



Brief article

# Consistent (but not variable) names as invitations to form object categories: new evidence from 12-month-old infants

Sandra R. Waxman\*, Irena Braun

*Department of Psychology, Northwestern University, 2029 Sheridan Road, Evanston, IL 60208-2710, USA*

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## Abstract

Recent research documents that for infants just beginning to produce words on their own, novel words highlight commonalities among named objects and, in this way, serve as invitations to form categories. The current experiment identifies more precisely the source of this invitation. We asked whether applying a consistent name to a set of distinct objects is crucial to categorization, or whether variable names might serve the same conceptual function. The evidence suggests that for 12-month-old infants, consistency in naming is critical. Infants hearing a single consistent novel noun for a set of distinct objects successfully formed object categories. Infants hearing different novel nouns for the same set of objects did not. These results lend strength and greater precision to the argument that naming has powerful and rather nuanced conceptual consequences for infants as well as for mature speakers.

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Recent developmental research has offered a window through which to view the origin and evolution of a relation between language and conceptual organization. Considerable attention has been devoted to examining whether and how naming influences infants' and young children's representations of individual objects and object categories. One of the most robust findings in this active research area is that object naming facilitates

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\* Corresponding author. Fax: +1 847 491 7859.

*E-mail address:* [s-waxman@northwestern.edu](mailto:s-waxman@northwestern.edu) (S.R. Waxman).

the formation of stable object categories (Balaban & Waxman, 1997; Fulkerson & Haaf, 1998; Waxman & Booth, 2003; Welder & Graham, 2001).

This phenomenon was first revealed in a novelty-preference task examining the influence of novel words on 12- to 13-month-old infants' object categorization (Waxman & Markow, 1995). The task involved two phases. During the *familiarization phase*, an experimenter offered the infant four different toys from a given category (e.g. four animals), one at a time, in random order. For infants in the experimental conditions, she introduced these objects using a novel name (e.g. "See the X?").<sup>1</sup> For those in the control condition, she offered no novel word (e.g. "See here?"). During the *test phase*, she simultaneously presented both (a) a new member of the now-familiar category (e.g. another animal) and (b) an object from a novel category (e.g. a fruit). Infants in all conditions heard precisely the same phrase ("See what I have?").

The predictions were straightforward. If infants notice the category-based commonalities among the familiarization objects, they should prefer the novel object at test. If naming highlights the commonalities among the familiarization objects and, in this way, supports the formation of object categories, infants hearing novel words during familiarization should reveal stronger novelty-preferences at test than those in the control condition. As predicted, infants hearing novel words revealed reliable novelty-preferences at test. Those in the control condition did not, suggesting that in the absence of naming, infants fail to form categories in this task. More recent work has revealed that naming does more than 'simply' highlight concepts that infants may already represent; it also supports the discovery of entirely novel concepts, comprised of entirely novel objects (Booth & Waxman, 2002; Fulkerson & Haaf, 2003; Gopnik, Sobel, Schulz, & Glymour, 2001; Maratsos, 2001; Nazzi & Gopnik, 2001).

We next considered whether infants' successful categorization stemmed specifically from the presentation of words. We therefore compared the influence of novel words vs. tone sequences on infants' categorization (Balaban & Waxman, 1997). For infants in the *Word* condition, a naming phrase accompanied the familiarization trials (as in Waxman & Markow, 1995). For infants in the *Tone* condition, a sine-wave tone (matched to the naming phrase in amplitude, duration, and pause length) accompanied the familiarization trials. Infants in the *Word* condition again revealed novelty-preferences; those in the *Tone* condition did not. This suggests that there is indeed something 'special' about words, since their facilitative effect cannot be accounted for by an appeal to the attention-engaging function of auditory stimulation more generally (also see Fulkerson & Haaf, 1998; Roberts & Jacob, 1992).

