Attention to Novel Objects during Verb Learning

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Three experiments provided evidence that 3.5- to 4-year-old English-speaking children (N = 72) attend to the appearances of novel objects, not only when they hear a novel noun, but also when they hear a novel verb. Children learning nouns in the context of novel, moving objects attended exclusively to the appearances of objects, even though nouns were also related to the motions of those objects. Children learning verbs attended equally to the appearances of objects and their motions. The latter result contrasted with the results from adults (N = 20), who focused more strongly on motions than on the appearances of objects when learning verbs. When familiar objects were instead employed, child verb learners attended more to motions than to the appearances of objects. Children may attend to novel objects during verb learning because knowledge of an object may be prerequisite to understanding what a verb means in the context of that object.

INTRODUCTION

Children who are learning a variety of different languages have been found to learn nouns earlier than verbs (Gentner, 1982). Although this noun advantage may not be universal, children seem to learn nouns at least concurrently with verbs even in “verb-centered” languages such as Korean and Mandarin, in which nouns can be dropped from a sentence and verbs appear in the salient, sentence-final position (Au, Dapretto, & Song, 1994; Choi & Gopnik, 1995; Gopnik & Choi, 1995; Tardif, 1996; Tardif, Gelman, & Xu, 1999). One explanation for the earlier acquisition of nouns compared with verbs is Gentner’s (1982; Gentner & Boroditsky, 2001) natural partitions hypothesis. According to this hypothesis, the ability of human perception to segregate objects from their surrounding environment, coupled with a straightforward mapping of those objects onto nouns, encourages the acquisition of object names. In contrast, although children are also quite good at perceiving motions, and most of children’s earliest words refer to objects that are capable of moving or being moved (Bloom, 1973; Nelson, 1973), the mapping of these motions onto verbs is more difficult and arbitrary. For example, Talm (1985) has noted that whereas the most common verbs in English convey the manner of motion of an object (e.g., run, skip), verbs in many other languages more often convey information about the path of an object (e.g., enter, exit). Thus, although perceptual machinery is dedicated to motions as well as objects, learning how a language conveys these perceived motions may be more difficult than learning how it conveys information about perceived objects.

The natural partitions hypothesis suggests that nouns are learned before verbs because verbs are more difficult. An alternative explanation, however, is that nouns are learned before verbs because verb learning is dependent on knowledge of objects, which is typically acquired during the process of noun learning. This view is suggested by a number of different sources. First, Bloom (1981) has noted that whereas children frequently produce nouns during the one-word period, verb use is rare until children start producing multiword utterances. On the basis of this observation, she proposed that verbs cannot be learned in isolation, but rather must be learned in combination with nouns. This suggests that to learn the meaning of a verb, children must rely on knowledge associated with nouns, typically knowledge of objects.

That verb learning is dependent on knowledge of objects is also suggested by Gentner’s (1981) theory of representational differences between nouns and verbs. According to this theory, object concepts are more conceptually cohesive than are relational concepts such as verbs. As a result, nouns are interpreted in much the same way regardless of their context. In contrast, representations of relational concepts interact more strongly with representations of other concepts. As a result, the interpretation of a verb may be dependent on the particular objects involved. For example, one’s interpretation of the verb “running” may be very different in the contexts of “man,” “horse,” “engine,” and “politician” (for evidence consistent with this suggestion, see Earles & Kersten, 2001). If this theory is correct, one would expect that children would have difficulty conceptualizing the motions of unfamiliar objects, because the representations of those objects are not yet established. In contrast, children should perform better at conceptualizing the motions of familiar objects, because those objects form an established conceptual framework on which representations of novel motions can be constructed.

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Finally, a role for object knowledge in verb learning is also suggested by Kersten's (1998a) division of labor theory of motion representation in language. According to this theory, object nouns are typically associated with a number of different manners of motion. For example, humans are capable of walking, running, skipping, and sauntering, and children learn to associate these motions with humans at an early age (Bertenthal, Proffitt, & Cutting, 1984). The role of manner of motion verbs, then, is to select which of the different manners of motion associated with a noun is relevant in the given instance. To accomplish this, a manner of motion verb is associated with a generic meaning. For example, the verb “run” may be associated with a meaning such as “to move rapidly.” When this verb is used in conjunction with a noun such as “person,” the verb selects the manner of motion associated with “person” that is most consistent with the generic meaning of the verb. Because different manners of motion are associated with different nouns, this same verb may select different meanings in different noun contexts (e.g., “person” versus “engine”).

The theories of Bloom (1981), Gentner (1981), and Kersten (1998a) suggest that knowledge of the types of motions that an object can perform (or be affected by, when the object involved is a patient rather than an agent) is necessary before a child can understand what a verb means in the context of that object. This knowledge would typically be acquired during the process of learning a noun for an object, and thus verb learning may benefit from prior learning of nouns. Noun learning per se is not absolutely necessary for the learning of verbs, however. What is important is that a child has knowledge of the category to which an object belongs, in particular knowledge of the types of motions that are typical for objects in that category. This object category knowledge may be acquired during the process of noun learning, but it may also be acquired independently of a label (for evidence that motions can be associated with object categories independently of a noun label, see Kersten, 1998b; Kersten & Billman, 1997).

