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Rapid Word Learning in 13- and 18-Month-Olds

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A number of theorists have argued that the productive naming explosion results from advances in abilities that underlie language learning (e.g., the realization that words are symbols, changes in conceptual structure, or the onset of word learning constraints). If any of these accounts are accurate, there should be parallel developments in comprehension. To explore this issue, 4 studies assessed whether pre- and postnaming explosion children differ in their ability to learn a new word after limited exposure. Thirteen- and 18-month-olds heard a new object label just 9 times in a 5-min training session and then their comprehension was assessed in a multiple-choice procedure. Under favorable testing conditions, both 18- and 13-month-olds showed comprehension of the new word, even after a 24-hr delay. These results suggest that well before the productive naming explosion, children can learn a new object label quickly.

Even to the casual observer, the differences in the linguistic abilities of 1-year-olds and 2-year-olds are striking. The average 1-year-old is just beginning to produce words, whereas the average 2-year-old has a large productive vocabulary and has begun to produce multiword utterances. Moreover, during this second year, many children undergo a *vocabulary spurt* or *naming explosion*—a marked increase in the rate at which new words are added to their productive vocabularies (Benedict, 1979; Bloom, 1973; Dromi, 1986; Goldfield & Reznick, 1990; Gopnik & Meltzoff, 1986; Lifter & Bloom, 1989; Nelson, 1973), and even children who do not show a rapid spurt greatly increase their productive vocabularies at this time (Goldfield & Reznick, 1990).

Noting these developments, many researchers have argued that during the second year there are changes in the cognitive or linguistic underpinnings of language use (Dore, 1978; Lock, 1980; McShane, 1979; Nelson & Lucariello, 1985). Before the naming explosion, language use is argued to be prelexical (Nelson & Lucariello, 1985), performative (Snyder, Bates, & Bretherton, 1981), nonreferential (Snyder et al., 1981), and associative (Lock, 1980). On these accounts, the naming explosion indicates that a new mode of language learning has been attained.

To illustrate, one widely cited explanation of the changes in language during the second year holds that it is at this time that children come to understand the referential power of language (Dore, 1978; Kamhi, 1986; Lock, 1980; McShane, 1979). McShane (1979), for example, argued that the naming explosion is the result of the child's attainment of the insight that words are symbols that refer to entities in the world. Lock (1980) proposed that once children have attained this insight,

> words now begin to be acquired in a different way; the laborious game of building up an association between a sound and an object recedes, and the child increases his vocabulary in some other, and as yet barely understood, way. (p. 120)

Thus, this understanding of language as referential results in the transition from a prelinguistic phase in which words are laboriously learned as nonlinguistic associates to a referential mode in which words function as linguistic entities. Reznick and Goldfield (1992) proposed that a related development leads to the naming explosion, namely, that it is at this time that children realize that all things can and should have names.

Another class of explanations of the naming explosion invokes conceptual development (Bloom, Lifter, & Broughton, 1985; Corrigan, 1978; Gopnik & Meltzoff, 1986; Lifter & Bloom, 1989; Nelson & Lucariello, 1985). According to these accounts, the naming explosion is related to the development of object permanence (Corrigan, 1978), object concepts (Nelson & Lucariello, 1985), object representation (Bloom et al., 1985; Lifter & Bloom, 1989), or categorization (Gopnik & Meltzoff, 1986). These explanations posit that new conceptual capacities, such as the ability to access object concepts (Nelson & Lucariello, 1985), allow children to become more sophisticated word learners.

Recently, a third account of the naming explosion has been proposed: that the advent of constraints on word learning enables the vocabulary spurt (Behrend, 1990; Markman, 1991; Mervis & Bertrand, 1993). According to this suggestion, early word learning is slow because very young children lack some or all of the constraints on word learning that older children have. These constraints limit the hypotheses to be considered when the child is confronted with a new word (Markman, 1989). After word learning constraints (e.g., the whole object assumption,

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taxonomic constraint, or mutual exclusivity) are in place, word learning proceeds more efficiently because children can now eliminate many potential hypotheses about the meaning of a new word and focus on those that are most likely to be correct.

These accounts, although differing in the specific developments they propose, all agree that some basic change in children's cognitive or linguistic abilities underlies the naming explosion. This improved competence renders children more sophisticated word learners and thus results in a vocabulary spurt. For example, Dromi (1986) writes:

> During this first phase [before the naming explosion], new words are learned by the child very slowly and inefficiently, as if the child laboriously learns every new word as a special case. During the second phase of the one-word stage . . . the child becomes much more efficient. The number of new words learned rises sharply and the child's ability to master the relationship between a word and its conventional meaning considerably improves. (p. 242)

In summary, these explanations imply that before the naming explosion and the insights or cognitive milestones that lead to it, learning a single new word would be a time-consuming process, requiring much exposure to the new word. In fact, it seems likely that for the earliest words acquired ("Hi," "Bye-bye," "Mommy," etc.), children may hear a word hundreds of times before producing it. At the time of the naming explosion, it is argued, children become efficient word learners, capable of learning new words after only limited exposure to them.

Although few of these theories explicitly consider developments in language comprehension (but see Lucariello, 1987; Reznick & Goldfield, 1992), the changes in learning ability that are proposed by these accounts would affect language comprehension as profoundly as they would affect language production. A nominal insight or a change in conceptual structure would alter children's underlying representations of word meaning. Constraints on word learning limit the inductive load for learning to understand, as well as produce, new words. In fact, most empirical demonstrations of these constraints concern comprehension of new words. Thus, these explanations of the naming explosion imply that improvements seen in children's language production at this age should be paralleled by improvements in language comprehension.

So far, however, the evidence for the naming explosion comes almost entirely from studies of children's language production, not comprehension. The naming explosion could, therefore, result from developments in abilities related specifically to production. There are many reasons why one might find a vocabulary spurt in production that have nothing at all to do with lexical insight, conceptual change, or constraints on word learning. Changes in memory, such as the ability to recall (rather than recognize) words, could explain changes in production (Huttenlocher, 1974). Alternatively, an increased motivation to use words to communicate or the realization that words can be used to serve a number of different functions (e.g., commenting or requesting) could also lead to a spurt in production. As another possibility, an increase in productive language could be the result of developments in articulatory control. Thus, changes in memory, motivation, or articulation could cause children to suddenly produce many words that they have understood for a while.

Therefore, to evaluate theories that postulate that the naming explosion is the result of a new mode of language learning, one must determine whether there is a spurt in comprehension at the time of the spurt in production. Comprehension, in fact, provides a more sensitive index of increased word learning competence, because the child's comprehension of words is not limited by factors that may limit language production, such as level of articulatory control, recall memory, and motivation to talk.

On analogy with the findings from production, one way to test for a spurt in comprehension would be to track the rate of growth of children's receptive lexicon during the second year. In a longitudinal study, Benedict (1979) used parental reports of the words children understood to estimate the size of children's receptive vocabularies. By this measure, she found that from the first words, understood, receptive vocabulary grew at a rapid and steady rate rather than showing an abrupt shift at around the time of the spurt in production. However, more rigorous empirical work on the size of early vocabularies is lacking. This is not surprising given the methodological problems posed by assessing comprehension in babies. Preferential looking techniques (Behrend, 1988; Fernald & McRoberts, 1991; Reznick, 1990; Thomas, Campos, Shucard, Ramsey, & Shucard, 1981) and multiple-choice tests (Baldwin, 1991, 1993; Bretherton et al., 1981; Fremgen & Fay, 1980; Lucariello, 1987; Ross, Nelson, Wetstone, & Tanouye, 1986; Smolak, 1981; Tomasello & Farrar, 1986) can be used to assess comprehension in babies and provide the necessary experimental controls. However, because both of these techniques require many trials just to test comprehension of one or two words, it is not feasible to use these methods to exhaustively assess receptive vocabulary size.

