed across exemplars). Naming errors were characterized as a semantic error–word substitution (i.e., another taught word, a real word), a semantic error–circumlocution (i.e., verbal, gesture, or gesture + verbal response that communicates semantic information), or an indeterminate error (i.e., no response/don't know).

Because each participant contributed one naming opportunity per condition, the data are binomial—learned or not learned. The statistical analysis that compares binomial data between three or more related (i.e., repeated measures) conditions is the Cochran Q test with McNemar change test post hoc (Siegel & John Castellan, 1988). There are binomial data that become ratio scaled data when the former are collapsed to examine main effects or interactions (i.e., cue level, exemplars, naming errors). In these cases, the repeated measures analysis of variance (ANOVA) was used. All analyses are two-tailed with the exception of the taught naming analysis. The findings from Capone and McGregor (2005) allowed this study to predict the direction of difference in that analysis in favor of the iconic gesture conditions. Partial eta-squared (η^2) was interpreted as small effect (0–.15), medium effect (.15–.30), and large effect (> .30; Cohen, 1988).

Reliability and Treatment Fidelity

Teaching and testing sessions were video recorded for treatment fidelity and reliability coding, respectively. Procedural reliability, a measure of treatment fidelity, was coded for 29% of the sessions by an independent coder who was blind to the purpose of the study. The experimenter provided the assigned *word + gesture* label three times per teaching session 100% of the time. The experimenter introduced the shape-similar and shape-dissimilar exemplars without labeling them 100% of the time. A second independent coder who was blind to the purpose of the study recoded the naming responses of 31% of the participants from videotapes. Point-by-point agreement of the children's naming performance was 100% between the independent coder and the experimenter.

Results

Naming of Taught Referents

Each child was taught one object per condition, contributing one naming opportunity per condition. Therefore, 16 naming trials per condition entered into analysis. The mean numbers of uncued naming responses in the shape, function, and point conditions were 0.56 (SD = 0.51), 0.31 (SD = 0.48), and 0.31 (SD = 0.48), respectively. The mean numbers of cued naming responses in the shape, function, and point conditions were 0.18 (SD = 0.40), 0.31 (SD = 0.48), and 0, respectively. A 3 (condition) × 2 (cue) Cochran's Q test detected a significant difference, $\chi^2(16) = 12.43$, $p = .03$. There was a main effect between conditions, $\chi^2(2) = 6.50$, $p = .04$, with the shape condition significantly ($p = .02$) supporting naming more often than the point condition. The function condition was marginally more supportive than the point condition ($p = .09$). A main effect also emerged between cue levels, $F(1, 15) = 4.46$, $p = .05$, $\eta^2 = .23$. More uncued responses were produced than cued responses across conditions. There was no interaction between condition and cues, $F(2, 30) = 1.32$, $p = .28$.

Category Test

The mean number of correct category responses of the shape-similar exemplar in the shape, function, and point conditions were 0.94 (SD = 0.25), 0.88 (SD = 0.34), and 0.88 (SD = 0.34), respectively. The mean numbers of correct category responses of the shape-dissimilar exemplars in the shape, function, and point conditions were 0.69 (SD = 0.47), 0.63 (SD = 0.50), and 0.56 (SD = 0.51), respectively. A 3 (condition) × 2 (exemplar) Cochran's Q test detected a significant difference, $\chi^2(5) = 11.71$, $p = .04$. There was a main effect for exemplar, with more shape-similar exemplars categorized than shape-dissimilar exemplars, $F(1, 15) = 12.74$, $p < .01$, $\eta^2 = .46$. There was no main effect for condition, $\chi^2(16) = 0.70$, $p = .70$, and no interaction between condition and exemplar, $F(2, 30) = 0.09$, $p = .92$.

