

Research Article

Labeling Guides Object Individuation in 12-Month-Old Infants

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ABSTRACT—A new manual search method was used to investigate the impact of naming on object individuation in 12-month-old infants. In Experiment 1, on a two-word trial, an experimenter looked into a box while the infant was watching and provided two labels (e.g., “Look, a fep!” and “Look, a wug!”). On a one-word trial, the experimenter instead repeated the same label (e.g., “Look, a zav!”). After the infant retrieved one object from the box, subsequent search behavior was recorded. Infants searched more persistently (i.e., for a longer duration) after hearing two labels than one, suggesting that hearing two labels led the infants to expect two objects inside the box. In Experiment 2, infants’ search behavior did not differ depending on whether they heard one or two emotional expressions, suggesting that the facilitation effect observed in Experiment 1 may be specific to linguistic expressions. Thus, we provide the first evidence that infants as young as 12 months are able to use intentional and referential cues to guide their object representations. These findings also suggest that a rudimentary version of the mutual-exclusivity constraint may be functional by the end of the first year.

What is the relationship between early language development and conceptual development? Several studies have shown that acquiring words for object categories exerts influence on various aspects of conceptual development in infants. When 9-month-olds are shown a series of pictures of animals, their categorization behavior is facilitated if they hear a common label for the animals; by 13 months, infants who are given a set of objects to manipulate and are provided with a common label

for the objects begin to categorize them on the basis of shape, color, or texture information (Balaban & Waxman, 1997; Waxman, 1999). In an inductive inference task, 13-month-olds use the presence of shared labels to help them decide whether two objects have the same nonobvious property, for example, making a sound when shaken (Graham, Kilbreath, & Welder, 2004; Welder & Graham, 2001). Last, when 9-month-old infants are shown two objects emerging from behind an occluder, one at a time, hearing contrastive labels for the two objects (e.g., “Look, a duck!” vs. “Look, a ball!”) facilitates the infants’ individuation of the objects (Xu, 2002, in press).

In the present study, we asked how powerful words are in guiding object individuation. Most infants begin to comprehend and produce some single words by the end of the first year. We investigated whether infants can use labeling to establish object representations even when objects are never shown to them. Many word-learning studies with young children have shown that they pay close attention to the intentional act of referring and that factors such as joint attention and speaker’s gaze play a critical role in how children decide which object is the referent of a new word (e.g., Baldwin, 1991, 1993; Bloom, 2000; Tomasello, Strosberg, & Akhtar, 1996; Woodward, Markman, & Fitzsimmons, 1994). In the present study, we provided these important intentional and referential cues to see if 12-month-old infants can use them to establish object representations based on labeling information. We sought to investigate the interaction between the use of intentional information in word learning and object individuation.

In Experiment 1, infants watched while the experimenter looked into the opening of a box and provided either two distinct labels three times each (e.g., “Look, a wug!” and “Look, a fep!”) or a single label (e.g., “Look, a zav!”) six times. The question was whether the infants would use the number of labels to determine how many objects were inside the box even when its content was invisible to them. In Experiment 2, infants watched the same events but instead heard two distinct emotional

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expressions (e.g., “Aah!” and “Eew!”) or a single emotional expression (e.g., “Wow!”). The question was whether these expressions would have the same effect as words did in Experiment 1. For adults, only words are symbols that stand in for categories or individual objects, whereas emotional expressions allow for the expression of attitudes (e.g., likes and dislikes) toward objects. Twelve-month-old infants have been shown to be sensitive to the emotional valence of these expressions (Moses, Baldwin, Rosicky, & Tidball, 2001).

EXPERIMENT 1

Method

Participants

Sixteen full-term 12-month-old infants participated in this study (mean age = 11 months 28 days, range = 11 months 10 days to 12 months 12 days; 9 boys and 7 girls). Two additional infants were excluded for fussiness and 2 for failing to reach into the box during the study. All infants were recruited from the greater Boston area. Parents were contacted by letters and follow-up telephone calls. Infants received a small gift (sippy cup, bib, or T-shirt) for their participation.

