The Relative Strengths of Indirect and Direct Word Learning

Vikram K. Jaswal and Ellen M. Markman
Stanford University

Indirect word learning lacks many of the overt social-pragmatic cues to reference available in direct word learning, yet the two result in equally robust mappings when comprehension is assessed immediately after learning. The 3 studies reported here investigated how 3-year-olds ($N = 96$) respond to more challenging tests of the relative strengths of indirect and direct word learning. In Study 1, children's comprehension of indirectly and directly learned proper and common names was tested after a 2-day delay. Both types of learning resulted in proper name mappings that picked out an individual and in common name mappings that could be extended to another category member. In Studies 2 and 3, children's comprehension was tested after they had been provided with additional, and sometimes inconsistent, information about the scope of previously learned words. There was a hint of a difference between indirect and direct word learning, but results overall suggested that the two were equivalent.

Very young children can learn new words rapidly, apparently effortlessly, and often accurately. For example, given just nine exposures to a new noun paired with unambiguous reference to a novel object, even 13-month-olds can learn and extend the new word appropriately in comprehension even after a delay of 24 hr (Woodward, Markman, & Fitzsimmons, 1994). Many studies on early word learning have used just this type of unambiguous labeling, which includes a deictic statement and an established joint focus of attention, to explore how children interpret new words provided in ostensive situations (e.g., Hall, Waxman, & Hurwitz, 1993; Imai, Gentner, & Uchida, 1994; Landau, Smith, & Jones, 1988; Markman & Wachtel, 1988; Soja, Carey, & Spelke, 1991; Waxman & Markow, 1995). But children also learn words in other, less ostensive contexts (L. Bloom, 1993). Indeed, only a small proportion of child-directed speech introduces words in isolation or in deictic statements (Snow & Ferguson, 1977; but see Brent & Siskind, 2001), and it is claimed that there are cultures in which children may not be exposed to ostensive labeling at all (Schieffelin, 1985). Thus, much of a child's vocabulary must be learned indirectly in situations in which the speaker does not necessarily share a joint focus of attention with the child at the moment an unknown word is introduced. In these situations, a variety of other sources of information can lead children to the correct interpretation of a new word (Hollich, Hirsh-Pasek, & Golinkoff, 2000; see P. Bloom, 2000, and Woodward & Markman, 1998, for reviews). In the studies reported in this article, we examined how well indirectly learned words functioned relative to directly learned ones under a variety of challenging circumstances.

Behavioral cues indicating the speaker's communicative intent offer a relatively direct route to disambiguating reference and represent one powerful source of information available to children learning words. For example, Baldwin (1991, 1993) found that 16-month-old infants did not map a new word to a salient object unless the speaker's eye gaze was directed at that object—a strategy that can prevent children from mapping a new word onto an incorrect referent. In another demonstration of children's ability to make use of direct cues signaling intent, Tomasello and Barton (1994) found that 24-month-olds could learn novel verbs and object labels when they were introduced before the presentation of the novel action or object as well as they learned them when they were introduced during the presentation. In fact, Akhtar and Tomasello (1996) found that under some circumstances, 2-year-olds could learn a new object label even when the label's referent was never presented with the word as long as the speaker behaviorally indicated an intent to refer to a particular unseen object. Recently, Akhtar, Jipson, and Callanan (2001) showed that 2-year-olds were as good at learning new object labels and action verbs when they overheard the introduction of the new words as when they were addressed directly. Together, these studies demonstrate that an already established joint focus of attention and temporal contiguity between a word and its referent are not prerequisites for word learning.

By design, the speakers in these studies did not initially share reference with the children; instead, they provided behavioral cues that young children were clearly able to understand and use to disambiguate the object of reference—unambiguous, overt referential cues such as eye gaze, a deictic statement, and so on. When such overt cues are not present, however, children can exploit other sources of information to disambiguate the referent, enabling them to learn a new word indirectly. In fact, these other sources of information are helpful even when there are clear social-pragmatic

cues, because they can help resolve other ambiguities about the word's meaning (e.g., Does it refer to a part? To a property?).

For example, the number of possible interpretations of a new word can be reduced by assumptions children make about word meaning (Golinkoff, Mervis, & Hirsh-Pasek, 1994; Markman, 1989, 1992; Waxman, 1991). One expectation infants and preschoolers seem to have is that a new word applied to a new object will refer to the whole object and not to its parts or properties (Baldwin, 1989; Kobayashi, 1998; Markman & Wachtel, 1988). Another preference children have about new words, and one that can be particularly helpful in the absence of clear social-pragmatic cues, is that each object has only one label (the mutual exclusivity assumption). This expectation allows children to make use of known words to bootstrap into learning new ones. In a simple experimental case of indirect word learning, when shown a pair of objects, one they knew the word for and one they did not (e.g., a shoe and a whisk), and asked to select the referent for a novel word, children as young as 15 months selected the novel object (Markman, 1992; Markman & Wachtel, 1988; Markman, Wasow, & Hansen, in press; Merriman & Bowman, 1989). In fact, Golinkoff, Hirsh-Pasek, Bailey, and Wenger (1992) showed that 2.5-year-olds could use a word they had just learned in this way to learn yet another new word. That is, when shown three familiar objects and one unfamiliar one and asked to select the *dax*, these children selected the unfamiliar object. When then shown a new array consisting of the object they just selected, another new object, and two familiar ones and asked to select the *jick*, they selected the only truly novel object (instead of the one they had just selected as the *dax*).

Another source of information that children can use to learn a new word indirectly, without clear social-pragmatic information, is grammatical form class. In a classic study by Brown (1957), 3- and 4-year-old children saw a picture of a pair of hands kneading a mass of material in a container and heard a sentence such as "In this picture, you can see X." When the new word was introduced as a verb (*sibbing*), children interpreted it as describing the kneading motion; when it was introduced as a count noun (*a sib*), they interpreted it as describing the container; and when it was introduced as a mass noun (*some sib*), they interpreted it as describing the material. Although children are not born recognizing the surface markings that distinguish between various grammatical form classes in their language (e.g., Waxman & Markow, 1995), once they have learned them, they can serve as a valuable source of information (see, e.g., Markman & Jaswal, in press, for an account of how the proper-noun/count-noun form class distinction in English may be learned).

Children can also draw on conceptual information to learn new words in nonostensive situations. For example, Goodman, McDonough, and Brown (1998) showed that 2-year-olds who knew the verb *to feed* and who heard the sentence "Mommy feeds the ferret" correctly inferred that the unknown word *ferret* must refer to an animate thing because only animate things can be fed. Similarly, 2- and 3-year-old children who were asked to "find *Blicket*" correctly inferred that the referent for *Blicket* must be animate because proper names are more often given to animate than to inanimate things (Jaswal & Markman, 2001; Liittschwager & Markman, 1993).

Although children can make use of a number of sources of information to learn new words indirectly, one might expect that a

mapping made directly, through ostensive labeling, would be stronger and more stable. After all, in direct instruction, all the available cues—including the behavioral social-pragmatic ones—converge on the same referent. The child still must interpret the word's meaning, but the object of reference is at least clear. Indeed, Baldwin and Moses (2001) suggested that "the best evidence on which to base the formation of new links between words and things in the world is social in kind: evidence that speakers are intending to talk about those things" (p. 310). What happens when children are faced with a word-learning situation that lacks "the best evidence," an indirect word-learning situation? When faced with a nonostensive situation that lacks overt social-pragmatic cues, children must both disambiguate the referent and interpret the word's meaning—in a sense, adding an extra step (see Hall, Quantz, & Persoage, 2000).

Most studies considering children's ability to use cues other than social-pragmatic ones do not provide a direct comparison between the strength of ostensive and nonostensive word learning. For example, in the Goodman et al. (1998) study showing that 2-year-olds could use the semantic restrictions of a known verb to infer the referent of a new word, there was never a test of how well the inferred words were learned compared with words that were directly trained (although children who failed to infer the appropriate referent also failed to learn the correct referent even after ostensive training). Similarly, in studies showing that children selected a novel referent for a novel word (e.g., Markman & Wachtel, 1988; Merriman & Bowman, 1989), there was no measure of the robustness of indirectly learned mappings compared with more directly learned ones. The Golinkoff et al. (1992) study described earlier sheds some light on this issue in showing that an indirectly learned word serves the role of a familiar one. However, the goal of that study was not to compare explicitly the strength of indirectly learned words with the strength of directly learned ones.

When the two have been compared directly, the findings to date suggest that they result in equally strong mappings. For example, in a previous investigation (Jaswal & Markman, 2001), we tested the extension patterns of indirectly and directly learned proper and common names. Proper and common names differ from each other in three well-studied ways (see Hall, 1999, for a review): First, in English, proper names are not preceded by an article or determiner, whereas common names can be. Second, as mentioned earlier, proper names are more likely to refer to animate than inanimate objects, whereas common names can refer to either. And third, proper names pick out particular individuals, whereas common names can be extended to other members of like kind. A number of studies, beginning with that of Katz, Baker, and Macnamara (1974), have shown that children as young as 17 months are sensitive to these distinctions. In particular, very young children will treat a proper name as referring to an individual provided that the name is given to an animate object. Indeed, the link between proper names and animate individuals is so strong that Gelman and Taylor (1984) found that many 2.5-year-olds who saw a researcher clearly and ostensively label an inanimate object with a proper name actually ignored this training and mapped the new proper name onto an unlabeled animate distractor item instead.

