

Mapping Words to Actions and Events: How Do 18-Month-Olds Learn a Verb?

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1. Introduction

“ One thing is clear. If many or most of the words children acquire, and most of the words they use in their running speech, are not names of objects, then object-specific lexical principles cannot be responsible for word learning. More general principles are required to explain how a child will learn any kind of word and not just object words. . .” (Bloom, 1998, pg. 330)

In her chapter in the Handbook of Child Development, Lois Bloom continued to challenge those who study early vocabulary development. Word learning must go beyond the study of object nouns to include the full range of potential labels for objects, actions and events. In recent years, many have attempted to address this concern. Waxman and her colleagues, for example, have worked extensively on how children learn adjectives or words for object properties (Waxman & Markow, 1998). Others have focused on the early learning of action words or verbs (Behrend, 1990; Fischer, Hall, Rakowitz, & Gleitman, 1994; Gleitman, 1990; Huttenlocher, Smiley, & Charney, 1983; Merriman, Marazita, & Jarvis, 1995; Naigles & Kako, 1993; Pinker, 1984; Tomasello, 2001)

These initiatives are just beginning. In particular, the last decade has witnessed tremendous progress in understanding verb acquisition. Some have explored the semantic components of verbs (path, manner, etc.; Langacker, 1987; Pinker, 1984; Talmy, 1985;) and how they are learned by children (Naigles, 1990). Others ask how the various components of actions are differentially distributed and learned across languages (Choi & Bowerman, 1991; Naigles & Terrazas, 1998; Tardiff, 1996). Researchers are also investigating how knowledge of the verb structure acts as a syntactic bootstrap for language learning and language processing (Fischer, Hall, Rakowitz, & Gleitman, 1994; Gleitman, 1990; see also Akhtar & Tomasello, in press for an alternative approach to verb and syntactic learning).

These programs of research have increased our understanding of how verbs are acquired once children have a grammar and a large number of action words. Little work, however, has explored the ways in which children learn their first action words. This paper begins to fill that gap in the literature. How do children map words onto the actions and categories of actions that form the foundation for verb learning? One reason this question has been largely ignored is because verb learning is considerably more complex than noun learning.

1.1 The intractable problems of verb learning

Gentner (1982, see also Gentner and Boroditsky, 2001) was among the first to address why verbs are so difficult for young children to learn. Verbs label events that are comprised of components like manner, instrument, path, and results – any of which can be the dominant focus for the label. Worse yet, across languages different components are highlighted such that *manner* is often conflated in English verbs (e.g. walk vs. skip) while *path* is often an integral part of Spanish verbs (e.g. ascendere). Verbs are also ephemeral. Object nouns often label things that are concrete (Langacker, 1987; Smith, 2000). For example, a mother can point to and label a block as the child plays with the block. Object noun categories are also often based on perceptual or functional similarity (Landau, Smith, & Jones, 1998). The events labeled by verbs, however, are abstract and are often labeled before or after the action has taken place (Tomasello & Kruger, 1992). Nouns tend to have more restricted meanings than do verbs. The average dictionary entry for the noun “ball” has only 2 definitions, while the verb “run” has a dramatic 53 entries – all under the classification -verb (The American Heritage Dictionary, 1994). Finally, object nouns can exist independent of actions. Actions on the other hand require an actor or an object. Thus, a child who hears an action label is faced with the ambiguity of determining whether the label maps to the object or the relationship between the objects and the actors in the scene.

On the one hand, then, scholars like Bloom (1998) encourage researchers to address word development broadly. On the other hand, scholars like Gentner (1982, also see Langacker, 1987; Talmy, 1985) explain why investigating word learning in verbs will be so difficult. This paper takes a first step in reconciling these two positions. Using work in early object labels as a platform, we ask whether principles of word learning for nouns might apply to the learning of action labels or verbs (Golinkoff, Hirsh-Pasek, Mervis, Frawley, & Parillo, 1995). Two basic principles of word learning that should apply equally to nouns and verbs are the principles of reference and extendibility (Hollich, Hirsh-Pasek, & Golinkoff, 2000). The principle of reference states that words refer to objects, actions and events, while the principle of extendibility states that words refer not only to single exemplars but to categories of objects, actions and events (Golinkoff, Hirsh-Pasek, Mervis, Frawley, & Parillo, 1995). For verb learning this means children have to learn,

not only that the action of “running” receives a consistent label (i.e., the principle of reference), but also that the label “running” applies equally well to scenes of Carl Lewis running and scenes of Grandma running (i.e. the principle of extendibility).