Materials and Apparatus

A box measuring 10 in. × 6 in. × 15 in. (width × height × length) was constructed out of foam core. The front and the back of the box each had an opening that measured 8 in. × 5 in. The front opening was covered with white spandex, which had a horizontal slit through the center. The content of the box was not visible to the infant when this cover was in place. The back of the box was covered with a black cloth flap.

All of the objects used were small and could be easily grasped by an infant. A plastic blue turtle was used during the familiarization phase. Four familiar objects (chosen out of 12: duck, dog, shoe, keys, bottle, book, car, banana, cup, ball, toy baby, and spoon) and 4 unfamiliar objects (blue-and-gray star, orange teether, yellow top, and pink kaleidoscope) were used on the test trials.

Each infant sat in front of a low table on a parent’s lap during the study. The experimenter sat on one side of the infant. One video camera recorded the infant’s responses from the side and was used for coding the infant’s search behavior. Another camera recorded the experimenter, the infant, and the parent.

Design and Procedure

The experiment consisted of one familiarization trial and eight test trials. The familiarization trial was included to get the infant acquainted with reaching into the box. During the familiarization trial, the experimenter looked into the box and said, “Look at that!” The experimenter then reached into the box, pulled out the blue turtle, and said, “Look at that!” She then placed the turtle back into the box, and the box was pushed forward toward

the infant. The infant was allowed to reach into the box (which he or she could not see into) and retrieve the object. If the infant did not retrieve the object, the experimenter verbally encouraged him or her to try. Once the infant retrieved the object, the box was pushed away. After the infant played with the turtle for 5 s, the object was taken away. The experimenter then shook the box and said, “It’s empty! There’s nothing in here.” The box was then removed from the table. The eight test trials followed.

Before the study started, parents were asked to fill out a language questionnaire that listed the 12 objects under consideration to be used as the familiar objects in the test phase. The parents were asked whether their infants comprehended any words for the objects and to rate their confidence in their children’s comprehension of those words using a scale from 1 to 5. They were also asked to indicate how often their children saw or played with each kind of object. The 4 objects that received the highest confidence ratings for comprehension were chosen as the familiar objects for the study. These objects were labeled with correct labels, and the 4 unfamiliar objects were labeled with nonsense words (*wug*, *bif*, *zav*, *fep*, *dak*, or *blick*).

Each infant received four pairs of test trials; each pair consisted of a one-word trial and a two-word trial. Two pairs used familiar objects, and two used unfamiliar objects. The order of familiar- and unfamiliar-object trial pairs, the labels used, and the object in the box were counterbalanced across infants.

On a *two-word trial*, the experimenter used her hands to open the spandex that covered the front of the box and looked in while the infant watched. The experimenter said each of the two words three times in infant-directed speech (e.g., “Look, a dog! I see a ball! A dog! A ball! I see a dog! Look, a ball”; Fig. 1). The experimenter looked at the infant after each utterance to make sure that the infant was focused on the experimenter and the box. The box was then pushed forward, and the infant was allowed to reach in. The box always contained just one object (e.g., a toy dog). Once the object was taken out of the box, the box was pulled away from the infant. The infant played with the object for 5 s while the experimenter said in a neutral tone, “Look at that! Look what you got. Can I see that?” The object was then taken away, and the box was pushed forward and stayed within reaching distance of the infant for 10 s. The infant’s search behavior during these 10 s was recorded. The box was then taken away to end the trial.

On a *one-word trial*, the procedure was identical to that of the two-word trial except that the experimenter uttered each object label six times (e.g., “Look, a car! I see a car! A car! A car! I see a car! Look, a car!”).

If the infants could use the number of labels to infer how many objects were inside the box, then they should have searched more persistently (as measured by duration of search) on two-word trials than on one-word trials after retrieving the first object. That is, if the infants had expected a second object inside the box (on two-word trials) but found the box empty (because the box always contained only one object), they should have