Word Extension: Naming Shape-Similar and Shape-Dissimilar Exemplars

To be included in this word extension analysis, an object had to be both categorized on the category test and named. The number of naming responses deleted from this analysis due to a failed category test was one in the shape condition, two in the function condition, and two in the point condition. For the shape-similar exemplars, the mean numbers of uncued naming responses in the shape, function, and point conditions were 0.50 (SD = 0.51), 0.31 (SD = 0.48), and 0.25 (SD = 0.45), respectively. The mean numbers of cued naming responses in the shape, function, and point conditions were 0.31 (SD = 0.48), 0.13 (SD = 0.34), and 0.13 (SD = 0.34), respectively. For the shape-dissimilar exemplars, the mean numbers of uncued naming responses in the shape, function, and point conditions were 0.19 (SD = 0.40), 0 (SD = 0.00), and 0.06 (SD = 0.25), respectively. The mean numbers of cued naming responses in the shape, function, and point conditions were 0.38 (SD = 0.50), 0.38 (SD = 0.50), and 0.06 (SD = 0.25), respectively.

A 3 (condition) × 2 (cue) × 2 (exemplar) Cochran's Q test detected a significant difference, $\chi^2(11) = 25.31$, $p = .01$. The analysis revealed a main effect for condition, $\chi^2(2) = 14.35$, $p < .01$, with the shape condition outperforming the function ($p = .01$) and point ($p < .01$) conditions; the function and point conditions were comparable ($p = .13$). There was also a main effect for exemplar, $F(2, 30) = 4.23$, $p = .05$, $\eta^2 = .22$. Children named more shape-similar than shape-dissimilar exemplars (see Figure 3). There was no main effect for cue, $F(1, 15) = 0.01$, $p = .92$.

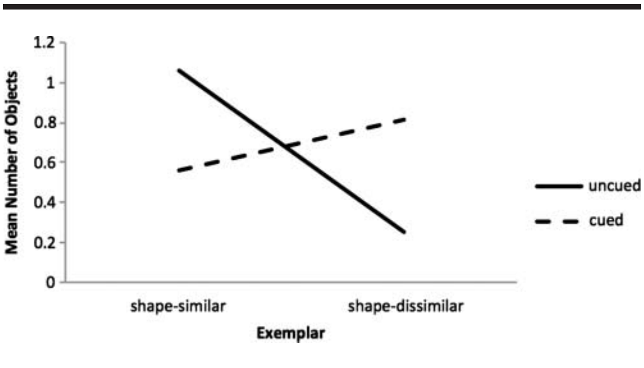
There was only one significant interaction between cue and exemplar, $F(2, 30) = 5.11$, $p = .04$, $\eta^2 = .25$. Children produced more uncued naming of shape-similar exemplars but more cued naming of shape-dissimilar exemplars. The remaining tests of interaction did not reach significance: Condition × Cue, $F(2, 30) = 0.75$, $p = .48$; Condition × Exemplar, $F(2, 30) = 0.81$, $p = .45$; or Condition × Cue × Exemplar, $F(2, 30) = 1.30$, $p = .28$.

Error Analysis

This analysis collapsed errors across referents (taught referents, shape-similar, shape-dissimilar) to further examine differences between conditions. This decision was made because in the naming analyses, the main effect found was for condition, and the only interaction with exemplar was related to cue, not condition. There were 48 uncued naming opportunities across taught referents, shape-similar exemplars, and shape-dissimilar exemplars in each condition. On average, children provided indeterminate errors on 0.31 (*SD* = 0.60), 0.81 (*SD* = 0.83), and 0.81 (*SD* = 1.16) of naming trials in the shape, function, and point conditions, respectively. A repeated measures (condition) ANOVA revealed a significant difference between conditions, $F(2, 30) = 4.0$, $p = .02$, $\eta^2 = .21$. The shape condition had fewer indeterminate errors than the function ($p = .02$) and point ($p = .02$) conditions, but the function and point conditions were comparable ($p = 1.0$).

Next, word substitutions (i.e., overextensions) and circumlocution errors were subject to between-conditions comparison. On average, children provided word substitutions on 0.19 (*SD* = 0.40), 0.38 (*SD* = 0.50), and 0.19 (*SD* = 0.54) of trials in the shape, function, and point conditions, respectively. On average, children provided circumlocution errors on 0.75 (*SD* = 0.86), 0.63 (*SD* = 0.89), and 0.75 (*SD* = 0.77) of trials in the shape, function, and point conditions, respectively. A 3 (condition) × 2 (error type) repeated measures ANOVA revealed no main effect of condition, $F(2, 30) = 0.04$, $p = .49$. There were, however, more circumlocution errors than word substitutions produced across conditions, $F(1, 15) = 8.14$, $p = .01$, $\eta^2 = .35$. No interaction between condition and type of semantic error emerged, $F(2, 30) = 0.63$, $p = .53$.

