Lexical Principles May Underlie the Learning of Verbs

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GOLINKOFF, ROBERTA MICHNICK; JACQUET, ROBERTA CHURCH; HIRSH-PASEK, KATHY; and NANDAKUMAR, RATNA. *Lexical Principles May Underlie the Learning of Verbs.* CHILD DEVELOPMENT, 1996, **67**, 3101–3119. To examine whether children (mean age 34 months) can fast map and extend novel action labels to actions for which they do not already have names, the comprehension of familiar and novel verbs was tested using colored drawings of Sesame Street characters performing both familiar and unfamiliar actions. Children were asked to point to the character "verbing," from among sets of 4 drawings. With familiar words and actions, children made correct choices 97% of the time. With novel action words, children performed at levels mostly significantly above chance, selecting a previously unlabeled action or another token of a just-names action. In a second, control experiment children were asked to select an action from among the same sets of 4 drawings, but they were not given a novel action name. Here children mainly demonstrated performance at levels not significantly different from chance, showing that the results from the main experiment were attributable to the presence of a word in the request. Results of these studies are interpreted as support for the availability of principles to ease verb acquisition.

How would we know that children had learned a novel verb? First, children should be able to produce or comprehend the newly learned verb in the original context in which it was learned. Second, to show true word learning, children should be able to extend the verb to new, nonidentical instances of the action that the verb labels. Although in theory (Quine, 1960) such learning might be arduous and require many trials, a number of studies show that children can "fast map" (Carey & Bartlett, 1978) a novel word to a meaning in a single trial. That is, upon hearing a novel word in a specific context, children implicitly recognize that they have heard a novel word and that it maps to a referent in that context. Of course, from a single exposure the child cannot know the nuances of a novel word's meaning; additional experience with the word in other sentential and extralinguistic contexts is necessary to refine the originally assigned meaning.

The Phenomenon of Fast Mapping

In Carey and Bartlett's (1978) study of fast mapping, 3- and 4-year-old children were introduced to a novel adjective ("chromium") by a teacher who casually asked children to "bring me the chromium tray, not the blue one, the chromium one" from among a set of trays. Children were able to respond correctly to the request as well as to demonstrate some recollection of the word's meaning (e.g., that it was a color word) after a delay of 1 week. Heibeck and Markman (1987) replicated and extended Carey and Bartlett's results to the domains of texture

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and shape. To make certain that children had actually learned an abstract meaning for the novel word and had not just treated it as the name of only the target item, they asked children to *extend* the newly learned word to another exemplar of the concept. Their findings indicated that fast mapping had indeed occurred, although more readily in the domains of shape and color than texture (see also, e.g., Au & Markman, 1987; Dockrell, 1981; Markman & Wachtel, 1988).

Fast mapping (and in some cases, extension of the novel word) also occurs with object words (Dockrell, 1981; Dockrell & Campbell, 1986; Hutchinson, 1986; Markman & Wachtel, 1988; Merriman & Bowman, 1989; Merriman & Schuster, 1991; Rice & Woodsmall, 1988). In one study by Golinkoff, Hirsh-Pasek, Bailey, and Wenger (1992), whose design was used in the research reported here, 28-month-old children showed an impressive degree of object label learning. On each trial, subjects were shown four objects, some of whose names they knew and some of whose names they did not know. During the course of a single experimental session, children were asked to fast map and extend a total of eight new object labels. Children could not have simply learned to give the experimenter the novel object on each trial since a familiar object was always requested as well. In addition, extension of the novel term to another exemplar was tested in the presence of yet another unfamiliar object which had not yet been named. This ruled out the possibility that children just interpreted the novel term as mapping to any novel object.

While the availability of the fast mapping process for the learning of adjectives and nouns has been shown repeatedly, fewer studies have examined the fast mapping of verbs or action labels. In the studies that have examined both object and action labels in the same fast mapping task, action labels often prove more difficult to fast map than object labels. Rice and Woodsmall (1988) showed 3- and 5-year-old children videotapes of events which presented new object, action, and property labels in a story format. Word learning occurred at a significantly lower rate with action labels compared to object and property labels. Merriman, Marazita, and Jarvis (1993, 1995) similarly found a difference in favor of the fast mapping of object labels over action labels in studies with 4-year-olds. Using a modification of the intermodal preferential looking paradigm (Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987), children were asked to point at one of two simultaneously presented videotapes. Either a novel and familiar object were paired or a novel and familiar action. These pairs were accompanied by a novel noun or a novel verb, respectively.

Why should the evidence suggest that object labels are easier to fast map than action labels? This phenomenon accords well with the early acquisition data that suggest that object words predominate over action words (e.g., Bates, Bretherton, & Snyder, 1988; Dromi, 1987; Gentner, 1983, 1988; Goldin-Meadow, Seligman, & Gelman, 1976; but see Bloom, Tinker, & Margulis, 1993; Gopnik & Choi, 1995; Tardiff, 1996) even in languages such as Korean which allow much noun ellipsis and place verbs in sentence final position (Au, Dapretto, & Song, in press). Verbs may appear more slowly than nouns for at least five reasons: First, verb learning requires uncovering the semantic components of the verb, for example, implied causation, direction or location of action, or manner of action (Behrend, 1990; Gentner, 1983; Pinker, 1989). Second, the referents of nouns—often concrete objects—are more stable and perceptually available than the referents of actions which, unless repetitive, tend to be ephemeral (Gentner, 1988; Givon, 1973); third, it may be more difficult to detect what is constant in an action compared to what is constant in an object. For example, is "running" still running when you observe both your grandmother and Frank Shorter do it? Fourth, multiple verbs can be used to describe the same event. "Running" may also be called "jogging," "dashing," or "sprinting." And finally, to use a verb appropriately the child must have mastered the obligatory argument structure it requires (Bloom, Lightbown, & Hood, 1975; Gleitman, 1990; Pinker, 1989) (e.g., does it or does it not require an object?). Although verb learning may present these problems, children do begin to acquire verbs in their productive lexicons by at least 21 months (Bloom & Lahey, 1978) and, in their receptive vocabularies, by at least 16 months (Golinkoff et al., 1987).

Why Does Fast Mapping Occur?

In fast mapping studies it is up to children (as it often is in life) to find a likely referent for a novel word. Although children appear to be capable of using social/pragmatic cues such as the speaker's gaze direction and intentionality (Baldwin, 1993; Tomasello & Barton, 1994) to assist them, such cues are not always available and, in any event, cannot aid children in deciding on the correct construal for the meaning of a novel word. To solve such problems for the learning of novel nouns, several researchers argue that children must possess a principle which allows them to readily assign new labels to previously unnamed objects. Markman (1987; Merriman & Bowman, 1989) offered the "mutual exclusivity" principle: children select the unnamed object because they are biased against allowing objects to have more than one name. Clark's (1983) "contrast" principle predicts that children choose the unnamed object on the assumption that a new word must differ in meaning from the words they already know. Golinkoff, Mervis, and Hirsh-Pasek (1994), finding these principles lacking after a careful review (see also Gathercole, 1989; Rice, 1990), suggested the "novel name–nameless category" principle (or N3C): the child will find an unnamed, as opposed to an already named, referent for a novel name. Golinkoff, Hirsh-Pasek, Mervis, Frawley, and Parillo (1995) argued that children must be similarly motivated to attach novel action names to unnamed actions. The rapid word learning observed in the second year of life could not occur if children did not search out potential referents for novel words in nonostensive contexts.