We hypothesized that infants learning their first verbs would be able map a novel word onto a novel action. Further, we hypothesized that infants and toddlers would be able to form a category of action and to extend the newly learned label to that category. Three studies were performed in the split screen preferential looking paradigm to test these hypotheses. In Experiment 1, children viewed one actor performing a novel action 4 times while hearing a label. They were then tested to determine their ability to extend that label to a novel actor performing the same action. In Experiment 2, children viewed four different actors each performing the novel action one time during the training phase. They were then tested to determine if children could now extend the novel label to a novel, 5th actor performing this same action. Experiment 3 was similar to Experiment 1, but in the training phase the visual display of the action was simplified. Each of the experiments differed only in the visual display during training.

2. Method

The split screen preferential looking paradigm was used across all three experiments. The child is seated on his or her caregiver’s lap 45 in. from a large screen television. The caregiver is instructed to keep his or her eyes closed throughout the experiment to assure they will not aid the child in anyway.

Table 1: General Design Across Experiments

Phase	Audio	Video
Attention	“Look She’s walking! Do you see her walking? Watch her walking!”	A girl walking first on one side of the television screen then the other
Salience (1)	“What’s up here? Look up here. What’s going on?”	Person A performing action 1, person B performing action 2
Training (4)	“Look she is blicking!” Watch her blicking! Do you see her blicking?”	Person performing target action **
Test (2)	“Who’s blicking? Do you see her blicking? Blicking is fun!”	Same as salience

*Note.** Changes across experiments*

On the television, the child first saw a person walking on one side of the screen for six s followed by the same clip on the other side of the screen. This was accompanied by the audio “Look, she’s walking. Do you see her walking? Watch her walking”. The purpose of this phase was to assure that he or she looks to both sides of the television screen to avoid visual fixation on either side. This was followed by two sets of verb pairs which each followed the same progression.

The salience phase was composed of two actors performing different actions on either side of the screen accompanied by a neutral audio: “Look up here. What’s up here? What are they doing?”. This was to assure that neither of the actions was inherently more interesting than the other. Next, in the training phase, children viewed four clips for six s each of a person performing an action accompanied by the audio: “Look she’s blicking! Do you see her blicking? Watch her blicking!” Lastly, in the two test trials, the video display was exactly the same as that shown in the salience phase; the only difference is the audio now asks the child to find the labeled action: “Which one is blicking? Watch her blicking”. If children correctly learned the action label, they will look longer towards the correct action during the test phase than they did during the salience phase when no label was given. A second novel verb pair followed this. It is important to note that each experiment was identical in the salience and test phases; the only difference was in the visual presentation of the training phase.

3. Experiment 1: Extending from one exemplar

One of the key components to learning action labels is learning that there is tremendous variability in the action as it is conducted by various actors. In the act of running, for example, even the same actor can perform the same action in very different ways. Further, one runner may have a broad stride and lift his legs higher. Thus, even when one substitutes one actor for another the label remains the same. Experiment 1 tests children’s ability to extend an action word from one exemplar to a novel one. Thus, in the training phase children see the same clip of a female actor performing a novel action four times each for six seconds while the action is labeled. In the test trials there are two novel actors, one performing the target action and the other performing a distractor action.

16 19-month-olds from a suburb of Philadelphia participated in this study ($M=19.27$, $SD=.89$, range =17.92-20.95).