An alternative to exhaustively testing receptive vocabulary is to selectively test words that have been shown to predict a given vocabulary size. If vocabulary growth proceeded according to a highly regular sequence, then knowledge of a late-occurring word would predict knowledge of all the earlier-occurring words. If it were possible to obtain and validate a sequence of this kind, the size of a child's receptive vocabulary could be estimated on the basis of their understanding of just a few words. More rigorous testing procedures (e.g., visual preference procedures or multiple-choice tests) could then be used to assess changes in vocabulary size over the course of several months or weeks.

Although no studies based on this approach have yet been conducted, Reznick and Goldfield (1992) partially based their procedure for tracking the rate of receptive vocabulary growth on this rationale. Between the ages of 12 and 22 months, children were given bimonthly visual preference comprehension tests. Reznick and Goldfield did not attempt to sample the child's entire receptive vocabulary but rather tested each child on a short list of words designed to contain words that would be easy, moderately difficult, and difficult for children at a particular age. Thus, there was a 12-month list, a 14-month list, and so on, and all of the children were tested on each one in the appropriate session. A spurt was defined as the first session in which a child understood at least 2 words more than in the past session. When this criteria was used, 18 of the 24 children studied showed a spurt in comprehension, 9 of these showing the spurt at the 22-month session. Reznick and Goldfield also assessed the rate of productive vocabulary growth through parental reports. Using the criterion of an increase of 10 words in production in a 2½-week period as evidence of a spurt in production, Reznick and Goldfield found a correspondence between spurts in production and comprehension: Most children either spurted in both comprehension and production or spurted in neither. Moreover, of the children who had both comprehension and production spurts, most had them both show up on the same bimonthly session.

In contrast to Benedict (1979), then, Reznick and Goldfield (1992) concluded that the vocabulary spurt in production is accompanied by a spurt in comprehension. There are several problems with this study, however, that weaken this interpretation of the results. For one, although the comprehension test words were chosen on the basis of evidence about their relative difficulty, the function relating number of words understood in testing to vocabulary size is unknown. Thus, we do not know how increases in number of words comprehended on the visual preference test reflect growth in the overall size of receptive vocabulary. In addition, as Reznick and Goldfield noted, a minor change in the criteria for having a spurt in comprehension changes when and if children show a spurt. In addition to the two-word increase criterion, Reznick and Goldfield evaluated children's performance on the basis of three- and four-word increases and found that a third of the 18 children who showed a spurt in comprehension on the basis of the two-word criterion either failed to show a spurt or spurted at a different time on the basis of the four-word criteria.

An alternative test of whether children have become more efficient word learners is to directly chart the rate at which they can learn a single new word. If children at the time of the naming explosion become more proficient language learners, then this difference should be seen in the relative ease with which children before and after the naming explosion can learn a new word. Directly measuring the rate of learning a new word avoids the problems of assessing a child's entire receptive vocabulary and tracking vocabulary growth over several months. A number of researchers have studied young children's word learning in controlled contexts (Nelson & Bonvillian, 1973; Ross et al., 1986; Schwartz & Leonard, 1980; Schwartz & Terrell, 1983; Tomasello & Farrar, 1986). In general, however, most lexical training studies have used production as the measure of word learning, and few have specifically explored developments at the time of the naming explosion.

One study that has measured children's ability to learn new words at the time of the naming explosion was conducted by Lucariello (1987). She found differences in the extent to which children before and after the naming explosion—as defined by having fewer than or more than 50 words in production—learned new words. Lucariello had mothers introduce their children to five new object labels in the course of a repeated play routine. She found that for both comprehension and production, children with fewer than 50 productive words learned fewer of the new words than children with more than 50 productive words. However, the comprehension test lacked important controls. For one, there were no validation trials to establish that the comprehension test was suitable for the age range studied. Thus, it is impossible to tell whether poor performance was due to a lack of understanding of the newly introduced words or to confusion on the multiple-choice test. In addition, the researcher who administered the test was not unaware of which choice was correct. Thus subtle, unintentional cues from the experimenter could have influenced children's performance. Moreover, in this study children were introduced to several new words and a complex routine (pizza making) involving several new actions. Very young children's limited processing abilities may have interfered with learning new words in this situation. Simpler training situations, involving fewer new words, objects, and activities, may prove more sensitive to early word learning abilities.

Oviatt (1980, 1982, 1985) explored young children's ability to learn a single new word in a simpler learning situation. In contrast to Lucariello's (1987) work, Oviatt's findings suggest surprising competence in children well below the age of the vocabulary spurt in production. In one study (Oviatt, 1980), 9- through 17-month-olds were introduced to a new word, either *rabbit* or *hamster,* as the name of a live animal, and they were then asked several probe questions aimed at assessing their comprehension of the new word. Children were asked about the target (e.g., "Where's the rabbit?"), and gestures and gaze toward the target were coded. To rule out false-positive responding, Oviatt also asked children about a nonsense word (e.g., "Where's the *kawlow*?"). Oviatt found that half of the 12–14-month-olds and most of the 15–17-month-olds looked and gestured toward the target when asked about the rabbit but did not give false-positive responses when asked about the *kawlow.* Unfortunately, two problems with this procedure make these findings difficult to interpret. First, children may have looked and gestured toward the rabbit not because they understood the question "Where's the rabbit?" but rather because they found the target item interesting. Because an adult had just pointed at and talked about the target item, children may have become more interested in the object or more comfortable with it. The nonsense label control was used to rule out this possibility. However, children may have avoided false positives on these trials because they recognized the nonsense word as novel and looked toward the experimenter in confusion. In addition, children were given more opportunities to respond to the target question than to the nonsense control question. Children were asked up to three times about the rabbit but were only asked one nonsense control question. Therefore, different levels of looking at the rabbit in the two conditions could simply be a product of having more opportunities to respond to target versus control questions.

In the following studies, we set out to measure the proposed change in word learning ability at the time of the vocabulary spurt in production. Using comprehension as the measure of learning, we asked whether (a) children before the naming explosion require extensive exposure to acquire a new word and (b) children past the naming explosion are able to acquire a new word after only limited exposure. To test this, we gave children who were before and after the vocabulary spurt in production controlled amounts of exposure to a new word—an invented name for an unfamiliar object—and then assessed their comprehension of the new word. Age was used as a means of selecting children likely to be on either side of the naming explosion.

Given existing descriptions of this period (Benedict, 1979; Dromi, 1986; Goldfield & Reznick, 1990; Nelson & Bonvillian, 1973), 13-month-olds should be well before the naming explosion and 18-month-olds should be in the midst of it. Parental estimates of children's vocabularies obtained from the Bates, Benigni, Bretherton, Camaioni, and Volterra (1979) checklist were used to confirm this.

A modified multiple-choice procedure was used to assess comprehension of the newly taught label. Standard multiple-choice procedures have worked well in studies involving children over the age of 2 years (e.g., Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Markman & Hutchinson, 1984) and have been somewhat successful in use with even younger children (Baldwin, 1991, 1993; Bretherton et al., 1981; Fremgen & Fay, 1980; Lucariello, 1987; Ross et al., 1986; Smolak, 1981; Tomasello & Farrar, 1986). In these procedures, children are shown a target object and one or more distracters and are asked to pick out the target. For a number of reasons, however, this form of the multiple-choice procedure is unlikely to be sensitive to the abilities of 1-year-olds.