In our previous investigation (Jaswal & Markman, 2001), 2- and 3-year-olds were shown a pair of objects, one having animate features (e.g., eyes, a biological body shape) and one without such features. Children who heard a request such as "Can you point to

Dax?" spontaneously selected the animate object, whereas those who heard "Can you point to *a dax*?" or "Can you point to one?" were about as likely to select the animate object as the inanimate object. Next, these same children were shown an array of three objects: the one they had just selected as the referent for the new word (*target object*); another member of like kind (*generalization object*); and a distractor item of the same animacy but of a different kind (*distractor object*). Children were asked to perform several actions with an object requested with the same name used previously (e.g., "Can you put [*a*] *Dax* in the bucket?"). Results showed that children restricted their selections to the animate target object following proper-name requests, treating the proper name as a marker for a unique individual. However, they selected both the target and generalization objects following common-name requests, treating the common name as a category term. A different group of children that received ostensive training (including social-pragmatic cues such as eye gaze, voice direction, and pointing) on the new names performed similarly. Indeed, the results from indirect and direct word learning were generally equivalent, suggesting that the words learned indirectly functioned as well as words learned directly.

Clearly, young children can learn new words in a variety of nonostensive contexts, and they seem to learn the words as well as they do in more ostensive contexts. However, little is known about how well mappings made indirectly hold up under more challenging circumstances. The studies comparing direct and indirect word learning described earlier—including those requiring the child to monitor overt social-pragmatic cues—used comprehension tests that took place immediately after the learning episode. In the real world, a learner might not encounter a new word or be called on to demonstrate an understanding of it until much later. Thus, our goal in Study 1 was to compare direct and indirect learning when the comprehension test occurred at least 2 days after the learning episode. In Studies 2 and 3, we presented an even more challenging test of the relative strengths of direct and indirect word learning by exploring how children responded to information that was sometimes inconsistent with their expectations about a new word and by considering whether this response varied depending on how they learned the word in the first place.

STUDY 1

Study 1 involved two experimental sessions. In the first session, children were shown a pair of objects, one animate and one inanimate. One group of children was asked to infer the referent for a new proper or common name. Here we expected to replicate earlier studies, which showed that children would select the animate and inanimate objects equally when the new name was common but that they would select the animate object when the new name was proper (Jaswal & Markman, 2001; Liittschwager & Markman, 1993). Another group of children received direct training on animate referents for both proper and common names. At a second session occurring 2 days later for most participants, children were shown the same referent they had selected or been trained on during Session 1 (target), another exemplar of like kind (generalization), and a distractor. They were asked to perform several actions with an object requested with the same proper or common name used in Session 1. Here the question was whether indirectly learned proper and common names would function as

robustly as directly learned ones even after a delay: Proper names should pick out only one particular referent, and common names should be extended to other members of like kind.

Method

Participants

Thirty-two young 3-year-olds (mean age = 3 years 0 months; range = 2 years 8 months to 3 years 2 months) of middle-class and upper-middle-class backgrounds participated in two, 5- to 10-min sessions at a university-affiliated preschool (31 of the children were enrolled at the school, and 1 was recruited through an advertisement in a parenting magazine). Sixteen were boys, and 16 were girls. Data from 5 additional children were collected but were excluded because of experimenter error (2), refusal to return for the second session (2), or failure to cooperate in the second session (1). In this and subsequent studies, the experimenter was familiar to the children, having spent at least 1 half-day in their classroom prior to testing or several minutes getting acquainted with them.

Design

Children were randomly assigned to one of two conditions: an indirect learning condition, in which the child inferred the referent for one new common name and one new proper name, or a direct learning condition, in which the experimenter ostensively trained the referent for each name. The result was 16 children per condition, balanced for sex. The average ages for the direct and indirect learning conditions were, respectively, 2 years 11 months and 3 years 0 months. Of the 5 additional children whose data were excluded, 1 who refused to return for the second session was from the indirect learning condition; the remainder were from the direct learning condition.

Children in each condition participated in one common-name trial block and one proper-name trial block during each session. In Session 1, each trial block consisted of a labeling trial and a baseline trial. In Session 2, each trial block consisted of a generalization trial.

Materials

We used the same set of objects used in our previous investigation (Jaswal & Markman, 2001), which consisted of four pairs of novel toys: two pairs of animate toys and two pairs of inanimate toys. Animate toys represented animals or creatures, typically with a face and arms and legs; inanimate toys were nonliving objects. Prior to the start of testing, we matched each animate pair with an inanimate pair, attempting to match attractiveness and size between animacy categories. (Baseline trials described below, as well as data from our previous study [Jaswal & Markman, 2001] confirmed that members of the sets were equal in attractiveness.) The result, as shown in Table 1, was two sets of four stimuli (two

Table 1
Stimulus Sets for Studies 1–3

Set	Stimuli	
	Animate	Inanimate
A	Stuffed mosquito*	Bendable wand*
	Kooshling doll*	Kaleidoscope
B	Seal character*	Shuttlecock*
	Dolphin character*	Suction cup

Note. Two slightly different exemplars of each object were used. Stimuli marked with asterisks were used in Study 3.

animate and two inanimate). For purposes of the generalization trial (described below), there were two slightly different exemplars of each toy. Exemplars of the same animate toy differed along dimensions such as hair color and style, clothing, and eye color, and exemplars of the same inanimate toy differed in color. Altogether, 16 objects were used in the study.

In addition, small plastic replicas of a shoe, a dog, a chair, Barney, Big Bird, and Winnie-the-Pooh served as stimuli for warm-up trials, and a tray with three equally spaced wells was used to present stimuli in Session 2. Also during Session 2, eight small activity props were used: a hamster ball, a puppet, a chute, a mousepad, a cloth, a bucket, a trashcan, and a box. Finally, a large balance was used during a filler task at the end of Session 1.

Procedure

Session 1

In Session 1, children either inferred the referents for new proper and common names (indirect learning condition) or were trained on them (direct learning condition).

Warm-up trials. Participants were tested individually in a quiet room at the preschool. The experimental session began with two warm-up trials, the purpose of which was to familiarize children with the requirements of the task. On one trial, they were asked to select either a shoe or a dog, and on the other trial, they were asked to select either Big Bird or Barney. Corrective feedback was given if necessary, and after a correct selection or a correction, the child was allowed to play with both objects. The second warm-up trial proceeded as the first but with the other pair of objects. The pair of objects presented first and the particular item requested from a pair were randomly determined. The requested item appeared once on the left and once on the right. Two children were corrected on both warm-up trials, and 1 child was corrected once.

After the warm-up trials, all children were presented with two experimental trial blocks: one common-name trial block and one proper-name trial block. In the common-name trial block, the name was preceded by an indefinite article (e.g., *a blicket*); in the proper-name trial block, it was not (e.g., *Blicket*). The word used was *blicket* on one trial block and *toma* on the other. The order of the two trial blocks, the particular animate–inanimate pair assigned to each, and the name used in each were counterbalanced across children.

Half of the children in each condition received the labeling trial first on both trial blocks, and half received the baseline trial first. Prior to this first trial, children were allowed to examine and handle the objects to be used in that trial block. This preexposure served to familiarize the children with the objects.

Labeling trial. All children were asked, "Would you like to see [*a*] *Blicket*?" Those in the indirect learning condition were then asked, "Do you think you can find [*a*] *Blicket*?" Those in the direct learning condition were told, "I'm going to show you [*a*] *Blicket*." All children were then shown one animate object and one inanimate one. Children in the indirect learning condition heard the researcher ask, "Where is [*a*] *Blicket*? Can you put your finger right on [*a*] *Blicket*?" Children in the direct learning condition watched the researcher grasp the animate object with one hand, point to it with the other, look at it, and say "This is [*a*] *Blicket*. Can you put your finger right on [*a*] *Blicket*?" All children in the direct learning condition successfully pointed to or touched the just-labeled animate object. After the labeling episode, all children were provided with neutral feedback (e.g., "Thank you") and allowed to play with both objects. Children in both conditions heard the label a total of four times and received the same interactive experience with the objects. The left–right position of the animate and inanimate objects was counterbalanced so that the animate object fell on the left on one trial block and on the right on the other.

Baseline trial. The baseline trial tested whether there was a preference for the animate or inanimate object when no new name was introduced. Children in both conditions were told, "This time, I want you to choose

one, whichever one you want to, okay?" They were then shown the animate–inanimate pair associated with the particular trial block and asked, "Can you put your finger right on one?" If they were reluctant to make a selection, they were encouraged to choose "whichever one you want to look at." After a selection, neutral feedback was provided, and children were allowed to play with both objects. The left–right configuration of the objects was opposite to the configuration in the labeling trial of that trial block.

Filler task. After completion of the two trial blocks, all children then participated in another, unrelated task for about 3–5 min. Children used a large balance to weigh and/or catapult the warm-up items. The purpose of this task was to have the last activity in Session 1 be something especially enjoyable so that children would be eager to return for Session 2.

Session 2

For most children, Session 2 took place 2 days after Session 1. It tested whether they would extend the proper and common names learned in Session 1 to another member of like kind or to a distractor. Because of illness and absence, not all subjects were available to be tested 2 days later, so they were tested at the next available opportunity: In the direct learning condition, the average delay was 2.7 days (range = 2–7 days); in the indirect learning condition, the average delay was 3.4 days (range = 2–9 days). The length of delay did not differ by condition, $t(30) = 1.06$, *ns*.

Warm-up trials. Children again participated in two warm-up trials corresponding to the warm-up trials from Session 1. On both trials, they were shown three warm-up objects presented on a tray, and they were asked to perform four randomly determined actions with one of the objects (e.g., "Can you put Big Bird down the chute?"). Corrective feedback was given if necessary. On one trial, the warm-up objects were Big Bird, Barney, and Winnie-the-Pooh; on the other trial, they were a shoe, a dog, and a miniature chair. The positions of the three objects on the tray were random with the constraint that the requested object appear in the left, middle, and right positions at least once. After completing four actions with one set of objects, children completed four different actions with the other set. One child was corrected four times, and 3 children were corrected once. The eight actions requested were to put the object in the box, to put it in the bucket, to put it down the chute, to put it on a mat, to put it in a trashcan, to put it under a cloth, to put it in a puppet's mouth, and to put it in a spinning ball.