3.1 Experiment 1: Results

There was no salience preference, $t(15) = -.673$, $p = .511$ (two-tailed). To determine whether children had learned the label, we used a measure of the difference of differences scores. Thus, the amount of time the child looked to the target and the non-target action during the salience trials and the test trials was computed. A score of the difference between the amount of time the child

looks to the non-target was subtracted from the amount of time they look to the target for each type of trial (salience and test). For the salience trials, this difference score indicated which image the child found inherently more interesting before training. For the test trials, the difference score represented which image the child felt matched the action label (a positive score indicated more attention towards the target action). To assess the impact of the training regardless of which image the child finds more interesting, a difference of difference scores was computed. This was the target minus the non-target looking time during the salience trials subtracted from the target minus non-target looking times during the test trials. This equation is used in each experiment. The difference of difference scores proved to be non-significant ($M = -.331$, $SD = 1.44$), $t(15) = .83$, $p = .21$ (one-tailed).

3.2 Experiment 1: Discussion

Infants were not able to extend a novel action label to a new person performing the target action. Because the overall percentage of attention to the television screen during the experiment was 84%, the children were at least attending to the task. Not only do the children fail to learn the label, but inspection of the means reveals that during the test phase, when they are asked to look to the target action, they are actually looking towards the non-target. Although this is not a significant finding, it is interesting. This is the first time that we have elicited this response using this paradigm. Perhaps the task was so difficult that the children transformed it into a perceptual learning task in which they prefer novelty.

Why were children unable to extend the label appropriately? It may be that we provided too few exemplars. Children may require more exemplars to form a category.

4. Experiment 2: Extending from multiple exemplars

In our noun learning studies three exemplars were necessary for children to learn and extend object categories. Considering actions are more variable and potentially more difficult to categorize, adding more exemplars could facilitate category formation. To test the hypothesis that children need exposure to multiple exemplars to form and extend the label for an action category we performed Experiment 2. In this experiment the salience and test trials are exactly the same as in Experiment 1. The only difference is in the training phase of the study. While in Experiment 1 children saw the same six second clip repeated four times, in this study they will see four distinct actors performing the target action one time each with the same audio track as was used in Experiment 1. Thus, the children receive no more training and no additional syntactical or semantic information than they did in Experiment 1; they only see more people performing the action.

Sixteen 19-month-old infants ($M = 19.36$, $SD = .65$, range = 18.23-20.56) from a suburb of Philadelphia participated in this study.

4.1 Experiment 2: Results

Again, there was no salience preference for either of the actions, $t(15) = .283$, $p = .781$ (two-tailed). Contrary to the hypothesis, however, even a one sample t-test showed the difference of difference scores was not significant, ($M=.17$, $SD = 1.440$, $t(16) = -.08$, $p = .48$ (one-tailed)).

4.2 Experiment 2: Discussion

The infants were still unable to demonstrate that they could abstract the action, categorize it, correctly attach the label and extend that label to a novel exemplar. It is interesting to note that the infants in this experiment did not show any preference for the novel, non-matching event. Yet, even the difference between Experiment 1 and Experiment 2 did not yield significant results. There are many possible reasons for this. It may be that the complexity of actions in general makes it more difficult for infants to focus on the relevant aspects of the scene. This problem can be addressed in multiple ways. The first is that the problem of variability is so overwhelming in an action scene that even more exemplars are necessary to focus the children and to enable category formation. Alternatively, it may be that the novel actions chosen for these experiments are themselves too complicated for children to process. Current research is investigating these possibilities. If the inability to focus on relevant aspects of the visual scene is hindering category formation, then any method that enhances invariants across actions or that eliminates irrelevant information from the scene should facilitate the learning of action labels.