FIGURE 3. Uncued and cued naming performance for each untrained exemplar.



Discussion

This study examined the role of semantic representation in naming by first manipulating semantic enrichment and then asking children to retrieve words while extending them to untrained exemplars. It is challenging to isolate semantic learning from lexical learning in studies that manipulate frequency of exposure (e.g., Gershkoff-Stowe, 2002; Schwartz & Terrell, 1983) because exposure to referents provides its own source of semantic enrichment. In addition, semantic representations accrue over a long developmental course (Bloom, 2000; Horst et al., 2006). With these things in mind, the study manipulated the quality of semantic exposure while controlling frequency of word-referent exposure. The hypothesis was that giving semantic enrichment a boost in the shape and function conditions would support not only naming of taught words but also word extension to name untrained exemplars. Although the sample size was small, there were medium to large effect sizes to the relationships.

First, children learned more taught words in the shape condition and learned marginally more words in the function condition than in the point condition. This result parallels the naming result in Capone and McGregor (2005). The prediction that semantic enrichment would lead to naming in the word extension task was supported by a more constrained result than expected. The reader should first note that the point condition never outperformed the shape or function conditions. However, it was performance in the shape condition that was superior to the point condition in naming both untrained exemplars of the object category. There were also fewer indeterminate errors in the shape condition. The finding that shape cues provide an advantage over even function cues is consistent with Capone and McGregor (2005). In that study, even though the shape and function conditions were comparable for total naming and semantic knowledge at test, there was an advantage in the shape condition for the fast mapping of new words as well as a slow-mapping advantage in uncued naming. If indeterminate errors are indicative of the weakest or missing word representations, then the current result of having fewer indeterminate errors in the shape condition suggests that shape cues were effective in establishing richer word representations from the start. This would be consistent with Capone and McGregor's (2005) finding of superior fast mapping in that condition.

Neither semantic circumlocutions nor success in categorizing the untrained objects differentiated the shape, function, and point conditions here. These results are indicative of a baseline level of semantic knowledge in all conditions. First, exposure to referents provides its own source of enrichment that is unavoidable. Second, the task support in the category test is high. The task was likely not sensitive to differences in representational richness. That is, even a weak representation could be tapped in that task. It was not surprising that only the naming tests were sensitive to differences in semantic enrichment.

Tapping Word Learning

To say that a word is learned is partially a reflection of how word learning is tapped. The task used to test learning is a variable that can limit the reflection of learning to an all-or-none phenomenon by examining only uncued naming or testing only recognition of taught words. This study attempted to illustrate the more continuous nature of word learning and retrieval. Instead of just tapping learning with uncued naming of taught words, here the learning space was broadened to include uncued and cued naming as well as taught and untrained exemplars. Cued naming was meant to tap word representations that were just on the threshold of activation. Cued naming provided some scaffolding but still far less scaffolding than what a forced-choice, yes–no or recognition trial with the taught object in sight would provide (Capone & McGregor, 2005). Fast mapping and highly supportive test tasks largely characterize how word extension has been measured. The finding that children extended words in a naming task, 5 days after the last teaching session, without the taught object in view, is a testament to the effect of semantic representation on word use that has not previously been shown. Only words that are richly represented in memory will be retained with this length of delay (e.g., Horst et al., 2006).

In addition to the testing procedure, the untrained exemplars used here provided their own support or challenge to word retrieval. An unpredicted effect of categorical exemplar emerged, regardless of condition. First, in the category test, children categorized shape-similar exemplars more often than shape-dissimilar exemplars even though the task was highly supported for both. In turn, children named more shape-similar exemplars than shape-dissimilar exemplars. Finally, there was an interaction between cueing and exemplar, with shape-dissimilar exemplars requiring a cue more often than shape-similar exemplars for word retrieval. Similarly, words that were directly taught were retrieved largely with uncued support. Therefore, shape-dissimilar exemplars presented a more difficult demand to categorize and subsequently name. Because both exemplars shared function, the only factor to differentiate them was the presence or absence of shared shape with the taught word. Jones and Smith (1993) have argued that object concepts are assembled online (see also Barsalou et al., 2003). These emerge from the interaction between an existing representation and an external representation (i.e., the object itself), of perceptual features (e.g., shape) and nonperceptual features (e.g., functional affordances), as well as task demands. When naming shape-dissimilar exemplars, children had to rely on their existing representation of shape–function relations because little support for that relationship came from the external representation of the object itself. Children accomplished this when taught with shape cues. If shape cues enriched the existing representation of shape, then it may have either allowed for the mapping of functional affordances or freed resources online for easier discerning of the relationship between existing shape representation and external function representation. Capone and McGregor (2005) found that children's existing representation of function in the shape condition was superior to the control condition even though functions were never labeled. That study suggested that shape cues lead to richer mapping of function.