The theories of Bloom (1981), Gentner (1981), and Kersten (1998a) may be thought of as specific instantiations of a more general class of linguistic theories regarding the relation between the meaning of a verb and its arguments. In particular, semantic structure theorists (e.g., Groenen, Pinker, Hollander, & Goldberg, 1991; Levin & Rappaport Horav, 1991; Pinker, 1989) have proposed that the argument structure associated with a verb is related to the meaning of the verb. Thus, if a verb appears in two different argument structures, it has two different (albeit related) meanings. An example of this phenomenon comes from the locative alternation. The locative alternation is exemplified in the sentences “The worker loaded bricks into the wagon,” and “The worker loaded the wagon with bricks.” According to semantic structure theorists, the meaning of the verb “load” in these two cases is different. In particular, the first sentence merely specifies that the worker caused some bricks to move into the wagon, whereas the second sentence specifies that the worker caused the wagon to become full by means of moving bricks. This explains why it is acceptable to say “The worker loaded bricks into the wagon but it was still only half full,” whereas it is strange to say “The worker loaded the wagon with bricks but it was still only half full.” Thus, theories of semantic structure are consistent with the theories of Bloom (1981), Gentner (1981), and Kersten (1998a) in suggesting that the same verb can have different meanings when used along with different arguments and argument structures. If these theories are correct, then attention to the number and nature of the arguments (i.e., nouns) associated with a verb may be useful in determining the meaning of that verb (for evidence with regard to argument structure, see Gleitman, 1990; Naigles, 1990; Naigles & Hoff-Ginsberg, 1995).

The theories of Bloom (1981), Gentner (1981), and Kersten (1998a) make a number of predictions with regard to children’s performance in a verb-learning task. First, if a novel verb were presented along with a motion performed by a novel object, children would have to learn about the nature of that object before fully comprehending the meaning of the verb. Thus, children may attend as much to a novel object as to its motion when learning a novel verb. Second, if a novel verb were presented along with a motion performed by a familiar object, children would not have to attend as strongly to that object to understand the meaning of the verb. In particular, they would already have some understanding of the kinds of motion that the object could participate in, and thus learning a verb would require determining which of those motions was associated with the verb. Finally, a verb learner with a more sophisticated understanding of the types of objects in the world and their interrelations may be able to recognize a novel object as an example of a previously encountered class of objects. Thus, an adult verb learner may attend less to novel objects than does a child, because the adult may rely on more general knowledge of object classes when interpreting the motion of an unfamiliar object.

Attention to Novel Objects during Verb Learning in Children

Evidence that children attend to novel objects during verb learning comes from the work of Behrend
Evidence that Adults Attend Primarily to Motions When Learning Verbs

Unlike research with children, research with adults suggests that they do not pay much attention to the appearances of novel objects when they are presented with a novel verb, but rather focus their attention on the actions of those objects. For example, Kersten (1998a) presented undergraduates with events involving interactions between two novel, buglike creatures. Each such event was accompanied by a sentence involving both a novel noun and verb (e.g., “The zeebee is morping.”). Each noun and verb was related to both an object attribute and an event attribute. In particular, each noun and verb always co-occurred with a particular body shape of one of the characters in the event as well as a particular path along which that character moved with respect to the second character. Participants were later tested on their knowledge of these relations by asking them to choose which of two events was a better example of a particular noun or verb. One event was entirely consistent with the word being tested, whereas the other event involved either a body shape or path that was inconsistent with this word.

Participants were found to be nearly perfect at choosing which of two events was the better example of a particular verb when those two events differed on the path of the moving character. In contrast, participants were at chance when asked to choose between two events that differed on the body shape of the moving character. It was not the case that changes in the body shape of the moving character were too subtle to be noticed, because participants were nearly perfect at choosing between two events that differed on the body shape of the moving character when knowledge of nouns rather than verbs was tested. These results suggest that adults focus their attention on the motions rather than the appearance of an object when they are presented with a verb, even when the object is novel in appearance.

Research with children thus suggests that they attend strongly to novel objects during verb learning, whereas research with adults suggests that they do not attend as strongly to novel objects. What is responsible for this difference? A possible explanation is that adults have a more sophisticated understanding of object categories and their interrelations. In particular, although the objects employed in the research of Kersten (1998a) were novel, participants may have treated them as examples of a more general class of objects, namely bugs. Consistent with this suggestion, participants often spontaneously referred to these objects as “bugs” in postexperimental interviews. Once participants identified these novel objects as examples of bugs, they may not have attended very strongly to their individuating characteristics, but rather relied on their general knowledge of the types of actions that bugs are capable of to help them...
figure out the meanings of the verbs. Children, on the other hand, may not always recognize the larger category to which an object belongs, and thus may treat novel objects as truly novel and worthy of attention.

Overview of Experiments

The present experiments were designed to investigate the extent to which children and adults attend to the appearances of novel objects in the same verb-learning task. In particular, they were designed to test whether 3.5- to 4-year-old English-speaking children, like adults, focus their attention on actions in the presence of a novel verb, or whether they also attend to the appearances of novel objects. The experiments also tested whether a tendency to focus on objects is reduced when familiar rather than novel objects are present. The method for the experiments was adapted from that of Kersten (1998a). Experiment 1 examined whether children and adults attend more strongly to the appearance of a novel object or to the path of that object when learning a novel verb and when learning a novel noun. Experiment 2 examined attention to novel objects in the context of a different type of motion, namely the manner of motion of an object. Finally, Experiment 3 tested children’s attention to an object and its path when familiar rather than unfamiliar objects were involved in the events.