These results offered clear evidence for a link between naming and conceptual organization in infants at the onset of lexical acquisition. They also underscore its conceptual force. Although the novel words were presented only during familiarization, their influence extended beyond the named objects, influencing infants' attention to

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<sup>1</sup> In the original experiments, Waxman and Markow (1995) examined the influence of two different kinds of novel words: count nouns (e.g. "See the *blicket*?") and adjectives ("See the *blick-ish one*?"). Infants at 12- to 13-months of age treated novel nouns and adjectives identically. Infants in both the *Novel Noun* and *Novel Adjective* conditions revealed reliable novelty-preferences at test. In the current experiment, we focus specifically on novel nouns.

the new—and as yet unnamed—objects presented at test. Naming also appears to advance infants beyond the commonalities that they can observe, and to point them toward the deeper, perhaps hidden commonalities that characterize some of our most fundamental concepts (see Booth & Waxman, 2002; Diesendruck, 2003; Gelman & Kalish, *in press*; Graham, Kilbreath, & Welder, 2004; Nazzi & Gopnik, 2001; Waxman & Lidz, *in press*; Welder & Graham, 2001). We therefore argued that words serve as invitations to form categories (Brown, 1958; Macnamara, 1982).

But what is the source of this invitation? We have suggested that applying the *same* name to a set of distinct objects is critical, that this shared name invites infants to search for coherence among the distinct individuals and, in this way, promotes the discovery of object categories. However, it is also possible that the invitation is more open-ended. Perhaps providing any name (indeed, any number of names) during familiarization could have this facilitative effect. Interestingly, a review of recent literature on naming reveals evidence compatible with each of these alternatives.

On the one hand, we know that 10-month-olds devote greater visual attention to objects that have been named than to those presented in silence (Balaban & Waxman, 1997; Baldwin & Markman, 1989). If this heightened level of attention to named objects is sufficient to support the discovery of the commonalities among them, then infants should categorize successfully whether the familiarization objects are given the *same* or *different* names.

On the other hand, there is reason to suspect that applying the same name is crucial. This suspicion comes from evidence regarding the role of naming in object individuation. Object individuation, or the ability to track the identity of distinct individuals over time and place, is a fundamental conceptual and logical capacity. Under certain circumstances, infants have difficulty tracking the identity of two distinct objects (e.g. a ball and a duck) (Wilcox & Baillargeon, 1998; Xu & Carey, 1996). This was demonstrated in experiments in which infants, seated before a stage with a small screen, watched as one object (a ball) emerged from one side of the screen and then returned. Next, a different object (a duck) emerged from the other side of the screen and returned. After several repetitions of such appearances and disappearances, the screen was lowered to reveal either one or two objects. If infants successfully traced the identity of the two objects, they should look longer on test trials revealing one object (the unexpected outcome) than on those revealing two (the expected outcome). Although 12-month-olds succeeded, 10-month-olds had difficulty in this rather complex task. Next, Xu considered the effect of naming each object as it appeared. Infants who heard the *same* name for both objects (e.g. “It’s a toy”) continued to have difficulty. In contrast, infants who heard *different* names for each object (e.g. “It’s a ball; it’s a duck”) now succeeded (Xu, 1999). Apparently, these distinct names highlighted the uniqueness of each individual (rather than their commonalities) and supported infants’ ability to trace their identity. Considered from this perspective, providing the *same* name for a set of different objects should support the formation of object categories, but providing *different* names should not.

In the current experiment, we test these alternatives by comparing the consequence of applying either the *same* or *different* novel names on 12-month-old infants’ categorization. We focus on superordinate level categories (e.g. animal) because the facilitative effect of naming has been most apparent here in 12-month-olds. (At the basic level (e.g. horse),

12-month-olds perform at ceiling even in the No Word control condition; Waxman & Markow, 1995.) In the *Consistent Noun* condition, infants heard the same name applied to the familiarization objects in a given set. In the *Variable Noun* condition, infants heard different names applied to the various familiarization objects. In the *No Word* control condition, no novel words were offered.