Discerning functional affordances may be dependent on perceptual features that could support them (Namy & Gentner, 2002). In studies by Gentner and Namy (1999; see also Namy & Gentner, 2002), comparison of multiple categorical exemplars led children to form object categories by extracting commonalities. What is interesting is that when children view two exemplars that are highly similar in shape—for example, a bicycle and a tricycle, each with bold tire outlines—children then identify a novel categorical exemplar that is shape dissimilar (e.g., a skateboard) even when the noncategorical foil is highly shape similar (e.g., a folded pair of glasses with bold rim outlines). The authors argued that when children compare perceptually similar exemplars, they map less obvious properties, such as function, as part of that category. Therefore, it appears that highlighting shape (whether through comparison, as in the Gentner and Namy studies, or through iconic gesture here) leads to the mapping of functional properties.

Semantic Representation and Word Extension

Word extension is an important development in word learning because it makes developing a lexicon efficient. Each word–referent pair does not need to be taught explicitly, a process that would be painstakingly laborious. Examining semantic representation is important because it is the semantic representation of a word that is activated when making inferences about object categories (Barsalou et al., 2003), but it is also semantic activation that drives retrieval of the word label (Levelt, 1992). This relationship between semantic representation and naming in a word extension task is particularly taxed when the taught object is not in sight because the child must rely on an existing representation of the taught word. Little is known about the effect of semantic learning, over time, on a child's extension of words, when asked to name untrained exemplars. In computer simulations of word learning, Plunkett et al. (1992) observed that errors in word extension were associated with weak semantic representations (i.e., dot configurations). The authors argued that extension errors likely result from weak image representations because these are not distinct from other representations to include potential exemplars as part of the accurate object categories. To date, no behavioral study had examined the relationship between semantic enrichment and naming in a word extension task. This study is also the first to systematically train both object shape and function, separately, in the same study, with the purpose of testing naming in a word extension task. It is interesting that the results are consistent with previous work. First, children showed accurate name extension with semantic enrichment around shape. Even when function was given comparable attention to shape, in teaching and exemplar experience, children associated shape and name and mapped functional affordances when shape was highlighted. Second, as would be predicted by Plunkett et al.

(1992), there were few overextension errors (i.e., word substitutions) observed overall.

If all objects in an object set shared function but not shape, why, then, would the function gesture not be the more effective word learning cue? There is no definitive explanation from the current data, but the results are consistent with much of the extant literature. To put the current result in context, the reader is reminded of two methodological points: First, children had hands-on experience with all objects, so that they were familiar with shape and function even before labeling and gesturing began. Second, the repeated measures design and counterbalancing of objects—at teaching, at exemplar experience, and at test—ensured comparable experience with objects between conditions. Therefore, differences that emerged between condition and by exemplar cannot be attributed to those methods.

Although children can use shape or function to form object categories, there is an empirical claim that shape has primacy in connecting word labels to object categories early on (Gentner, 1978). Young toddlers learn that it is a good bet that two objects that share shape also share a name (Gentner, 1978; Rosch, 1973; Samuelson & Smith, 1999), and children's early bias toward shape is positively related to vocabulary growth (Gershkoff-Stowe & Smith, 2004). As children develop into preschoolers, this bias toward shape is thought to weaken (e.g., Imai, Gentner, & Uchida, 1994). Yet in Kemler Nelson et al. (2000), even 4-year-old children had a bias toward making shape-based extensions if responding was more immediate; more delayed responses were function based. McGregor, Friedman, et al. (2002) also found that naming errors in 5-year-old children were associated with limited knowledge of features related to shape.