EXPERIMENT 1

Experiment 1 examined the learning of novel nouns and verbs in 3.5- to 4-year-old English-speaking children and in adults. As in Kersten (1998a), each noun or verb was related to the body shape of one character as well as the path of that character with respect to a second character. Participants were tested on their knowledge of these relations by presenting them with events involving a different body or path and asking them if these test events were still examples of the words heard during learning. On the basis of the results of Kersten (1998a), adults were predicted to accept an event as an example of a noun as long as the body of the moving character was consistent with that noun. That is, they were expected to pay little attention to motion when learning nouns. On the other hand, they were expected to accept an event as an example of a verb as long as the path of the moving character was consistent with that verb. In other words, they were expected to pay little attention to the appearance of the object in motion when learning verbs. Children who were learning nouns were predicted to perform similarly to adults, focusing strongly on the body shape of the moving object. Children who were learning verbs, however, were expected to perform quite differently from adults, attending not only to the path of the object but also to the body shape of that object.

Method

Participants

Twenty children (10 boys and 10 girls) who ranged in age from 41 to 48 months ($M = 44$ months) participated. These children were recruited from files of potential participants maintained by Indiana University developmental psychology researchers. These files contain names and ages of children found through birth announcements, advertisements in local newspapers and radio programs, or referrals from parents of other participants. Although demographic data were not collected on the children who participated in this study, this population of children is predominantly White and middle class, with English being the sole or primary language spoken in the home. Each child was tested in the laboratory and was given a small gift (e.g., a T-shirt or beach ball) at the end of the experiment. Five boys and 5 girls were randomly assigned to the noun condition, whereas the remaining participants were assigned to the verb condition. Four additional children (2 boys and 2 girls) were disqualified because they failed to complete the experiment or said either “yes” or “no” to every test question. Of these children, 3 were in the verb condition and 1 was in the noun condition.

Twenty adults (2 men and 18 women) who ranged in age from 21 to 40 years also participated in the experiment. These adults were recruited from an undergraduate course on personality at Florida Atlantic University and received extra credit for their participation. Ten adults were randomly assigned to the noun condition, and 10 were assigned to the verb condition.

Stimuli

Pretraining events. All stimuli in this experiment were shown on a 19-inch (.48 m) color television monitor, viewed at a distance of about 1.5 m. To familiarize participants with the task, they were first shown pretraining events involving known objects. The first pretraining event depicted a teddy bear jumping up and down on a line representing the ground. Participants in the noun condition were told “See that? That’s a bear!” Participants in the verb condition were told “See this one? He’s jumping!” This event lasted 12 s. The second pretraining event depicted a boy sleeping in a bed. Note that this event varied from the first pretraining event both on the ac-
tion and the object involved. Participants in the noun condition were asked “Is this a bear?” Participants in the verb condition were asked “Is this one jumping?” Participants who said “No” were given positive feedback, whereas participants who responded incorrectly or did not respond were told, “That’s not a bear, that’s a boy,” or “He’s not jumping, he’s sleeping.”

Learning Events. Twenty-four events were presented along with noun or verb labels to teach participants the meanings of those words. Each event involved two buglike creatures (see Figure 1). One creature, the agent, moved throughout each event, whereas a second creature, the reference object, remained stationary and served as a frame of reference for the motion of the agent. Events varied on a number of attributes. Some attributes involved the body parts of the two creatures. Both the agent and the reference object were composed of three attributes: a head, a body, and a pair of legs. Agent body had two possible values, whereas all other parts of the creatures had four possible values. A further static attribute involved the environment in which the event took place, defined by background pictures in the two upper corners of the screen. The four possible environments were a desert, a swamp, a mountainous terrain, and a rocky plain.

The motion of the agent also varied on two attributes. One attribute was agent path, or the direction taken by the agent with respect to the reference object. Agents either moved toward or away from the reference object. A second attribute was the leg motion of the agent. There were four possible values of this attribute (for descriptions of the different leg motions, see Kersten, 1998a). An additional source of variation in the events came from the starting locations of the two characters. The location of the reference object was always in one of the two lower quadrants of the screen. The location of the agent was to the left of the reference object on half of the events and to the right on the other half. The agent started each event separated from the reference object by a distance such that an agent moving toward the reference object would just come in contact with the reference object at the end of the event.

Each participant was presented with either two nouns (i.e., “zeebee” and “taygo”) or two verbs (i.e., “morping” and “spogging”). In either case, the two words could be distinguished by two different attributes, agent body and agent path. In particular, the words “zeebee” and “morping” always corresponded to an agent with a rounded, orange body with red spots on it (see the object on the left in Figure 1) moving toward the reference object. This event was presented 15 times. In contrast, the words “taygo” and “spogging” always corresponded to an agent with a rectangular, purple body with gray spots on it (see the object on the left in Figure 2) moving away from the reference object. This event was presented only nine times and was included primarily to give participants negative feedback about the meanings of the words “zeebee” and “morping.” All other attributes besides agent body and path varied randomly across the events. Note that this random variation included aspects of the appearance of an object (e.g., the legs and head of the agent), as well as aspects of the motion of that object (e.g., the leg motion of the agent). This random variation was included to simulate the variation in real-world examples of nouns and verbs. For exam-
ple, only certain aspects of an object (e.g., its shape) are relevant to the meaning of a noun, whereas others (e.g., its size) are irrelevant. Similarly, only certain aspects of an event are relevant to the meaning of a particular verb, and thus the examples of a verb often vary along a number of other aspects that are orthogonal to the meaning of the verb (Huttenlocher & Lui, 1979; Kersten & Billman, 1997).

Nouns were always presented in the present tense (e.g., “This is a zeebee.”). Verbs were presented in several different tenses because of findings by Tomasello and Kruger (1992). This work demonstrated that children learned verbs better when they were presented in either the future or past tense than in the present tense. Thus, in addition to being labeled in the present tense for each event (e.g., “This one is morping.”), verbs were often labeled in the future tense prior to an event (e.g., “This one’s gonna morp.”), and in the past tense after an event (e.g., “See that? He morped!”).