5. Experiment 3: Point light displays, the ultimate simplification

In this experiment we attempt to focus children's attention to the pertinent information in the scene by presenting the training in point light displays. First introduced into the perception literature by Johansson (1973), point light displays consist of 13 points of light corresponding to the head and major joint points of a human performing an action. What remains in these point light displays is a light sequence based on the typical motion information associated with a given action. Just as in subjective contours where a triangle seems to emerge when only its angles are visible (Kellman & Spelke, 1983), point light displays offer viewers apparent actors and objects without specifying their properties. What point light displays do preserve are the semantic components of the verb such as manner (how an action is performed) and path (the trajectory an action follows; Talmy, 1985). We will refer to the confluence of the semantic components that remain in point light portrayals of action as "verbal essence." There is reason to believe that point light displays can be

interpreted by young infants (Bertenthal, 1993). Research from our own lab also suggests that older children can derive verb meaning from point light displays (Golinkoff, et al., under review). Thus, it seemed reasonable to assess reference and extendibility of action labels using point light displays with infants.

If children struggled with Experiment 2 because they were unable to extract the “verbal essence” of the scene, showing point light displays of the action during training should make the task easier. This is because point light displays force children to focus on the component of the action that receives the label, in this case the manner of the action. If infants are able to focus on the manner of the action, they should then be able to correctly attach a label and extend that label to a novel live action person.

In this experiment the salience was exactly the same as in Experiments 1 and 2 (i.e., live action people). The training consisted of the same video clip shown in Experiment 1, now rendered into a point-light display, shown four consecutive times. Thus, we are still asking children to label the action for one exemplar and to extend it. The exemplar used in training was in point-light display as opposed to a live action person. The test, however, was a novel live action person performing the target action. The test was precisely the same as that used in Experiments 1 and 2 above.

Sixteen 19-month-olds from a suburb of Philadelphia participated in this study ($M=19.47$, $SD=.75$, range =18.16-21.07).

5.1 Experiment 3: Results

No salience preference was found between the two actions, $t(16) = -.91$, $p = .38$ (two-tailed). As hypothesized, a one-sample t-test showed the difference of difference scores was significant ($M=.93$, $SD=1.310$, $t(16)= -2.84$, $p < .01$ (one-tailed)).

5.2 Experiment 3: Discussion

In this final experiment the 18-month-olds were able to learn the correct label for the point light display of an action and correctly extend that label to the action when performed by a live actor. The only difference between this experiment and Experiments 1 and 2 was the visual display of the training phase. Here, by simplifying the action as much as possible, through the use of point-light displays, children were able to attend to the correct information and label it. Through this simplification infants were able to abstract the “verbal essence” of the action and extend the label to a novel agent.

The verbal essence is the semantic component of the event that is encoded by the verb. In this case, the most important semantic component in these scenes was the manner of the action, the overall body movement that remains consistent across actors. The point light displays highlighted the most important component which helped children to create a semantic category and correctly extend a label based on the similarity.

6. General Discussion

To use verbs flexibly, children must be able to map verb labels onto actions and extend these labels to categories of action. Thus, the word “running” is used with Grandma but applies equally well to Carl Lewis. As this example illustrates, extension along action categories appears to be a more challenging task than the extension of object labels. In Experiment 1, 18-month-olds failed to learn a label for the novel aerobics action. They failed to extend that label to a new exemplar during the testing phase. Experiment 2 was conducted to determine whether the children needed more varied exposure to the action category to learn a label. While infants performed more competently in this task, they still failed to demonstrate evidence for the principles of reference and extension. Finally, Experiment 3 was performed in an effort to focus children on the action and the relevant components of the action. Here the infants demonstrate the ability to map the label onto the action and to extend the label to a new exemplar. It is relevant that across the three experiments, the testing phase remained exactly the same. Only the visual displays in the training trials varied. Further, it is noteworthy that across the three experiments there was a trend such that infants performed more competently in Experiment 2 than in Experiment 1 and more competently in Experiment 3 than in Experiment 2 (see Figure 1).