One final note should be made regarding the untrained exemplar manipulation. Specifically, there was no untrained exemplar that shared shape but not function with the taught object. This was a deliberate exclusion because the focus of the current study was on the naming of taught object categories. The shape-similar/function-dissimilar distinction would test overextension of names. The primary aim of the current study was not to study overextension.

Overextension

Naming in the context of overextension does not necessarily reflect how children accurately extend names when they have knowledge of an object. In studies of overextension, word substitution errors are examined because there is no knowledge of object category. In turn, overextensions are overwhelmingly shape based (Gershkoff-Stowe, 2001; Gerhskoff-Stowe et al., 2006; see also Bowerman, 1976; Clark, 1973). That is, previous studies of overextensions revealed children's reliance on shape knowledge in error when overextending words to categories that they did not know. The finding that semantic circumlocutions far outweighed word substitutions here suggests that errors in word extension change as children have experience with an object category. When considered in the context of Gershkoff-Stowe (2001), this is an important addition to the literature. Here, children activated the correct semantic representation because the majority of semantic circumlocution errors on untrained exemplars (84%) expressed function knowledge. It was retrieval of the word form that failed. An interesting direction for future work would be to track changes in error types from fast- to slow-mapping intervals.

Overextension errors were rare, but when they did occur, they were largely another taught nonce word. Because the object categories were developed with special attention to distinct shape and function, it would be unlikely that children mistook one object for another. Instead, the few overextension errors that did occur were more likely due to perseverative responding (Gershkoff-Stowe & Smith, 1997). Perseverative responding, or repetition of a previously said word, occurs when lexical activation from a previous trial has not yet returned to baseline. This was rare, however, with so few objects to name at one time it is possible that a few instances of carryover between test trials occurred. It cannot be ruled out, though, that perseverative naming could have been a conscious effort on the child's part to use his or her newly learned word and not related to processing. In either event, it was rare.

Gesture as a Semantic Enrichment Cue

A semantic boost to learning was provided via iconic gestures and was compared with a noniconic gesture (pointing). This constituted an added level of control over the no-gesture (control) condition in Capone and McGregor (2005). The data suggest that iconic gestures service word learning differently than pointing, at least at this juncture of development. Several studies have established that 1-year-old children take advantage of pointing for word learning, usually in concert with the caregiver's eye gaze toward the referent (e.g., Tomasello, Carpenter, & Liszkowski, 2007; Woodward, 2004). Booth et al. (2008) conducted a systematic study of sociopragmatic cues that compared word learning in 2.5-year-old toddlers, across four cue types: gaze at the referent, gaze and point at the referent, gaze and touch the referent, or gaze and touch and push the referent. Learning was tested for naming and recognition of taught words and untrained exemplars. What was interesting is that even though pointing, touching, and touching and pushing the referent all improved toddlers' recognition of both trained and untrained exemplars, there were no significant effects on naming. In fact, there was a very low occurrence of naming even after fast mapping when given these cues.

Iconic and pointing gestures have not yet been systematically compared for their effectiveness as a word learning cue before now. One study was suggestive. Zammit and Schafer (2010) prospectively observed mothers talking with their infants starting at age 9 months until the infants were 26 months. No instruction was given to the mothers regarding gesture. They were asked to talk to their children about a predetermined set of nouns, using each noun individually. Analyses showed that mothers used both iconic and point gestures when talking to infants. Iconic gestures in particular, though, were associated with the emergence of these nouns in the infants' receptive vocabularies.

Whereas both pointing and iconic gestures can draw attention to an object, the iconic gesture may also orient children to attend to or strengthen their inferences about specific features and their connections to the word label. The data presented here, in concert with Capone and McGregor (2005), support the idea that iconic gestures are semantic cues that enrich semantic learning and, in turn, lead to richer word use. It has been suggested that gesturing helps children learn because it externalizes an existing representation from memory (e.g., Goldin-Meadow et al., 2001). When gesture is present externally, the child is less reliant on maintaining the information in working memory. In the case of object word learning, the child needs to make inferences about word–referent pairing and salient semantic features that define that object's taxonomy (e.g., Keil, 1989). Iconic gestures may have made these inferences explicit for the child.