Test events. Twenty-four events tested for knowledge of relations between the words accompanying the learning events and the attributes, agent body and agent path. The first test event came after the fifth learning event, after which learning events and test events were interspersed. All test events seen by a particular participant tested for knowledge of one word. In particular, participants in the noun condition were asked, “Is this a zeebee?” Participants in the verb condition, on the other hand, were asked, “Is this one morping?” There were four different types of test events (see Figure 3). One type, object + motion match events, involved an agent body and path that were both consistent with the accompanying word. A second type, no match events, involved an agent body and path that were not consistent with the accompanying word, but rather were consistent with the other word the participants had learned (i.e., “taygo” for participants in the noun condition or “spogging” for participants in the verb condition). A third test type, object match events, involved an agent body that was consistent with the accompanying word, but a path that was inconsistent. A fourth test type, motion match events, involved a path that was consistent with the accompanying word, but an agent body that was inconsistent. Each participant was presented with six of each of the four types of test events. All attributes that varied randomly during the learning events continued to vary randomly in the test events. Thus, a par-

![Figure 3](image-url)
Participant could only use knowledge of agent body and path when evaluating the test events.

Procedure

Children played with toys in the testing room while their parents read and signed the consent form. Adults were simply led into the testing room and signed the consent form. Adults were told that the task was designed for children and that it would perhaps seem silly to them, but that it was very important for them to do their best. All participants were then asked, “Do you want to watch some cartoons?” They were then shown the two pretraining events. Next, participants were introduced to a hand puppet called “Bobo.” Participants were told that Bobo was a baby dinosaur and needed to learn to speak dinosaur talk. Participants were asked if they would like to help teach Bobo some new words. They were then shown the learning and test events.

Design

There were three independent variables in this experiment. The first was the type of test event presented to a participant (object + motion match versus object match versus motion match versus no match), manipulated within participants. The second was the part of speech of the word accompanying each test event (noun versus verb), manipulated between participants. The third was the age group of the participant (child versus adult), also manipulated between participants. The dependent variable was the proportion of “yes” responses to the test questions.

Results

Aggregated Results

The results of Experiment 1 are depicted in Figure 4. An ANOVA was conducted on the proportion of “yes” responses to the four different types of test questions. An α level of .05 was adopted for this and all other analyses. This analysis revealed a significant main effect of test type, $F(3, 108) = 65.02, p < .001, MSE = .06$. This main effect was moderated by several interactions, however. First, there was an interaction of test type and part of speech, $F(3, 108) = 32.79, p < .001, MSE = .06$. Second, there was an interaction of test type and age group, $F(3, 108) = 3.33, p < .05, MSE = .06$. Finally, there was a three-way interaction of test type, part of speech, and age group, $F(3, 108) = 4.22, p < .01, MSE = .06$.

Post hoc analyses were carried out to understand this three-way interaction. Separate ANOVAs were carried out for the noun condition and the verb condition. In the noun condition, there was a main effect of test type, $F(3, 54) = 89.40, p < .001, MSE = .04$. Newman-Keuls tests revealed that the proportions of “yes” responses to the object + motion match events and to the object match events were not significantly different, whereas these two proportions were significantly greater than the proportions of “yes” responses to the motion match and no match events. These last two proportions, in turn, were not significantly different. These results indicate that participants were willing to accept an event as an example of the noun “zeebee” as long as it involved the correct object, and that they ignored the motion of that object when making their decisions. There was not a significant interaction of test type and age group, $F(3, 54) < 1$. 

Figure 4 Aggregated results of Experiment 1. The y-axis represents the proportion of “yes” responses to each of the four test types. Error bars reflect standard errors.
indicating that children and adults performed similarly in the noun condition.

In the verb condition, there was also a main effect of test type, $F(3, 54) = 27.50, p < .001, \text{MSE} = .08$. This main effect was moderated, however, by a significant interaction of test type and age group, $F(3, 54) = 5.64, p < .01, \text{MSE} = .08$. Newman-Keuls tests revealed that adults’ proportions of “yes” responses to the object + motion match and motion match events were not significantly different, whereas these two proportions were significantly greater than the proportions of “yes” responses to the object match and no match events. These last two proportions, in turn, were not significantly different. These results indicate that adults were willing to accept an event as an example of the verb “morping” as long as it involved the correct motion, and that they ignored the appearance of the object in motion when making their decisions.

In contrast to the results of adults, Newman-Keuls tests revealed that children made a significantly greater proportion of “yes” responses to object + motion match events than to any of the other three test types. The proportions of “yes” responses to motion match and object match events were not significantly different. The difference between each of these two proportions and the proportion of “yes” responses to no match events was also not significant, although there was a trend for children to make more “yes” responses to motion match and object match events than to no match events. These results indicate that children were less willing to accept an event as an example of the verb “morping” if either the object or its motion were changed, and they were even less likely to accept an event if both the object and motion were changed.

Individual Differences

The aggregated results of children in the verb condition suggest that they attended equally to the appearances of objects and the motions of those objects. Several different patterns of individual performance could yield this result, however. First, the majority of children could indeed focus equally on objects and motions. Second, half of the children could focus primarily on objects and half could focus primarily on motions. Finally, some combination of these two patterns could also produce this result.

To determine which of these patterns is evident, the results of individual participants are presented in Figure 5. In this figure, the proportion of “yes” responses in the object match trials is represented on the x-axis, whereas the proportion of “yes” responses in the motion match trials is represented on the y-axis. The results of the adult participants are depicted in the upper panel of Figure 5. Inspection of the open circles reveals that all adults in the noun condition attended primarily to the appearances of objects. Inspection of the filled-in circles reveals that all but 2 adults in the verb condition attended primarily to motions. Of the remaining 2, 1 attended primarily...
to objects (i.e., the one in the lower right-hand quadrant), whereas the other attended equally to objects and motions (i.e., the one along the diagonal).