Generalization trials. The generalization trials for children in the indirect and direct learning conditions were identical. Children saw three objects presented on a tray: a target, a generalization stimulus, and a distractor. The target was the same object that they had selected in Session 1 (indirect learning condition) or the one that had been labeled for them in Session 1 (direct learning condition); the generalization stimulus was another member of the same category as the target; and the distractor stimulus was an object from a category different from that of the target and generalization stimuli but of the same animacy. Because of the way the stimuli were counterbalanced, objects that served as targets for some children served as generalization stimuli for others; similarly, stimuli that were targets or generalization stimuli for some children served as distractors for others.

Children were asked to perform eight actions: Four of those requests included the name that had been associated with the target in Session 1 (test requests: "Can you put [*a*] *Blicket* down the chute?"), and the other four requests included the word *one* instead (baseline requests: "Can you put one in the bucket?"). The purpose of the baseline requests was to ensure that any effect following a test request was the result of the name rather than of a preference based, for example, on the attention drawn to the named object. The order of the test and baseline requests was random with two constraints: The first request always had to be a test request, and no more than two test or baseline requests could be made successively. The position of the objects on the tray was random with the constraint that the

target appear in each position (left, center, and right) at least once. The eight activity props were the same as those used during the warm-up for Session 2 and were chosen randomly without replacement. After completing the generalization trial corresponding to the first trial block of Session 1, children participated in a second generalization trial corresponding to the second trial block.

Videotape

In this and subsequent studies, sessions were videotaped and scored off-line.

Results and Discussion

Coding of Session 1 involved noting whether children selected the animate or inanimate object in the labeling trials (for children in the indirect learning condition) and the baseline trials (for all children). Coding of Session 2 involved noting the percentage of selections children made of the target, generalization, or distractor stimuli in response to the four test requests and the four baseline requests of each generalization trial. Preliminary analyses indicated no reliable differences in response patterns that were due to sex, order of trial blocks, or order of baseline and labeling trials; subsequent analyses were thus collapsed across these factors. The results are presented in two parts, the first corresponding to analysis of animacy selections in Session 1 and the second corresponding to analysis of the generalization trials in Session 2.

Session 1: Labeling and Baseline Trials

Table 2 shows that in the indirect learning condition, 13 of the 16 children selected the animate object as the referent in the proper name labeling trial, more than would be expected by chance ($p < .05$, binomial expansion). In contrast, there was no animacy preference in the common-name labeling trial for the indirect learning condition ($p > .2$) or in either of the baseline trials for the

Table 2
Number of Children (Out of 16) Selecting Animate Object in Labeling and Baseline Trials

	Indirect learning		Direct learning: Baseline trial
Study	Labeling trial	Baseline trial	
Study 1			
Proper name	13*	5	5
Common name	10	8	9
Study 2			
Proper name	13*	6	7
Common name	6	8	4
Study 3			
Proper name 1	15*	8	4
Proper name 2	14*	7	8

Note. In Studies 1 and 2, children learned a proper name and a common name; in Study 3, they learned two proper names. Children in the indirect learning condition selected between animate and inanimate objects in both the labeling and baseline trials, whereas those in the direct learning condition received ostensive training that the animate object was the referent during the labeling trial and then made a selection between the animate and inanimate objects during the baseline trial.
* Significantly more than chance (8), $p < .05$ by binomial expansion.

indirect or direct learning conditions ($ps > .4$). Thus, as in previous work (Jaswal & Markman, 2001; Liittschwager & Markman, 1993), children clearly used grammatical form class to infer that the referent for a proper name should be animate and that the referent for a common name could be either animate or inanimate.

Session 2: Generalization Trials

At Session 2, we tested whether indirectly learned mappings functioned as well as directly learned ones even after a delay: A proper name should pick out the same individual during this second session as during the first, whereas a common name can be extended to other members of like kind.

Indirect Learning Condition

Common name. The 10 children in the indirect learning condition who had selected the animate object as the referent for the new common name in Session 1 went on to select the animate target, generalization, and distractor objects 43%, 35%, and 21% of the time, respectively, during the test requests of Session 2. The remaining 6 children in the indirect learning condition who had instead selected the inanimate object as the referent in Session 1 selected the inanimate target, generalization, and distractor objects 44%, 40%, and 15% of the time, respectively. The percentage of selections of each type of object was the same regardless of the animacy of the original choice (all $ps > .6$ by t tests); common-name data were therefore collapsed across animacy.

The data from the generalization trial are shown in Figure 1A. When asked to choose an object with the same common name as that used in Session 1, as predicted by a common-name interpretation, children selected the target and generalization objects about equally (44% and 37% of the time, respectively) and at chance levels ($ps > .2$, where chance is 33% because there were three possible objects from which to choose). They selected the distractor 19% of the time, less than would be expected by chance, $t(15) = 2.16$, $p < .05$.

Preferences after baseline requests were different from those after test requests: When children were simply asked to perform an action with any one of the three objects, as shown in Figure 1A, they selected the target less frequently than expected by chance, $t(15) = 2.95$, $p < .05$, and the distractor and generalization objects at chance levels ($ps > .2$).

Proper name. As shown in Figure 1A, the 13 children in the indirect learning condition who selected the animate object as the referent for the proper name during Session 1 clearly treated the proper name as referring to a specific individual during Session 2: After test requests, the target was selected 81% of the time, more frequently than expected by chance, $t(12) = 5.87$, $p < .01$, whereas the generalization and distractor objects were selected less frequently than expected by chance ($ps < .05$). (Note that the degrees of freedom for statistical tests involving the proper-name generalization trial of the indirect learning condition depend on the number of children who selected the animate object in response to a proper-name request during the labeling trial. In this particular case, 13 of the 16 children did so, and so the degrees of freedom for this test are 12. A similar logic applies to the other analyses using these data.) After baseline requests, the three objects were selected at chance levels ($ps > .1$), indicating that the target
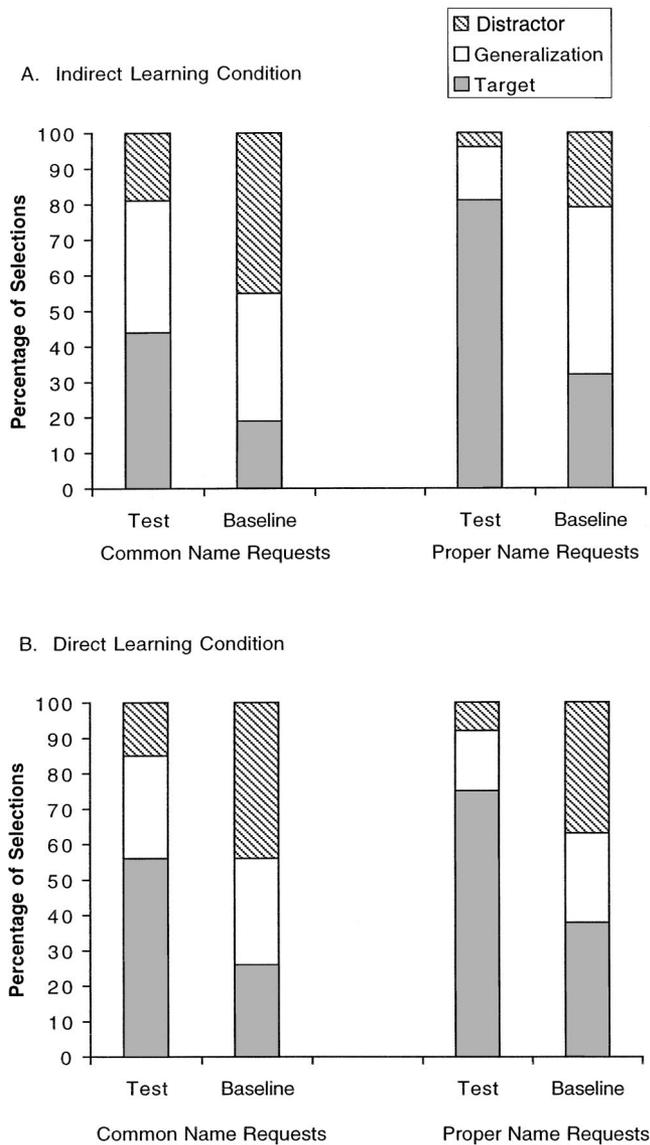
Figure 1. Average percentage of selections of each object in the generalization trials of Study 1 (delay) as a function of the grammatical form class of the request and the type of request.

preference after test requests was due to the name and not to a more general preference.

Importantly, children were more likely to select the target after a proper-name test request than a common-name one, paired $t(12) = 2.82$, $p < .05$. In other words, an indirectly learned proper name was treated as referring to a specific animate individual, whereas an indirectly learned common name was more likely to be extended to another category member. Even after a delay of a few days, indirectly learned mappings of proper and common names were clearly maintained.

Direct Learning Condition

Common name. In Session 1, all 16 children in the direct learning condition received ostensive training that an animate

object was the referent for the common name. After the test requests in Session 2, as Figure 1B shows, these children went on to select the target 56% of the time, more frequently than expected by chance, $t(15) = 2.41$, $p < .05$; the generalization object 29% of the time, a rate not different from chance ($p > .6$); and the distractor just 15% of the time, less frequently than expected by chance, $t(15) = 2.86$, $p < .05$. In contrast, after the four baseline requests, all three items were selected at chance levels ($ps > .1$).

Proper name. All children in the direct learning condition also received training in Session 1 that a different animate object was the referent for a proper name. After proper-name test requests in Session 2, these children selected the target, generalization, and distractor objects 75%, 17%, and 8% of the time, respectively, as shown in Figure 1B. The target was selected at above-chance levels, $t(15) = 5.51$, $p < .01$, whereas the generalization and distractor objects were selected at below-chance levels ($ps < .05$). After baseline requests, the three objects were selected at chance levels ($ps > .1$). As with the children in the indirect learning condition, those in the direct learning condition were also more likely to select the target after a proper-name than a common-name test request, although only marginally so, paired $t(15) = 1.75$, $p = .10$.