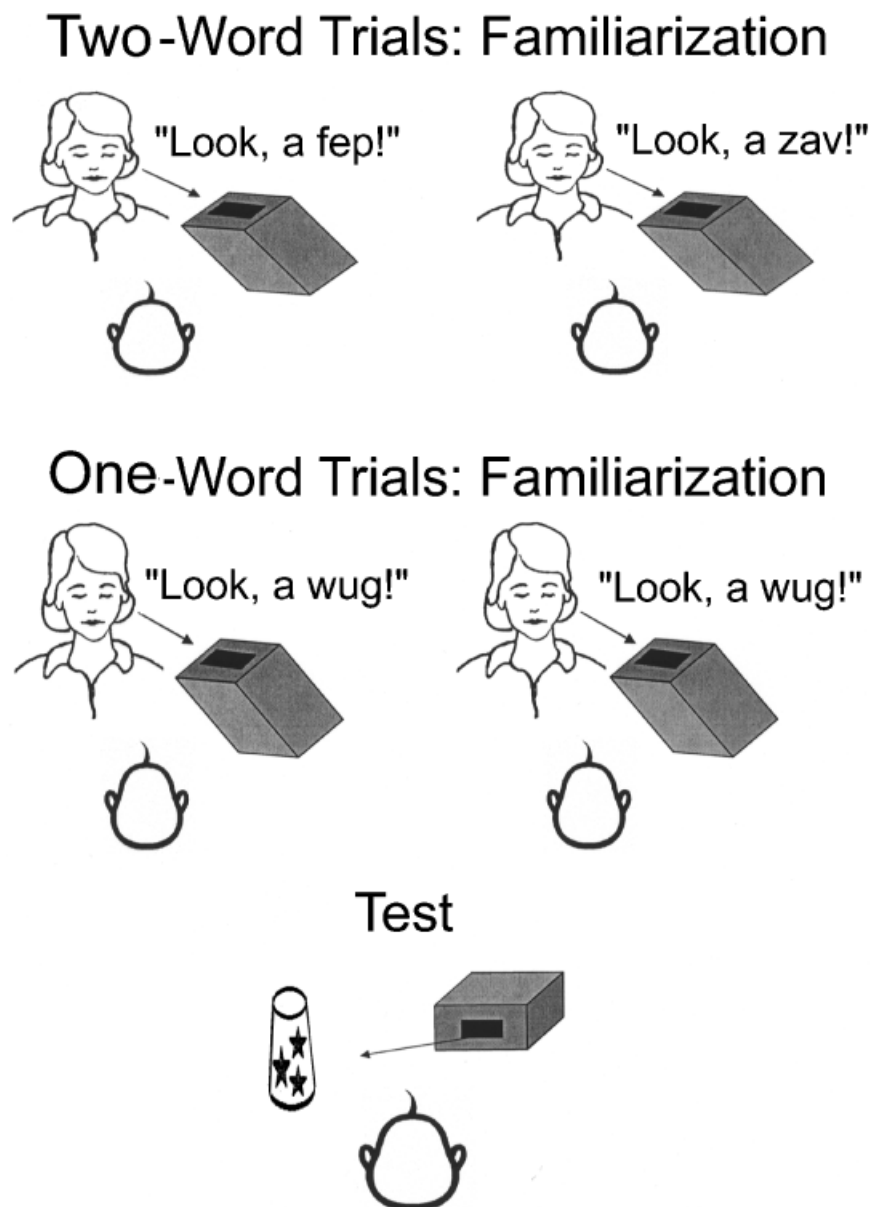


Fig. 1. Schematic representation of the two-word and one-word trials in Experiment 1.

searched persistently for the second object. In contrast, if the infants had expected only one object in the box (on one-word trials) and found the box empty, they should have searched cursorily (because there was nothing else to do) but given up quickly.

Data Analysis

Duration of search was coded from the videotape. The critical question was whether infants searched longer on the two-word trials than on the one-word trials after they had retrieved one object from the box and the box was empty. As in previous studies (Van de Walle, Carey, & Prevor, 2000; Xu & Baker, in press), an infant was considered to be searching inside the box when the third knuckles of the infant's hand were inside the

slit in the spandex that covered the front opening of the box. Observers were unaware of the order of test trials and of the trial types.