For one, preferences for particular objects can interfere with very young children's performance on these tasks. Children may fail to choose a target because they have a strong preference for one of the distracters. Conversely, children may correctly choose the target not because they understand the experimenter's request, but because they happen to prefer the target item over the distracters. The latter is especially relevant for studies in which children have been told a label for one of the objects in an array. Baldwin and Markman (1989) have shown that, for 10- to 20-month-olds, giving an object a name makes it more interesting than objects that have not been named. Thus, children in a lexical training study might choose the right object not because they understand the label, but because labeling has increased their interest in the object. This potential confound can be ruled out in a number of ways, for example, by using target items as distracters for other targets to rule out false positives (e.g., Smolak, 1981), or by assessing children's object preferences by simply asking children to "take one" of the items on some trials (e.g., Baldwin, 1991, 1993). A number of lexical training studies that report word learning in young children fail to assess the role of preferences in children's object choices (e.g., Ross et al., 1986; Tomasello & Farrar, 1986).

A second problem of interpretation arises when children fail to perform correctly. Children might understand a word yet respond incorrectly because they find the task too difficult or confusing. It is important to be sure, for example, that the multiple-choice test does not exceed children's information-processing limitations. As a possible case in point, Tomasello and Farrar (1986) found that only about half of the children they tested at Stage 5 of object permanence (average age of 15 months) performed above chance levels on a multiple-choice test of comprehension of a newly taught object label. However, their test of comprehension required children to choose from an array of four objects, which may have been overwhelming for the younger children. It is impossible to tell, then, whether this poor performance is due to lack of learning or to task demands. To distinguish these possibilities, one must demonstrate that children can choose the correct object when asked about words they know well.

A further problem for multiple-choice tests is the possibility of experimenter bias. Subtle, unintentional cues from the experimenter could influence the baby's choices. Although visual preference measures typically control for this possible confound by using experimenters who are unaware of the procedures (e.g., Behrend, 1988; Reznick, 1990; Thomas et al., 1981), multiple-choice procedures typically do not.

In the four studies in this article, we made modifications in standard multiple-choice procedures to avoid these problems. To counteract the effects of strong preferences for particular items and to make the task more engaging, we embedded the test questions in one of several play activities. Each activity required doing something with small objects, for example, putting them into a box with a lid or through a basketball hoop. Thus, the focus was on completing the activity, not on choosing an object to hold. We hoped this would help keep children motivated as well as help reduce responding on the basis of preferences. Extensive pilot work showed this procedure to be sensitive to the knowledge of children as young as 13 months of age.

In addition to test trials concerning the newly taught label, children received two types of control trials. Familiar label validation trials, on which children were asked about well-known items, provided evidence that this comprehension test was suitable for 1-year-olds. Children's preferences were assessed on preference control trials on which they were presented with the target and distracter and were asked to "get one" to use in one of the play activities. These preference control trials allowed us to assess the possibility that preferences for particular objects led to spurious correct responses. Finally, to preclude the possibility of the tester giving the child inadvertent cues or feedback, we made the tester unaware of which of two potential referents had been labeled for the child.

In summary, we designed a multiple-choice measure that (a) minimized the effects of preferences for particular objects, (b) minimized attentional demands, (c) included the necessary preference control and validation trials, and (d) eliminated the potential for experimenter bias by keeping the experimenter unaware of which item was the correct choice for a particular child.

Study 1

Method

Subjects

The participants in all four studies were healthy, full-term babies who came from middle-class, monolingual, English-speaking homes in the San Francisco Bay area. They were recruited mainly through ads in local parent-directed publications and received either a small toy or $5 for their participation.

In the first study, there were 48 children, twenty-four 13-month-olds and twenty-four 18-month-olds. The 13-month-olds had a mean age of 13 months 18 days, ranging from 13 months 2 days to 13 months 30 days. The 18-month-olds had a mean age of 18 months 18 days, ranging from 18 months 1 day to 18 months 28 days. There were 12 girls and 12 boys in each age group. An additional 13 children were run but were not included in the analysis. Seven of these children (five 13-month-olds and two 18-month-olds) did not complete the procedure because of fussiness. Six of these children were omitted because of experimenter error.

Stimuli

The children were taught a label for one of two different novel objects: a large plastic paper clip or a small plastic strainer. The unlabeled object served as a distracter in the test of comprehension. There were three exemplars of each type of object that differed from each other only in color. Each child was assigned one color of each type as the training pair. The remaining two colors of each type were used as generalization pairs in the comprehension phase of the study.

Procedure

The child, parent, and experimenter sat on the floor throughout the session. To prevent feedback or inadvertent coaching, the experimenter instructed parents to act as observers as much as possible and not to label the new objects or initiate interactions with their child. Parents generally sat off to one side while the child and experimenter interacted in the center of the room. Children were free to roam about the room and explore. The training and test procedures were timed with reference to children's interests. Thus, children were told labels or were asked test questions only when they were interested and attentive. This allowed us to optimize children's performance and helped children to complete a relatively long procedure without undue tiring or fussiness.

The session typically lasted 30–40 min and was divided into two phases: a training phase and a testing phase. One experimenter administered the training phase, and a second experimenter administered the testing phase. This allowed the tester to be unaware of which of the two novel objects had been named for the child. The first experimenter introduced the child to two new objects and gave one of them the label *toma*. The second experimenter, who was unaware of which of the two objects had been called the *toma* for the child, administered the comprehension test. In testing, the child was presented with the two new objects and was asked to get the *toma*.

Training phase. After a few minutes of warm-up play between the child and the first experimenter, exposure to the new word began. The first experimenter introduced the child to the training pair of novel objects. For half of the children the strainer was labeled, for the other half the clip was labeled. To control for any effects of a particular novel word, and to allow the tester to be unaware of which object was labeled, the same label, *toma*, was used regardless of which of the objects was labeled.

In each of the following studies, children were given only limited exposure to the new label. Our goal was to approximate the conditions under which children gain their first exposure to a new word. Transcripts of parent–child dialogues (Brown, 1973) and studies of parental labeling of new objects (Fernald & Morikawa, 1993) show that when parents first introduce a new word to young children, they repeat it frequently over the course of a few minutes of attending to the object. On the basis of this evidence, we chose nine repetitions of the new word in a 3- to 5-min introduction as representative of parental labeling. The experimenter repeated the invented label three times, using natural "motherese" labeling frames while she and the child jointly attended to the labeled object, saying, for example, "That's a toma. See, it's a toma. Look, it's a toma." This was repeated twice during the 3- to 5-min session, yielding nine repetitions of the word *toma*. In an attempt to make both objects equally salient to the child, the experimenter also drew attention to and commented on the unlabeled object nine times, in similar triplets, for example, "Oooo, look at that. Yeah, see it? Wow, look at that." While one object was being labeled or commented on, the other was put out of sight. The experimenter was careful to label or comment only when the child was attentive to the target object. She alternated labeling and commenting triplets, interspersing play with nontarget toys between each triplet. The object that was given the label and the object that was presented first were counterbalanced.