Verb Extension

The fast mapping of verb meaning would be of limited utility if the child could not use a newly learned verb to label novel exemplars of the action; the economy of linguistic representation rests on the fact that words label categories (be they categories of objects, actions, or properties) and not unique instances. For nouns and adjectives, research indicates that after only one or two nonostensive exposures to a word-referent combination, extension occurs to new exemplars of the word (e.g., Golinkoff, Hirsh-Pasek, et al., 1992; Heibeck & Markman, 1987). Very little is presently known about whether extension of novel verbs occurs as readily. Behrend (1990; Behrend, Harris, & Cartwright, 1955) and Forbes and Farrar (1993) study verb extension as a way to discover how children construe verb meaning. First, Behrend et al. (1995) taught children a novel verb for a novel action. For example, children were shown a videotape of a person twirling a spaghetti server to collect tangled yarn and told that the person is "pinting." Second, children were shown variations on this event in which either the instrument was changed (a rachet) or the action changed (scooping) or the result or outcome of the event was changed (the yarn was left dangling). The dependent variable was the frequency with which children were willing to extend the novel verb to the different types of changes. Three-year-old children extended the novel verb most to instrument changes and much less to both action and result changes; 5-year-olds also extended most to instrument changes and rejected result changes.

One of the variables in the Forbes and Farrar (1993) study that significantly reduced extension for both children and adults was a change in "causative agent" or whether "the person either moved himself or was moved by others" (p. 278). A change in who is the agent of an action seems to be one of the most basic kinds of change that an action can undergo; even 14-month-old infants can discriminate changes in the agent-patient relationships in an event from more superficial changes (such as the left-right direction of the action across a movie screen) (Golinkoff, 1975; Golinkoff & Kerr, 1978). Thus, even before children have learned many verbs they apparently recognize that a change in the agency of a nonlinguistic event is a significant change in the meaning of the event. And yet, to accurately extend a novel verb, children must know that the same action can be performed by a number of agents. Thus, verb extension, like noun extension, is based on the implicit recognition that a verb labels a category of actions, potentially performed by a variety of agents, in a variety of locales and orientations.

Once again, researchers who have studied noun acquisition have posited principles for noun extension that may work for verb extension. The assumption that object words label categories has been captured in different ways by three principles: the "taxonomic assumption" (Markman & Hutchinson, 1984), the "noun-category bias" (Waxman & Kosowski, 1990), and the "categorical scope" principle (Golinkoff et al., 1994; Golinkoff, Shuff-Bailey, Olguin, & Ruan, 1995; Shuff-Bailey & Golinkoff, 1995). For object labels, the categorical scope principle states that children will extend names to other exemplars in the same basic level category. Golinkoff, Hirsh-Pasek, et al. (1995) argued that categorical scope applies to action words as well. Specifically, an action word may be extended to an action of the same type regardless of (1) the agent performing the action and (2) superficial differences in the manner in which the action is performed. That is, each instance of an action of the same type—even though performed by a different agent, or in a different place, or in a different manner—should be called by the same name in order to keep the number of action terms within the realistic limits of human memory. The present study tests for the most basic form of action word extension: can a newly learned action word be immediately extended to a new agent performing the same exact action?

To test children's fast mapping and extension of novel action words, 3-year-olds were shown drawings of popular Sesame Street characters performing some familiar actions (e.g., waving) and some unfamiliar actions (e.g., doing an arabesque). The first question was whether children would assume that a novel action word mapped to an unfamiliar action, in the presence of familiar actions. Importantly, no explicit link was made between the novel action and the novel action term; it was up to the child to figure out to which action the novel term mapped. The second question was whether children would extend newly learned action words to other examplars of the same type. Children were shown another character performing the just labeled novel action alongside characters performing familiar actions as well as another unnamed action. If children select the second exemplar of the just heard action name, and not the novel action without the label, they will be showing that they consider the novel action name to be (*a*) not just linked to the original action (a sort of "proper verb" hypothesis) and (*b*) not just a label for any unnamed action but for a particular action, namely, the one just labeled.

Experiment 1

To test for the fast mapping and extension of novel verbs, children participated in a task where they were asked to select drawings of Sesame Street characters performing both novel and familiar actions. From among a set of four drawings, children were asked to give the experimenter a picture of both a known action (e.g., "Which one is waving?") and an unfamiliar action (e.g., "Which one is glorping?") on each trial in counterbalanced order. Some trials were designed to test for fast mapping and some for extension of the newly learned verb. Fast mapping would be demonstrated if children selected the unfamiliar action in response to a request which included a novel verb. Verb extension (in comprehension) would be demonstrated if children selected another exemplar of the novel action, performed by a different character, on a subsequent trial. On one of the trials that tested for fast mapping, children were given a second novel name and asked to select an action in the presence of the previously named novel action and an unnamed novel action. If children are guided by a principle to map novel action terms to unnamed actions, they should believe that they already have a name for the first unnamed action and select the second unnamed action. However, given how few exposures children will have to the novel verb, that trial in particular, and this study in general, are a rigorous test of whether children can fast map and extend novel verbs.

Subjects

Six boys and six girls (mean age = 34 months, 21 days; range 32,18–35,29) all native speakers of English producing multiword speech, were tested individually in a university laboratory as their parents silently looked on. (Children were selected to be approximately 6 months older than subjects in the parallel noun study [see Golinkoff, Hirsh-Pasek, et al., 1992] in accord with findings in the literature that knowledge of verbs generally comes after children have already learned some nouns.)

Procedure

Stimuli.—Stimuli consisted of 27 colored drawings (each 3 inches by 4 inches) depicting actions performed by Big Bird, Cookie Monster, Bert, and Ernie. As Table 1 shows, 18 of the 27 were familiar actions (e.g., eating) and five were unfamiliar actions (e.g., doing a split). Four of the unfamiliar actions were also seen performed by a second character. For the selection of familiar actions, research was consulted for the names of actions young children were likely to know (e.g., Bloom et al., 1975; Golinkoff et al., 1987). The unfamiliar actions were selected on the criteria that they could be easily discriminated from the familiar actions and were unlikely to be witnessed by children or, if witnessed, heard described with verbs. Figure 1 shows each of the unfamiliar actions with their phrasal descriptions.

To test whether the actions that we labeled "familiar" and "unfamiliar" had this status for young children, or indeed, whether children interpreted these two-dimensional drawings as depicting actions.

TABLE 1

THE 18 FAMILIAR AND FIVE UNFAMILIAR ACTIONS USED IN EXPERIMENTS 1 AND 2

Action Type	
Familiar	Unfamiliar
clapping	doing a split[a]
coloring	doing an arabesque[a]
crying	doing a backbend[a]
dressing	doing a pushup
drinking	tilting one's head[a]
eating	
falling	
kicking	
pointing	
reading	
riding	
running	
sitting	
sleeping	
standing	
throwing	
washing	
waving	

[a] To test for extension, there were two drawings of each of these actions, e.g., one card showed Big Bird doing a split and one card showed Ernie doing a split.

we conducted a study with a separate group of youngsters. Nine slightly older children (six males and three females, mean age = 39 months, 9 days; range 35,10–43,28) were tested individually with the action drawings. Children on average 5 months older than the experimental subjects were tested since younger children were reluctant to apply labels to the actions. All children were native speakers of English and spoke in multiword sentences.