The lower panel of Figure 5 depicts the results of children. Inspection of the open circles reveals that nearly all children in the noun condition focused primarily on the appearances of objects. All but 2 children are in the lower right-hand corner of the figure. Of the remaining 2, 1 was perfectly conservative (i.e., the child said “no” to all of the object match and motion match events), and 1 was perfectly liberal (i.e., the child said “yes” to all of these events). Inspection of the filled-in circles reveals several different patterns of performance among children in the verb condition. Some children focused primarily on the appearances of objects. If this group is operationally defined as those children who made at least 33% more “yes” responses to object match trials than to motion match trials, then 3 children fall into this group. Other children in the verb condition focused primarily on motions. If this group is operationally defined as those children who made at least 33% more “yes” responses to motion match trials than to object match trials, then 3 children fall into this group. Finally, 4 children attended approximately equally to objects and motions. Of these, 2 were relatively conservative and 2 were relatively liberal. Thus, a combination of the two patterns of individual performance described above seems to be responsible for the overall pattern of results. In particular, the results of some children resembled the group results in that they attended equally to objects and motions. The remaining children preferred one type of information over the other, with half focusing primarily on objects and half focusing primarily on motions.

Discussion

The results of Experiment 1 provide evidence that children attend to the appearances of novel objects not only during noun learning but also during verb learning. English-speaking children were as likely to accept an event involving a consistent object and an inconsistent motion as an example of a verb as they were to accept an event involving an inconsistent object and a consistent motion. This suggests that they attended as much to objects as they did to motions when they were learning the verb.

Children who were learning verbs attended more to motions than did children who were learning nouns, who focused primarily on objects. This suggests that English-speaking children of this age have some understanding that verbs are different from nouns. Children’s performance was still quite different from that of adults, however, who were willing to accept an event as an example of a verb as long as the motion depicted in that event was consistent with prior examples of the verb. In contrast to the learning of verbs, the learning of nouns proceeded quite similarly in children and adults. Both children and adults were willing to accept an event as an example of a noun as long as the appearance of the moving object in the event was consistent with prior examples of that noun, regardless of the motion of that object.

Although the aggregated results of children in this experiment suggest that they attended equally to objects and motions when learning verbs, analysis of individual performance suggests that this overall pattern actually reflects a combination of three different patterns of performance. In particular, one group of children attended primarily to motions, a second attended primarily to objects, and a third attended to both objects and motions. One may be tempted to conclude that this third group of children was simply guessing, accounting for their lack of preference for one type of information over the other in this task. Even these children, however, showed evidence of systematic responding. In particular, whereas this third group of children averaged 58% and 44% “yes” responses in the object match and motion match events, respectively, they averaged 83% “yes” responses in the object + motion match events. The fact that they were less likely to accept an object match event than to accept an object + motion match event as an example of “morp” suggests that they attended to motion when making their responses. Furthermore, the fact that they were less likely to accept a motion match event than to accept an object + motion match event suggests that they also attended to the appearances of objects when making their choices. Thus, the lack of preference for objects or motions on the part of these children does not reflect unsystematic guessing, but rather a pattern of attending to both objects and motions.

Although the present results are consistent with the hypothesis that English-speaking children attend to novel objects as well as to motions during verb learning, there are some alternative hypotheses that must be considered. First, it is possible that children may have been confused by the presentation of verbs in several different tenses at several different points throughout an event, accounting for their lack of preference for motion over the appearances of objects. In particular, a verb was presented sometimes in the future tense (e.g., “This one is gonna morp”) before an event began, sometimes in the present progressive (e.g., “This one is morping”) while an event was taking place, and sometimes in the past tense (e.g., “See that? He
EXPERIMENT 2

Experiment 2 tested this alternative hypothesis for the results of Experiment 1. In particular, it tested whether English-speaking children focus more strongly on motions than on the appearances of objects when manners of motion rather than paths are the relevant type of motion. The design of Experiment 2 was identical to that of Experiment 1 except that each noun and verb was always accompanied by a particular body and leg motion of the agent rather than a particular body and path of the agent. Path varied randomly from event to event, just as leg motion had varied in Experiment 1. If children focused specifically on manner of motion in the presence of a novel verb, then they should have been better at associating verbs with leg motions in this experiment than they were at associating verbs with paths in Experiment 1.

Method

Participants

Twenty children (10 boys and 10 girls) who ranged in age from 43 to 48 months\(^1\) participated in this experiment. Children were recruited in the same manner as in Experiment 1. None of the children in Experiment 2 had participated in Experiment 1. Five boys and 5 girls were randomly assigned to the noun condition, whereas the remaining participants were assigned to the verb condition. Four additional children (2 boys and 2 girls) were disqualified because they failed to complete the experiment or said either “yes” or “no” to every test question. Two of these children were in the verb condition and 2 were in the noun condition.

Stimuli

The learning events were identical to those of Experiment 1 except that each noun or verb was always accompanied by a particular leg motion of the agent rather than a particular path. The noun “zeebee” and the verb “morping” were always accompanied by an agent that angled its legs forward and back as it moved, with one leg moving forward as the other moved back (see Figure 6). The noun “taygo” and the verb “sogging” were always accompanied by an agent that moved its legs up and down in tandem along the length of its body. The test events were identical to those of Experiment 1 except that the match or mismatch of verbs with leg motion rather than path was varied. In particular, object match events involved a body of the agent that was consistent with the presented word, but a leg motion that was inconsistent; whereas no match events involved both an incorrect body and an incorrect leg motion.