Iconic gestures may be particularly amenable to drawing attention to the semantic features that define an object category because gesture exploits the visual modality. The visual modality is processed holistically in contrast to the verbal modality. The verbal modality is processed temporally and must be maintained in working memory longer. In this case, iconic gestures may free processing resources for storage of information. With repeated or enriched exposure, processing resources may be used to integrate new information with the existing representation. Indeed, Wu and Coulson (2007) showed that when iconic gestures are paired with spoken language, neural activation increases for semantic processing and word integration.

Clinical and Research Implications

There are three implications for the language clinician and researcher. First, like typically developing children, children with language impairments show weak semantic knowledge of items they fail to name (e.g., McGregor, Newman, et al., 2002). Therefore, one aspect of intervention and research should continue to be a focus on semantic factors that can effect change on naming behavior (e.g., McGregor et al., 2007). Second, the language clinician and the researcher can broaden how they tap word learning in children to include word extension over time. For example, once the child shows that she or he has learned taught words in the clinical setting, the clinician could collect untrained exemplars of those words and probe the child's naming of them. The clinician could also provide parents with a checklist of the words their child learned. A parent could then inventory whether the child was using those words outside of the treatment session. Naming taught words in their own environment would indicate extension of the taught word. This kind of learning measure speaks not only to the effectiveness of intervention but also to the efficiency of an intervention. It is efficient because training does not have to target every word–referent pairing, just a subset of referents. This kind of measure will also speak to more functional aspects of word learning and use.

The third implication relates to future work with late-talking children. Increasing the object vocabulary is a valid intervention goal for late talkers. Rescorla, Mirak, and Singh (2000) found that even though late-talking children had smaller vocabularies than is typical, those with larger versus smaller vocabularies made greater gains in vocabulary and grammar development over time. Jones (2003) showed that late-talking toddlers do not show a shape bias in making categorical decisions about objects. The use of shape (and function) cues in word learning interventions may prove to be useful in semantic enrichment. Empirical questions remain about children's ability to extend words when they have language impairment and how semantic enrichment might effect change there.

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References

Acredolo, L., & Goodwyn, S. (1996). *Baby signs: How to talk to your baby before your baby can talk*. Chicago, IL: NTB/Contemporary.

Alibali, M. W., & Goldin-Meadow, S. (1993). Gesture–speech mismatch and mechanisms of learning: What the hands reveal about a child's state of mind. *Cognitive Psychology, 25,* 468–523.

Barsalou, L. W., Kyle Simmons, W., Barbey, A. K., & Wilson, C. D. (2003). Grounding conceptual knowledge in modality-specific systems. *Trends in Cognitive Sciences, 7,* 84–91.

Bates, E., Benigni, L., Bretherton, I., Camaioni, L., & Volterra, V. (1979). Cognition and communication from nine to thirteen months: Correlational findings. In E. Bates (Ed.), *The emergence of symbols: Cognition and communication in infancy* (pp. 69–140). New York, NY: Academic Press.

Beck, I., & McKeown, M. (1991). Conditions of vocabulary acquisition. In R. Barr, M. L. Mamil, P. Mosentahal, & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. 2, pp. 789–814). New York, NY: Longman.

Bello, A., Capirci, O., & Volterra, V. (2004). Lexical production in children with Williams syndrome: Spontaneous use of gesture in a naming task. *Neuropsychologica, 42,* 201–213.

Bjorklund, D. F., & Schneider, W. (1996). The interaction of knowledge, aptitude and strategies in children's memory performance. *Advances in Child Development and Behavior, 26,* 59–89.

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

Booth, A. E., McGregor, K. K., & Rohlfing, K. J. (2008). Socio-pragmatics and attention: Contributions to gesturally guided word learning in toddlers. *Language, Learning and Development, 4,* 179–202.

Bowerman, M. (1976). Semantic factors in the acquisition of rules for word use and sentence construction. In D. M. Morehead & A. E. Morehead (Eds.), *Normal and deficient child language* (pp. 99–179). Baltimore, MD: University Park Press.

Capone, N. C. (2007). Tapping toddlers' evolving semantic representation via gesture. *Journal of Speech, Language, and Hearing Research, 50,* 732–745.