Testing phase. After the exposure phase, the first experimenter left the room and the second experimenter entered. The second experimenter took a few minutes to greet the parent and become acquainted with the child, and then tested the child's comprehension of the new word using the modified multiple-choice procedure described earlier. Children were introduced to several activities, each of which involved completing some action with a small object, for example, putting objects through a cardboard chute or in a box. An activity was first introduced with nontest filler items that were generally familiar to young children (e.g., ducks, cars, and keys), and the child was rewarded with applause and cheering for using the filler items in the activity. Once the child was engaged in the activity and had performed it with several filler items, the experimenter cleared away all extraneous toys, ensured that the child was paying attention, and brought out a tray containing the target and distracter objects. The experimenter repeated the test question (e.g., "Can you put the *toma* in there?") at least five times before the child was allowed to choose an object. The first question was asked before the child saw either object, and the remaining questions were asked as the tray was raised above the child's head and then lowered to waist height. Once children chose an object, they were encouraged to complete the activity (e.g., putting the chosen toy through the chute) but were not rewarded for their choice. When the child had completed the activity, the experimenter brought out nontest filler items to continue the activity. To maintain children's interest, the experimenter reinforced the child's use of nontest items with cheers, applause, and so on. If the child refused to choose an object after repeated asking, or if the child removed both objects from the tray simultaneously, that trial was readministered later in the session. The tester waited a minimum of 20 s between questions because pilot work indicated that children did better when there were breaks between trials.

There were three trial types: new label, preference control, and familiar label trials. On *new label* trials, children were presented with exemplars of both the clip and the strainer and were asked for the *toma*. Because the tester did not know which object had been labeled as the *toma* for the child, it was impossible for her to give any unintentional coaching or feedback that would encourage correct choices. Each child received three new label test trials; on one they were presented with the same clip and strainer they had seen during training; on the other two test trials they were presented with the generalization pairs. The order of pairs was randomly assigned.

As discussed earlier, children could choose the right object not because they understand the label but because it has been made more interesting by labeling. To rule out this potential confound, we assessed children's preferences on *preference control* trials. On these trials, children were presented with the two new objects, the clip and the strainer, and were simply told to take one to use in an activity (e.g., "Can you put one in the chute?"). If children choose correctly on test trials because they have a preference for the named object, their preference should show up on these trials as well. The pairs used for the preference trials were the same as those used for the trained label trials.

Familiar label trials provided validation of the comprehension measure and gave children some relatively easy questions. On these trials, children were asked to choose between two objects with known labels (e.g., *dog, spoon, cup, shoe, cat,* and *bottle*). For each child, we selected the familiar pair before the lab visit by asking parents over the phone which of these words their child best understood. There were two exemplars of each familiar object type. One pair of exemplars was used for two of the familiar object trials and the other was used for one trial.

Which pair was used twice, as well as the order of pair presentation, was randomly assigned. As much as possible, the familiar object pairs used were balanced within age group; that is, if one child was presented with the pair dog–spoon and was asked for the dog, another child was presented with the same pair and was asked for the spoon.

In the first study, there were nine comprehension trials in all, three trials of each of the different types. The trials were presented in blocks of three, one of each trial type. Within a block, order of trials was random. The side (right or left) that the target object was on was randomized for each child, with the constraints that the target could not appear on one side more than five out of nine times and that for each trial type the target occurred twice on one side and once on the other.

Vocabulary Estimates

To confirm that children in the two age groups were at opposite ends of the naming explosion, we obtained parental estimates of children's vocabularies through a checklist questionnaire (Bates et al., 1979). During the lab visit, the experimenter explained the questionnaire to parents. Parents then took the questionnaire home to complete and mail back. A number of researchers have noted that the vocabulary spurt in production often occurs when children have around 50 words in production (Benedict, 1979; Dromi, 1986; Goldfield & Reznick, 1990; Nelson, 1973), and the criterion of having more or fewer than 50 productive words has been used to assign children to pre- versus postnaming explosion groups (Lucariello, 1987). Thus the parental vocabulary checklist provided a way of estimating whether children had passed the vocabulary spurt. These estimates allowed us to verify that the two age groups represented different ends of the naming explosion and allowed us to compare the performance of children who had fewer than 50 productive words with those who had more than 50 productive words.

Results

Vocabulary Measures

Vocabulary data confirmed that children in the two age groups represented different ends of the naming explosion. Questionnaires were returned for 16 of the 18-month-olds and 19 of the 13-month-olds. The 18-month-olds produced an average of 119 words and the 13-month-olds produced an average of 29. The two age groups differed from each other in the average size of productive vocabulary, $t(33) = 4.20$, $p < .001$, and the average productive vocabulary size for each group differed significantly from 50: 18-month-olds produced more than 50 words, $t(15) = 3.14$, $p < .01$, and 13-month-olds produced fewer than 50 words, $t(18) = 3.09$, $p < .01$. Sixteen of the nineteen 13-month-olds had fewer than 50 words in production. Twelve of the sixteen 18-month-olds had more than 50 words in production. This difference in distributions was statistically significant, $\chi^2(1, N = 35) = 12.43$, $p < .001$. Thus, the vocabulary estimates confirmed that children in the two age groups showed pre- versus postnaming explosion vocabulary levels.

Word Learning

For each child, the number of choices of the target item in each condition was tallied. Preliminary analyses revealed no significant effects of sex, experimenter, or object chosen to be labeled on children's performance in the multiple-choice test. The critical question is whether children in each age group learned the new word, as evidenced by choosing the target object systematically. To test this, we ran planned contrasts comparing the average number of target choices in each condition to chance (50%). Children in both age groups performed significantly above chance on familiar label trials, showing that our measure of comprehension was valid for both 13- and 18-month-olds (see Table 1). When asked to choose between two objects for which they already knew names, the 13-month-olds chose correctly 68% of the time, $t(23) = 3.09$, $p < .005$, and the 18-month-olds chose correctly 76% of the time, $t(23) = 4.52$, $p < .001$.

As Table 1 shows, when they were asked to get the *toma,* the 18-month-olds chose the correct object 76% of the time, performing significantly above chance, $t(23) = 5.17$, $p < .0001$. When they were asked to "get one" of the objects on preference control trials, 18-month-olds did not systematically choose the object that had been labeled in training, choosing it at chance levels (57%), $t(23) = 0.72$, $p = .477$. Moreover, a planned contrast showed that 18-month-olds chose the previously labeled object more often on new label trials than on control trials, $t(23) = 3.20$, $p < .01$. Thus, because 18-month-olds showed no preference for the previously labeled object on control trials, their above-chance responding when asked about the new label cannot be explained by a preference for the previously labeled object. The 13-month-olds, on the other hand, did not show word learning. When asked to get the *toma,* they did not choose the correct object at above chance rates (49%), and their performance on these trials did not differ from their performance on preference control trials (56%).

Nonparametric analyses confirmed this pattern of results. Kolmogorov-Smirnov tests comparing the obtained distribution of responses for each trial type with the distribution predicted by random responding yielded significant differences from chance for 18-month-olds on familiar label trials ($p < .01$) and new label trials ($p < .01$) but not for preference control trials ($p > .20$). In addition, a paired sign test confirmed that 18-month-olds selected the previously labeled object more often on new label trials than on preference control trials ($p < .05$). For 13-month-olds, Kolmogorov-Smirnov tests revealed a marginal difference from chance for familiar label trials ($p < .10$) and no significant differences from chance for either new label or preference control trials.

When the performance of children who had fewer than 50 productive words was compared with the performance of children who had more than 50 productive words, a similar pattern of results was obtained. Children at both vocabulary levels chose correctly when asked about well-known objects: Children with fewer than 50 words were correct on 67% of these trials, and children with more than 50 words were correct on 82% of these trials, $t(19) = 2.43$, $p < .05$ and $t(14) = 5.04$, $p < .001$, respectively. Children with more than 50 words in production chose correctly on 64% of the trials on which they were asked to retrieve the newly labeled object, which differed marginally from chance responding, $t(14) = 2.09$, $p = .055$. Children with fewer than 50 words in production did not show evidence of word learning, responding correctly on these trials only 58% of the time.