Each child was told that we were going to show him or her some pictures of the Sesame Street characters, some of which would be "silly" and some "okay." In the "silly" ones the child might not know what the person was doing and wouldn't know what to call it. In the "okay" ones, the child would know what the person was doing and what to call it. Children were told that they should put the silly ones in the silly pile (in front of a picture of a silly face) and the okay ones in the okay pile in front of the smiley face. The child was then handed one card at a time (with the unfamiliar ones interspersed randomly) and asked to place the card in the appropriate pile. As the child placed each card in a pile (whether it was familiar or unfamiliar and regardless of the pile to which it was assigned) the experimenter asked, "What's he doing here?" or "Can you tell me what *character name* is doing?" If children did not interpret these drawings as portrayals of actions they could have answered in other ways despite the use of a gerundive sentence frame. Even older children will override the form class information present in experimenters' questions if they are predisposed to answer in another way (e.g., Markman & Wachtel, 1988). Children greatly enjoyed this game and were very successful at it.

The results indicated that children did indeed interpret the drawings as depictions of action. They often answered with a pronoun and a verb in the progressive form, as in "He's eating." They were also not reluctant to indicate that they "didn't know" or that the action was "silly" when it was unfamiliar. Of the 18 cards which showed familiar actions, children were able to provide the correct name for the action 91.4% of the time. For the five cards which showed unfamiliar actions, children labeled them only 15.6% of the time, and when they did, it was with great hesitation and uncertainty. Thus, children's labeling responses validated our hunches as to which actions were familiar and which unfamiliar. Additional support for children's ability to interpret these cards as depictions of action comes from their comprehension responses during the familiarization test.

Familiarization.—The 27 stimulus cards were first spread out randomly on the floor in front of the child. Children were first asked to name the familiar actions in random order in response to a question like, "What is Big Bird doing here?" Only two of the children were willing to label the actions. Therefore, the rest were tested for comprehension of the action names. Children were asked to select a card from an assortment of three cards arranged side by side in front of the child in response to the question. "Can you find a picture of someone *washing?*" The position of the correct card was counterbalanced across trials. No child persistently made choices of a particular character or spatial position; indeed, the vast majority of children's choices were correct. In the rare cases (about 10%) when a child selected the wrong card, the experimenter prompted the child to label the card correctly by reminding the child when such an action might be carried out. If a child asked what a character was doing in an action for which a label was not requested, attention was di-

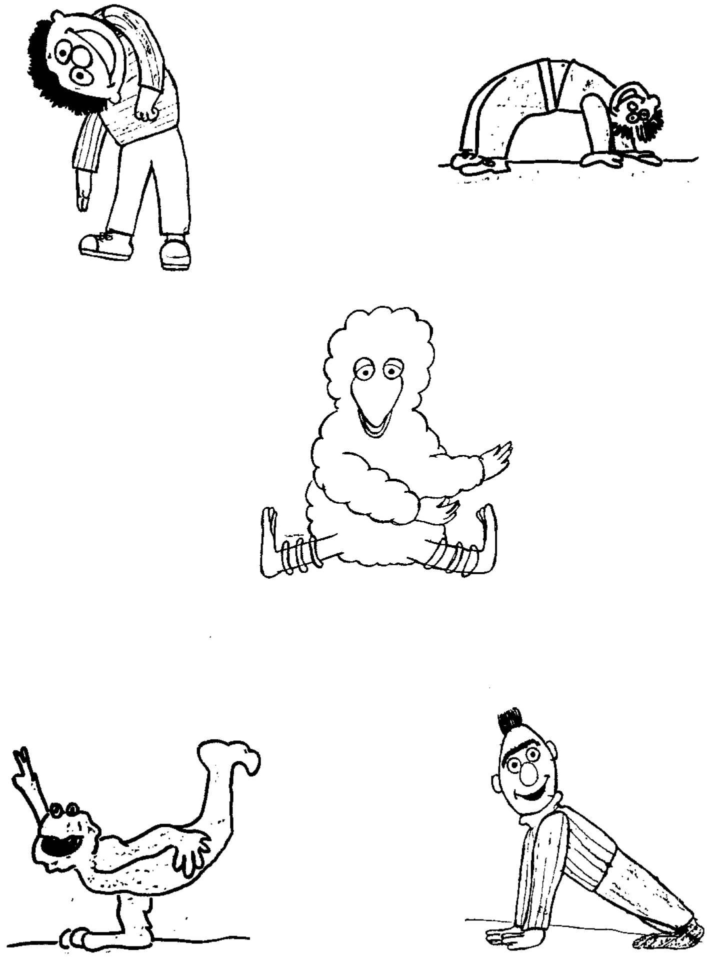

FIG. 1.—The five unfamiliar actions. Going clockwise from the top left, the actions depicted are bending the back, arching one's back (with back facing floor) while on hands and feet, sitting with legs apart with arms to one side, doing a push-up, doing an arabesque.

verted to another card. The cards were then removed, and the experiment proper began.

Test.—Children were given two blocks of four trials each. Table 2 presents the experimental design for one block of trials. A trial consisted of two questions, one asking for a familiar action and one asking for an unfamiliar action. Asking for a familiar action on each trial eliminated the possibility that subjects would simply develop a strategy of choosing the unfamiliar action. Since each trial asked two questions of the child, and since there were four trials in a block of trials, the child responded to a total of eight questions for each block of trials. The entire experiment then, consisted of a child's responses to 16 test questions—half about familiar and half about unfamiliar actions.

The stimulus display for each trial consisted of the same drawings used in the familiarization phase now mounted in groups of four on a piece of 8 inch × 11 inch laminated construction paper as shown on Figure 2. To lessen any confusion, each character was always shown in the same quadrant on each sheet (e.g., Ernie always appeared in the upper left cell). The cell in which the "correct" response was found was counterbalanced across trials. In the description of the test trials below, familiar actions will be labeled with an "F" and unfamiliar actions with a "U"; numeral subscripts will be used to indicate when a different familiar or unfamiliar action was used. When a second token of an unfamiliar action was used, the subscript will contain an "*a*" for the original action and a "*b*" for the second token.

TABLE 2

EXAMPLE OF EXPERIMENTAL DESIGN FOR ONE BLOCK OF TRIALS

	Possible Familiar Actions[a]	Possible Unfamiliar Actions	Action Requested[b]
Trial 1	eating (F_1)	daxing (U_{1a})	Where's daxing?
	reading (F_2)		Where's eating?
	sleeping (F_3)		
Trial 2	standing (F_4)	unlabeled (U_2)	Where's standing?
	crying (F_5)	daxing (U_{1b})	Where's daxing?
Trial 3	sitting (F_6)	lorping (U_{3a})	Where's falling?
	falling (F_7)	daxing (U_{1a})	Where's lorping?
Trial 4	coloring (F_8)	lorping (U_{3b})	Where's waving?
	waving (F_9)	unlabeled (U_2)	Where's lorping?