We expected that infants in the *Consistent Noun* condition would reveal reliable novelty-preferences at test, but that those in the *No Word* condition would not. This would replicate previous findings. At issue is performance in the *Variable Noun* condition. If consistency in naming is crucial to the invitation to form categories, then infants in the *Variable Noun* condition, like those in the *No Word* condition, should fail to form categories. In contrast, if any name (or any number of names) heightens attention sufficiently to support the discovery of object categories, then infants in the *Variable Noun* condition, like those in the *Consistent Noun* condition, should reveal novelty-preferences.

## 1. Method

### 1.1. Participants

Fifty-four infants (27 female) with a mean age of 12.65 months (ranging from 12.01 to 13.26 months) were recruited from middle-class families in the greater Chicago area. All were acquiring English as a native language. Infants who completed at least three of the four sets (described below) were included in the final sample. Seven additional infants were excluded, six for failing to reach this criterion (2 per condition) and one for experimenter error.

### 1.2. Materials

Forty commercially manufactured toys, ranging from  $3 \times 3 \times 4$  to  $16 \times 7 \times 8$  cm, were selected to form four different sets of 10 objects each. (See Fig. 1 for an example and Appendix for a complete list.) Within each set, the familiarization objects varied in color and size, and the test objects were matched for color and size.

### 1.3. Procedure

Identical to Waxman and Markow (1995). Infants were tested individually in a laboratory playroom. They sat in an infant seat, directly across from the experimenter. The parent, seated to the infant's side,<sup>2</sup> was instructed not to talk or to influence in any way their infant's interest. Sessions lasted approximately 10 min and were videotaped for later coding. The procedure included a familiarization and test phase. Each infant was presented with all four different sets.

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<sup>2</sup> In some instances, infants preferred to sit in their parent's lap.







	Familiarization Phase				Test Phase
	Trial 1	Trial 2	Trial 3	Trial 4	
					 
Consistent Label:	Look! It's a keeto!	Look! It's a keeto!	Look! See what I have!	Look! It's a keeto!	Look! See what I have!
	After 10 sec: Yes, it's a keeto!	After 10 sec: Yes, it's a keeto!	After 10 sec: Do you like that?	After 10 sec: Yes, it's a keeto!	
Varied Label:	Look! It's a keeto!	Look! It's a bookoo!	Look! See what I have!	Look! It's a dimbee!	Look! See what I have!
	After 10 sec: Yes, it's a keeto!	After 10 sec: Yes, it's a bookoo!	After 10 sec: Do you like that?	After 10 sec: Yes, it's a dimbee!	
No Word:	Look! Look here!	Look! Look here!	Look! See what I have!	Look! Look here!	Look! See what I have!
	After 10 sec: Do you like that?	After 10 sec: Do you like that?	After 10 sec: Do you like that?	After 10 sec: Do you like that?	

Fig. 1. A representative sample of the objects and instructions in each condition.

### 1.3.1. Familiarization phase

The experimenter offered the infant the familiarization objects from a given set (e.g. four different animals) one at a time, in random order, for 30 s each. For each set, half of the infants in each condition were familiarized to objects from one category (e.g. animals); the other half were familiarized to objects from the other (e.g. tools). This ensured that each test object was novel for half the infants and familiar for those remaining.

In all conditions, the experimenter used infant-directed speech. This speech register effectively arouses and sustains infants' attention; it also facilitates infants' ability to parse words and phrases (Fernald & McRoberts, 1996; Gerken, 1996; Gleitman, 1990).

Infants were randomly assigned to one of three conditions (Fig. 1). To secure the infant's attention, the experimenter began each familiarization trial by calling the infant's name, while holding an object directly in front of the infant, but just beyond reach. In the *No Word* (control) condition, the experimenter drew attention to each object but offered no label, saying, e.g. "Look! Look here!" In the *Consistent Noun* condition, she said, "Look! It's a(n) X!", using the same nonce noun throughout the familiarization trial for a given set. In the *Variable Noun* condition, she said, "It's a(n) X!", presenting a different nonce noun for each named object within a given set. After approximately 10 s, the experimenter indicated the object again, using one of the following phrases: "Do you like that?" (*No Word* condition); "Yes, it's a(n) X" (*Consistent* and *Variable Noun* conditions). These instructions were offered on familiarization trials 1, 2, and 4. On familiarization trial 3, all infants heard, "Look! See what I have?" This phrase was also presented later at test (see below), thus insuring that the test phrase was not novel for infants in any condition.

