Published in final edited form as:
Cogn Dev. 2009 April 1; 24(2): 113–124. doi:10.1016/j.cogdev.2008.12.001.

Vacuuming with my *mouth*?: Children's ability to comprehend novel extensions of familiar verbs

Rebecca Seston,
Boston University

Roberta Michnick Golinkoff,
University of Delaware

Weiyi Ma, and
University of Delaware

Kathy Hirsh-Pasek
Temple University

Abstract

Can 6- and 8-year-olds (and adults) comprehend common instrument verbs when extended to novel situations? Participants heard eight unusual extensions of common verbs and were asked to paraphrase the verbs' meanings. Half of the verbs used were *specified instrument* verbs that include the name of the instrument used to perform the action (e.g., a *vacuum* is used *to vacuum*); the other half were *open instrument* verbs (e.g., *write*) whose function can be performed with a range of objects. Results suggest that children's ability to interpret verb extensions increases with age, that open instrument verb extensions were more difficult to comprehend than specified instrument verb extensions and that performance on verb extension correlates with scores on a standardized test of language acquisition. Verb knowledge continues to develop well beyond the preschool years.

There is a commonly held belief that children have accomplished much of language acquisition by at least early elementary school (Brown, 1973; Crain, 1992; Ingram, 1989; Limber, 1973; Marcus et al., 1992; Pinker, 1984, 1989; Bowerman, 1978). By that time, most children are speaking in complete sentences and using verbs with their accompanying arguments correctly. The fact that verbs prove to be so difficult for young children to learn and extend to new exemplars in laboratory settings (Behrend, 1990; Childers & Tomasello, 2002; Forbes & Poulin-Dubois, 1997; Golinkoff, Jacquet, Hirsh-Pasek, & Nandakumar, 1996; Imai, Haryu, & Okada, 2005; Imai et al., 2008; Kersten & Smith, 2002; Maguire, Hirsh-Pasek, & Golinkoff, 2006), despite verb usage by children in vivo, suggests that verb knowledge may not be as comprehensive as it appears. The present study examined the depth and extent of children's verb knowledge by asking whether 6- and 8-year-olds comprehend novel extensions of familiar verbs. Thus, this study tests the “conservative extension hypothesis” (Ma, Golinkoff, Song, & Hirsh-Pasek, under review) which states that children are more conservative in how they construe the meaning of verbs and therefore tend to extend verbs more narrowly than adults

Please address correspondence to: Rebecca Seston, Department of Psychology, Boston University, 64 Cummington Street, Boston, MA 02215, Email: rseston@gmail.com, Phone: (312) 919-1515.

do, a claim supported by previous research (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Harris, Barrett, Jones, & Brookes, 1988; Tomasello, 1992).

The ability to extend the meaning of a word to new exemplars is one of the best tests of word learning (Behrend, 1995; Forbes & Farrar, 1995; Imai et al., 2008). Correct or incorrect extensions reveal how broadly children construe meaning. While children may appear to use a particular verb appropriately in a range of situations (e.g., the dog *runs*; sister *runs*), when pressed systematically, their extensions may be unduly limited (e.g., *run* may not be used to describe what a grandmother is doing) (Bowerman, 1980; Dromi, 1987; Huttenlocher, Smiley, & Charney, 1983; Imai et al., 2008). Very young children, for example, are reluctant to extend a verb to situations beyond the original context in which the verb was first encountered (Behrend, 1990; Forbes & Farrar, 1993, 1995; Forbes & Poulin-Dubois, 1997; Imai et al., 2008; Kersten & Smith, 2002; Ma et al., under review; Maguire et al., 2002; Tomasello, 2000). This conservatism may be warranted; languages vary in how actions are lexicalized in verbs as well as their verbs' permissible extensions (Talmy, 1985). For example, in English, different types of verbs employ different criteria for extension (Talmy, 1985): Some verbs are extended based on the *manner* in which the action is performed (e.g., “throw”), others are extended based on the *result* of the action (e.g., “break”), and still others on the *path* of the motion (e.g., “exit”). To extend a verb, then, children must be sure of a verb's meaning, which requires multiple exposures to a variety of verb-action combinations (Childers, in press; Childers & Paik, in press; Gentner, 2006). Thus, even if children produce a particular verb, their understanding of when that verb can be extended may have a more protracted trajectory.

Extending a familiar verb to newly observed exemplars could be the culmination of three steps in verb learning (Gleitman, 1990; Golinkoff et al., 2002). First, children must attend to and individuate actions in their environment. Research suggests that infants are keenly aware of movement and use it to individuate both objects (e.g., Mandler, 1992, 1998) and actions (Sharon & Wynn, 1998; Wynn, 1996). Second, they must form abstract categories of actions in the absence of language (e.g., “run” for both a Olympiad and a grandmother) (Pruden, Hirsh-Pasek, Maguire, & Meyer, 2004; Pulverman, Hirsh-Pasek, Golinkoff, Pruden, & Salkind, 2006; Song et al., 2006; Wynn, 1996). Third, children must make word-action mappings and extend these labels to action categories (Naigles & Hoff, 2006). The action “running,” for example, requires bending the knees and placing the feet one in front of the other quickly for forward movement. These action components are necessary to apply the verb and may be called the essence of the verb *run*. Knowing this “verbal essence” (Golinkoff et al., 2002) allows the label *run* to be extended to a variety of agents, objects, and superficial differences in how the action is performed (e.g., running in zigzags, or while holding a baton). In other words, children must treat the arguments around a verb as “slots” that can be filled by many different words.