Results and Discussion

Infants searched more persistently in the empty box on the two-word trials ($M = 2.3$ s, $SD = 1.5$) than on the one-word trials ($M = 1.7$ s, $SD = 1.2$), $t(15) = 2.24$, $p < .05$, $d = 1.15$ (a rather large effect size; see Fig. 2). Performance did not differ between the familiar and unfamiliar objects, $F(1, 60) = 0.367$, $p = .54$. On a nonparametric test, 13 of the 16 infants searched longer on the two-word trials than on the one-word trials (Wilcoxon $p < .05$).

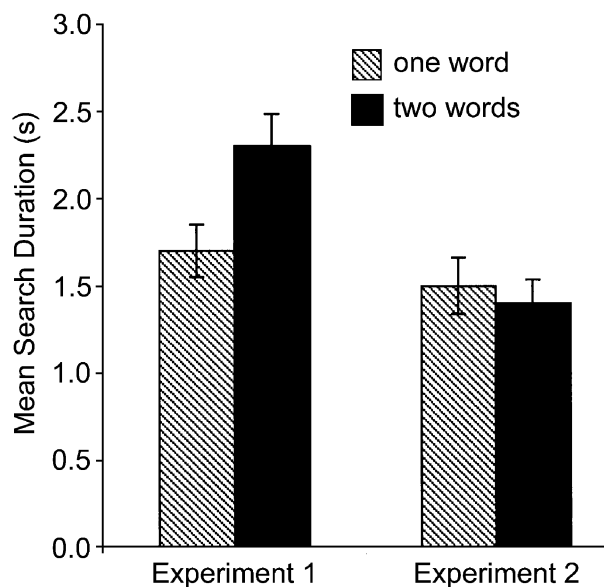


Fig. 2. Mean search times on one-word and two-word trials in Experiments 1 and 2.

Infants were able to use the number of labels used referentially to determine the number of objects that should have been inside the box. They searched 35% longer on the two-word trials than on the one-word trials when they found the box empty after they retrieved one object from inside the box. Their performance did not differ between known words (according to parental report) and novel words, suggesting that by 12 months, infants already have a general expectation that distinct words refer to distinct objects. To further explore whether these effects might be specific to linguistic expressions, in Experiment 2 we investigated whether emotional expressions, used in identical conditions, also help infants establish object representations.

EXPERIMENT 2

Method

Sixteen full-term 12-month-old infants participated in this study (mean age = 12 months 1 day, range = 11 months 14 days to 12 months 18 days; half boys and half girls). Two additional infants were excluded for fussiness and 3 for failing to reach.

The design and procedure were the same as in Experiment 1 except for the following. On the two-word trials, two emotional expressions, rather than two labels, were used (either “Aah!” and “Eew!” or “Wow!” and “Yuck!”—with positive and negative valence, respectively). The experimenter uttered the two emotional expressions three times each while looking into the box (e.g., “Aah!” “Eew!” “Aah!” “Eew!” “Aah!” “Eew!”). The expressions were exaggerated to convey the emotional valence, and the experimenter’s facial expressions matched the valence of the vocal expressions. On the one-word trials, one of the four emotional expressions was uttered a total of six times.

If infants can use the number of emotional expressions they hear to infer how many objects should be involved in an event, then they should have searched more persistently (as measured by duration of search) on the two-word trials than on the one-word trials after retrieving one object from inside the box.

Results and Discussion

Infants did not search more persistently on the two-word trials ($M = 1.4$ s, $SD = 1.1$) than on the one-word trials ($M = 1.5$ s, $SD = 1.3$) when they found the box empty after retrieving one object (see Fig. 2), $t(1, 15) = 0.325$, $p = .65$. On a nonparametric test, 5 of the 16 infants searched longer on the two-word trials than on the one-word trials (Wilcoxon $p > .1$). A chi-square test comparing Experiments 1 and 2 yielded a statistically reliable difference ($p < .005$, $\phi = 1.44$).