### 1.3.2. Test phase

Infants in all conditions were treated identically. Following the familiarization trials, two test objects were presented simultaneously: (a) a new member of the now-familiar category (e.g. another animal) and (b) an object from a novel category (e.g. a tool). The experimenter held these in front of the infant, but slightly beyond the infant's reach, saying "See what I have?" The test objects were then placed within the infant's reach, separated by approximately 36 cm. Left–right placement was randomized across sets. After 45 s, the objects were removed. Infants manipulated the objects freely throughout the procedure. If an infant pushed a toy out of reach, the experimenter placed it back within reach as quickly as possible.

### 1.3.3. Language measure

Parents completed the MacArthur Communicative Development Inventory: Infant (MCDI) (Fenson et al., 1991). Infants' production ( $M=13$  words; range 0–176) and comprehension ( $M=87$  words; range 4–385) were significantly correlated ( $r(54)=.63$ ;  $p < .001$ ).<sup>3</sup>

### 1.3.4. Coding

The videotaped sessions were coded with sound removed so that coders remained blind to the experimental hypotheses and to condition assignment. For each infant, we conducted a frame-by-frame analysis of their behavior to derive their total amount of attention devoted to each object. On each frame, coders judged whether the infant was (or was not) attending to the object. We included attention in either the visual (looking) or haptic (fingering, banging, mouthing) modality. This inclusive measure correlates highly with looking-time (Ruff, 1986; Waxman & Markow, 1995), but is sensitive to a broader range of infants' exploratory behavior. Each infant was coded thoroughly by two different, independent coders. Consistency between the two coders, computed for each set and then averaged over sets and participants, was 99%.

## 2. Results

We computed a novelty-preference score for each infant on each set, dividing the total accumulated attention devoted to the novel test object by the attention devoted to both the novel and familiar test objects. As predicted, infants in the *Consistent Noun* condition ( $M=.64$ ;  $SD=.12$ ) revealed a reliable novelty-preference,  $t(17)=4.89$ ,  $p=.0001$  and those in the *No Word* condition ( $M=.57$ ;  $SD=.18$ ) performed at chance. Infants in the *Variable Noun* condition ( $M=.56$ ;  $SD=.20$ ) also performed at chance.

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<sup>3</sup> Although we scheduled only infants whose parents reported (via telephone interview) that their infant produced more than two words, a more thorough examination using the MCDI that parents completed during their laboratory visit revealed that some infants in our sample actually produced fewer (*Consistent Noun* ( $n=2$ ), *Variable Noun* ( $n=3$ ), *No Word* ( $n=1$ )). Removing these infants from the analyses did not change the results. At the other end of the spectrum, there was one infant whose parent reported exceptionally high production (176) and comprehension (385). Removing this infant from the analyses did not change any results.

Table 1  
Number of infants in each condition revealing a mean novelty-preference score (averaged across the four sets) of  $>.50$  or  $<.50$

Condition	Mean novelty-preference score	
	$>.50$	$<.50$
Consistent label <sup>a</sup>	16	1
Variable label	12	6
No Word	10	8

<sup>a</sup> One infant displayed a mean novelty-preference score of exactly  $.50$  and is therefore excluded from this analysis.

We then conducted two planned contrasts to evaluate more precisely the competing alternatives raised in the introduction. The first contrast tested the hypothesis that novelty-preferences in the *Consistent Noun* condition would exceed those in the *Variable Noun* and *No Word* conditions (combined). This comparison was significant,  $t(48) = 1.74$ ,  $p < .05$ , supporting the view that for 12-month-olds, consistent naming is a crucial component in the invitation to form categories.<sup>4</sup> The second contrast tested the alternative hypothesis that performance in the *Consistent Noun* and *Variable Noun* conditions (combined) would exceed those in the *No Word* control. This comparison failed to reach significance, suggesting that variable names fail to support the formation of inclusive categories.