Research has shown that young children have difficulty extending even highly familiar verbs. Theakston, Lieven, Pine, and Rowland (2002) investigated 2- to 3-year-olds' acquisition of the different forms of the verb “go”: *go*, *going*, *gonna*, *goes*, *gone*, and *went*. Children's use of each form of the verb “go” was examined according to the particular meaning encoded. For example, the meaning of ‘movement’ (as in “I am going in the car”) is different from the meaning of ‘belonging’ (as in “Does that piece go there?”), which is different from the meaning of ‘disappearance’ (as in “Where's that book gone?”). Children reliably used *go* for the first meaning, *goes* for the second, and *gone* for the third. Results indicated that children did not possess a single lexical entry for “go” but rather a number of separate or partially related entries representing each meaning.

Ma et al. (under review) find evidence for narrow verb extensions even in Chinese, although children speaking Mandarin have many more verbs in their early vocabularies than do English-speaking children (Tardif, 2006). Chinese 3-year-olds and adults were shown video clips of

filmed actions ranging in typicality and asked to judge whether they were examples of given verbs. Results were striking: Chinese children's verb knowledge was much more limited than adults' despite the early age at which these verbs were acquired and the high frequency with which they appear in input to children. Thus, despite the advantages in verb learning that Chinese seems to offer, extension is a problem.

Children's narrow construal of verb meaning is also supported by Gallivan (1988). Examining 3-, 4-, and 5-year-olds' understanding of the meanings of 10 familiar verbs (e.g., *jump*, *bounce*), she found that children's verb concepts were initially quite particular and limited. Thus, the fact that children *use* verbs may not mean that they appreciate the range of their meanings or the circumstances in which they can apply (Tomasello, 2000).

Although little research has been conducted on older children's usage of familiar verbs, they also have difficulty learning and extending novel verbs under laboratory conditions. Using videotaped displays, Imai et al. (2008) showed 3- and 5-year-old English-speaking children a woman performing an unfamiliar action with an unfamiliar object. The event was labeled either with a novel noun (“Look, a twill!”) or a novel verb (“Look, twilling!”). At test, children saw both a same action/different object event and a different action/same object event and were asked, “Where is the twill?” in the noun condition or “Where is she twilling?” in the verb condition. Both age groups successfully extended the object label; even 3-year-olds had no difficulty in extending the name of a novel noun to a similar object. Only 5-year-olds, however, successfully extended the action label – and only in a condition in which they received a full sentence in training. This finding was not restricted to English speakers. Imai et al. also reported that Japanese and Chinese children only succeeded in learning and extending novel verbs beginning at age five.

Behrend's (1990) research with 3-, 5-, and 7-year-olds (as well as adults) suggested that children find it easier to extend a verb along some meaning components than others. The experimenter labeled a novel action that included three components - an instrument, a manner, and a result. At test, one component was changed and participants were asked if the verb label still applied. For example, the novel verb *tizzing* was applied to the action “scooping up a piece of clay (manner) with a metal bookend (instrument) and placing it on top of a platform (result)” (p. 689). The possible changes to this action were using a spatula (instrument change), inserting the instrument *into* the clay (manner change) and failing to balance the clay on the platform (result change). Results showed that participants of all ages were more likely to accept instrument changes than manner or result changes. Using a similar method, Forbes and Farrar (1995) found the same patterns.

In Behrend's (1989) work, children were provided with multiple contexts for novel verbs. Three- and 5-year-old children witnessed three actions labeled by the same verb but in which one component (e.g., instrument) varied across actions. They were then shown three test events in which one of the components (instrument, manner, or result) was changed and asked if the verb they had just learned applied to the action. Results indicated that by age 5, children were always willing to extend a verb to an instrument change and somewhat less willing to extend a verb to manner and result changes. Taken together, these studies suggest that while verb extension is difficult, children find it easier to extend verbs to novel instrument changes than to changes in other meaning components (e.g., manner).

In sum, young children appear to have difficulty recognizing the core meaning of verbs (Gallivan, 1988; Imai et al., 2008; Theakston et al., 2002; Tomasello, 2000), resulting in fewer extensions of both familiar and novel verbs, compared to the extensions that adults make. Around the age 5, children succeed in extending novel verbs to new situations under certain conditions in the laboratory (Behrend, 1989, 1990; Forbes & Farrar, 1995; Imai et al., 2008).

Yet children may have relied on the surface features of the action (i.e., its 'shape') to extend verbs, as they do with object labels (Diesendruck & Bloom, 2003: Golinkoff et al., 1996), and not on the verbs' full meaning. A more accurate test of children's ability to extend verbs requires an examination of how familiar verbs, encountered many times, are extended to new situations.