Although emotional expressions are, like words, intentional and allow people to express their attitudes toward objects or events, they did not help infants determine the number of objects inside the box. These results may be explained in terms of the different functions of words for object categories and emotional expressions. Although two people may have very different attitudes toward, say, broccoli and spiders—one might say “Aah!” upon seeing these objects, whereas the other might say “Eew!”—both people nevertheless use the words *broccoli* and *spider* to refer to these categories or instances of them. Similarly, a person’s attitude toward broccoli may be different in different situations—on one occasion, the person might say “Aah” toward broccoli and on another occasion the same person might say “Eew”—but the person would always use the word *broccoli* to refer to this vegetable. Thus, one important difference between words and emotional expressions may be that only words are symbols that are shared by a community of speakers (i.e., the principle of conventionality; Clark, 1983). Furthermore, distinct labels tend to refer to distinct object categories. The use of emotional expressions, in contrast, is much more idiosyncratic and changeable over time.

GENERAL DISCUSSION

Two experiments examined the effect of intentional and referential information in naming (e.g., speaker’s gaze and communicative intent) on how infants establish representations of distinct objects in an event. Twelve-month-old infants were able to use the number of labels to determine the number of objects inside a box whose content was invisible to them, both when the objects and words involved were familiar and when they were unfamiliar. This effect may be specific to linguistic expressions, as the number of emotional expressions used did not help infants establish the number of objects inside the box. Thus, we provide the first evidence that naming, when presented with abundant intentional and referential cues, can guide the

process of establishing distinct objects in an event for infants as young as 12 months.

Using the presence of two words to infer the presence of two objects requires at least some rudimentary version of the mutual-exclusivity assumption (Markman, 1989; Markman, Wasow, & Hansen, 2003). If the infants had thought that two words could refer to the same object, they would not have searched longer for a second object on the two-word trials than on the one-word trials in Experiment 1. Our findings suggest that the mutual-exclusivity assumption may be functional as early as 12 months. Furthermore, in Experiment 2, the number of emotional expressions did not help infants decide how many objects were inside the box, even though the contextual information was identical to that of Experiment 1. This was a surprising result because the pragmatics of the situation was the same in the two experiments. Diesendruck and Markson (2001) suggested that the mutual-exclusivity constraint is best construed as a pragmatic constraint, as opposed to a constraint that is specific to word learning. In a standard experiment testing for mutual exclusivity, children are presented with two objects—one for which they have a name, such as a cup, and one for which they do not have a name, such as a garlic press. They are then asked to give the experimenter, for example, “the zav.” The typical preschooler picks up the object for which he or she does not have a name (the garlic press). The pragmatic account says that the child’s behavior is explained by a Gricean principle (Grice, 1975): If the experimenter had wanted the cup, he or she would have asked for “the cup.” Because the experimenter asked for “the zav,” he or she must have meant the other object. Diesendruck and Markson strengthened their argument that mutual exclusivity is not specific to words by reporting a parallel finding involving two arbitrary facts.

Our findings provide indirect evidence against a purely pragmatic account of mutual exclusivity because under identical conditions, only two words, not two emotional expressions, led the infants to establish a representation of two objects inside the box. In Experiment 1, the infants did not see either of the two objects, but they assumed that the two novel words referred to two different objects. In Experiment 2, in contrast, the infants did not assume that the two emotional expressions referred to two different objects, even though at this age infants understand the intentional and referential nature of such expressions (Moses et al., 2001). It is important to note that the words appeared in a sentence context (e.g., “Look, a ____!”), whereas the emotional expressions appeared by themselves (e.g., “Aah!”), because we had decided to present these auditory stimuli in the most natural manner. However, it seems unlikely that these differences in presentation were responsible for the different results in the two experiments.

One remaining question is whether the infants interpreted the distinct words as referring to distinct kinds of objects (types) or distinct individual objects (tokens). Given the results concerning the effects of labeling on categorization in infants (e.g.,

Balaban & Waxman, 1997; Waxman, 1999) and the effects of labeling on inductive inference in infants (e.g., Welder & Graham, 2001), it is likely that the 12-month-old infants in our study interpreted the words as referring to distinct kinds of objects. Further empirical studies are needed to establish this directly. Taking together the results from studies of categorization, individuation, and inductive inference, we suggest that words may be “essence placeholders” for children who are at the beginning of language development (see also Gelman, 2003; Xu, 2002, 2003, in press). Upon hearing a word for an object, infants assume that the word refers to a kind of object, and this allows them to categorize and make inductive inferences on new objects of the same kind. Therefore, even early in development, linguistic information may exert powerful influences on conceptual development.

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