For both 13- and 18-month-olds, performance on generaliza-

Table 1
Percentage of Comprehension Test Trials on Which Children Chose the Target Object in Study 1

Age group	Familiar label	Preference control trials	New label trials: Overall	New label trials: Training pair	New label trials: Generalization pair
13-month-olds	68*	56	49	50	48
18-month-olds	76*	57	76*	88*	71*

* Above 50% chance level, $p < .005$.

tion trials did not differ from performance on trials on which children were asked about the training pair. Eighteen-month-olds chose correctly on 88% of training pair trials and 71% of generalization trials, $t(23) = 1.78$, $p = .09$. Moreover, performance on both trial types differed significantly from the 50% chance rate for both training pair trials, $t(23) = 5.44$, $p < .0001$, and generalization trials, $t(23) = 3.12$, $p < .005$. This suggests that the 18-month-olds did not learn the new word as a highly specific term or proper name but rather acquired a category term. Thirteen-month-olds chose correctly on 50% of training pair trials and 48% of generalization trials. These rates did not differ from each other or from chance.

To further assess the differences in performance of the two age groups, we performed an analysis of variance (ANOVA) with age group as a between-subjects variable and condition as a within-subjects variable. This analysis revealed main effects of age group, $F(1, 46) = 4.63$, $p < .05$, and condition, $F(2, 92) = 3.72$, $p < .05$. Post hoc analyses revealed that overall, the 18-month-olds chose the target object more often than the 13-month-olds did ($p < .05$), and performance in the familiar condition differed from performance in the control condition ($p < .05$, with Bonferroni correction). Thus, although planned contrasts revealed that 18-month-olds but not 13-month-olds performed above chance on new label trials, an ANOVA did not yield an interaction between age group and condition.

These results suggest that although 18-month-olds can learn a new word after limited exposure, 13-month-olds cannot. However, our pilot work showed that when we asked children about well-known words, 13-month-olds' performance fluctuated with even minor procedural modifications. Therefore, even though the comprehension test in this study was designed to be more sensitive than standard procedures, we decided to try an even simpler test before concluding that 13-month-olds are not capable of fast word learning.

Study 2

In Study 1, children were asked three different kinds of questions: "Can you get the toma?" "Can you get one?" and "Can you get the spoon?" These three question types were interspersed with each other over the course of nine trials in all. This interspersing of different questions may pose problems for 13-month-olds. Our pilot work showed that 13-month-olds performed better on familiar label trials when repeated trials requesting a particular object came without interruption by requests for another object. This suggests that by interspersing trial types in the first study we may have made the test of comprehension unnecessarily difficult for these children. Therefore, in Study 2, we blocked trial types rather than interspersing them. To further simplify the test of comprehension, we eliminated preference control questions, asking only familiar label and new label questions.

Method

Subjects

Babies were recruited as in Study 1. Thirty-two 13-month-olds (16 girls and 16 boys) participated in this study. The average age was 13 months 15 days; ages ranged from 13 months 1 day to 13 months 29 days. One additional subject was run but was eliminated from the analysis because he had been told about the new word as the name for a strainer by the mother of a friend who had previously been in the study.

Stimuli

As in Study 1, children were taught a new word, *toma*, for one of two new objects, a plastic strainer or a large plastic paper clip. There were two exemplars of each object type. Each child was randomly assigned one exemplar of each type as the pair used in label training. The other pair was used in generalization trials of the comprehension test.

Procedure

As in Study 1, there were two phases, a training phase and a testing phase, each administered by a different experimenter. The training phase was identical to the one used in the first study. The testing phase was a simplified version of the procedure used in the first study. As in Study 1, the test questions were embedded in activities such as putting objects in boxes or through a basketball hoop. Because we were concerned that the youngest children in Study 1 might have had trouble contending with three different question types coming in unpredictable order, in this study, each child received only two types of comprehension questions, new label trials and familiar label trials. Moreover, the question types were blocked rather than interspersed. There were four questions of each type. The question type given first and the type of object labeled were counterbalanced. There were two exemplars of each new object type. Each child was assigned one pair as the training pair, the other as the generalization pair. Each child was asked twice about the training pair and twice about the generalization pair. For each child, right and left placement and pair were counterbalanced. There were two exemplars of each type used in the familiar item questions. Each pair

Table 2
Percentage of Comprehension Test Trials on Which 13-Month-Olds Chose the Target Object in Study 2

Sex	Familiar label trials	New label trials: Overall	Training pair	Generalization pair
All subjects	72*	65*	70*	58
Girls	77*	73*	78*	69†
Boys	67*	56	63	47

* Above 50% chance level, $p < .05$. † Marginally different from chance, 50%, $p = .054$.

was used for two of the four questions. The order of familiar pairs used was randomly assigned for each subject. As in Study 1, we obtained parental estimates of children's vocabularies through a checklist questionnaire (Bates et al., 1979) that parents completed at home and then mailed back.

Results

The children in this study were comparable with the 13-month-olds in Study 1 in vocabulary level. Of 27 children for whom parental questionnaires were returned, 26 children had fewer than 50 words in production. On average, children had 11 words in production; this differed significantly from 50, $t(26) = 15.00$, $p < .0001$. Thus, these children showed prenaming explosion vocabulary levels.

Table 2 summarizes the findings of the comprehension test. Once again, the number of trials on which children responded correctly was compared with the mean predicted if children responded randomly (choosing the target on two of four trials). This analysis revealed that, as in Study 1, children performed above chance levels when asked about well-known objects, choosing correctly 72% of the time, $t(31) = 5.26$, $p < .0001$. In contrast to Study 1, on this new, more sensitive test, 13-month-olds also chose correctly when asked about the new label, choosing the target on 64% of the trials, which differed significantly from chance responding, $t(31) = 2.83$, $p < .01$. This pattern was confirmed by nonparametric tests. One sample sign tests comparing obtained scores to chance yielded significant differences for both familiar label trials ($p < .0005$) and new label trials ($p < .05$).

Preliminary analyses revealed no effects of experimenter, named object, or order of trials (familiar label vs. new label first) on children's performance on the multiple-choice test. An ANOVA with condition (familiar vs. unfamiliar) as a within-subjects variable and sex as a between-subjects variable revealed no effects of condition but a nearly significant main effect of sex, $F(1, 30) = 4.05$, $p = .053$, showing that girls tended to score higher than boys on both familiar and new label trials. Girls chose correctly on 77% of familiar label trials and 73% of new label trials, both exceeding chance levels, $t(15) = 4.58$, $p < .0005$ and $t(15) = 3.34$, $p < .005$, respectively. Although boys performed at above-chance levels when asked about well-known labels ($M = 67\%$), $t(15) = 2.91$, $p < .05$, their performance did not differ from chance responding when they were asked about the newly trained label ($M = 56\%$). Girls and boys did not differ in average age (13 months 17 days vs. 13 months 15 days) or productive vocabulary (9 vs. 13 words). There was no significant interaction between sex and testing pair type (training pair vs. generalization) for new label trials.

In this study, in contrast to Study 1, there was a difference in performance on training pair versus generalization trials: Children were more likely to choose correctly on test trials involving the training pair than on generalization trials, $t(31) = 2.27$, $p < .04$. Children chose correctly on 70% of test trials involving the training pair, performing at greater than chance levels, $t(31) = 4.10$, $p < .0005$. However, they did not choose correctly at greater than chance rates on generalization trials ($M = 58\%$). This leaves open the possibility that children were treating the new label as a highly specific term or proper name.