Comparing Extension Patterns After Indirect and Direct Learning

To examine whether extension patterns were the same regardless of whether the new names had been inferred or trained, we created difference scores for each subject and each trial block: The percentage of selections of the generalization object after test requests was subtracted from the percentage of selections of the target object after test requests. Positive scores represented more selections of the target object than the generalization object, negative scores represented more selections of the generalization object than the target object, and scores close to 0 represented about equal selections of the target and generalization objects. These difference scores were created for all 16 children in the direct learning condition but only for the 13 children in the indirect learning condition who had spontaneously selected the animate object as the referent for the proper name during Session 1. We chose to use only these 13 children because we were interested in extension patterns for proper names applied to animate as opposed to inanimate objects. Table 3 shows these average difference scores, and all are positive, indicating that children tended to make more selections of the target than the generalization object.

A two-way mixed analysis of variance (ANOVA) was conducted on these difference scores. The between-subjects variable was condition (indirect learning condition vs. direct learning condition), and the within-subject variable was the frame of the request (common name vs. proper name). The only significant effect was of frame, $F(1, 27) = 8.72$, $p < .01$, indicating that the preference for the target was stronger after proper-name test requests than common-name ones. The effect of condition was not significant, $F(1, 27) < 1$, nor was there an interaction between condition and frame, $F(1, 27) < 1$. In other words, proper names were more likely to pick out particular individuals than were common names regardless of whether the names had been inferred or trained. Direct learning, with all of its overt social-pragmatic

Table 3
Average Difference Scores (and Standard Deviations) From Generalization Trials

	Common name		Proper name	
	Indirect learning	Direct learning	Indirect learning	Direct learning
Study 1: Delay	14 (61)	27 (66)	65 (52)	58 (55)
Study 2: Additional/inconsistent information	−17 (43)	−16 (58)	−37 (59)	4 (60)
Study 3: Delay + information manipulation				
Neutral comment			43 (63)	42 (79)
Inconsistent naming event			14 (76)	−3 (74)

Note. Difference scores were calculated by subtracting the percentage of selections of the generalization object after test requests from the percentage of selections of the target after test requests. Positive scores represent more selections of the target object; negative scores represent more selections of the generalization object; scores close to 0 represent about equal selections of the target and generalization objects.

cues to disambiguate the referent, did not result in a more stable mapping than indirect learning, which lacked those cues.

Summary

Results from this delayed extension test were quite similar to those from the immediate test in our previous investigation (Jaswal & Markman, 2001, Studies 1 and 2), in which there was also no statistical difference between direct and indirect learning and in which the target was also selected more frequently after proper-name requests than common-name ones. Despite the present study's requirement that the mappings be maintained over a delay, indirect learning was once again as robust as direct learning.

In this and most other word-learning studies, children were exposed to a new word, and then, at some later point, they were tested on it to determine whether they learned the word accurately. But there is another important aspect of word learning that has received relatively little consideration—namely, the process by which children revise or augment their initial hypotheses about word meaning in the face of new information. Researchers have pointed out that a single exposure to most new words cannot provide children with the complete adult meaning of the new word (e.g., Dockrell & Campbell, 1986; Goodman et al., 1998). Indeed, Mervis (1987) has argued that what she calls "child-basic categories" encoded in early words are often different from "adult-basic" ones, and how those early categories evolve depends crucially on the way that information is subsequently provided: In some circumstances, information is rejected, and in other situations, it is not. In Studies 2 and 3, we explored this issue by considering whether there are differences in how children deal with subsequent (and sometime inconsistent) information about a word depending on how the word was learned in the first place. This provides another, more challenging method to investigate the relative strengths of indirect and direct word learning.

STUDY 2

In Study 2, children learned new proper and common names either indirectly or directly, as in Study 1, and then were tested on their extension of these names. However, after selecting the referent for a new name (indirect learning condition), or after being trained that an animate object was the referent (direct learning

condition), children watched as the researcher subtly, but unambiguously, labeled the generalization object with the same name just given to the target. When the name was proper, this information violated an expectation, because Study 1 and previous work have demonstrated that children expect a proper name to apply only to a single, animate object (Gelman & Taylor, 1984; Hall, 1999; Jaswal & Markman, 2001; Katz et al., 1974; Sorrentino, 2001). When the name was common, the information did not violate an expectation but actually accurately characterized the scope of the new word—namely, that it applied to another member of like kind. In both proper- and common-name cases, children could interpret the researcher's label as an error to be ignored, as a correction of their original selection, or as information to be incorporated in some way into their representation of the word's meaning. Although indirect and direct word learning have so far appeared equivalent, mappings made indirectly without overt social-pragmatic cues indicating reference may be more corrigible than those made directly.

Method

Participants

Thirty-two older 3-year-olds (mean age = 3 years 8 months; range = 3 years 4 months to 4 years 2 months) of middle-class and upper-middle-class backgrounds participated in a single 10- to 15-min session at a university-affiliated preschool. Sixteen were boys, and 16 were girls. None had participated in Study 1. Data from 4 additional children were excluded because of experimenter error (2), video failure (1), or failure to understand any aspect of the task (1).

Design

As in Study 1, children were randomly assigned to one of the two conditions: indirect learning or direct learning. The result was 16 children per condition, balanced for sex. The average age in each condition was 3 years 8 months. Of the children who were excluded, 3 were from the indirect condition, and 1 was from the direct condition. Children in each condition participated in a single session consisting of one common-name trial block and one proper-name trial block. Each trial block consisted of a labeling trial and a baseline trial and was followed by the researcher providing inconsistent (in the proper-name trial block) or additional (in the common-name trial block) information and then a generalization trial.

Materials

The materials were the same as those used in Study 1.

Procedure

Warm-Up Trials

The warm-up trials were the same as those used in Study 1. This time, however, children made a selection between, for example, a shoe and a dog, and then they were immediately shown the shoe, the dog, and the miniature chair and asked to perform four actions with one object. Two children were corrected once on the initial selection, 2 were prevented from selecting the wrong object once during the activity portion of the warm-up trials, and 2 were prevented from doing so twice.

Experimental Trials

Following the warm-up trials, as in Study 1, all children were presented with two experimental trial blocks: one common-name block and one proper-name block. Each trial block consisted of a labeling trial, a baseline trial, and a generalization trial. The only differences from Study 1 were that all three trials occurred during the same session and that the researcher provided inconsistent (in the proper-name trial block) or additional (in the common-name trial block) information before each generalization trial.

The information manipulation was carried out in the following way: After a child had inferred the referent for a new proper or common name (in the indirect learning condition) or been trained on it (in the direct learning condition), the researcher (V. K. Jaswal) said, "Let me just get set up for the next part." He then introduced the target or distractor object, saying "We're going to need this," and placed it on a small overturned box. Next, he introduced the target or distractor object (whichever had not just been introduced), saying "And we're going to need this," and placed it on the box next to the other object. Finally, he introduced the generalization object, and said, for example, "And we're going to need [this] *Blicket*," using the same proper or common name that had previously been associated with the target. In the proper-name trial block, this naming event was inconsistent because *Blicket* should apply only to the target; in the common-name trial block, the naming event merely gives additional information about the scope of the common name—that it applies also to the generalization object. The generalization object was then placed on the box next to the other objects for about 5–10 s while the researcher busied himself preparing the activity props for the generalization trial.

All objects were then removed from the table, and for the next minute, children participated in the same unrelated filler task used in Study 1, which involved the weighing and catapulting of the warm-up objects. The purpose of this task was to reduce demand characteristics that might occur if the generalization trial immediately followed the information manipulation. Pragmatically, it seemed (and pilot testing revealed it to be) unnatural to provide a particular piece of information and then to test that information immediately. (Half of the children received the same 1-min filler task before the information manipulation as well as after it; results were the same as when there was only one filler task, and so the data are reported together.)

Even if children make primary or exclusive selections of one object after test requests in the generalization trial, they might still be willing to extend the tested name to another object if asked. To investigate this possibility, after each generalization trial, the researcher pointed to the target, generalization, and distractor objects used in that trial, one at a time and in a random order, and asked the child to respond "yes" or "no" when asked whether each was called by the tested name (e.g., "Is this [a] *Blicket*?").

Results and Discussion

Coding of selections was conducted as in Study 1. (One child's responses were scored during his session rather than from video-

tape because he did not have permission to be videotaped.) Preliminary analyses indicated no reliable differences in response patterns that were due to sex, order of trial blocks, or order of baseline and labeling trials; subsequent analyses were collapsed across these factors.

Labeling and Baseline Trials

Results of the labeling and baseline trials were similar to those of Study 1, as shown in Table 2: In the indirect learning condition, 13 of the 16 children selected the animate object as the referent in the proper-name labeling trial, more than would be expected by chance ($p < .05$, binomial expansion). In contrast, there were no preferences for the animate object in the common-name labeling trial for the indirect learning condition ($p > .8$) or in either of the baseline trials for the indirect or direct learning conditions ($ps > .5$).

Generalization Trials

The critical manipulation in this study was that before each generalization trial, the researcher labeled the *generalization* object with the same proper or common name that had been used earlier for the target. For proper names, this labeling was inconsistent with the original information. For common names, the labeling was entirely consistent with what we knew children expected the scope of the new common name to be. In what follows, to keep the terminology consistent with that in Study 1, we refer to the object originally selected or named in the labeling trial as the *target*, the object of like kind about which the researcher made the offhand comment as the *generalization object*, and the object of different kind as the *distractor*.

Indirect Learning Condition

Common name. The 6 children in the indirect learning condition who had selected the animate object as the referent for the new common name selected the animate target, generalization, and distractor objects 22%, 76%, and 1% of the time, respectively, during the test requests of the generalization trial. The remaining 10 children in the indirect learning condition who had instead chosen the inanimate object as the referent selected the inanimate target, generalization, and distractor objects 40%, 52%, and 8% of the time, respectively. As in Study 1, the percentage of selections of each type of object was the same regardless of the animacy of the original choice (all $ps > .05$ by t tests); common-name data were therefore collapsed across animacy.