[a] The second block of trials used a different set of familiar and unfamiliar actions (see Table 1).

[b] Familiar actions were requested first on half of the trials, according to four random orders.

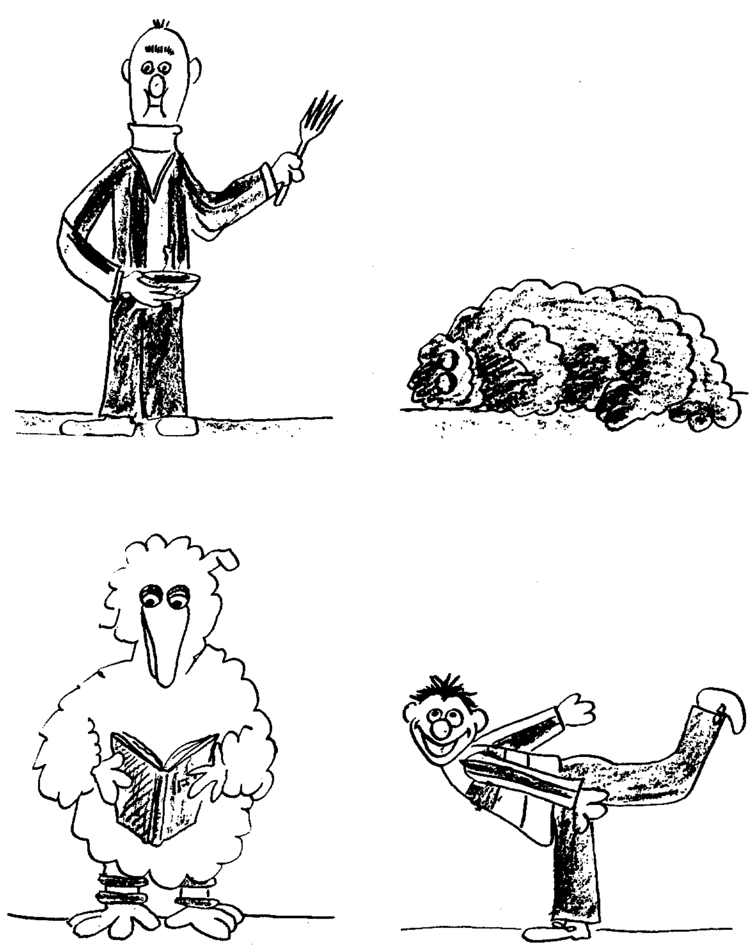

FIG. 2.—A sample stimulus sheet. Going clockwise from the top left, the actions depicted are eating, sleeping, "daxing," and reading.

Trial 1 within each set of four trials was designed to examine whether children would assume that a new term mapped to a previously unnamed action. The stimulus group presented to the child consisted of three familiar actions (F_1, F_2, and F_3) and one unfamiliar action (U_{1a}), making the likelihood that a child could select the unfamiliar action by chance 25%. In counterbalanced order, the experimenter asked for one familiar action and for the unfamiliar action. The carrier phrases used to request familiar and unfamiliar actions were the same. For example, children were asked, "Can you show me someone *verbing*?" or "Do you see someone *verbing* here?" Carrier phrases were changed when a child hesitated or acted confused by the request. The child's response consisted of pointing. After the child answered the two questions for the first trial, the stimulus group was removed and replaced with a new group for the second trial.

For trial 2, the stimulus group consisted of two different familiar actions (F_4 and F_5), a new unfamiliar action (U_2), and the unfamiliar action from Trial 1 now performed by a different character (U_{1b}). This second character performed the unfamiliar action seen on Trial 1 in exactly the same position and facing in the same direction as the original exemplar. Thus, if the two tokens of the unfamiliar action from Trials 1 and 2 were superimposed, they would be highly similar in shape. The purpose of this trial was to see whether children would extend a newly learned verb to another token under the circumstances that (1) they had only seen a single exemplar of it and (2) another unfamiliar action was present.

The stimulus group for Trial 3 consisted of two different familiar actions (F_6 and F_7), the original unfamiliar action seen on Trial 1 (U_{1a}), and a new unfamiliar action (U_{3a}). This trial tested whether children preferred to assign a new unfamiliar action name to an as yet unlabeled action (U_{3a}) as opposed to the previously labeled unfamiliar action (U_{1a}). That is, would subjects, offered another new action name, select the new unfamiliar action rather than the action previously labeled on Trials 1 and 2? This trial represented a very stringent test of whether the child had learned the name of the original action since the subject had been exposed to the original name/action combination only two times. If children had in fact learned the new verb used in Trials 1 and 2, they should assume that the second new verb referred to the new unnamed action and not to the action that had already been labeled in Trials 1 and 2.

The stimulus group for trial 4 consisted of two different familiar actions (F_8 and F_9), the unfamiliar, unlabeled action seen on trial 2 (U_2), and a second token of the unfamiliar action seen and labeled on Trial 3 (U_{3b}), now performed by another character. The goal of this trial was the same as the goal of Trial 2: Would subjects extend another new action term, heard only once on the previous trial, to the second token of that unfamiliar action? Thus, the subject was asked for the same novel action that had just been named on Trial 3.

To summarize, Trial 1 tested principles which predict that an unnamed action should be selected as the referent for a novel action term. Children had to figure out to which action the novel term mapped. Trial 2 tested whether children would extend the new term heard on Trial 1 to another token. Performance here was predicted under principles that state that children interpret novel terms as applying to categories. Trial 3 increased the complexity of the task by presenting yet another unnamed action with the previously labeled action seen on Trial 1. Trial 4 was also a test of the principles which state that words are extended categorically since children were asked to extend a second novel action term that they had heard on the previous trial.

Results

Are there differences by sex of the subjects?—We conducted a two-way mixed ANOVA with the between-subjects factor of sex and the within-subjects factor of familiarity (familiar vs. unfamiliar questions). On each trial (there were four trials in each of two blocks), one question was asked about a familiar action and one about an unfamiliar action for a total of eight questions about familiar actions and eight about unfamiliar actions. Subjects were assigned two scores of 0–8, one for the number of questions answered correctly about familiar actions and one for the number of questions answered according to predictions about unfamiliar actions. Because neither the main effect of sex nor the interaction approached significance, subsequent analyses were pooled over sex.

Do children select the correct, familiar actions?—The only significant effect found in the above analysis was question type: Questions asked about familiar actions were significantly easier for children to answer than questions about unfamiliar actions, $F(1, 23) = 27.70$, $p < .001$. The mean number correct for familiar actions was 7.75 (SD = .45); for unfamiliar actions, the mean number answered according to predictions was 5.58 (SD = 1.31).

Do children select a novel action as the referent for a novel action term?—Table 3 shows the proportion of children's selections in response to requests using a novel action word. Percentages were computed out of 24 possible responses since on each trial (1–4), the 12 subjects were asked two questions of that type. Underlined scores represent the responses that were predicted by the relevant lexical principles. When a cell has no entry, the response could not occur on that trial. Table 4 presents the data for each subject by trial type. A score of "0" means that on the two occasions when the child received a trial of that type, the child did not select the appropriate unfamiliar action on either trial. Similarly a score of "1" means that the child selected the appropriate unfamiliar action on one of the two trials of that type. A superscript of "1" means that the "1" was scored on the first trial and not on the second; the absence of a superscript means that the "1" was achieved on only the second trial. Finally, a score of "2" means that the child selected the appropriate unfamiliar action on both trials of a particular type.