The present study examines first whether 6- and 8-year-old children comprehend novel extensions of familiar verbs. By this age, children have presumably heard these verbs on numerous occasions and in numerous linguistic and situational contexts. For this reason, asking children to extend a familiar verb in a new way presents an excellent test of children's linguistic knowledge. Because extending a novel verb to an instrument change appears to be an easier task than extending a novel verb to a manner or result change (Behrend, 1990; Forbes & Farrar, 1995), this study focuses on instrument verb extension. In addition, and unlike much prior work, the present study provided children with a context for interpreting novel extensions. Children were read short descriptions of a person performing a familiar action with a novel instrument (e.g., "When Taylor spilled his milk on the table, *he vacuumed it up with his mouth*") and were asked to explain what the verb extension (the italicized portion) meant. Can 6- and 8-year-old children understand familiar instrument verbs when these verbs are extended to novel instruments not ordinarily used?

Second, this study explores how children's understanding of verb extensions is affected by the concreteness of the verb. There appear to be two types of instrument verbs in English. One type conflates manner or result with the instrument, referred to here as "specified" instrument verbs, and one type does not, referred to here as "open" instrument verbs. An example of a specified instrument verb is the verb *shovel*. Shovel conflates the result of the action (i.e., removing granular material) with the instrument used to perform the action (i.e., a shovel) (Behrend, 1990; Koenig, Mauner, & Bienvenue, 2002). In contrast, while the action labeled by the open instrument verb *write* requires an instrument, the verb does not specify a particular implement for performing the action. Specified instrument verbs are arguably more noun-like, and thus more concrete, than open instrument verbs because they encode the name of the instrument (a noun). Here we used four specified instrument verbs (*comb*, *hammer*, *shovel*, and *vacuum*) and four open instrument verbs (*chop*, *scrub*, *sweep*, and *write*). Control sentences that did not contain novel verb extensions were also included, both as fillers between the test sentences as well as for purposes of comparing children's responses on sentences without novel extensions.

Two competing hypotheses predict different results. First, children's understanding of verb extensions may be negatively correlated with a verb's semantic concreteness such that the broader the meaning, the more easily children can comprehend extensions of those verbs. Thus, specified instrument verb extensions should be more difficult than open instrument verb extensions.

The second hypothesis predicts that children's understanding of verb extensions will be positively correlated with a verb's semantic concreteness. When learning verbs with broader meanings (such as open instrument verbs), children may form multiple representations for a single verb, making the core meaning more difficult to learn and extend (Tomasello, 2000). Thus, specified instrument verb extensions should be easier than open instrument verb extensions. Support for the latter hypothesis comes from research showing that highly concrete verbs (or verbs with high imageability) are easier to learn than less concrete verbs (Gentner, 1982; Gentner & Boroditsky, 2001; Gillette, Gleitman, Gleitman, & Lederer, 1999; Ma, Golinkoff, Hirsh-Pasek, McDonough, & Tardif, in press; Maguire et al., 2006; McDonough, Hirsh-Pasek, Golinkoff, & Lannon, 2008), and thus may be easier to extend.

Method

Participants

Twelve children at each of two ages and 12 adults, all balanced for gender, participated: 6-year-olds (*M*=6.50 years; range 6.00-6.92), 8-year-olds (*M*=8.41 years; range: 8.00-8.92), and undergraduate university students. Participants were Caucasian (83%) and African American (17%). All were native English speakers. Children were tested individually in a quiet room on a university campus.

Procedure

Participants were examined individually and asked to paraphrase 16 sentences, each preceded by a one- to three-sentence short story to provide context. The experimenter explained that there were no right or wrong answers, and participants were praised, independent of performance, for their responses. The experimenter read each of the stories and asked for children's help in explaining its end. For example, the experimenter read, "While baby John was waiting for dinner, he *hammered the table with his fork*," repeated the italicized portion, and asked "What does it mean to say he *hammered the table with his fork*?" If a child could not respond to a question, the question was repeated once. If the child could still not respond or said "I don't know," the experimenter moved on to the next story and the lack of response was treated as missing data. Sessions lasted approximately 10 minutes. Children's responses were videotaped, transcribed, and coded. Adult participants received the stories in written form and responded in writing.

There were eight experimental sentences. Four contained a specified instrument verb, and four contained an open instrument verb. Four control sentences not containing novel verb extensions were included to allow children to demonstrate their baseline paraphrasing abilities. Four other sentences were randomly inserted as fillers (see Table 1). Two of each sentence type was randomly assigned to one of two blocks of trials. Block order was counterbalanced between subjects.

Coding

Responses fell into two main categories: correct and incorrect. Correct responses required mention of the part of verb meaning that remained constant across exemplars of the action. For example, as the core meaning of *vacuum* is "removal by means of suction," the response, "He sucked it up with his mouth"(the *vacuum* story) was considered correct – even when, as occasionally happened, the instrument was not explicitly mentioned (e.g., "He sucked it up").