Capone, N. C., & McGregor, K. K. (2005). The effect of semantic representation on toddlers' word retrieval. *Journal of Speech, Language, and Hearing Research, 48,* 1468–1480.

Carey, S. (1978). The child as word learner. In M. Halle, J. Bresnan, & C. A. Miller (Eds.), *Linguistic theory and psychological reality* (pp. 264–293). Cambridge, MA: MIT Press.

Church, R. B., & Goldin-Meadow, S. (1986). The mismatch between gesture and speech as an index of transitional knowledge. *Cognition, 23,* 43–71.

Clark, E. (1973). What's in a word? On the child's acquisition of semantics in his first language. In T. E. Moore (Ed.), *Cognitive development and the acquisition of language* (pp. 65–110). New York, NY: Academic Press.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Dell, G. S. (1990). Effects of frequency and vocabulary type on phonological speech errors. *Language and Cognitive Processes, 5,* 313–349.

Dollaghan, C. A. (1985). Child meets word: "Fast mapping" in preschool children. *Journal of Speech and Hearing Research, 28,* 449–454.

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., . . . Reilly, J. S. (1993). *MacArthur Communicative Development Inventories*. San Diego, CA: Singular.

Gentner, D. (1978). What looks like a jiggy but acts like a zimbo? A study of early word meaning using artificial objects. *Papers and Reports on Child Language Development, 15,* 1–6.

Gentner, D., & Namy, L. L. (1999). Comparison in the development of categories. *Cognitive Development, 14,* 487–513.

Gershkoff-Stowe, L. (2001). The course of children's naming errors in early word learning. *Journal of Cognition and Development, 2,* 131–155.

Gershkoff-Stowe, L. (2002). Object naming, vocabulary growth, and the development of word retrieval abilities. *Journal of Memory and Language, 46,* 665–687.

Gershkoff-Stowe, L., Connell, B., & Smith, L. (2006). Priming overgeneralizations in two- and four-year old children. *Journal of Child Language, 33,* 461–486.

Gershkoff-Stowe, L., & Smith, L. B. (1997). A curvilinear trend in naming errors as a function of early vocabulary growth. *Cognitive Psychology, 34,* 37–71.

Gershkoff-Stowe, L., & Smith, L. B. (2004). Shape and the first hundred nouns. *Child Development, 75,* 1098–1174.

Goldin-Meadow, S., Nusbaum, H., Kelly, S. D., & Wagner, S. (2001). Explaining math: Gesturing lightens the load. *Psychological Science, 12,* 516–522.

Goodwyn, S. W., & Acredolo, L. P. (1993). Symbolic gesture versus word: Is there a modality advantage for onset of symbol use? *Child Development, 64,* 688–701.

Hollich, G. J., Hirsh-Pasek, K., Golinkoff, R. M., Brand, R. M., Brown, E., Chung, H. L., . . . Rocroi, C. (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.*

Horst, J. S., McMurray, B., & Samuelson, L. K. (2006). Online processing is essential for learning: Understanding fast mapping and word learning in a dynamic connectionist architecture. In R. Sun (Ed.), *Proceedings of the Twenty-Eighth Annual Conference of the Cognitive Science Society* (pp. 339–344). Mahwah, NJ: Erlbaum.

Horst, J. S., & Samuelson, L. K. (2008). Fast mapping but poor retention by 24-month-old infants. *Infancy, 13,* 128–157.

Imai, M., Gentner, D., & Uchida, N. (1994). Children's theories of word meaning: The role of shape similarity in early acquisition. *Cognitive Development, 9,* 45–75.

Jones, S. S. (2003). Late talkers show no shape bias in a novel name extension task. *Developmental Science, 6,* 477–483.

Jones, S. S., & Smith, L. B. (1993). The place of perception in children's concepts. *Cognitive Development, 8,* 113–139.

Jones, S. S., Smith, L. B., & Landau, B. (1991). Object properties and knowledge in early lexical learning. *Child Development, 62,* 499–516.

Keil, F. C. (1989). *Concepts, kinds, and cognitive development*. Cambridge, MA: MIT Press.

Kemler Nelson, D. G. (1999). Attention to functional properties in toddlers' naming and problem solving. *Cognitive Development, 14,* 77–100.