As can be seen on Table 3, on trial 1 where there were three familiar actions and one unfamiliar action, children selected the novel action 83% of the time. To evaluate whether, out of a group of 12, children selected the novel action at a rate greater than that expected by chance, second-order binomial probabilities were calculated in the following way. First, the probability of a single child obtaining a score of 0, 1, or 2 was calculated. Thus, since the chance probability of a child selecting the unfamiliar item on a single trial is .25 (given four choices), the chance probability of a child selecting the unfamiliar item on both trials of the same type and scoring 2 out of 2 is $(.25) \times (.25) = .0625$. The chance probability of scoring 1 out of 2 is $(.25) \times (.75) \times 2 = .3750$, and the

TABLE 3

PERCENTAGES OF CHILDREN'S ACTION SELECTIONS (Standard Deviations in Parentheses) IN RESPONSE TO REQUESTS USING A NOVEL VERB (Experiment 1) OR TO REQUESTS WITHOUT A NOVEL VERB (Experiment 2)

	ACTION TYPE					
TRIAL AND EXPERIMENT	First Novel	Token of First Novel	Second Novel	Token of Second Novel	Familiar	Distractor Novel
1: Test of selection of novel action:[a]						
Novel verb	$\underline{83}$ (25)				17	
No word	$\underline{29}$ (79)				71	
2: Test of extension of just-learned novel verb:[b]						
Novel verb		$\underline{71}$ (40)			17	12
No word		$\underline{25}$ (52)			42	33
3: Test of whether just-learned novel verb will novel verb:[a]						
Novel verb	25		$\underline{63}$ (38)		12	
No word	16		$\underline{50}$ (60)		34	
4: Test of extension of second, just-learned novel verb:[b]						
Novel verb				$\underline{67}$ (39)	17	20
No word				$\underline{29}$ (67)	42	29

NOTE.—Underlined numbers were the hypothesized outcomes; cells with no entry could not occur on that particular trial.

[a] These trials pertain to the principles of mutual exclusivity and novel name–nameless category.

[b] These trials pertain to the taxonomic assumption and to the categorical scope principle.

TABLE 4

Individual Children's Responses in Experiments 1 and 2 by Trial Type

Age	Sex	Trial Type: 1[a]	2	3	4
Experiment 1: Asked for novel verb by name:					
35-24	F	1^1	2	2	1^1
35-7	F	1^1	1^1	1^1	1
35-24	F	1^1	2	2	2
34-2	F	2	2	1	2
32-14	F	1	2	1^1	1^1
34-2	F	2	2	0	2
32-24	M	2	0	2	1^1
33-24	M	2	1^1	1^1	1^1
35-29	M	2	1	1	0
32-24	M	2	0	2	2
35-12	M	2	2	0	0
32-18	M	2	2	2	2
Experiment 2: Asked to pick one:					
33-05	F	0	0	1^1	0
35-18	F	1^1	1	1	0
35-23	F	0	1	1	2
34-28	F	0	0	0	0
35-2	F	1	0	1	1^1
36-10	F	0	1^1	1	1^1
35-23	M	0	1^1	2	0
35-34	M	0	0	1	1
35-22	M	0	0	1	0
34-17	M	2	1^1	2	1^1
34-20	M	1^1	1	0	1
34-8	M	2	0	1^1	0

[a] A score of 0 means that on neither of the two trials of that type did the child select the unknown action; a score of 2 means that the unknown action was selected on both trials. A score of 1 with the superscript 1 means the child selected the unknown action only on the first trial of that type; the absence of a superscript means that the child selected the unknown action only on the second trial of that type.

chance probability of scoring 0 out of 2 is (.75) × (.75) = .5625. Second, expected frequencies for scores of 2, 1, and 0 were calculated by multiplying each of the chance probabilities by the number of subjects (12); expected frequencies are .75, 4.5, and 6.75, respectively. Third, a second-order application of the binomial distribution was used to obtain the probability that as many as eight or more children in a sample of 12 would obtain scores of 2 out of 2 by chance. This probability (the sum of the probabilities that exactly 8, exactly 9, exactly 10, exactly 11, and exactly 12 children would score 2) is very small (.000000091). In the group of 12 children there are thus, significantly more children responding as predicted to the two trial 1 questions than would be expected to do so by chance (i.e., given a probability of .25 of choosing in accordance with the predictions in response to each question about an unfamiliar novel action word).

Another way to look at these scores is to examine the probability that 12 children (the entire sample) would score either 1 or 2 out of 2 by chance. The probability of scoring 1 or 2 is the probability of scoring 1 plus the probability of scoring 2 (.375 + .0625 = .4375). By the second-order binomial, the likelihood that all 12 children in a group of 12 would score either 1 or 2 by chance is very small (.00004917).

Will children interpret a second new action word as applying to yet another unnamed action?—On trial 3, a previously labeled novel action and a novel, unnamed action were presented with two familiar actions. The overall rate of selection of the unnamed novel action was 63% and five of 12 children obtained a score of 2. By the second-order binomial, the likelihood that five or more children in a group of 12 would select the second unfamiliar object by chance is .000519. Also, five of the 12 children obtained a score of 1. We next evaluated the likelihood that 10 children out of a group of size 12 would score either 1 or 2 out of 2 by chance. This probability is also small (.005365). When children erred on trial 3, they selected the just-named action 25% of the time and a familiar action 12% of the time.

Will children extend a just-learned novel term to another novel action of the same type?—In trial 2, when presented with another token of the action that they had just selected as the referent for the novel verb in trial 1, children selected the token of the just-named action 71% of the time. Furthermore, seven children achieved a score of 2. The likelihood that seven or more children would achieve a score of 2 by chance alone is .000002227. The remaining five children achieved a score of 1 (3) or 0 (2). The probability that 10 children would score either 1 or 2 out of 2 by chance is also small (.005365).

Extension was seen also in trial 4 where 67% of children's responses were selections of another token of the action they had seen on the prior trial. Here five children received scores of 2, a number significantly greater than would be expected by chance in a group of size 12 (binomial p = .000519). Of the remaining children, two obtained a score of 0, and five children obtained a score of 1. The probability that 10 or more children in a group of size 12 would receive a score of 1 or 2 out of 2 by chance is small (.005365).

Were children consistent in their individual response patterns?—Two types of analyses were performed. First, each subject was given one point for performance according to predictions on each of four trials (across two blocks of trials) that tested the same principle. Thus, trials 1 and 3 tested for whether a novel name would be mapped to an unnamed action, and trials 2 and 4 tested for extension. On trials 1 and 3, eight out of 12 subjects received scores of 3 (five subjects), or 4 (three subjects), indicating that the majority of subjects mapped the unknown term to the unnamed action on 75% or more of their trials. This frequency (eight or more in a group of 12) can be interpreted in light of the binomial: The probabilities of an individual child's scoring 3 and 4 out of 4 by chance are .0469 and .0039, respectively. By a second-order application of the binomial expansion, the chance probability that eight or more children out of a group of 12 will score 3 or 4 is .00000002. Thus, the likelihood that two-thirds of the subjects could have achieved scores of 3 or 4 by chance is quite slim. Further, this occurred despite the greater difficulty of trial 3, where a just-named action was also present. It appears that the majority of the children were indeed motivated to affix novel names to unnamed actions. Each of the four children who did not attain scores of 3 or 4 obtained a score of 2.