Procedure

The procedure was identical to that of Experiment 1.

\(^1\)\text{M} = 45\text{ months}
Design

There were two independent variables in this experiment. One was the type of test event presented to a participant (object/motion match versus object match versus motion match versus no match), manipulated within participants. The second variable was the part of speech of the word accompanying each test event (noun versus verb), manipulated between participants. The dependent variable was the proportion of “yes” responses to the test questions.

Results

Aggregated Results

The results of Experiment 2 are depicted in Figure 7. An ANOVA was conducted on the proportion of “yes” responses to the four different types of test questions. This analysis revealed a significant main effect of test type, $F(3, 54) = 41.78, p < .001, \text{MSE} = .06$. Newman-Keuls tests revealed that the proportions of “yes” responses to object/motion match events and to object match events were not significantly different, although there was a trend for children to make fewer “yes” responses to object match events. These two proportions, in turn, were significantly higher than the proportions of “yes” responses to the motion match and no match events. There was no significant difference between the proportions of “yes” responses to the motion match and no match events. These results indicate that children based their decisions primarily on the appearances of the objects in the events.

There was not a significant main effect of part of speech, $F(1, 18) < 1$, nor did the interaction of part of speech and test type attain significance, $F(3, 54) = 2.09, p = .11, \text{MSE} = .06$. These results indicate that children distributed their patterns of responses across the four test types in a similar manner in the noun condition and in the verb condition, making their decisions primarily on the basis of the appearance of the object in motion for both nouns and verbs.

Individual Differences

The results of individual participants are presented in Figure 8. Inspection of the open circles reveals that all but 1 child in the noun condition attended primarily to objects. The remaining child was very conservative, saying “no” to nearly all of the motion match and object match events. Inspection of the
filled-in circles again reveals several different patterns of performance in the verb condition. Five participants (i.e., those in the lower right-hand corner) attended primarily to objects. Two participants (i.e., those in the upper left-hand corner) attended primarily to motions. The remaining 3 participants (i.e., those along the diagonal) attended equally to objects and motions, with 2 participants being relatively liberal and 1 participant being relatively conservative.

Discussion

The results of Experiment 2 again revealed that English-speaking children attend to the appearance of a novel object as to the motion of that object when learning verbs. The proposed explanation for these results is that children use object category knowledge to help them figure out the meaning of a verb. In particular, children’s knowledge of the types of motions that are exhibited by a given type of object may help them to figure out what a verb may mean in the context of that object. Thus, if a child is presented with a verb in the context of a novel object, children may attend not only to the motion of that object but also to the appearance of the object to figure out which types of motion a given type of object is capable of. If this account is correct, children who were presented with a verb in the context of a familiar object would not have to attend as strongly to the appearance of that object, because they would already know what types of motion that object was capable of. Learning the verb would thus involve figuring out which of the types of motion associated with an object covaried with the presentation of the verb.

EXPERIMENT 3

The results of Experiments 1 and 2 indicate that 3.5- to 4-year-old children attend just as strongly to the appearance of a novel object as to the motion of that object when learning verbs. The proposed explanation for these results is that children use object category knowledge to help them figure out the meaning of a verb. In particular, children’s knowledge of the types of motions that are exhibited by a given type of object may help them to figure out what a verb may mean in the context of that object. Thus, if a child is presented with a verb in the context of a novel object, children may attend not only to the motion of that object but also to the appearance of the object to figure out which types of motion a given type of object is capable of. If this account is correct, children who were presented with a verb in the context of a familiar object would not have to attend as strongly to the appearance of that object, because they would already know what types of motion that object was capable of. Learning the verb would thus involve figuring out which of the types of motion associated with an object covaried with the presentation of the verb.

Experiment 3 was designed to test the prediction that children learning verbs should not attend as strongly to a familiar object as they do to a novel object. In particular, rather than presenting all children with the motions of novel bugs, half of the children were presented with the motions of cars and trucks. Because children were expected to already know what types of motions these objects were capable of, they were predicted to attend more strongly to the motions of these objects than to the appearances of these objects, to determine which of these motions, in fact, covaried with the presentation of a verb. The other half of the children were again presented with the motions of novel bugs. These children were expected to attend just as strongly to the appearances of these objects as to their motions, as in Experiments 1 and 2.

Method

Participants

Thirty-two children (16 boys and 16 girls) who ranged in age from 41 to 48 months (M = 45 months) participated in this experiment. Sixteen children (8 boys and 8 girls) who ranged in age from 43 to 47 months (M = 45 months) were assigned to the novel objects condition, whereas 16 children (8 boys and 8 girls) who ranged in age from 41 to 48 months (M = 45 months) were assigned to the familiar objects condition. Four additional children (2 boys and 2 girls) were disqualified because they failed to complete the experiment or said either “yes” or “no” to every test question. Children were recruited in the same manner as in Experiments 1 and 2. None of the children in Experi-
ment 3 had participated in either of the previous experiments. All children learned verbs in this experiment.

Stimuli

The stimuli for participants in the familiar objects condition differed from those of Experiment 1 in that the events depicted the motions of cars and trucks rather than novel bugs. One event type (i.e., “morping”) involved the motion of a car toward a van (see Figure 9). The other event type (i.e., “spogging”) involved the motion of a truck away from the van (see Figure 10). Thus, both the type of motion and the type of object were related to verbs, as in the previous experiments. A line underneath the objects represented the ground. The wheels of the cars and trucks rolled as those objects moved. The colors of the cars, trucks, and vans varied randomly, with four possible colors of each object. As in Experiment 1, the moving object appeared to the left of the reference object (i.e., the van) on half of the trials and to the right of the reference object on the other trials.