A proportion of children's responses to the experimental sentences were pantomimed (12.5% for 6-year-olds; 14.6% for 8-year-olds). To give children the benefit of the doubt for understanding these sentences, pantomimes were coded as well. These were invariably correct. For example, in response to the *vacuum* story, a 6-year-old answered, "He went like this," while pursing his lips and sucking in.

A proportion of responses merely repeated the sentences (7.5% for adults; 10.5% for 8-year-olds; 13% for 6-year-olds). The control sentences (e.g., "She licked her ice cream cone") had obvious, straightforward meanings and participants appeared to have had difficulty paraphrasing and resorted to repeating. Because the same could be true with the experimental sentences, children were given the benefit of the doubt for understanding these sentences and repeats were coded as correct.

Incorrect responses fell into one of two categories, literal interpretation and misinterpretation. Response categories were mutually exclusive. *Literal* responses incorporated the same verb

but a different instrument. For example, children who responded “He vacuumed it up with a vacuum” or “He was writing with a pen” seemed to interpret the vignette literally, as if the standard instrument was used. A response was also coded as *literal* if the verb was changed to correspond with the instrument (e.g., “He *ate* the table with the *fork*” in response to “He hammered the table with his fork”). Here the verb *hammer* was replaced by a verb associated with the instrument – *to eat*. Responses were coded as *misinterpretations* when participants did not provide a good paraphrase, suggesting that they had not extracted the verb's meaning from the sentence. For example, a response to the sweep story, “Her feet stuck to it,” was considered a misinterpretation as it did not mention the element of pushing debris.

The authors agreed upon the essential part of the meaning of each verb in advance. Adults' responses helped to recalibrate the coding scheme for children's responses. An independent coder blind to the hypotheses and age of participants recoded one third of the data from each age group. Interrater reliability was high (Kappa = .86, $p < .001$).

Results

As not every participant responded to every sentence, a proportion score was obtained by dividing the total number of correct responses by the number of stories to which an individual participant responded. This score was used in all analyses.

What variables influence comprehension of novel extensions of familiar verbs?

Participants' responses were analyzed in a 3(age group) × 2(gender) × 2(extension type: specified vs. open instrument) repeated measures analysis of variance (ANOVA). The proportion of correct responses differed across extension type, $F(1,30) = 10.52$, $p < .005$, and age group, $F(2,30) = 15.67$, $p < .001$. Post-hoc analyses revealed that 6-year-old children gave correct responses ($M = 0.66$, $SD = 0.20$) significantly less often than 8-year-olds ($M = 0.90$, $SD = 0.15$), who performed as well as adults ($M = 0.98$, $SD = 0.05$). There was no main effect of gender.

The proportion of correct responses was greater for specified instrument verbs ($M = 0.92$, $SD = 0.16$) than for open instrument verbs ($M = 0.78$, $SD = 0.32$). However, the extension type by age group interaction was significant, $F(2,30) = 3.24$, $p = .05$. Paired samples *t*-tests indicated that, as expected, the extension type effect was only significant for children (6-year-olds: specified - $M = 0.79$, $SD = 0.21$; open - $M = 0.52$, $SD = 0.36$), $t(11) = 2.17$, $p = .05$; 8-year-olds: specified - $M = 0.98$, $SD = 0.07$; open - $M = 0.83$, $SD = 0.25$), $t(11) = 2.60$, $p < .05$) (see Figure 1).

Extension type also interacted with gender, $F(1,30) = 6.79$, $p < .05$ (but not age). Females found specified instrument verb extensions ($M = 0.94$, $SD = 0.14$) easier to understand than open instrument verb extensions ($M = 0.69$, $SD = 0.35$), $t(17) = 3.79$, $p < .01$. Males, however, found both verbs types equally challenging (specified - $M = 0.89$, $SD = 0.18$, open − $M = 0.86$, $SD = 0.26$), $t(17) = 0.44$, $p = .67$.

As pantomimed responses were coded as correct, perhaps the difference between verb extension types occurred merely because more specified instrument verb stories utilized body parts (e.g., “comb …with fingers”), lending themselves more readily to a pantomimed response. A comparison of the 5 items (3 specified and 2 open) that mentioned body parts against the 3 items that did not (e.g., “scrub … with diaper”) indicated no difference in the proportion of correct responses, $t(23) = -0.62$, $p = .54$. Thus, specified instrument verb extensions are *not* easier merely because more of the test sentences allowed for the use of body parts.

How did performance on control sentences compare to verb extensions?

A 3 (age group) × 2 (gender) × 3 (sentence type: specified vs. open vs. control) repeated measures ANOVA on the proportion of correct responses was conducted. A main effect of sentence type, $F(2,60) = 6.51$, $p < .01$, was subsumed by a sentence by age group interaction, $F(4,60) = 2.66$, $p < .05$. At all ages, participants understood the specified verb extensions as well as the control sentences (6-year-olds - $t(11) = .22$, $p = .83$; 8-year-olds − $t(11) = 1.00$, $p = .34$; adults − $t(11) = 1.00$, $p = .34$). However, for 6-year-olds, open instrument verb extensions were more difficult than control sentences (6-year-olds − $t(11) = -2.25$, $p < .05$). This was not true for 8-year-olds or adults (ps > .15) (see Figure 1).