On trials 2 and 4, where another unnamed novel action was presented in addition to a new token of the action seen on the prior trial, six out of 12 children reliably extended a just-learned novel action term to a new token on at least 75% of their trials, receiving scores of 3 (two subjects) or 4 (four subjects). As above, the likelihood by the binomial that a single child could answer 3 or 4 out of 4 trials according to predictions by chance is (.0469 + .0039) = .0508. The chance probability that six or more children out of 12 will score 3 or 4 by chance is .00012. This result suggests that children recognize that words—in this case action terms—are applied to categories of action. Of the six children who did *not* attain scores of 3 or 4, four received scores of 2.

The second intrasubject analysis asked whether children were consistent from trial to trial in their interpretation of the same term. In other words, if a child selected the novel action on trial 1, did the child then select the token of that action on trial 2, and then a different novel action on trial 3, thereby acting as if the first unknown action already had a name? For this analysis, a child needed to answer the first three trials *in a row* according to predictions to receive a point, an extremely conservative criterion that would be expected to be met by chance only with the probability of .0156. Subjects could receive a score of 0, 1, or 2, commensurate with the number of blocks of trials in which three questions in a row were answered consistently. Thus, a child who obtained a score of 0 failed to answer three in a row consistently on either of the trial blocks. A score of "1" means that the child answered three in a row consistently on only one of the two blocks of trials; "2" means that the child answered three in a row consistently on both blocks.

Results again suggest that children are not operating randomly. The likelihood of a single individual obtaining a score of either 1 or 2 is .031 (the sum of the probability of getting 1 and the probability of getting 2). Since seven out of 12 subjects received scores of 1 (six subjects) or 2 (one subject), two-thirds of the children, seen as individuals, appear to be treating a just-learned term with consistency from trial to trial. The data become more impressive, however, when, using the second-order binomial, the chance likelihood that seven or more children in a group of 12 would receive a score of 1 or 2 is calculated. This probability is very small (.000000018).

Summary.—Results from a task which gave young children considerable opportunity to respond inconsistently suggest that children readily fast map novel verbs to novel actions. From a single exposure to a novel action word in a nonostensive task, two-thirds of the sample appeared to assume that a new word applies to an action which does not already have a name (trial 1) and that the novel verb can be immediately extended (trial 2 and trial 4). However, on trial 3, where a second novel verb was introduced, children seemed somewhat confused. This is not surprising in that on this trial, children were asked to take a second novel term to apply to an unnamed action in the presence of a novel action that had been named only twice on the prior trials.

Thus, the data from the trials considered singly (that is, trial 1, 2, 3, or 4) present a mixed picture of young children's ability to fast map and extend novel verbs. When the data from the trials that tested the same principles were taken together, however, the results are more supportive of the predictions. Children were consistent in their performance on the trials that tested for fast mapping as well as on those that tested for extension of a novel verb. On the fast mapping trials (1 and 3), there is only a very small likelihood that eight children out of a sample of 12 could obtain scores of 3 or 4 out of 4 correct by chance. Similarly, on the trials which tested for the extension of a novel verb to another exemplar (2 and 4), there is a very small likelihood that, by chance, six children out of 12 could consistently extend a novel verb to a second exemplar. More impressively, eight of the 12 children treated the novel verbs as though they mapped to the same action on the first three consecutive trials in either or both blocks of trials. This latter finding means that children fast mapped (trial 1) and extended the first novel verb (trial 2) and then, when they heard another novel verb on trial 3, did not select the action that had just been named. That is, they correctly treated the new action term as though it applied to the newest unnamed action.

Before these results can be fully evaluated, however, a control experiment is needed to rule out the possibility that children would have responded similarly without being offered a novel label. If children are behaving according to certain lexical principles they should only do so in the presence of a label. Without a label, their behavior should look random.

Experiment 2

This control study was designed to determine whether the choice of novel actions in Experiment 1 was controlled by the use of a novel action label. The results of the prior experiment may be attributable to artifact (perhaps a preference for novelty, see Merriman, 1991) and not to the operation of lexical principles if children behave the same way when asked to select an action without being offered a name. This experiment exactly duplicates the design of the main experiment. Thus, children were still asked for a familiar action on each trial and still had to choose from among familiar and unfamiliar actions (see Table 2). However, wherever a novel action was requested by name in Experiment 1, children here were asked, "Can you show me someone doing something?"

Subjects

Twelve children (six boys and six girls) (mean age = 35 months, 2 days; range = 33,05–36,10) were tested. All were Caucasian and native speakers of English with multiword speech.

Procedure

The same two-part procedure was used as in the Experiment 1, with the exception that no novel action was requested by name.

Results

Responses to familiar actions.—When a familiar action was requested by name, children were correct on 100% of the trials.

Did children select the same unknown action from Experiment 1 when the request did not include a novel term?—On trial 1, when requests did not include a novel term, children selected the novel action only 29%

of the time (see Table 3). Recall that, as displayed on Table 4, a child could obtain a score of 0 (not selecting the novel action on either of the two trials of that type); a score of 1 (selecting the novel action on one of the two trials of that type); or a score of 2 (selecting the novel action on both trials of that type). The majority of responses on trial 1 were 0 (seven children); the rest were scores of 2 (two children) and 1 (three children). To evaluate whether the number of children (out of 12 tested) selecting the novel action was significantly greater than the number expected by chance, second-order binomial probabilities were used to compute change levels at the high tail of the distribution as in Experiment 1. However, since there were so few scores of 2 in Experiment 2, these probabilities were only computed by considering whether the number of children who scored either 1 or 2 out of 2 in a group of size 12 exceeded chance. First, the probability of a single child obtaining a score of 0, 1, or 2 was calculated. These probabilities are .5625 for a score of 0, .375 for a score of 1, and .0625 for a score of 2. Second, expected frequencies for scores of 0, 1, or 2 were calculated by multiplying each of the chance probabilities by the number of subjects (12); expected frequencies are 6.75, 4.5, and .75, respectively. Third, a second-order application of the binomial distribution was used to obtain the probability that five or more children in a sample of 12 would obtain scores of 1 or 2 out of 2 by chance. Since this probability is high (.22619), it appears that children did not select the novel action with a frequency significantly greater than that expected by chance when it was not requested by name on trial 1.

Did children select the second novel action on trial 3, despite the fact that it was not requested by name?—On trial 3, children's selection of the novel action they had not already seen on trial 1 was at a rate of 50% (see Table 3). As Table 4 shows, two children scored 2, two children scored 0, and the eight remaining children scored 1. The probability that 10 or more children out of 12 could obtain a score of 1 or 2 by chance is small (.005365). This significant result suggests that the novelty of the second unnamed novel action may have played a role in children's responses on this trial. Nonetheless, comparisons of children's performance across the two experiments (see below) suggest that even on trial 3, arguably the most difficult trial, children in the main experiment responded systematically while children in this experiment did not.