Thus, simplifying the comprehension test allowed us to find evidence that 13-month-olds, at least the girls, may map new words to new objects after only limited training. However, because there was no preference control condition in this study, this good performance on new label trials might reflect a preference for the previously labeled object rather than learning of the new word. Therefore, in Study 3 a preference control was added to eliminate this possible confound.

Study 3

Study 3 included three conditions: the preference control condition in which children were shown the target and distracter and were asked, for example, to "put one down the chute," as well as the new label and familiar label conditions. To simplify and shorten the comprehension test, we gave the three question types as between-subjects conditions. After the training phase, one group of children was asked only new label questions, another was asked only preference control questions, and a third was asked only familiar label questions.

Method

Subjects

Babies were recruited as in Study 1. Ninety-six children participated in this study (forty-eight 13-month-olds and forty-eight 18-month-olds). Half of the children in each age group were girls and half were boys. The 13-month-olds had a mean age of 13 months 11 days, ranging from 13 months 0 days to 13 months 29 days. The 18-month-olds had a mean age of 18 months 13 days, ranging from 18 months 0 days to 18 months 30 days. Eleven additional children were run (four 13-month-olds and seven 18-month-olds) but were eliminated from the analysis. Three 13-month-olds and three 18-month-olds were eliminated because of experimenter error. One 13-month-old and four 18-month-olds were eliminated because of failure to complete all comprehension test trials.

Procedure

As in the previous studies, there was a training phase and a testing phase, each administered by a separate experimenter. The training phase was identical to training in the previous studies: Each child heard

Table 3
Percentage of Comprehension Test Trials on Which Children in the Three Testing Conditions Chose the Target Object in Study 3

Age group	Familiar label condition	Preference control condition	New label condition: Overall	New label condition: Training pair	New label condition: Generalization pair
13-month-olds	68*	39	63*	63	63
18-month-olds	81*	61	59	56	63

* Above 50% chance level, $p < .05$.

one object given the new label nine times and the other object commented on nine times. All children went through the training phase.

In the testing phase, the questions were given in blocks of four, as in Study 2. The three comprehension question types—new label questions, familiar label questions, and preference control questions—were between-subjects conditions. To prevent experimenter bias, the trainer was kept unaware of the testing condition for each child. There were 16 children (8 girls and 8 boys) in each condition in each age group. In pilot work, 13-month-olds performed better when first asked about familiar items. Beginning with familiar questions may help young children to understand and practice the task before dealing with harder questions. For this reason, all of the children were given four familiar warm-up questions before test trials.

After the warm-up, children in the new label condition were presented with the two new objects and were asked to get the *toma.* As in Study 2, there were two pairs of new exemplars, each of which was presented twice. Right and left placement and pair were counterbalanced for each subject. Children in the familiar label condition were tested on a second pair of familiar labels for the second block of questions. As in previous studies, there were two exemplars of each type, which were assigned to fixed pairs, and each pair was asked about twice. Children in the preference control condition were presented with the same pairs as in the novel label condition, but rather than being asked for the *toma,* they were asked to take one to put through the chute or complete one of the other activities. The object labeled and object introduced first were counterbalanced across sex and condition.

Results

As in the first two studies, the 13-month-olds showed pre-naming explosion vocabulary levels and differed from the 18-month-olds in vocabulary size. Questionnaires were returned for thirty-nine 13-month-olds and forty 18-month-olds. On average, the 13-month-olds had 13 words in production, and the 18-month-olds had 104; these means differed significantly from each other, $t(77) = 5.80$, $p < .0001$, and each differed from 50 words, $t(38) = 18.37$, $p < .0001$ and $t(39) = 3.75$, $p < .001$, for 13-month-olds and 18-month-olds, respectively. However, although thirty-eight of thirty-nine 13-month-olds with available questionnaire data had fewer than 50 words in production, only twenty-three of forty 18-month-olds with available questionnaire data had more than 50 words in production. Although these distributions differed from each other, $\chi^2(1, N = 79) = 28.177$, $p < .0001$, some of the older children may not have been beyond the vocabulary spurt.

Table 3 provides a summary of the comprehension test findings. As in Studies 1 and 2, to assess learning, we compared the number of trials on which children chose the target object with chance levels for each condition. Thirteen-month-olds performed above chance on familiar label trials: When asked about a familiar object, they responded correctly on 68% of the trials, $t(15) = 3.00$, $p < .01$. Moreover, 13-month-olds showed clear evidence of having learned the new word. As in Study 2, they performed significantly above chance on new label trials: When asked to find the *toma,* they chose the correct object 63% of the time, exceeding chance performance, $t(15) = 2.45$, $p < .05$. Thirteen-month-olds in the preference control condition did not choose the previously labeled object at above-chance levels (M = 39%), $t(15) = -1.45$, $p = .17$. Moreover, a planned contrast showed that 13-month-olds in the new label condition chose the target object more often than 13-month-olds in the control condition did, $t(30) = 2.57$, $p < .02$. This pattern of results was confirmed by nonparametric tests. One sample sign test comparing the obtained performance with chance levels confirmed that 13-month-olds chose above chance on familiar label trials ($p < .05$) and new label trials ($p < .05$, one-tailed) and did not differ from chance responding on control trials ($p > .3$). A Mann-Whitney test confirmed that children in the new label group chose the target object more often than children in the control group did ($U = 69.5$, $p < .05$). Thus, once again, 13-month-olds showed themselves capable of learning a new object label after only limited exposure to it. Moreover, their good performance reflected comprehension of the new word, not just heightened interest in the previously labeled object.

In contrast to Study 2, there were no sex differences in 13-month-olds' performance on the comprehension test and no difference in performance on new label trials involving the generalization versus training pair of objects. Thirteen-month-olds chose the correct object when asked for the *toma* 63% of the time on both generalization and training pair test trials. In contrast to Study 2, then, these findings do not support the conclusion that 13-month-olds interpreted the new word as specific to the training object.

The 18-month-olds' performance on the comprehension test was puzzling. Although children in the familiar label condition performed well above chance—choosing the correct familiar object on 81% of the trials, $t(15) = 7.32$, $p < .0001$—18-month-olds who were asked to get the *toma* did not choose the correct object at above-chance rates. These children chose the target object only 59% of the time, not differing from the children in the preference control condition or from chance. Sign tests confirmed that for this age group, performance was above chance for familiar label trials ($p < .0001$) but did not differ from chance for new label trials ($p > .5$) and control trials ($p > .2$). There were no sex differences in performance on test trials, and performance on trials involving the training pair and generalization pair was equally low (56% and 63% respectively), $t(15) = .522, p = .61$.

The findings for 18-month-olds seem odd given both the findings of Study 1, in which 18-month-olds were systematically correct on new label trials in a more demanding test of comprehension, and the findings of Study 2 and this study that 13-month-olds successfully learned the new word. One possible explanation for this discrepancy is that the changes we made in the procedure to simplify the demands for 13-month-olds may have somehow disrupted 18-month-olds' performance. In particular, by reducing the variety of question types and blocking the questions, we may have made the procedure boring for the 18-month-olds. This explanation is supported by the fact that four 18-month-olds but only one 13-month-old failed to complete all test trials.

Performance on the comprehension test was also analyzed for those children with productive vocabularies of fewer than 50 versus more than 50 words. In the familiar condition, children at both vocabulary levels performed above chance. Children with fewer than 50 words in production chose correctly on 75% of the test trials, and children with more than 50 words in production chose correctly on 85% of the test trials, both differing significantly from 50% chance levels, $t(19) = 5.21, p < .0001$ and $t(4) = 5.72, p < .005$, respectively. In the new label condition, children with fewer than 50 words in production chose correctly on 64% of trials, which was significantly above chance, $t(15) = 2.33, p < .05$, and children with more than 50 words in production chose correctly on 67% of trials, which differed only marginally from chance, $t(7) = 2.00, p = .08$.