Did comprehension of novel extensions differ by verb?

A 4(open instrument verbs) by 2(age group: 6-year-olds vs. 8-year-olds) repeated measures ANOVA revealed that the four open instrument verb extensions were equally difficult to interpret, $F(3,54) = 1.79$, $p = .16$. An ANOVA with the same structure on the specified instrument verb extensions yielded the same result, $F(3,66) = 0.10$, $p = .96$ (Table 2). Also appearing in Table 2 are imageability ratings for each verb (see Discussion).[1]

How does verb extension performance predict standardized test performance.?

Drawing on another group of 6-year-olds (n = 12; mean age = 6.45 years), from a different study, we replicated the 6-year-old findings and assessed correlations between verb extension performance and on the DELV (Diagnostic Evaluation of Language Variation; Seymour, Roeper, & de Villiers, 2003), an assessment of children's syntactic, semantic, and pragmatic language skills. A significant correlation emerged between performance on the verb extension task and on subtests of the DELV (syntax − $r = .56$, $p = .06$; semantics − $r = .67$, $p < .05$). These high correlations suggest that verb extension is an important aspect of children's developing language skills.

What kind of errors did children make?

The proportion of error type per child was calculated by dividing the number of responses within an error category (i.e., literal interpretation and misinterpretation) by the total number of errors produced. If a particular kind of error dominated, a mean score for that category should differ significantly from chance (0.50). Two one-sample t-tests by age group revealed no significant effects, indicating that when children made errors they did not err in a consistent way.

Discussion

The purpose of this study was to examine the conservative verb extension hypothesis articulated by Ma et al. (under review) among children who have considerable verb knowledge and experience using verbs. Although numerous studies indicate that verbs can be difficult for young children to learn in a laboratory context (Hirsh-Pasek & Golinkoff, 2006), the present study asked whether older children (6- and 8-year-olds), who have already accumulated a sizeable verb lexicon, demonstrate the ability to comprehend unusual extensions of familiar verbs.

Two concerns might be raised. First, because we were interested in how children comprehended unusual extensions of familiar verbs, we could not control for children's exposure to each verb.

[1]Neither the data from Bird et al. (2001) nor Masterson and Druks (1998) supplied imageability ratings for all eight target verbs. Therefore, we collected imageability ratings from 26 native English-speaking adults on 120 words, including the eight target verbs. Ratings for the matched target verbs and a random sample of control nouns were not significantly different from ratings presented by Bird et al. (2001).

However, retrospective age of acquisition for each of the verbs ranged from 2.17 (*comb*) to 4.39 (*vacuum*) (Bird, Franklin & Howard, 2001). (Retrospective age of acquisition was collected on a 1-7 scale where 1 = 0-2 years and 7 = age 13 and over, with interim bands of 2 years. Therefore a score of 4.39 means the verb was learned at 6 to 8 years of age.)

Thus, we could assume that children had at least some experience with each verb. Furthermore, age of acquisition was not significantly correlated with proportion correct ($r = .26$, $p = .54$).

Second, one might wonder whether the verb extension task measured children's verbalization abilities rather than their verb knowledge per se. The control sentences addressed this issue. Adults performed equally well on control and verb extension sentences, and 8-year-olds performed as well as the adults on control and specified instrument verb extension sentences. Six-year-olds, while performing significantly worse overall than the 8-year-olds on the control sentences, understood the control sentences as well as the specified instrument verb extensions. Thus, the fact that performance on the control sentences exceeded performance on the open instrument verb extensions, indicates that children's problems with novel verb extensions cannot be reduced to difficulty in verbalizing their thoughts.

The present study allowed children to reveal their verb extension capabilities for several reasons. First, we used familiar verbs. Unlike prior studies that used novel verbs (Forbes & Farrar, 1995), we gave children every chance to show their verb knowledge. Novel verbs do not afford children the opportunity to witness wide-ranging exposures to how the verbs are used. Even adults might not be sure how far novel verbs can be extended. Second, verbs with actions that can be observed, such as instrument verbs, appear early in children's vocabularies (Bird et al., 2001; Maguire et al., 2006). Testing instrument verbs seemed a good way to explore verb knowledge because they are instantiated in real world events (as opposed to a mental verb like “think”; Maguire et al., 2006; Poulin-Dubois & Forbes, 2006). Third, the extension task was preceded by a short story to provide a context for the required extension, a practice that assists children in interpreting novel word usages (Winner, 1988). Furthermore, if children know *why* the action is occurring, they may be able to extend the verb more easily (Baldwin, 1995; Tomasello, Strosberg & Akhtar, 1996). Finally, to give children the benefit of the doubt, we accepted non-verbal pantomimed “explanations.” Despite these facilitating factors, results indicated that novel extensions of familiar open instrument verbs are difficult for both 6- and 8-year-olds to comprehend. Six-year-olds were only successful 52% of the time and 8-year-olds 83% of the time.