An analysis of individual infants' performance bolsters this interpretation. For each infant, we calculated a mean novelty-preference score (averaged across the four sets). Table 1 presents the number of infants in each condition with novelty-preference scores above or below  $.50$ . This number varied significantly as a function of condition,  $\chi^2(2) = 6.75$ ,  $p = .03$ . The distribution of scores in the *Varied Label* condition differed from that in the *Consistent Label* condition,  $\chi^2(1) = 4.12$ ,  $p = .04$ , but did not differ from the *No Word* control.<sup>5</sup> Thus, the results of the main parametric analysis reflect tendencies that are characteristic of most individuals.

### 3. General Discussion

Naming has powerful conceptual consequences. Previous work has demonstrated that for infants as young as 9–12 months of age, words serve as invitations to form categories: Applying the same name to a set of distinct objects (e.g. a duck, raccoon, and dog) highlights the commonalities among them and supports the formation of an inclusive category (e.g. animal). The current goal was to identify the source of this invitation. Is it crucial that the same name be applied to the various individuals? Or can any name (indeed, any number of names) exert this facilitative effect? The evidence favors the first alternative. In a strong replication of previous work, infants in the *Consistent Noun*

<sup>4</sup> Because the variance in the *Consistent Noun* condition was half that in the other two conditions, we based these analyses on an assumption of unequal variance.

<sup>5</sup> This pattern also holds up under the Likelihood Ratio test, which takes small expected frequencies into account (Hays, 1973).

condition successfully formed object categories. In contrast, infants in the *Variable Noun* condition, like those in a *No Word* control, provided no evidence of categorization.

This suggests that for 12-month-olds, consistent (but not variable) names support categorization. Whether this holds true in younger infants remains an open question (Waxman and Braun, in preparation). It is possible that for younger infants, either variable or consistent names serve as invitations to form object categories, but that by 12 months, infants' experience in word-learning prompts them to restrict the invitation to consistent names. Whatever the developmental antecedents, the current evidence brings us closer to understanding the source of the naming effects at 12 months, and provides a liaison between research investigating the role of naming in object categorization and individuation.

These results reveal that naming has a powerful and rather nuanced effect on infants' representations of objects at the close of their first year. Naming distinct objects with **distinct** names highlights the uniqueness of each and supports the process of object individuation (Xu, 1999), but does not highlight commonalities among the (differently) named objects and does not support the formation of an inclusive object category. In contrast, naming distinct objects with the **same** name highlights the commonalities among them and supports categorization (Booth & Waxman, 2003; Fulkerson & Haaf, 1998; Welder & Graham, 2001), but does not support object individuation. In the process of word learning, then, infants learn more than 'names for things'. For infants just beginning to build a vocabulary and for mature speakers alike, word-learning engages some of our most elemental concepts—concepts including 'individual' and 'category'. Consistent (but not variable) names support the establishment of a stable repertoire of object categories.

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## Appendix

### Complete list of stimuli

Set	Familiarization phase <sup>a</sup>			Test Phase	
1A: ANIMAL					
duck	lion	raccoon	dog	cat	screwdriver
B: TOOL					
pliers	saw	hammer	wrench		

(continued on next page)



## Appendix (continued)

Set	Familiarization phase <sup>a</sup>				Test Phase	
2A: VEHICLE						
truck	convertible	airplane	car		leopard	airplane
B: ANIMAL						
panda	horse	hippopotamus	bobcat			
3A: PRODUCE						
celery	carrot	asparagus	tomato		pineapple	dog
B: ANIMAL						
giraffe	elephant	camel	bear			
4A: TOOL						
hammer	ratchet	screwdriver	pliers		wrench	van
B: VEHICLE						
airplane	bulldozer	train	boat			

<sup>a</sup>For each set, half of the infants in each condition were familiarized to the objects in A, and half were familiarized to the objects in B. All infants saw the same test objects.

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