To further assess differences between the age groups, we performed an ANOVA with age group and condition as between-subjects variables. This analysis yielded main effects of age group, $F(1, 90) = 4.28, p < .05$, and condition, $F(2, 90) = 8.26, p < .001$, and no significant interaction. Post hoc Bonferroni tests showed that overall, 18-month-olds chose the target object more often than 13-month-olds did ($p < .05$) and that children in the familiar label condition chose the target object more often than children in the new label condition ($p < .05$) and more often than children in the control condition ($p < .0001$). Thus, as in Study 1, although planned contrasts revealed that the two age groups differed as to whether their performance on new label trials was above chance, an ANOVA did not indicate that children in the two age groups differed in their performance in different conditions.

An ANOVA revealed a main effect of target object. Children in both age groups were more likely to choose correctly when the target object was the strainer than when it was the clip, $F(1, 28) = 7.62, p < .05$. Children chose correctly when the target was the strainer 72% of the time, $t(15) = 3.66, p < .005$, but only chose correctly 50% of the time when the target was the clip, not differing from random responding.

Although both 13- and 18-month-olds' performance on the multiple-choice test varied as a function of testing procedure, the results of these first three studies suggest that children at both ages are able to make word–object mappings after only limited exposure to a new word. That 13-month-olds so readily learn object labels is surprising, given the wealth of literature on the differences between children at either end of the naming explosion. If 13-month-olds, who are well before the naming explosion, can make word–referent mappings so quickly, why are their vocabularies so small? In a final study, we investigated one possible explanation for this paradox. Although 13-month-olds can establish initial mappings between new words and their referents quickly, maybe they also forget them quickly. Perhaps these mappings are fleeting and easily disrupted. Only when word learning is robust enough to persevere over time could children's vocabulary increase. Given this memory requirement, differences between the two age groups might be evident after a delay. To test this, in Study 4, we imposed a 24-hr delay between the training and testing phases of the procedure.

Study 4

Method

Subjects

Sixteen 13-month-olds and sixteen 18-month-olds participated in this study. The 13-month-olds had a mean age of 13 months 15 days (ranging from 13 months 0 days to 13 months 29 days), and the 18-month-olds had a mean age of 18 months 14 days (ranging from 17 months 29 days to 18 months 28 days). There were equal numbers of girls and boys in each age group. Two additional children participated but were not included in the final analysis. One (a 13-month-old boy) was excluded because of excessive fussiness. The other (an 18-month-old girl) was excluded because she already knew a name for the strainer. One child was contacted but was not scheduled because she did not understand the names for at least three of the familiar toys used in the familiar condition.

Procedure

Children visited the lab on two occasions. First, they came in for a brief training session that was identical to training for the first three studies, with the exception that the invented label used was *tukey* rather than *toma*. Then they returned to the lab 24 hr later to meet the second experimenter for the comprehension test. In this study, the comprehension test was the same as in Study 2. That is, each child was asked familiar label questions and new label questions. The two trial types were given in blocks of four, and the order of trial types was counterbalanced. Because none of the previous studies showed a preference for the previously labeled object on preference control trials, we omitted the control condition in this study.

Results

As in the previous studies, 13-month-olds in general showed prenaming explosion vocabulary levels. On average they produced 25 words, significantly fewer than 50, $t(11) = 3.50, p < .005$. Of 13 children for whom vocabulary estimates were available, only 2 had more than 50 words in production. The return rate for questionnaires for the 18-month-olds was quite low. Only seven parents returned the estimates. For the children of these parents, the average size of productive vocabulary was 73

Table 4
Percentage of Comprehension Test Trials on Which Children Chose the Target Object in Study 4

Age group	Familiar label trials	New label trials: Overall	Training pair	Generalization pair
13-month-olds	69*	67*	69†	66†
18-month-olds	73*	77*	72*	81*

* Above 50% chance level, $p < .05$. † Marginally above 50% chance level, $p < .10$.

words, and 3 of the 7 children had fewer than 50 words in production. The 18-month-olds' mean vocabulary size differed from the mean vocabulary size of the 13-month-olds, $t(18) = 2.32$, $p < .05$, but did not differ from 50 words.

Table 4 summarizes the main findings from the test of comprehension. Preliminary analyses revealed no effects of condition, target object, experimenter, or sex. Once again, children in both age groups performed above chance when asked about familiar labels: 13-month-olds chose correctly on 69% of these trials, $t(15) = 2.32$, $p < .05$, and 18-month-olds chose correctly on 73%, $t(15) = 4.34$, $p < .001$. In addition, both 13- and 18-month-olds showed retention of the newly taught label. When asked to get the *tukey,* 13-month-olds chose the correct object 67% of the time and 18-month-olds chose correctly 77% of the time, both differing from chance responding, $t(15) = 2.42$, $p < .05$ and $t(15) = 3.17$, $p < .01$, respectively. Nonparametric tests generally confirmed this pattern of findings. One sample sign test comparing observed performance to chance yielded significant differences for familiar label trials for both 18-month-olds ($p < .005$) and 13-month-olds ($p < .05$, one-tailed). Performance on new label trials exceeded chance in these analyses for 18-month-olds ($p < .05$) but was only marginally above chance for 13-month-olds ($p = .073$, one-tailed).

Once again, for children in both age groups, performance on generalization trials did not differ from their performance on test trials involving the training pair: for 13-month-olds *M* (training pair) = 69% and *M* (generalization pair) = 66%, $t(15) = 0.29$, $p = .77$; for 18-month-olds *M* (training pair) = 72% and *M* (generalization pair) = 81%, $t(15) = 1.38$, $p = .19$. This is in keeping with the findings of Studies 1 and 3 and suggests that children are not learning the word as a highly specific term or proper name but rather are acquiring a category term.

A 2 (age group) × 2 (condition) × 2 (experimenter) × 2 (order of condition) ANOVA yielded only a nearly significant Order of Condition × Condition interaction, $F(1, 28) = 4.00$, $p = .054$. A post hoc Tukey's test showed that children performed marginally better on familiar label questions when they were given first ($p < .10$). There were no other condition differences or interactions, and, in contrast to Studies 1 and 3, no age difference in performance. Thus, again, an ANOVA provided no evidence that 13-month-olds and 18-month-olds differed in their performance on new label trials.

Thus, imposing a delay between introduction of the new word and comprehension testing did not differentiate between the two age groups. Thirteen-month-olds, who are well before the age of the vocabulary spurt, show an ability to learn and maintain a new word–object mapping.

Discussion

In these studies, we set out to measure changes in word learning ability at the time of the vocabulary spurt in production. Given that most explanations for the naming explosion have invoked developments in underlying linguistic competence or cognitive abilities that affect word learning, it seemed obvious that this change should be reflected in children's ability to learn new words as measured by comprehension. Our first study seemed to confirm this: Although 18-month-olds showed comprehension of a new word after only limited exposure to it, 13-month-olds did not. However, subsequent studies revealed that this finding was caused by the demands of the comprehension test rather than to a lack of learning on the part of the 13-month-olds.