As successful extension implies that children appreciate a verb's core meaning, the ability to extend a verb to a novel situation is arguably a truer test of word knowledge than observing how verbs are produced in ordinary, everyday contexts. Gentner's (1983, 1989) “structural alignment theory” speaks to the process children might use in comprehending verb extensions. Children must align the relevant components of the different action events in which a verb is used, compare across these different scenes, and focus only on the similarity of the higher order relation between the scenes, ignoring information not inherently related to the verb's meaning (such as the actor's facial expressions) (Childers, in press; Imai et al., 2005).

The fact that specified instrument verb extensions are easier to understand than open instrument verb extensions presents something of a paradox. On the one hand, since open instrument verbs do not mention the instrument in the verb itself, they are undoubtedly used in a wider range of constructions than specified instrument verbs. That would suggest that extending open instrument verbs might be easier than extending specified instrument verbs. Yet their novel extensions are harder to comprehend than the extensions of narrower, specified instrument verbs. For example, one is more likely to hear the verb “write” used with a variety of instruments while the verb “vacuum” is usually used with a single instrument. Yet a novel

instrument used with “write” was harder for children to comprehend than a novel instrument used with “vacuum.”

Why might this be so? First, “imageability” may predict the ease with which a verb can be extended. Ratings of word imageability (the ease with which a word gives rise to a mental image; Paivio, Yuille, & Madigan, 1968), regardless of form class, predicts age of acquisition in both English-speaking (Bird et al., 2001; McDonough et al., 2008) and Chinese-speaking (Ma et al., in press) children. To the extent that high imageability is a cipher for a relatively coherent meaning, specified instrument verbs that encode the instrument used are higher on this attribute (mean imageability score = 5.19) than open instrument verbs (mean imageability score = 4.70), $t(25) = 2.90$, $p < .01$.

Second, the actions encoded by specified instrument verbs may be less variable in shape than the actions encoded by open instrument verbs. Smith and colleagues (Smith, 2000; Landau, Smith, & Jones, 1988) argued that nouns are extended on the basis of the shape of their referents. To find the shape of an event, one must lose the detail of each individual event and abstract a single representation (Mandler, 2005), a process tantamount to finding the event's essential components (Golinkoff et al., 2002). Because young children can extend familiar verbs when seen in “point-light displays” (lights on the joints of the human body filmed in the dark; Golinkoff et al., 2002; Maguire et al., 2002), the shape of an action appears to be a factor in verb learning and extension. This shape-based explanation fits with Gentner's (1983, 1989) progressive alignment hypothesis. According to that hypothesis, “repeated comparisons involving overall concrete similarities can facilitate noticing higher-order relational commonalities” (Kotovsky & Gentner, 1996, p. 2804). The shape of an action, a “concrete similarity,” remains virtually unchanged across exemplars for specified instrument verbs. For example, v*acuuming the rug* will be virtually identical in shape to a scene of *vacuuming the stairs*. For the open instrument verb of *chopping*, on the other hand, *chopping wood* looks quite different from *chopping a carrot*. Thus, the typical appearance of the open instrument verbs is more variable than that of the specified instrument verbs, perhaps making the meaning of the verb harder to extract and therefore more difficult to extend to novel situations.

Conclusions

Three important findings emerged from the present research. First, the conservative extension hypothesis was upheld. Even 6-year-old children, who have had considerable experience in using verbs and hearing them used in diverse situations, appear to have a narrow understanding of verbs. Despite the fact that familiar (as opposed to novel), visible (as opposed to mental) verbs were presented in story contexts (as opposed to in isolation), and that pantomimed responses were included as response options (instead of relying only on verbal responses), 8- and especially 6-year-old children were poor at understanding unusual verb extensions. Second, children proved better at understanding extensions of specified than open instrument verbs. Third, the verb extension task used here correlates well with children's semantic and syntactic knowledge on a standardized language test. In sum, the present data suggest that significant elements of verb meaning may not be available to children for some time, a finding having implications for children's oral and written comprehension and production.

Acknowledgments

We thank the Early Learning Center at the University of Delaware for their participation as well as Amanda Brandone and Nicole Tomlinson for assistance with data coding. Portions of the research were supported by grants to the second and fourth authors from the National Science Foundation (SBR-990-5832 and BCS-0642529) and the National Institutes of Health (5R01HD050199).

References

Baldwin, DA. Understanding the link between joint attention and language. In: Moore, C.; Dunham, PJ., editors. Joint attention: Its origins and role in development. Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.; 1995. p. 131-158.

Bates, E.; Benigni, L.; Bretherton, I.; Camaioni, I.; Volterra, V. The emergence of symbols: Cognition and communication in infancy. New York: Wiley; 1979.

Behrend, DA. Default values in verb frames: Cognitive biases for learning verb meaning. Proceedings of the 11th annual meeting of the Cognitive Science Society; Hillsdale, NJ: Erlbaum; 1989. p. 252-258.

Behrend DA. The development of verb concepts: Children's use of verbs to label familiar and novel events. Child Development 1990;61:681–696. [PubMed: 2364743]

Behrend, DA. Processes involved in the initial mapping of verb meanings. In: Tomasello, M.; Merriman, W., editors. Beyond names for things: Children's acquisition of verbs. Hillsdale, NJ: Erlbaum; 1995. p. 251-273.