The data from the generalization trial are shown in Figure 2A. When asked to perform an activity with an object requested by a common name, children selected the generalization object 61% of the time, more frequently than expected by chance, $t(15) = 4.49$, $p < .01$. The target was selected 33% of the time, a rate that was clearly not different from chance, and the distractor was selected just 6% of the time, less frequently than by chance, $t(15) = 9.8$, $p < .01$. When children were simply asked to select any one of the three objects in baseline requests, they showed a different pattern of responses, as shown in Figure 2A, selecting the distractor more frequently than by chance, $t(15) = 3.05$, $p < .01$; the target at
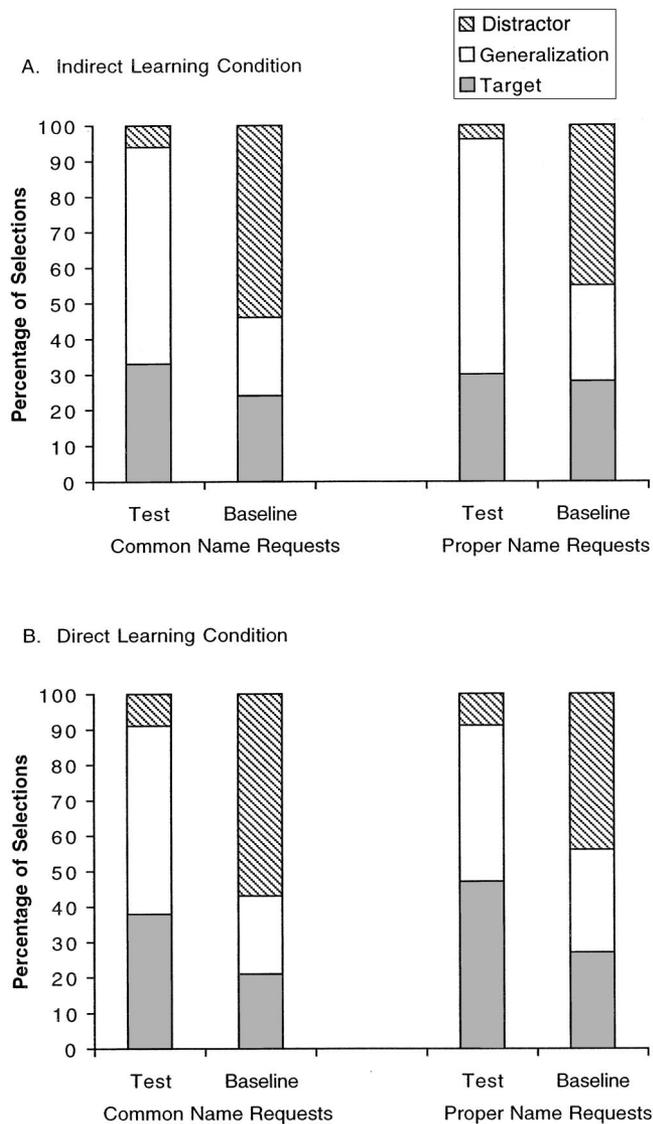
Figure 2. Average percentage of selections of each object in the generalization trials of Study 2 (additional/inconsistent information) as a function of the grammatical form class of the request and the type of request.

chance levels ($p > .05$); and the generalization object less frequently than by chance, $t(15) = 2.5, p < .05$.

Proper name. Even following proper-name requests, and in contrast to the results of Study 1, children who learned the new name indirectly were most likely to select the generalization object after a test request. Figure 2A shows that the 13 children who spontaneously selected the animate object as the referent for the proper name went on to select the target, generalization, and distractor objects 30%, 66%, and 4% of the time, respectively. As these numbers suggest, the target was selected at chance levels ($p > .6$); the generalization object was selected more frequently than expected by chance, $t(12) = 4.05, p < .01$; and the distractor was selected less frequently than expected by chance, $t(12) = 11.31, p < .01$. After baseline requests, the three objects were selected at chance levels ($ps > .2$). Unlike in Study 1, where

the target was selected more frequently after proper-name than common-name test requests, in Study 2, the target was selected at equivalent levels in both ($p > .4$).

Direct Learning Condition

Common name. The 16 children in the direct learning condition received ostensive training that an animate object was the referent for the common name and then heard the researcher call the generalization object by the same name. Figure 2B shows that the pattern of results from the generalization trial was similar to that of children in the indirect learning condition: They selected the generalization object 53% of the time, more frequently than by chance, $t(15) = 2.52, p < .05$; the target 38% of the time, at chance levels ($p > .6$); and the distractor 9% of the time, less frequently than by chance, $t(15) = 3.74, p < .01$. The pattern after baseline requests showed that the distractor was selected more frequently than expected by chance, $t(15) = 2.78, p < .05$, and that the generalization and target objects were selected at chance levels ($ps > .05$).

Proper name. The same children also received training that another animate object was the referent for a proper name and then heard the researcher call the generalization object by that proper name. Unlike the generalization trial results from the indirect learning condition, this time children were equally likely to select the target (47%) and the generalization object (43%), and both were selected at chance levels ($p > .05$). The distractor was selected 9% of the time, less frequently than chance, $t(15) = 6.43$, $p < .01$. After baseline requests, the three objects were selected at chance levels ($ps > .1$). Despite a slight tendency to make more selections of the target after proper-name than common-name test requests, the target was actually selected at equivalent levels following both ($p > .4$), as in the indirect learning condition.

Comparing Extension Patterns After Indirect and Direct Learning

The analyses up to this point indicate, once again, that indirect and direct word learning may be equivalent. In both cases (and in contrast to the results of Study 1), the target was selected at the same levels after both proper- and common-name test requests, and this was true both when the names were learned indirectly and when they were learned directly. To test the effect of type of learning more directly, we created difference scores like those used in Study 1, representing the difference between the percentage of target selections and the percentage of generalization object selections after test requests. We used data from all children in the direct learning condition but only data from those 13 children in the indirect learning condition who had spontaneously selected the animate object as the referent for the proper name. Table 3 shows these difference scores, which are mostly negative, indicating that children tended to make more selections of the generalization object than the target—the opposite of what was found in Study 1.

Using these data, we conducted a two-way mixed ANOVA analogous to the one conducted in Study 1. The between-subjects variable was condition (indirect learning condition vs. direct learning condition), and the within-subject variable was the frame of the request (common name vs. proper name). Unlike in Study 1, the effect of frame was not significant, $F(1, 27) < 1$. This time,

however, there was a hint of a difference between indirect and direct learning: There was a marginal effect of condition, $F(1, 27) = 3.09$, $p < .10$, indicating that the preference for the generalization stimulus may have been stronger in the indirect learning condition. There was no interaction between frame and condition, $F(1, 27) = 1.33$, ns, which suggests that the preference for the generalization object in the indirect learning condition was stronger for both proper and common names.

The naming probes that followed each generalization trial offered an additional measure of extension. Children were simply asked to respond "yes" or "no" when asked whether the target, generalization object, and distractor could be called by the tested name. For the sake of consistency with the difference score analyses, we report data from all children in the direct learning condition but only data from the 13 children in the indirect learning condition who spontaneously selected the animate object as the referent for the new proper name. As shown in Table 4, 8 children in the indirect learning condition agreed that the target and generalization objects were both referents of the new name, but only 3 in the direct learning condition did so. In contrast, whereas only 3 children in the indirect learning condition agreed that a single object (target, generalization object, or distractor) was a referent of the new name, 10 in the direct learning condition did so. The distributions in the two conditions were significantly different from each other, $\chi^2(1, N = 24) = 5.92$, $p < .05$, and remained significantly different from each other when we included another category corresponding to the "other" responses, $\chi^2(2, N = 29) = 6.00$, $p < .05$.

However, in the common-name trial block, children in both the indirect and direct learning conditions tended to agree that both the target and generalization objects could be called by the common name. Eleven children in the indirect learning condition and 9 in the direct learning condition agreed that both the target and the generalization object were referents for the new common name, whereas 2 children in the indirect learning condition and 6 in the direct learning condition agreed that only a single object was the referent. The distributions in the two conditions were not different from each other, $\chi^2(1, N = 28) = 2.07$, ns, nor were they different from each other when we included the third category corresponding to "other" responses, $\chi^2(2, N = 29) = 2.92$, ns.

These probe data suggest that most children in the indirect learning condition revised their hypothesis about the proper name's referent such that the name could apply to both the target and the generalization object. Whether this means that they treated the name as a common name or as a brand name (e.g., two Big Birds, two Barneys, two Blickets) cannot be determined from the available data. Nonetheless, the interesting feature of the probe data is that many children in the direct learning condition may also have revised their hypothesis about the new name's referent, but they apparently still treated the proper name as applying to a single individual. In contrast, most children in both conditions interpreted the common name as applying to both objects.

Provocative as these data are in suggesting a difference between indirect and direct word learning, a note of caution must be inserted at this point. Although some researchers have had success using yes/no questions as their primary response measure (e.g., Hall, 1994, 1996), we have often found these data uninterpretable: Without extensive pretraining, some children require a good deal of coaxing to respond, fail to understand that agreeing once does not preclude them from agreeing again, or give responses that are

Table 4

Distribution of Children's Responses to Yes/No Naming Probe

Condition	n^a	Single-object responses			Target and generalization objects	Other[b]
		Target	Generalization	Distractor		
Study 2						
Proper name						
Indirect	13	2	1	0	8	2
Direct	16	5	3	2	3	3
Common name						
Indirect	13	1	1	0	11	0
Direct	16	5	0	1	9	1
Study 3						
Neutral comment						
Indirect	13	8	1	2	1	1
Direct	15	12	1	0	2	0
Inconsistent naming event						
Indirect	14	4	3	0	5	2
Direct	16	2	5	3	5	1

Note. Children could agree, by saying "yes" or "no", that none, one, two, or all three of the objects (target, generalization, and distractor) were referents of the tested name.
[a] The number of children asked the yes/no probe question was different across conditions and manipulations because these data exclude children in the indirect condition who selected the inanimate object as the referent for the new proper name. In addition, the researcher erroneously omitted the question for 2 children in Study 3 (1 each in the neutral comment indirect and direct learning conditions).   [b] The Other category includes all other responses, including that all three objects were referents of the name, that none of the objects were referents of the name, and so forth. These responses are grouped together because no more than 2 children in any condition responded with one of these patterns.

incompatible with those they just made during the activity-based generalization trial. Furthermore, the probe data might lead one to expect an interaction between condition and frame, and yet in the ANOVA on the difference scores from the generalization trial, there was no interaction. That slightly different results were obtained depending on the task used (activity-based generalization trial vs. yes/no trial) will require further investigation.