Kemler Nelson, D. G., Frankenfield, A., Morris, C., & Blair, E. (2000). Young children's use of functional information to categorize artifacts: Three factors that matter. *Cognition, 77,* 133–168.

Landau, B., Smith, L. B., & Jones, S. S. (1988). The importance of shape in early lexical learning. *Cognitive Development, 3,* 299–321.

Landau, B., Smith, L. B., & Jones, S. S. (1998). Object shape, object function, and object name. *Journal of Memory and Language, 38,* 1–27.

Levelt, W. J. M. (1992). Accessing words in speech production: Stages, processes and representations. *Cognition, 42,* 1–22.

McGregor, K. K. (1997). The nature of word-finding errors of preschoolers with and without word-finding deficits. *Journal of Speech, Language, and Hearing Research, 40,* 1232–1244.

McGregor, K. K., & Capone, N. C. (2004). Genetic and environmental interactions in determining the early lexicon: Evidence from a set of tri-zygotic quadruplets. *Journal of Child Language, 31,* 311–337.

McGregor, K. K., Friedman, R. M., Reilly, R. M., & Newman, R. M. (2002). Semantic representation and naming in young children. *Journal of Speech, Language, and Hearing Research, 45,* 332–346.

McGregor, K. K., Newman, R. M., Reilly, R. M., & Capone, N. C. (2002). Semantic representation and naming in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 45,* 998–1014.

McGregor, K. K., Sheng, L., & Ball, T. (2007). Complexities of expressive word learning over time. *Language, Speech, and Hearing Services in Schools, 38,* 353–364.

Namy, L. L., & Gentner, D. (2002). Making a silk purse out of two sow's ears: Young children's use of comparison in category learning. *Journal of Experimental Psychology: General, 131,* 5–15.

Piaget, J. (1952). *The origins of intelligence in children*. New York, NY: Norton.

Plunkett, K., Sinha, C. G., Moller, M. F., & Strandsby, O. (1992). Symbol grounding or the emergence of symbols? Vocabulary growth in children and a connectionist net. *Connection Science, 4,* 293–312.

Rescorla, L., Mirak, J., & Singh, L. (2000). Vocabulary growth in late talkers: Lexical development from 2;0 to 3;0. *Journal of Child Language, 27,* 293–311.

Rosch, E. (1973). On the internal structure of perceptual and semantic categories. In T. E. Moore (Ed.), *Cognitive development and the acquisition of language* (pp. 111–144). San Diego, CA: Academic Press.

Samuelson, L., & Smith, L. B. (1999). Early noun vocabularies: Do ontology, category structure, and syntax correspond? *Cognition, 71,* 1–33.

Schwartz, R., & Terrell, B. (1983). The role of input frequency in lexical acquisition. *Journal of Child Language, 10,* 57–66.

Siegel, S., & John Castellan, N. (1988). *Nonparametric statistics for the behavioral sciences*. New York, NY: McGraw-Hill.

Smith, L. B., Jones, S. S., Landau, B., Gershkoff-Stowe, L., & Samuelson, L. (2002). Object name learning provides on-the-job training for attention. *Psychological Science, 13,* 13–19.

Storkel, H. (2001). Learning new words: Phonotactic probability in language development. *Journal of Speech, Language, and Hearing Research, 44,* 1321–1337.

Tomasello, M., Carpenter, M., & Liszkowski, U. (2007). A new look at infant pointing. *Child Development, 78,* 705–722.
Wilkinson, K. M., & McIlvane, W. J. (2001). Methods for studying symbolic behavior and category formation: Contributions of stimulus. *Developmental Review, 21,* 355–374.
Williams, K. (1997). *Expressive Vocabulary Test*. Circle Pines, MN: AGS.
Woodward, A. L. (2004). Infants' use of action knowledge to get a grasp on words. In D. G. Hall & S. R. Waxman (Eds.), *Weaving a lexicon* (pp. 149–172). Cambridge, MA: MIT Press.
Wu, Y. C., & Coulson, S. (2007). How iconic gestures enhance communication: An ERP study. *Brain and Language, 101,* 234–245.
Zammit, M., & Schafer, G. (2010). Maternal label and gesture use affects acquisition of specific object names. *Journal of Child Language,* 1–21.