The stimuli for participants in the novel objects condition were identical to those of the verb condition of Experiment 1 except that there was no variation on leg motion. Instead, each agent always moved by angling its legs forward and backward in tandem.

This was done to equate the number of motion attributes with that of the familiar objects condition, which involved no variation on manner of motion. Thus, in both conditions, path was the only motion attribute to vary.

Procedure

The procedure was identical to that of Experiment 1.

Design

There were two independent variables in this experiment. One was the type of test event presented to a participant (object + motion match versus object match versus motion match versus no match), manipulated within participants. The other was the familiarity of the objects involved in the events (novel versus familiar), manipulated between participants. The dependent variable was the proportion of “yes” responses to the test events.

Results and Discussion

Aggregated Results

The results of Experiment 3 are depicted in Figure 11. An ANOVA was conducted on the proportion of “yes” responses to the four different types of test questions. This analysis revealed a significant main effect of test type, $F(3, 90) = 22.64, p < .001, MSE = .08$. This main effect, however, was moderated by an interaction of test type and object familiarity, $F(3, 90) = 3.26, p < .05, MSE = .08$.
Post hoc analyses were carried out to understand this interaction. Separate ANOVAs were carried out for the novel objects condition and the familiar objects condition. In the novel objects condition, there was a main effect of test type, $F(3, 45) = 12.68, p < .001, \text{MSE} = .09$. Newman-Keuls tests revealed that the proportion of “yes” responses to the object + motion match events was higher than to any of the other test types. The proportions of “yes” responses to the motion match and object match test events did not significantly differ, whereas the proportions of “yes” responses to each of these two test types was significantly greater than the proportion of “yes” responses to the no match events. Thus, children in the novel objects condition were less likely to accept an event as an example of the verb “morping” if either the motion or the object in motion was changed, and they were even less likely to accept an event if both the object and its motion had changed.

There was also a significant main effect of test type in the familiar objects condition, $F(3, 45) = 13.27, p < .001, \text{MSE} = .08$. Unlike in the novel objects condition, however, Newman-Keuls tests revealed that the proportions of “yes” responses to the object + motion match events and to the motion match events were not significantly different. These two proportions, in turn, were significantly higher than the proportions of “yes” responses to object match and no match events. There was no significant difference between the proportions of “yes” responses to the object match events and to the no match events. These results indicate that children in the familiar objects condition attended primarily to the motions of objects when learning verbs.

Individual Differences

The results of individual participants are presented in Figure 12. As can be seen in the top panel of Figure 12, several different patterns of performance were again evident in children in the novel objects condition. Five children (i.e., those in the upper left-hand corner) attended primarily to motions. Nine children (i.e., those in the lower right-hand corner) attended primarily to objects. The remaining 2 children (i.e., those along the diagonal) attended equally to objects and motions. Of these, 1 was relatively liberal and 1 showed no clear response pattern.

As can be seen in the lower panel of Figure 12, several different patterns of performance were also evident in children in the familiar objects condition. Nine children (i.e., those in the upper left-hand corner) attended primarily to motions. In marked contrast to the novel objects condition, only 1 child (i.e., the one in the lower right-hand corner) attended primarily to objects. Finally, six-children (i.e., those along the diagonal) attended equally to objects and motions. Of these, 2 were relatively conservative, 2 were relatively liberal, and 2 showed no clear response pattern. Thus, individual patterns of performance, as well as the aggregated results, reveal that children were more likely to attend to motions than to familiar objects when learning a verb.
GENERAL DISCUSSION

The results of the present research revealed that 3.5-to 4-year-old English-speaking children attend just as strongly to novel objects as they do to motions when presented with a novel verb. Experiment 1 revealed that children associated nouns primarily with objects, even though the objective relations of nouns to the paths of those objects were equally strong. In contrast, children associated verbs just as strongly with objects as with paths. These verb-learning results contrasted with the results from adults, who associated verbs primarily with paths. Experiment 2 revealed that children also attended to novel objects when learning a different kind of verb, namely manner of motion verbs. Finally, Experiment 3 employed well-known real-world objects and found that children attended more strongly to motions than to objects in the same verb-learning task.

Implications for Theories of Verb Learning

These results have a number of implications for theories of verb learning. First, by the time they are 3.5 to 4 years of age, English-speaking children have some knowledge that nouns and verbs convey different meanings. In particular, children were more likely to attend to motions when learning a verb than when learning a noun. Different children varied in their verb-learning strategies, however. Some children attended primarily to motions, some attended primarily to objects, and still others attended equally to objects and motions. A possible explanation for this variation in verb-learning strategies is that children may differ in their knowledge of object categories. In particular, some children may have recognized the novel objects in Experiments 1 and 2 as examples of the superordinate category “bug,” whereas others may have treated these same objects as truly novel. Children who classified the two objects (i.e., “zee-bees” and “taygos”) into the same superordinate category may not have attended very strongly to their individuating characteristics, but rather may have relied on their knowledge of the types of actions that are typically performed by bugs to help them determine the meaning of a verb. Children who treated the objects as truly novel, on the other hand, may have attempted to learn the types of actions performed by each of the two categories of bugs, thus requiring them to attend to objects as well as actions.