Summary

Children who learned a proper name for one individual and then heard the researcher use the same name to make an offhand reference to a different individual certainly were influenced by that inconsistent naming event, selecting the generalization object as a referent for the name more frequently than in previous studies. There was a hint of a difference in the extent to which children who learned the new names indirectly were influenced relative to those who learned the names directly, the first indication that indirect and direct word learning may not always be equivalent. On the other hand, this effect was only marginal and so may not be reliable. Our final study was designed to explore in detail the provocative possibility that indirectly made mappings might be more open to revision than directly made mappings.

STUDY 3

The purpose of Study 3 was to investigate whether an indirectly learned proper name would be more susceptible to inconsistent information about the referent for the name than would a directly learned proper name. We used only proper names in this study because we wanted to concentrate on the situation in which a difference between indirect and direct word learning was most likely to emerge, namely, a situation involving inconsistent information. In the procedure used in Study 2, only the information given about proper names was inconsistent; the information given about common names was actually consistent with children's expectations. In addition to concentrating only on proper names, we also decided to provide the inconsistent information and to test extension after a delay rather than immediately, because pragmatically, this seemed more natural.

Method

Participants

A group of 32 older 3-year-olds (mean age = 3 years 8 months; range = 3 years 1 month to 4 years 1 month) of middle-class and upper-middle-class backgrounds participated in two 5- to 10-min sessions at the same university-affiliated preschool. Sixteen were boys, and 16 were girls. None had participated in the earlier studies. Data from 2 additional children were not included because of experimenter error.

Design

As in the previous studies, children were randomly assigned to one of the two conditions: indirect learning or direct learning. The result was 16 children per condition, balanced for sex. The average ages were 3 years 9 months and 3 years 7 months in the indirect and direct learning conditions, respectively. The excluded children were both from the direct learning condition. Children in each condition participated in two proper-name trial blocks, each of which consisted of a labeling trial and a baseline trial at

Session 1 and a generalization trial at Session 2. Prior to one of the generalization trials, inconsistent information was provided about the referent for the new name; prior to the other generalization trial, a neutral comment was made. We concentrated exclusively on proper names in this study because we were most interested in how children responded to inconsistent information about the scope of a new word.

Materials

Materials were the same as those used in the previous studies and included a subset of the same stimuli, as indicated in Table 1.

Procedure

Warm-Up Trials

The warm-up trials were the same as those used in Study 1. One child was corrected once at Session 1, and 8 were corrected once at Session 2.

Session 1: Labeling and Baseline Trials

The procedure at Session 1 was nearly identical to the one used in Study 1 except that children either inferred the referents for two new proper names (indirect learning condition) or were trained on them (direct learning condition). The two names were *Gazzer* and *Dawnoo*. Children participated in baseline trials with the same stimuli, either before or after the corresponding labeling trial. Finally, as in Study 1, at the end of Session 1, children participated in a filler task. Because of the unexpected strength of 1 child, the balance used in this filler task collapsed about halfway through the study; as a result, about half of the children participated in a different filler task involving tea strainers used as cranes to pick up the warm-up stimuli.

Session 2

Session 2 took place 2 days later or at the next available opportunity: In the direct learning condition, the average delay was 2.7 days (range = 2–9 days); in the indirect learning condition, the average delay was 2.3 days (range = 2–5 days). The length of the delay did not differ by condition, $t(30) < 1$, *ns*.

Information manipulation. Prior to one of the two generalization trials, the researcher provided inconsistent information about the referent for one of the proper names learned at Session 1. The manner in which this inconsistent naming event occurred was the same as in Study 2 and involved displaying and commenting on the target and distractor objects and then introducing the generalization object with the same proper name that had been associated with the target object at Session 1. Half of the children in each condition heard the inconsistent naming event before the first generalization trial, and half heard it before the second. Prior to the other generalization trial, the researcher made exactly the same comments about the other set of stimuli, but rather than calling the generalization object by the same name associated with the target at Session 1, he made a neutral comment such as "And we're going to need this."

After both the inconsistent naming event and the neutral comment, the researcher removed the three objects from the table and introduced the same filler activity used at the end of Session 1, this time for approximately 1 min. As in Study 2, the purpose of this filler task was to avoid providing a particular piece of information and then testing that same information immediately.

Generalization trial. The two generalization trials themselves were identical and were carried out exactly as they were in the previous studies: Children were asked to perform four test and four baseline actions with an object they chose from an array consisting of the target, the generalization stimulus, and the distractor. Because the names tested in Study 3 were both proper names, all test requests involved proper names.

Yes/no naming probe. As in Study 2, to offer an additional measure of extension, after each generalization trial, the researcher pointed to the target, generalization, and distractor objects used in that trial, one at a time and in a random order, and asked whether each was called by the tested name (e.g., "Is this *Gazzer*?").

Results and Discussion

Coding of selections was conducted as in the previous studies. Preliminary analyses indicated no reliable differences in response patterns that were due to sex, order of baseline and labeling trials at Session 1, or whether the inconsistent naming event occurred prior to the first or second generalization trial of Session 2; subsequent analyses were collapsed across these factors.

Session 1: Labeling and Baseline Trials

As in the previous studies, there was a clear animacy preference in proper name trials but no such preference in baseline trials. As Table 2 shows, in the first labeling trial of the indirect learning condition, 15 of the 16 children selected the animate object as the referent of the proper name, and 14 of 16 did so in the second trial—in both cases, more than would be expected by chance ($p < .05$, binomial expansion). In contrast, there were no preferences for the animate object on either of the baseline trials for either the indirect or direct learning conditions ($ps > .5$).

Session 2: Generalization Trials

The critical manipulation in this study was that before one of the two generalization trials at Session 2, the child witnessed an inconsistent naming event in which the researcher labeled the *generalization* object with the same proper name that had been used for the target during Session 1. Prior to the other generalization trial, the researcher simply made a neutral comment about the generalization object. We used the same terminology as in Study 2: The object originally selected or named in the labeling trial is referred to as the *target*, the object of like kind about which the researcher made the offhand comment is referred to as the *generalization object*, and the object of different kind is called the *distractor*.

Indirect Learning Condition

Neutral comment. Just as in Study 1, children who spontaneously selected the animate object as the referent for a new proper name at Session 1 and then heard a neutral comment about the generalization object in Session 2 went on to treat that name as referring specifically to the target object. (For the set of stimuli corresponding to the neutral comment at Session 2, 2 children at Session 1 spontaneously selected the inanimate object as the referent for the proper name; their data are not included here.) As shown in Figure 3A, after test requests, these 14 children selected the target 59% of the time, more frequently than expected by chance, $t(13) = 2.40$, $p < .05$, whereas the generalization and distractor objects were selected at chance levels ($p > .05$). In contrast, and also shown in Figure 3A, after baseline requests, a different pattern emerged: The target was selected less frequently than expected by chance, $t(13) = -2.29$, $p < .05$, whereas the generalization and distractor objects were again selected at chance levels ($p > .2$).
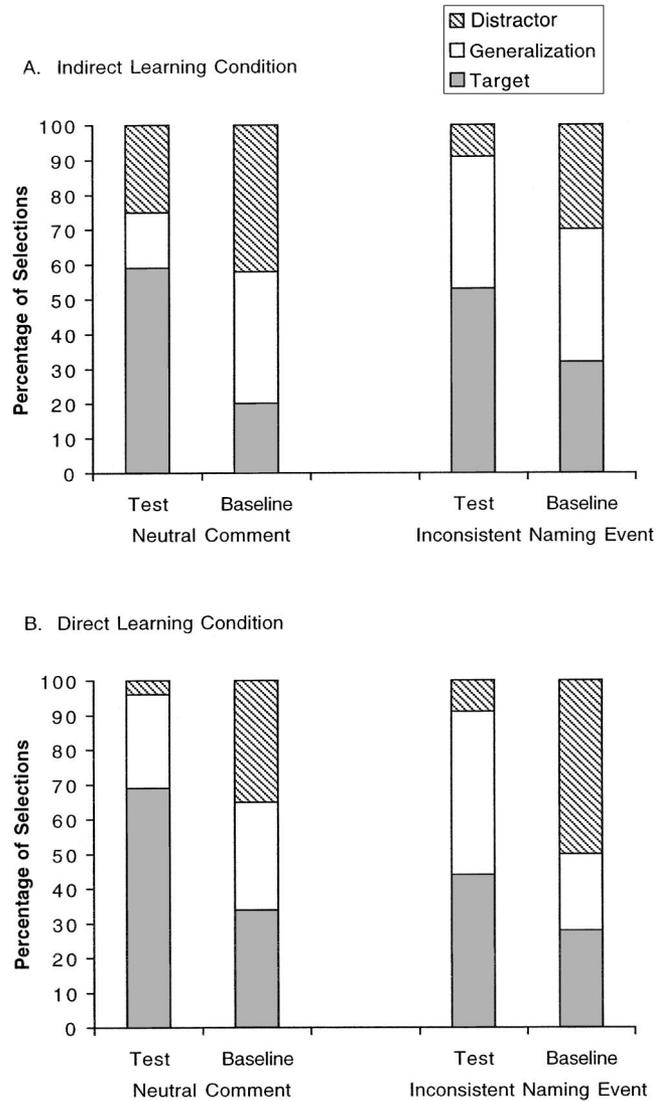

Figure 3. Average percentage of selections of each object in the generalization trials of Study 3 (delay + information manipulation) as a function of whether the trial followed the neutral comment or the inconsistent naming event, and the type of request.