In Studies 2 through 4, in which we simplified the comprehension test by limiting the number and type of questions asked of any one child and blocking questions of a given type together, 13-month-olds consistently chose the correct object at above-chance levels. Because the training phase was identical in all of the studies, the improved performance of 13-month-olds in Studies 2 through 4 most likely reflects the changes we made in the testing procedures. In these studies, when age differences in performance emerged, they reflected poorer performance in general by 13-month-olds, rather than a deficit on new label trials alone: Although there were main effects of age group in two studies, there was no significant Age × Condition interaction in any of the four studies. Moreover, in Study 4 there were no age or condition differences in performance. In this study, even though there was a 24-hr delay between training and testing, 13-month-olds performed as well as 18-month-olds and chose correctly at the same rate on familiar label and new label trials.

Because the experimenter who administered the comprehension test was unaware of which of two new objects had been labeled for the child, this good performance cannot be a result of inadvertent cues by the experimenter. Moreover, this above-chance responding cannot simply be caused by children's preferring objects that have been previously labeled, because children showed no preference for the previously labeled object on control trials. Rather, the performance of both 13- and 18-month-olds must reflect learning the mapping between a new word and its referent.

Children in both age groups showed word learning under relatively stringent testing conditions. In each study, the training phase and comprehension test were administered by different experimenters using different sets of play activities. Thus, children were able to show their knowledge of the new word in a situation that differed from the training conditions. In addition, in all but one study, children generalized a newly learned label to novel exemplars of the training category. Even when we imposed a 24-hr delay between exposure to the new word and comprehension testing, both 13- and 18-month-olds were systematically correct in their responses on the comprehension test.

Although we did not directly measure the naming explosion in production, we used criteria—age and productive vocabulary size—that have been shown to be good indicators of whether children have passed the naming explosion to select groups of children who were likely to be at opposite ends of naming explosion. On the basis of these criteria, the 13-month-olds were most likely before the age of the naming explosion. However, some of the 18-month-olds may not have had a naming explosion. Nevertheless, our findings show that 13-month-olds, who are about 6 months away from the age at which the naming explosion is typically seen, and who have very small productive vocabularies, are able to learn a new word in comprehension after hearing it only nine times.

Thus, although many explanations for the naming explosion in production predict a concomitant spurt in the ability to learn a single new word, much to our surprise, we did not find one. These findings argue against theories that posit that the naming explosion is the result of broad changes in word learning competence. Thirteen-month-olds showed no signs of going through a "laborious game of building up an association between a sound and an object" (Lock, 1980, p. 120). Rather than requiring hundreds of learning trials, they acquired a new word in comprehension after hearing it repeated only nine times over the course of about 5 min. Thirteen-month-olds clearly have some aspects of word learning figured out. Obviously, however, they must lack other abilities that make this early learning less effective than the word learning of older children. Thus, young children may often map new labels to objects quickly and efficiently, but lack other abilities such as those that enable them to effectively organize their lexicon, or to recall newly learned items in the face of heightened information-processing demands. Without these abilities, children would be unable to rapidly acquire an extensive productive lexicon. Conversely, developmental advances in any of these abilities could contribute to the spurt in productive vocabulary.

This explanation offers a way to reconcile the results of these studies with the findings of Goldfield and Reznick (1990) and Lucariello (1987), which showed increases in receptive vocabulary acquisition at the time of the naming explosion. Recall that Lucariello (1987) found that children with postnaming explosion vocabulary levels produced and comprehended more of a set of newly trained words than children with prenaming explosion vocabulary levels, and Goldfield and Reznick (1990) reported increases in the number of words children comprehend at the time of the naming explosion in production. Both of these findings may reflect changes in children's ability to organize and retrieve newly learned information rather than changes in the ability to learn per se.

Alternatively, the naming explosion could result from developmental changes that are specific to production. As discussed in the introduction, many accounts of the naming explosion invoke changes that would affect comprehension of language as profoundly as production (e.g., the realization that words are symbols, changes in conceptual structure, or the onset of word learning constraints). However, language production and comprehension are subserved, in part, by different sets of skills, and the course of development for these two abilities may differ as a result (Clark & Hecht, 1983). Thus, the naming explosion could be the result of the acquisition of some key productive ability. This possibility is supported by Dapretto, Bjork, and Gelman (1991), who found that the naming explosion is linked to developments in recall memory for words.

Finally, we note that although our findings suggest that the productive naming explosion does not reduce to an increased ability to learn a new word, they do not rule out the possibility of a shift from a prelinguistic to a linguistic mode of language processing during the second year of life. The mode change theories of the naming explosion may be right about the changes they propose but wrong about the effectiveness of prelinguistic "word learning" mechanisms. Perhaps prenaming explosion children have highly effective nonlinguistic associative mechanisms that allow them to map sound patterns onto the environmental entities that are presented with them, whereas postnaming explosion children learn words through more advanced linguistic mechanisms. The correct performance of 13-month-olds on the multiple-choice test could conceivably be the result of simple associative learning rather than word learning.

This leads us to confront the most fundamental of questions about early word learning: What counts as a word? The widely accepted standard is to take performance on tests that require children to choose, look at, point to, or touch the correct item in response to a verbal request as indicating comprehension of a word in preschoolers as well as infants (e.g., Fernald & McRoberts, 1991; Golinkoff et al., 1987; Landau, Smith, & Jones, 1988; Markman & Hutchinson, 1984; Reznick, 1990; Taylor & Gelman, 1988; Thomas et al., 1981). These responses do not, however, necessarily differentiate between learning a nonlinguistic associate and learning a linguistic symbol (cf. Huttenlocher & Higgins, 1978). Although no one seriously doubts whether preschoolers understand words as linguistic entities, given our findings of early competence, a more stringent test for comprehension of a linguistic symbol in 1-year-olds may be required.

A number of investigators have proposed criteria for symbolic word use in infants as well as nonhuman primates, including using a word in the absence of the referent (Hockett, 1960; Huttenlocher & Higgins, 1978; Pettito, 1988), using a word to fulfill several different pragmatic and semantic functions (Dore, 1978; Hockett, 1960; Huttenlocher, 1974; Macnamara, 1982; Pettito, 1988), using words to describe and categorize objects (Hockett, 1960; Macnamara, 1982; Pettito, 1988; Premack, 1990), and using words with the intention of communicating (Grice, 1975; Macnamara, 1982; Premack, 1990; Terrace, 1985). Note, however, that these analyses all require production of potential symbols, not comprehension. Given the present findings, an important direction for future research is to develop comparable criteria for comprehension.

Recent work by Baldwin (1991, 1993) provides a first step in this direction. For mature language users, understanding a speaker's intentions plays a crucial role in language comprehension. If words are learned by young babies as nonlinguistic associates, then a mere contingency between some sound pattern and the presence of some object would be sufficient to produce a learned association. Alternatively, if young word learners understand the pragmatic aspects of reference, they should seek out and use cues to the speaker's intentions when interpreting new words. Baldwin found that infants as young as 16–18 months are sensitive to these cues in word learning. In her studies, babies were introduced to several new words and new objects. On some trials, the experimenter uttered the label while looking at the object the child was holding. On other trials, the experimenter uttered a label while looking into a bucket, away from the toy the child was holding and looking at. Even though there was a contingency between the presence of a new toy and the presence of a new label, babies resisted accepting the new label for the toy they held if the speaker's attention was clearly elsewhere. Eighteen-month-olds went a step further and inferred that the new word was the name for the object hidden in the bucket.

The fast word learning of 13-month-olds highlights the need to extend Baldwin's (1991, 1993) work to younger infants as well as exploring other facets of understanding words as linguistic entities. For now, we conclude that, when the measure of learning is comprehension, children who have approximately 6 months to go before the spurt in production are nevertheless able to map a new object label to its referent after only limited exposure.

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