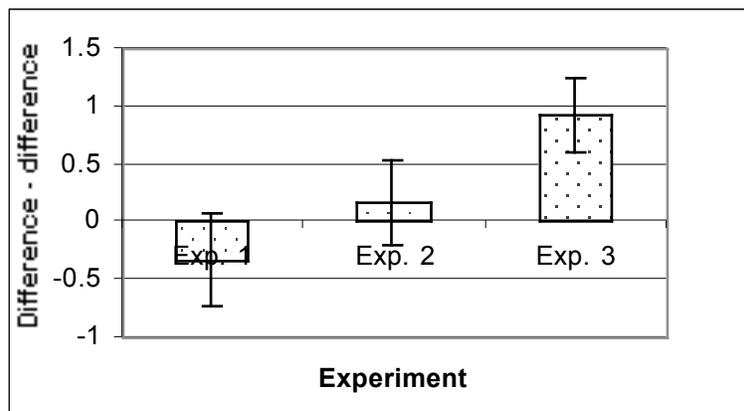


Figure 1: Comparison of the difference of difference scores of each experiment

What is it about the point light displays that enabled the infants to show their word learning skills in this but in no other word learning condition? One possibility is that the point light displays bleached the scene to help infants focus on what was relevant for verb learning. Actions are complex, including multiple components and relations between objects and actors. Point light displays “simplify” the task by allowing children to abstract the invariant semantic

components that describe that action: the process of extracting the “verbal essence” of events (Golinkoff, et al., under review).

It is possible that children determine the reference for an action and learn to extend that reference based on the verbal essence that serves as a kind of averaged representation of what that action looks like. Marconi (1997) captured this idea: “Many verbs of motion have ... *a typical appearance, a physiognomy*” (p. 159, italics ours). This typical appearance may represent what Pinker (1989) labeled the “shape” of an action. But for motion verbs, the notion ‘shape’ seems to be composed jointly of four components, what linguists refer to as “figure,” “ground,” “manner,” and “path” (e.g., Frawley, 1992; Talmy, 1985). A motion event must at a minimum involve a *figure* (be it animate or inanimate) doing the motion against some *ground* or location. Therefore, figure and ground do not distinguish between motion events. What does distinguish between motion events is the *manner* in which the motion is performed and whether the motion proceeds along a *path* relative to the ground. That is, “manner” captures *how* the motion is performed as well as its intensity and duration. Motion verbs like “tapping,” “knocking,” and “pounding” are distinct in that they differ in intensity but not in path since they entail motion at a stationary location. Others like “walking” and “jumping” differ in manner (although both involve the legs) and path: Walking occurs along a forward path while jumping takes place on a vertical path. The fact that walking typically entails a forward path is signaled by the fact that speech about walking along another path requires the speaker to add a prepositional phrase, as in, “walking in circles.”

We propose that to learn the referent for an action label or to extend the label correctly to a newly observed instance of an action, children would have to abstract the verbal essence of an action. The idea of verbal essence discussed here is reminiscent of how Mandler (1992, 1998) used “image schemas.” Children must lose the detail of the individual event to be able to recognize new instances and extend their verbs. For Mandler, events babies witness are stored as “image-schemas” or analog representations. These image-schemas, abstracted from children’s interpretations of how objects move in space, help reduce infinitely varying perceptual displays into a limited number of meaningful schemas.

One could argue that the infants in our paradigm needed help in constructing action categories because the actions portrayed were complex, unusual, and exemplified in such an unfamiliar setting. Perhaps infants can abstract action categories on their own if they are the actors (Huttenlocher & Smiley, & Charney, 1983), if there is some intention on the part of the actor, or if the child hears a richer syntactic frame used with the action. All of the actions used in this task were intransitive and frames delivered were fairly bare. Research in our laboratory is currently investigating whether infants would have performed in the live action tasks if, 1) richer syntactic frames were used, 2) physically simpler action displays were used, and 3) children saw actions accompanied with social intention.

While there are many unanswered questions, the fact remains that 18-month-old infants in this task *did* demonstrate the ability to use the principle of reference with respect to a novel action. They were also able to form a category of action in what would appear to be a very limited visual scene – extending what they learned to a more complex scene. These data tell us that infants can and do abstract the verbal essence out of the events that they see and thus have the foundation they need for building a vocabulary of verbs. Our current work is directed not only to learning more about how infants accomplish this task but also towards the exact kinds of knowledge that infants take from the visual scene as they prepare themselves for verb learning.

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