Inconsistent naming event. In contrast to the target preference occurring after the neutral comment, and as shown in Figure 3A, after the inconsistent naming event, children selected the target and generalization objects about equally (53% and 38% of the time, respectively), rates not different from chance levels ($ps > .05$), and they selected the distractor less frequently than expected by chance, $t(14) = -4.74$, $p < .01$. (Again, 1 child's data are not included here because, at Session 1, he selected the inanimate object as the referent for the proper name for the corresponding set of stimuli.) After baseline requests, all three objects were selected at chance levels ($p > .4$).

Direct Learning Condition

Neutral comment. Figure 3B shows that test requests after a neutral comment about the generalization object resulted in selec-

tions primarily of the target object, just as in the indirect learning condition. Indeed, the target was selected 69% of the time, more frequently than expected by chance, $t(15) = 3.60$, $p < .01$, whereas the generalization object was selected at chance levels ($p > .5$) and the distractor was selected less frequently than expected by chance, $t(15) = -13.84$, $p < .01$. After baseline requests, all three objects were selected at chance levels ($p > .7$).

Inconsistent naming event. Just as in the indirect learning condition, after the inconsistent naming event, children selected the target and generalization objects about equally often (44% and 47% of the time), levels not different from chance ($ps > .05$), and they selected the distractor less frequently than expected by chance, $t(15) = -4.86$, $p < .01$. After baseline requests, all three objects were selected at chance levels ($p > .05$).

Comparing Extension Patterns After Indirect and Direct Learning

It made little difference whether exposure to a proper-name/referent mapping at Session 1 was indirect or direct: In both cases, children were more likely to select the target object after a neutral comment about the generalization object, and they selected the target and generalization objects about equally after the inconsistent naming event. To examine whether there were differences in the magnitude of this effect depending on condition, we again created difference scores representing the difference between the percentage of target selections and the percentage of generalization object selections after test requests. We used data from all children in the direct learning condition, but only data from those 14 children in the indirect learning condition who had spontaneously selected an animate object as the referent on both proper-name trials. Table 3 shows that these difference scores were higher (representing more target selections than generalization selections) after the neutral comment than after the inconsistent naming event.

Using the difference score data, we conducted a two-way mixed ANOVA analogous to the ones conducted in Studies 1 and 2. The between-subjects variable was condition (indirect learning condition vs. direct learning condition), and the within-subject variable was the information manipulation (whether the generalization trial had been preceded by the neutral comment or by the inconsistent naming event). The only significant effect was of the information manipulation, $F(1, 28) = 4.56$, $p < .05$. The effect of learning condition was not significant, $F(1, 28) < 1$, nor was there an interaction between learning condition and information manipulation, $F(1, 28) < 1$. In other words, children who learned the new proper names directly were just as affected by the inconsistent naming event as were those who learned the new names indirectly: On average, children made more selections of the target than of the generalization object after the neutral comment and about equal selections of the two after the inconsistent naming event.

The naming probes that followed each generalization trial once again offered an additional measure of extension. Children were simply asked to respond "yes" or "no" when asked whether the target, generalization object, and distractor could be called by the tested name. For consistency with the difference score analyses, we included all children for whom data were available in the direct learning condition but only those children in the indirect learning condition who spontaneously selected an animate object as the referent for both proper-name trials. As Table 4 shows, after the neutral comment, most children in both the indirect and direct learning conditions considered the target to be the exclusive referent for the new name. There was no difference between the two conditions in the distribution of the number of children who selected a single object as the referent for the proper name and those who selected both the target and generalization objects as referents, $\chi^2(1, N = 27) < 1$; the analysis remained nonsignificant when the additional category of "other" responses was added, $\chi^2(2, N = 28) = 1.36$.

After the inconsistent naming event, the distribution of children's responses to the yes/no probe was more variable: Some children considered the target alone to be the referent, others considered the generalization object alone or even the distractor alone to be the referent, and still others agreed that both the target and generalization objects were referents of the new name. Again, however, there was no difference in the distributions of responses between the two conditions in terms of the number who selected a single object as the referent for the proper name and the number who selected both the target and generalization objects as referents, $\chi^2(1, N = 27) < 1$; the analysis remained the same when the additional category of "other" responses was added, $\chi^2(2, N = 30) < 1$. Unlike results from the yes/no probe in Study 2, results from the yes/no probes in this study were consistent with the lack of condition differences from the activity-based generalization trials.

Summary

As in Study 1, when extension was tested after a delay, proper-name mappings made indirectly and directly were equally robust. As in Study 2, when faced with information that was inconsistent with their expectations about the name's referent, children in both conditions were influenced by that information in deciding how to extend the new name. However, the results from Study 3 are more conclusive, showing that, at least when the inconsistent information and test occurred after a delay, mappings made indirectly and those made directly were equally influenced by inconsistent information about the name's referent.

GENERAL DISCUSSION

These three studies compared indirect and direct word learning under more challenging circumstances than have been used previously, generally finding the two to be equivalent in terms of their ability to withstand a delay and their susceptibility to revision. Although there was a hint of a difference between indirect and direct learning in Study 2, and although there may be situations in which the two operate differently, we have so far been unable to document any reliable and significant difference between the two.

In Study 1, even after a delay of a few days, 3-year-olds treated proper names as referring to animate individuals and common names as referring to animate or inanimate kinds regardless of whether they had initially learned the names indirectly or directly. A number of other studies have shown that children can maintain mappings of *directly* learned words over various delays. In a study by Woodward et al. (1994), for example, 13-month-olds who learned a new word on one day demonstrated comprehension of that word 24 hr later. Similarly, Markson and Bloom (1997) showed that 3- and 4-year-olds and adults could retain newly

learned words (and facts) even after a delay of a month. Other studies have shown that children can also maintain mappings of *indirectly* learned words over various delays. In a study by Goodman et al. (1998), the 2-year-olds who used the semantic restrictions of a verb in order to infer the appropriate referent tended to retain the mapping when tested a day later without the semantically restricting verb. Finally, in a seminal study of indirect word learning, Carey and Bartlett (1978) showed that about half of the 3- and 4-year-old children who learned a new color word indirectly could demonstrate some appropriate understanding of the new word 1 week later. Unlike these earlier studies, which focused either on direct or indirect word learning, our Study 1 was designed explicitly to compare direct and indirect word learning following a delay, and we found them to be equivalent. Indeed, the results were similar to those from our previous investigation (Jaswal & Markman, 2001), in which we used the same design but an immediate test and also found the two types of learning to be equivalent.

Research in the theory of mind domain has shown that children are generally poor at reporting how or when they learned a particular piece of information (e.g., Gopnik & Astington, 1988; Gopnik & Graf, 1988; O'Neill & Gopnik, 1991; Taylor, Esbensen, & Bennett, 1994). For example, Gopnik and Graf asked 3-year-olds how they knew what was inside a drawer. Many of these children erroneously reported having seen the object when they actually had heard about it. A failure to find a difference between indirect or direct word learning in our studies could indicate that children simply discarded or did not encode the manner in which they learned the new words. However, Taylor and her colleagues showed that when a learning situation is explicitly marked as such, children are better able to remember the source of their knowledge. In their Experiment 4, 4-year-olds who learned a new color name through indirect means, such as being handed a chartreuse-colored pen with the request "Would you please color the house *chartreuse*?" tended to report that they had always known the word *chartreuse*. In contrast, those who learned the word in an explicit situation, such as being told "Do you know the color *chartreuse*? I'll teach it to you. This one is *chartreuse*," were more likely to report having learned it on the day of the test session. Thus, children are capable of retaining some information about the manner in which they learned a new word, at least in a situation roughly analogous to our direct learning condition, and this could have an effect on their confidence in the word–referent mapping.

Moreover, even in those situations in which children cannot report explicitly how they learned something, they may nonetheless implicitly treat that information differently depending on the source. For example, in a recent study, Sabbagh and Baldwin (2001) showed that when preschoolers heard a speaker express uncertainty about the referent for a new word, they were less likely to later remember the mapping than they were when the speaker had not expressed uncertainty. One explanation is that children may have implicitly "marked" the word–referent link when the speaker was not confident. An alternative, also considered by Sabbagh and Baldwin, is that the mapping simply was less well encoded at the initial learning point. Both of these possibilities seem independent of being able to report explicitly anything about the nature of the initial learning event.

One objection to the characterization of our indirect word-learning situation as "indirect" is that children may have interpreted the failure of the researcher to make a correction after their selection in the labeling trial as acknowledgment that they were correct, essentially turning the situation into a kind of direct learning situation. This strategy would require attention to more subtle social-pragmatic cues than the overt behavioral ones available in the direct learning condition. That performance with these more subtle cues was still as good as performance with obvious cues is still notable. One way to investigate this interpretation would be to have children learn a new word indirectly in a situation in which they would not expect to receive any information about the accuracy of their mapping. Another possibility, used in Studies 2 and 3, would be to have children learn new words, either directly or indirectly, and then provide them with new information about the scope of the word in the form of the labeling of an additional referent. If differences emerged in how children treated the new information, it would indicate that they do not construe the indirect learning situation in the same way as the direct learning situation.

There is little previous work on how children deal with additional (and possibly inconsistent) information in word learning, but at least one previous study is relevant. Savage and Au (1996) used two speakers to expose children to two different labels for the same object, a violation of mutual exclusivity, the proposed default assumption that each whole object will have only one label (e.g., Liittschwager & Markman, 1994; Markman & Wachtel, 1988; Merriman & Bowman, 1989). They found that some children retained the first word–referent link, others replaced that with the second word–referent link, and still others actually integrated the second label, overriding mutual exclusivity. In our Study 3, children who learned a new proper name and then a few days later heard the researcher call another object by that name seemed to resolve this discrepancy by treating the new name as a common name or a brand name, applicable to both the originally labeled object and the object to which the researcher referred. This was true in both the indirect and direct word learning conditions.