Bird H, Franklin S, Howard D. Age of acquisition and imageability ratings for a large set of words, including verbs and function words. Behavior Research Methods, Instruments, and Computers 2001;33:73–79.

Bowerman, M. The acquisition of word meaning. In: Waterson, N.; Snow, C., editors. The Development of Communication. New York: Wiley; 1978. p. 263-278.

Bowerman, M. The structure and origin of semantic categories in the language-learning child. In: Foster, ML.; Brandes, SH., editors. Symbol as sense: New approaches to the analysis of meaning. New York: Academic Press; 1980. p. 277-299.

Brown, R. A first language: The early stages. Cambridge, MA: Harvard University Press; 1973.

Childers, J. The structural alignment and comparison of events in verb acquisition. In: Sloutsky, VS.; Love, BC.; McRae, K., editors. Proceedings of the 30th Annual Cognitive Science Society; Austin TX: Cognitive Science Society; in press

Childers J, Paik J. Korean- and English-speaking children use cross-situational information to learn novel predicate terms. Journal of Child Language. in press.

Childers J, Tomasello M. Two-year-olds learn novel nouns, verbs, and conventional actions from massed or distributed exposures. Developmental Psychology 2002;38:967–978. [PubMed: 12428708]

Crain S. Language acquisition in the absence of experience. Behavioral and Brain Sciences 1992;14:597–650.

Diesendruck G, Bloom P. How specific is the shape bias? Child Development 2003;74:168–178. [PubMed: 12625443]

Dromi, E. Early lexical development. London: Cambridge University Press; 1987.

Forbes JN, Farrar MJ. Children's initial assumptions about the meaning of novel motion verbs: Biased and conservative? Child Development 1993;8:273–290.

Forbes JN, Farrar MJ. Learning to represent word meaning: What initial training events reveal about children's developing action verb concepts. Cognitive Development 1995;10:1–20.

Forbes JN, Poulin-Dubois D. Representational change in young children's understanding of familiar verb meaning. Journal of Child Language 1997;24:389–406. [PubMed: 9308424]

Gallivan J. Motion verb acquisition: Development of definitions. Perceptual and Motor Skills 1988;66:979–986.

Gentner, D. Why nouns are learned before verbs: Linguistic relativity versus natural partitioning. In: Kuczaj, SA., II, editor. Language development: Vol 2 Language, thought, and culture. Hillsdale, NJ: Lawrence Erlbaum Associates; 1982. p. 301-334.

Gentner, D. Structure-mapping: A theoretical framework for analogy. *Cognitive Science*. In: Collins, A.; Smith, EE., editors. Readings in cognitive science: A perspective from psychology and artificial intelligence. Vol. 7. Palo Alto, CA: Kaufmann; 1983. p. 155-170.Reprinted in

Gentner, D. The mechanisms of analogical learning. In: Vosniadou, S.; Ortony, A., editors. Similarity and analogical reasoning. London: Cambridge University Press; 1989. p. 199-241.Reprinted in Knowledge acquisition and learning, 1993, 673-694

Gentner, D. Why verbs are hard to learn. In: Hirsh-Pasek, K.; Golinkoff, R., editors. Action meets word: How children learn verbs. New York: Oxford University Press; 2006. p. 544-564.

Gentner, D.; Boroditsky, L. Individuation, relativity and early word learning. In: Bowerman, M.; Levinson, SC., editors. Language, culture, and cognition: Vol 3 Language acquisition and conceptual development. New York, NY: Cambridge University Press; 2001. p. 215-256.

Gillette J, Gleitman H, Gleitman L, Lederer A. Human simulations of vocabulary learning. Cognition 1999;73:135–176. [PubMed: 10580161]

Gleitman L. The Structural Sources of Verb Meanings. Language Acquisition 1990;1:3–55.

Golinkoff RM, Chung HL, Hirsh-Pasek K, Liu J, Bertenthal BI, Brand R. Young children can extend motion verbs to point-light displays. Developmental Psychology 2002;38:604–614. [PubMed: 12090489]

Golinkoff RM, Jacquet RC, Hirsh-Pasek K, Nandakumar R. Lexical principles may underlie the learning of verbs. Child Development 1996;67:3101–3119. [PubMed: 9071772]

Harris M, Barrett M, Jones D, Brookes S. Linguistic input and early word meaning. Journal of Child Language 1988;15:77–94. [PubMed: 3350878]

Hirsh-Pasek, K. Action meets word: How children learn verbs. Golinkoff, RM., editor. New York, NY: Oxford University Press; 2006.

Huttenlocher J, Smiley P, Charney R. Emergence of action categories in the child: Evidence from verb meanings. Psychological Review 1983;90:72–93.

Imai M, Haryu E, Okada H. Mapping novel nouns and verbs onto dynamic action events: Are verb meanings easier to learn than noun meanings for Japanese children? Child Development 2005;76:340–355. [PubMed: 15784086]

Imai M, Li L, Haryu E, Okada H, Hirsh-Pasek K, Golinkoff R, Shigematsu J. Novel noun and verb learning in Chinese, English, and Japanese. Child Development 2008;79:979–1000. [PubMed: 18717902]

Ingram, D. First language acquisition: Method, description, and explanation. New York: Cambridge University Press; 1989.