Did children select the second token of the novel action on trials 2 and 4—Children selected the second token of the novel actions at the rates of 25% on trial 2 and 29% on trial 4. On trial 2, six children obtained a score of 0, and six children obtained a score of 1. Trial 4 results were quite similar: six children scored 0, five children scored 1, and one child scored a 2. The likelihood that in a group of 12 children six children would score either 1 or 2 out of 2 by chance (applicable to both trials 2 and 4) is .205246. Therefore, when the request was made without a label, the numbers of children out of a group of 12 who selected the second token of the first novel action on trials 2 and 4 were not significantly greater than would be expected by chance.

Were children consistent in their individual response patterns?—The same two analyses that were performed in Experiment 1 were performed here. First, each subject was given one point for performance according to predictions on each of four trials that tested the same principle. For trials 1 and 3 combined (fast mapping trials), there are two children out of 12 who score either 3 or 4. Three children scored a 2, six children scored a 1, and one child scored a 0. By applying the second-order binomial we find that the probability that two or more children in a group of 12 would score either 3 or 4 is .1215. Thus, since this probability is not low enough to justify an inference that a significantly greater number of children received scores of 3 or 4 than would be expected to do so by chance, we conclude that children do not select the unnamed action when it is not requested by name.

On trials 2 and 4 (extension trials), only one child scored 3; no children scored 4. Three children scored 2, four children scored 1, and four children scored 0. By the second-order binomial the probability that 1 or more out of 12 children would score either 3 or 4 is .4649. Thus, when the second token of the unnamed action was not requested by name, the children did not select it more than would be expected by chance in a group of this size (12).

The second intrasubject analysis asked whether children were consistent from trial to trial in their responses as they had been when a verb was used in the main experiment. That is, did children pick the same action or a token of it on trials 1 and 2, respectively, and then select the newest novel action on trial 3? With two blocks of trials, subjects could therefore receive a score of 0, 1, or 2. No child received a score of 2, one child scored 1, and the remaining 11 children scored 0. By the second-order binomial, the probability that 1 or more out of 12 children would obtain a score of 1 or 2 is .3147. Thus, children do not appear to be operating consistently when the unnamed action was not requested by name.

Comparison of children's responses to the unfamiliar actions across the two experiments.—Fisher's exact test was performed to compare across experiments the proportions of children with scores on pairs of trials of the same type. Thus, the number of children in each experiment obtaining scores of 3 and 4 versus 0, 1 and 2 on trials 1 and 3 and on trials 2 and 4 were assembled into 2 × 2 tables as shown in Table 5. By the Fisher's exact test, the proportion of children with scores of 3 and 4 for both sets of trials (1 and 3; 2 and 4) differed significantly between the two experiments ($p < .05$ for both sets).

Another way in which the Fisher's was applied was to compare the number of children in each experiment who gave a consistent interpretation across the first three trials of a block of trials. Thus, children could have obtained scores of 2, 1, or 0, commensurate with the number of trial blocks in which they selected the novel action (trial 1), a token of it (trial 2), and then a different action on trial 3. In Experiment 1, seven children received scores of 1 or 2, and five children received scores of 0; in Experiment 2, one child received a score of 1 and the rest received scores of 0. The Fisher's test revealed that a significantly higher proportion of children received scores of 1 or 2 in the main experiment than in the control experiment ($p < .005$).

Summary.—The control experiment was designed to see if children would respond similarly to the children in the main experiment despite the fact that actions in the control study were not requested by name. If children had responded similarly, some explanation other than lexical principles, such as a novelty preference, would have been responsible for the results in the main experiment. Clearly, children in the control experiment, considered as a group, for the most part did not obtain a significantly larger number of high scores than would be expected by chance in a group of size 12. The only exception to the interpretation that children in the control experiment acted randomly comes from trial 3 when it is analyzed singly. Here, significantly more children than would be expected by chance in a group with 12 members selected what would have been the newest unnamed action in the main experiment (i.e., the action that should be selected in accordance with predictions of the lexical principles). However, this result is mitigated when trials 1 and 3 are analyzed together.

Another way in which the children in the control experiment were shown to perform differently than children in the main experiment was in the comparisons across experiments, both by group and by individual subjects. The children in the control experiment were much less likely than those in the main experiment to select the appropriate unfamiliar action in response to a request without a name. These findings suggest that children in Experiment 1 engaged in true (if limited) word learning and responded in a consistent and principled way

TABLE 5

OBSERVED FREQUENCIES OF HIGH (3–4) AND LOW (0–2) SCORES ON FAST MAPPING TRIALS (Trials 1 and 3) AND EXTENSION TRIALS (Trials 2 and 4) IN THE MAIN AND CONTROL EXPERIMENTS

		Experiment	
Trials	Scores	Main	Control
1 and 3	3–4	8	2
	0–2	4	10
	Fisher exact $p < .05$		
2 and 4	2–4	6	1
	0–2	6	11
	Fisher exact $p < .05$		

when offered a label in the presence of an unfamiliar action.

General Discussion

The purpose of this research was to see whether children could fast map and extend novel motion verbs; prior research already showed that children could fast map and extend novel nouns (e.g., Golinkoff, Hirsh-Pasek, et al., 1992) and adjectives (e.g., Heibeck & Markman, 1987). In this experiment, children were presented with four new action names in a single session. To succeed, they had to be able to fast map a new term to a novel action and then to extend this term to the same action performed by a different agent. Together with Merriman et al. (1993, 1995) and Rice and Woodsmall (1988), this is one of the few studies that have tested for verb learning in a nonostensive context. That is, the experimenter never made an explicit link between the actions and the action names; it was up to the child to infer to which action the novel verb mapped. Nonetheless, we hypothesized that children would have little difficulty with this task since by 34 months of age most children have acquired many verbs. Experiment 2 was a control experiment which presented children with the task of selecting a novel action in the absence of a novel label. If, in the main experiment, children's responses are guided by something other than lexical principles (say, a preference for novelty), then performance in the control experiment should continue to exceed chance levels.

First Mapping of Verb Meaning Is Predicted by Lexical Principles

Experiment 1 tested whether children would select a previously unnamed action in response to requests using a novel term in the presence of both named and unnamed actions. This question was relevant to principles such as mutual exclusivity (Markman, 1987), contrast (Clark, 1983), and N3C (Golinkoff et al., 1994), all of which attempt to account for the rapid learning of novel names. The principle of N3C states that novel terms map to unnamed categories. Unlike the principles of contrast (Clark, 1983, 1987) or mutual exclusivity (Markman, 1987, 1989) which make a number of other assumptions, N3C predicts only that children will attach novel labels to unlabeled categories. Results from Experiment 1 indicated that N3C applies to novel action names as well; children selected the novel action to be the referent for the novel action name on both trials 1 and 3, although to a lesser degree on trial 3. On that trial, children had to choose between two known actions (e.g., eating), one action that had just been named, and a novel action that had not yet been named. According to the principles that state that a novel term should be taken as the name for a referent without a name, children should have reliably chosen the unnamed novel action. This trial, however, represents a highly rigorous test of these principles since children had only two exposures to the first novel verb/action combination. Another possible explanation for the weaker results on this trial may have to do with the greater potential for verbs to overlap in reference more than do nouns, as discussed above.