Results from Study 2, in which the inconsistent information immediately followed the initial learning, were more equivocal: Children who learned a new name indirectly were marginally more likely than those who learned the name directly to be influenced by the inconsistent information. These results, although hardly robust or conclusive, do leave open the possibility that under some circumstances, perhaps when inconsistent information follows immediately on the heels of the initial learning, indirect and direct word learning operate differently.

In the meantime, the preponderance of evidence suggests that indirect and direct word learning are largely functionally equivalent. This is noteworthy because our indirect word-learning situation lacked all of the overt, behavioral social-pragmatic cues—eye gaze, voice direction, a deictic statement—that we know children are extremely sensitive to (e.g., Baldwin & Tomasello, 1998; Tomasello, 2001). Without this "best evidence" (Baldwin & Moses, 2001), children were nonetheless capable of using the confluence of syntactic and semantic cues to learn a new word indirectly. When tested immediately (Jaswal & Markman, 2001) or after a delay (Study 1), the resulting mapping was as robust as a mapping based on ostensive instruction. And when faced with a delay and inconsistent information about the referent for a new proper name, the mapping made indirectly was not more fragile

than the one made directly (Study 3): Both were equally open to revision on the basis of that inconsistent information.

It is worth noting that being open to new information about a word's meaning must be a key aspect of word learning, because first hypotheses that are wrong, too broad, or too narrow require revision. In this respect, proper names are not representative of other grammatical form classes: Understanding a proper name requires learning only the specific individual to which the name applies. Beyond making a link to the referent, proper names do not actually have a meaning, at least according to many accounts, whereas other content words do. For example, a child may start out thinking that *brother* means *boy*, which clearly will require revision. Similarly, a child may understand that *chartreuse* is a color without understanding precisely which color it is (Carey & Bartlett, 1978; Dockrell & Campbell, 1986). Arriving at the adult meaning of many words can only be achieved through an extended period of refinement on the basis of later information.

References

Akhtar, N., Jipson, J., & Callanan, M. A. (2001). Learning words through overhearing. *Child Development, 72,* 416–430.

Akhtar, N., & Tomasello, M. (1996). Two-year-olds learn words for absent objects and actions. *British Journal of Developmental Psychology, 14,* 79–93.

Baldwin, D. A. (1989). Priorities in children's expectations about object label reference: Form over color. *Child Development, 60,* 1291–1306.

Baldwin, D. A. (1991). Infants' contribution to the achievement of joint reference. *Child Development, 62,* 875–890.

Baldwin, D. A. (1993). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language, 20,* 395–418.

Baldwin, D. A., & Moses, L. J. (2001). Links between social understanding and early word learning: Challenges to current accounts. *Social Development, 10,* 309–329.

Baldwin, D. A., & Tomasello, M. (1998). Word learning: A window on early pragmatic understanding. In E. Clark (Ed.), *The proceedings of the twenty-ninth annual child language research forum* (pp. 3–23). Chicago: Center for the Study of Language and Information.

Bloom, L. (1993). *The transition from infancy to language: Acquiring the power of expression.* Cambridge, England: Cambridge University Press.

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

Brent, M. R., & Siskind, J. M. (2001). The role of exposure to isolated words in early vocabulary development. *Cognition, 81,* B33–B44.

Brown, R. (1957). Linguistic determinism and the part of speech. *Journal of Abnormal and Social Psychology, 55,* 1–5.

Carey, S., & Bartlett, E. (1978). Acquiring a single new word. *Papers and Reports on Child Language Development, 15,* 17–29.

Dockrell, J., & Campbell, R. (1986). Lexical acquisition strategies in the preschool child. In S. A. Kuczaj & M. D. Barrett (Eds.), *The development of word meaning* (pp. 121–154). New York: Springer-Verlag.

Gelman, S. A., & Taylor, M. (1984). How two-year-old children interpret proper and common names for unfamiliar objects. *Child Development, 55,* 1535–1540.

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

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

Goodman, J. C., McDonough, L., & Brown, N. B. (1998). The role of semantic context and memory in the acquisition of novel nouns. *Child Development, 69,* 1330–1344.

Gopnik, A., & Astington, J. W. (1988). Children's understanding of representational change and its relation to the understanding of false belief and the appearance–reality distinction. *Child Development, 59,* 26–37.

Gopnik, A., & Graf, P. (1988). Knowing how you know: Young children's ability to identify and remember the sources of their beliefs. *Child Development, 59,* 1366–1371.

Hall, D. G. (1994). Semantic constraints on word learning: Proper names and adjectives. *Child Development, 65,* 1291–1309.

Hall, D. G. (1996). Preschoolers' default assumptions about word meaning: Proper names designate unique individuals. *Developmental Psychology, 32,* 177–186.

Hall, D. G. (1999). Semantics and the acquisition of proper names. In R. Jackendoff, P. Bloom, & K. Wynn (Eds.), *Language, logic and concepts: Essays in honor of John Macnamara* (pp. 337–372). Cambridge, MA: MIT Press.

Hall, D. G., Quantz, D. H., & Persoage, K. A. (2000). Preschoolers' use of form class cues in word learning. *Developmental Psychology, 36,* 449–462.

Hall, D. G., Waxman, S. R., & Hurwitz, W. M. (1993). How 2- and 4-year-old children interpret adjectives and count nouns. *Child Development, 64,* 1651–1664.

Hollich, G. J., Hirsh-Pasek, K., & Golinkoff, R. M. (2000). Breaking the language barrier: An emergentist coalition model for the origins of word learning. *Monographs of the Society for Research in Child Development, 65*(3, Serial No. 262).

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

Jaswal, V. K., & Markman, E. M. (2001). Learning proper and common names in ostensive versus inferential contexts. *Child Development, 72,* 768–786.

Katz, N., Baker, E., & Macnamara, J. (1974). What's in a name? A study of how children learn common and proper names. *Child Development, 45,* 469–473.

Kobayashi, H. (1998). How 2-year-olds learn novel part names of unfamiliar objects. *Cognition, 68,* B41–B51.

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

Liittschwager, J., & Markman, E. M. (1993, March). *Young children's understanding of proper versus common nouns.* Poster presented at the biennial meeting of the Society for Research in Child Development, New Orleans, LA.

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

Markman, E. M. (1989). *Categorization and naming in children: Problems of induction.* Cambridge, MA: MIT Press.

Markman, E. M. (1992). Constraints on word learning: Speculations about their nature, origins, and domain specificity. In M. R. Gunnar & M. Maratsos (Eds.), *Minnesota Symposium on Child Psychology* (Vol. 25, pp. 59–101). Hillsdale, NJ: Erlbaum.

Markman, E. M., & Jaswal, V. K. (in press). Acquiring and using a grammatical form class: Lessons from the proper-count distinction. In D. G. Hall & S. R. Waxman (Eds.), *Weaving a lexicon.* Cambridge, MA: MIT Press.

Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology, 20,* 121–157.

Markman, E. M., Wasow, J. L., & Hansen, M. B. (in press). Use of the mutual exclusivity assumption by young word learners. *Cognitive Psychology.*

Markson, L., & Bloom, P. (1997). Evidence against a dedicated system for word learning in children. *Nature, 385,* 813–815.

Merriman, W. E., & Bowman, L. L. (1989). The mutual exclusivity bias in

children's word learning. *Monographs of the Society for Research in Child Development, 54*(3–4, Serial No. 220).

Mervis, C. B. (1987). Child-basic object categories and early lexical development. In U. Neisser (Ed.), *Concepts and conceptual development: Ecological and intellectual factors in categorization* (pp. 201–233). Cambridge, England: Cambridge University Press.

O'Neill, D. K., & Gopnik, A. (1991). Young children's ability to identify sources of their beliefs. *Developmental Psychology, 27,* 390–397.

Sabbagh, M. A., & Baldwin, D. A. (2001). Learning words from knowledgeable versus ignorant speakers: Links between preschoolers' theory of mind and semantic development. *Child Development, 72,* 1054–1070.

Savage, S. L., & Au, T. K. (1996). What word learners do when input contradicts the mutual exclusivity assumption. *Child Development, 67,* 3120–3134.

Schieffelin, B. (1985). The acquisition of Kaluli. In D. I. Slobin (Ed.), *The cross-linguistic study of language acquisition: Vol. 1. The data* (pp. 525–593). Hillsdale, NJ: Erlbaum.

Snow, C., & Ferguson, C. (Eds.). (1977). *Talking to children.* New York: Cambridge University Press.

Soja, N. N., Carey, S., & Spelke, E. S. (1991). Ontological categories guide young children's inductions of word meaning: Object terms and substance terms. *Cognition, 38,* 179–211.

Sorrentino, C. (2001). Children and adults represent proper names as referring to unique individuals. *Developmental Science, 4,* 399–407.

Taylor, M., Esbensen, B. M., & Bennett, R. T. (1994). Children's understanding of knowledge acquisition: The tendency for children to report that they have always known what they have just learned. *Child Development, 65,* 1581–1604.

Tomasello, M. (2001). Perceiving intentions and learning words in the second year of life. In M. Tomasello & E. Bates (Eds.), *Language development: The essential readings* (pp. 111–128). Malden, MA: Blackwell.

Tomasello, M., & Barton, M. (1994). Learning words in nonostensive contexts. *Developmental Psychology, 30,* 639–650.

Waxman, S. R. (1991). Convergences between semantic and conceptual organization in the preschool years. In S. A. Gelman & J. P. Byrnes (Eds.), *Perspectives on language and thought: Interrelations in development* (pp. 107–145). Cambridge, England: Cambridge University Press.

Waxman, S. R., & Markow, D. B. (1995). Words as invitations to form categories: Evidence from 12- to 13-month-old infants. *Cognitive Psychology, 29,* 257–302.

Woodward, A. L., & Markman, E. M. (1998). Early word learning. In D. Kuhn & R. Siegler (Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (5th ed., pp. 371–420). New York: Wiley.

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