A second implication of the present results is that there is development in the tendency to focus on novel objects when learning verbs. In particular, the present findings are consistent with the prior results of Behrend (1990) and Forbes and Farrar (1995) in showing that 3.5- to 4-year-old English-speaking children attend more strongly to novel objects than do adults when learning a verb. The objects involved in these prior studies were instruments, whereas the objects in the present study were agents. The finding that both of these types of objects are given greater attention by children than by adults in a verb-learning situation suggests that a tendency for children to focus on novel objects during verb learning is very general in nature and not restricted to particular classes of objects. Adults may be less likely than children to attend to novel objects during verb learning because adults are more likely to infer the larger category to which those objects belong. Adults may thus be able to make use of existing category knowledge rather than having to learn what types of actions a given type of object is capable of performing. Consistent with this explanation, children in the familiar objects condition of Experiment 3 performed quite similarly to adults who were presented with novel objects in Experiment 1, suggesting that adults treated these novel objects as examples of familiar categories.

A third implication of the present results is that children are not as likely to attend to familiar objects as they are to attend to novel objects when learning a verb. This finding is consistent with Gentner’s (1981) theory of representational differences between nouns and verbs. According to this theory, representations of object concepts are highly cohesive, with mutually facilitatory connections among the various attributes of an object. Objects are thus interpreted in largely the same way, regardless of the context in which they occur, because the detection of even a subset of the attributes of an object is sufficient to activate the representations of all of the attributes of an object. In contrast, representations of relational concepts are much less internally cohesive, with a smaller number of mutually facilitatory connections among “core” attributes of a relation and a larger number of connections to other concepts such as nouns. A verb may thus have different meanings in the context of different objects, because the external connections to the representations of these objects may result in different sets of attributes becoming activated. This theory suggests that to learn the meaning of a verb in the context of unfamiliar objects, children first have to establish representations for those objects. Thus, children may attend to objects as well as motions when those objects are unfamiliar. In contrast, when learning the meaning of a verb in the context of familiar objects, representations of those objects are already established, and thus less attention to objects is required.

Greater attention to novel than to familiar objects is
also consistent with Kersten’s (1998a) division of labor theory of motion representation in language. According to this theory, the role of English manner of motion verbs is to select from a number of manners of motion associated with an object category. Thus, knowledge of the different motions (e.g., strolling, sauntering) associated with a category (e.g., human) may be necessary before one can successfully interpret a verb used in the context of that object category. Learning which motions are associated with which object categories requires attention to both the appearances of objects and the motions of those objects. Once an object is familiar, however, learning a verb may only require figuring out which of the motions associated with that object covaries with the presentation of the verb.

Although the division of labor theory predicts attention to novel objects during the learning of manner of motion verbs, children in the present experiments also attended to novel objects when learning path verbs. According to the division of labor theory, path verbs mean roughly the same thing regardless of the nature of the objects involved. For example, the motion of “colliding” can be represented reasonably accurately by the gesture of two fists moving into contact with one another, regardless of whether the objects involved are football players, cars, or planets. Thus, the division of labor theory predicts that children would not have to attend to the nature of the objects involved in order to learn path verbs. The fact that children did attend to novel objects when learning path verbs may indicate that object category knowledge is useful not only when learning manner of motion verbs but also when learning path verbs. Alternatively, children in the present experiments may simply have applied strategies that were useful in their prior verb-learning experience. Because the children in the present experiments were English speakers, this prior verb-learning experience in all likelihood involved primarily manner of motion verbs. Thus, children may have applied strategies that were useful in the learning of manner of motion verbs, regardless of whether they were in fact learning manner of motion or path verbs.

Relative Novelty of Actions and Objects

There is a possible alternative explanation for the present results. Given the evidence for a preference for novelty in verb learning (Golinkoff, Jacquet, Hirsh-Pasek, & Nandakumar, 1996; Merriman, Evey-Burkey, Marazita, & Jarvis, 1996; Merriman, Marazita, & Jarvis, 1993), it is possible that children simply attended to the most novel characteristic of an event when they were presented with a verb to be learned. Children may thus have attended to the buglike creatures in these experiments because they were the most novel characteristic of the events. In contrast, children may have been less likely to attend to the cars and trucks in Experiment 3 because these were less novel.

This hypothesis does not explain, however, why adults attended less strongly to novel objects than did children. Adults as well as children show a preference for novelty when learning verbs (Kersten, Goldstone, & Schaffert, 1998), and yet adult verb learners in Experiment 1 focused primarily on motions even though they were presented with the same novel objects as were children. For the novelty hypothesis to be a viable explanation for the present results, additional explanatory mechanisms would be required to account for this developmental evidence. For example, one possible explanation could be that adults are more sensitive than children to markers of syntactic category, and thus are able to ignore the novelty of objects and focus on motions when they are presented with a novel word with verb morphology (e.g., “-ing,” “-ed”). Children, on the other hand, may be more driven by visual stimulus characteristics, and thus may focus on the most novel or interesting characteristic of an event, regardless of the type of word involved. Additional research is necessary to dissociate this novelty hypothesis from the hypothesis that verb learning is dependent on knowledge of objects.

Conclusions

The present experiments provide evidence that 3.5- to 4-year-old English-speaking children attend not only to motions but also to novel objects when they are presented with a novel verb. This attention to novel objects during verb learning is proposed to be useful because the nature of an object places constraints on what a verb may mean in the context of that object. This account also offers an explanation for why, in many languages, children acquire nouns before verbs. In particular, both noun and verb learning are dependent on object category knowledge, but verb learning requires the further step of determining which of the different motions associated with an object category is relevant to the meaning of a verb. Thus, provided that nouns are used with sufficient frequency and saliency as labels for these object categories, nouns will tend to be learned earlier than verbs.

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