Performance on trial 3 looks less ambiguous in two other analyses. First, when the two trials (1 and 3) that tested for fast mapping are taken together, the results clearly indicate—especially in comparison to the performance of the children in the control study—that most children did fast map the novel term to the respective novel actions on these trials. Second, the comparison between the number of children in the main and control experiment who responded according to the word learning principles on three trials *in a row* within a block also shows a clear pattern of adherence to the fast mapping principles. Children who responded consistently selected the first unnamed action on trial 1, the second token of that action on trial 2, and finally, the second unnamed action on trial 3. Two-thirds (eight) of the children in the main experiment responded with this degree of consistency; no child in the control experiment did. No word learning experiments of which we are aware have held children to this high a standard to provide evidence for the operation of lexical principles.

N3C (or a principle like it) seems to be useful throughout the life span for the rapid acquisition of object names (Golinkoff, Diznoff, et al., 1992), property names (e.g., Heibeck & Markman, 1987), and action labels as well (the present study). To use N3C, or for that matter, any principle that states that new terms are mapped to unnamed items, children must have the following knowledge: First, they must be capable of interpreting others' communications as referential acts. Golinkoff et al. (1994) called this the principle of "reference" and found evidence of its use at the beginning of the second year of life. By the time children are 2 years old, the ability to detect a referential act is quite sophisticated. Tomasello and

Barton (1994), inspired by Baldwin (1993), showed that 2-year-old children will not map an action label to the first action they see if that action was apparently performed accidentally. Rather, children will wait to map a novel verb to the second novel action, apparently performed intentionally. Second, children must recognize that the word they are hearing is novel. This implies that they must already have a vocabulary of some size to compare the novel word against. In fact, Mervis and Bertrand (1994) showed that N3C (as it applied to the learning of novel object labels) was only in place *after* children showed evidence of having undergone a vocabulary spurt. Third, children must have some way to distinguish whether the novel word is a noun, or a verb, or an adjective. To do this children can rely on one or more redundant linguistic cues (Goldfield, 1993; Golinkoff, Diznoff, Yasik, & Hirsh-Pasek, 1992) such as the presence or absence of articles, final placement in the sentence, and prosodic cues such as stress, as well as nonlinguistic cues.

Interestingly, our findings on the fast mapping of verbs parallel those of Rice and Woodsmall (1988) and Merriman et al. (1993, 1995) in finding verb learning a bit more difficult than noun learning. The present study's design is identical to the design of a prior study on nouns (Golinkoff, Hirsh-Pasek, et al., 1992) except for the use of only two blocks of trials instead of three. Although the rate of selection of the unfamiliar item when requested by a novel term was virtually identical (72% for nouns, 70% for verbs), the children in the verb study were, on average, 5 months older. Especially with only two blocks of trials, they might have been expected to perform at a higher level than the younger children in the noun study. There are two possible explanations for this difference, one of which can be ruled out. First, it is not the case that children failed to interpret the stimulus drawings as actions and were just confused. The stimulus evaluation study (see Experiment 1) showed that children interpreted these stimuli as portraying actions, as they probably do in a book-reading situation.

Second, the fast mapping of verb meaning may require more exposures than the fast mapping of noun meaning. This makes sense on the rationale that many subevents may occur when a new action is performed, and it may take a few exposures to the action/verb combination to tease out which portion of the novel action is "core" and which is more peripheral and a function of the individual actor. Perhaps until children are fairly certain about what exactly is being labeled, they are a bit reluctant to use and extend a new verb. Support for this view comes from Forbes and Farrar (1993), who reported that 3-year-olds generalized novel verbs significantly less than 7-year-olds or adults. Furthermore, if we assume that children do not encounter much in the way of negative evidence (e.g., Pinker, 1989), it is quite adaptive for children to be somewhat conservative in their fast mapping and extension of novel verbs.

Extension of Novel Verbs is Predicted by Lexical Principles

Experiment 1 also tested whether children will readily extend a newly learned action term after a single exposure to another instance of the action performed by another agent. Much of the power words have would be lost if children—like Victor, the wild boy of Aveyron (Itard, 1932)—expected each word to label a single, unique exemplar. Children fortunately do not hold that expectation and extend just-learned nouns (Golinkoff, Hirsh-Pasek, et al., 1992), adjectives (Heibeck & Markman, 1987), and verbs (the present study) after only a single exposure to them. Three principles (the noun-category bias, the taxonomic assumption, and categorical scope) have been proposed to account for extension.

Golinkoff et al. (1994) and Golinkoff, Shuff-Bailey, et al. (1995) provided evidence that the categorical scope principle better captures the basis for *object* word extension since it specifies that novel words are to be extended on the basis of basic level category membership. The jury is still out, however, on the issue of whether verb meanings, like noun meanings, are organized in a subordinate-basic-superordinate hierarchy (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). For example, Kegl (1989) made the case that action terms can be organized hierarchically while the word of Huttenlocher and Lui (1979) and Miller and Johnson-Laird (1976) indicates that verb organization is flatter and less hierarchical than the organization of nouns. Whether or not verbs turn out to be organized hierarchically the way nouns are, it is still the case that children must construct a principle to guide verb extension to other actions in the same category. Golinkoff, Hirsh-Pasek, et al. (1995) asserted that "categorical scope for verbs states that action labels are extended to other actions that appear to require the same semantic components as the original action" (p. 208). "Semantic component" refers to elements of meaning like "theme," "path," and "manner" that the world's languages either conflate, within the meaning of their verbs or mark outside the verb with a separate form (Frawley, 1992). Although considerably more research is needed, it appears that children can detect these semantic components through their observation of events (Pinker, 1989) as well as from the syntactic frames which surround the verb (Gleitman, 1990; Hirsh-Pasek & Golinkoff, in press). When errors of verb extension occur, categorical scope predicts that they will likely be a result of the child failing to note one of the semantic components conflated in the verb. For example, Choi and Bowerman (1992) report that a Korean child used the verb *ollita* (cause to go up) incorrectly, to mean "putting [something] away regardless of directionality" (that is, up or down) because this child failed to realize that the element of path was included in the verb.

This study, which tested for verb extension by showing a new agent performing the action in exactly the same way, may be an easier situation than children typically encounter. In the real world, even when the same agent performs the same action, the action is never done in exactly the same way. In addition, the location of the action may change, as well as the instrument used to perform it, or the manner in which it is performed. Further, all the novel actions depicted were intransitive. Fast mapping results from Merriman et al. (1995) with 2-year-olds (but not 4-year-olds, see Merriman et al., 1993) suggest that intransitive actions without an object may be easier to fast map (and perhaps, to extend) than transitive actions. It would be interesting to explore whether the fast mapping and extension observed in this study would occur at the same rate if transitive actions were tested.

Conclusions

The present study is important because it is among the first to show that fast mapping and rapid extension occur with verbs. Further, children's word-learning behavior was in accordance with the prediction of principles that have been demonstrated to hold for object word learning. The availability of such principles across form classes may help explain word acquisition phenomena like the vocabulary spurt.

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