Kersten AW, Smith LB. Attention to novel objects during verb learning. Child Development 2002;73:93–109. [PubMed: 14717246]

Koenig JP, Mauner G, Bienvenue B. Class specificity and the lexical encoding of participant information. Brain and Language 2002;81:224–235. [PubMed: 12081394]

Kotovsky L, Gentner D. Comparison and Categorization in the Development of Relational Similarity. Child Development 1996;67:2797–2822.

Landau B, Smith L, Jones S. The importance of shape in early lexical learning. Cognitive Development 1988;3:299–321.

Limber, J. The genesis of complex sentences. In: Moore, TE., editor. Cognitive development and the acquisition of language. Oxford, England: Academic Press; 1973. p. 169-186.

Ma W, Golinkoff RM, Hirsh-Pasek K, McDonough C, Tardif T. Imageability predicts age of acquisition of verbs in Chinese children. Journal of Child Language. in press.

Ma W, Golinkoff RM, Song L, Hirsh-Pasek K. Chinese children's comprehension of verb extensions of familiar verbs. Manuscript under review.

Maguire, MJ.; Hennon, EA.; Hirsh-Pasek, K.; Golinkoff, RM.; Slutzky, CB.; Sootsman, J. Mapping words to actions and events: How do 18-month-olds learn a verb?. In: Skarabela, B.; Fish, S.; Do, AH., editors. Proceedings of the 27th Annual Boston University Conference on Language; Somerville, MA: Cascadilla Press; 2002. p. 371-382.

Maguire, M.; Hirsh-Pasek, K.; Golinkoff, RM. A unified theory of word learning: Putting verb acquisition in context. In: Hirsh-Pasek, K.; Golinkoff, RM., editors. Action meets word: How children learn verbs. New York, NY: Oxford University Press; 2006. p. 364-391.

Mandler JM. The foundations of conceptual thought in infancy. Cognitive Development 1992;7:273–285.

Mandler, JM. Representation. In: Kuhn, D.; Siegler, R., editors. Handbook of child psychology: Vol 2 Cognition, perception, and language. 5th. New York, NY: John Wiley & Sons, Inc.; 1998. p. 255-308.

Mandler JM. Commentary: A confusion between understanding and understanding symbols. Developmental Science 2005;8:315–316. [PubMed: 15985063]

Marcus GF, Pinker S, Ullman M, Hollander M, Rosen TJ, Xu F. Overregularization in language acquisition. Monographs of the Society for Research in Child Development 1992;57(4 Serial No 228)

Masterson J, Druks J. Description of a set of 164 nouns and 102 verbs matched for printed word frequency, familiarity and age-of-acquisition. Journal of Neurolinguistics 1998;11:331–354.

McDonough C, Hirsh-Pasek K, Golinkoff RM, Lannon R. An image is worth a thousand words: Why nouns tend to dominate verbs in early word learning. 2008 Manuscript submitted for publication.

Naigles, L.; Hoff, E. Verbs at the very beginning: Parallels between comprehension and input. In: Hirsh-Pasek, K.; Golinkoff, R., editors. Action meets word: How children learn verbs. New York, NY: Oxford University Press; 2006. p. 336-363.

Paivio A, Yuille JC, Madigan SA. Concreteness, imagery, and meaningfulness values for 925 nouns. Journal of Experimental Psychology 1968;76:1–25. [PubMed: 5672258]

Pinker, S. Language learnability and language development. Cambridge, MA: Harvard University Press; 1984.

Pinker, S. Learnability and cognition: The acquisition of argument structure. Cambridge, MA: The MIT Press; 1989.

Poulin-Dubois, D.; Forbes, JN. Word, intention, and action: A two-tiered model of action word learning. In: Hirsh-Pasek, K.; Golinkoff, RM., editors. Action meets word: How children learn verbs. New York, NY: Oxford University Press; 2006. p. 262-285.

Pruden, SM.; Hirsh-Pasek, K.; Maguire, MJ.; Meyer, MA. Foundations of verb learning: Infants form categories of path and manner in motion events. In: Brugos, A.; Micciulla, L.; Smith, CE., editors. Proceedings of the 28th Annual Boston University Conference on Language Development; Somerville, MA: Cascadilla Press; 2004. p. 461-472.

Pulverman, R.; Hirsh-Pasek, K.; Golinkoff, RM.; Pruden, S.; Salkind, SJ. Conceptual foundations for verb learning: Celebrating the event. In: Hirsh-Pasek, K.; Golinkoff, RM., editors. Action meets word: How children learn verbs. New York, NY: Oxford University Press; 2006. p. 134-159.

Seymour, HN.; Roeper, TW.; de Villiers, J. Diagnostic evaluation of language variation - Norm Referenced. San Antonio, TX: Psychological Corporation; 2003.

Sharon T, Wynn K. Individuation of actions from continuous motion. Psychological Science 1998;9:357–362.

Smith, LB. Learning how to learn words: An associative crane. In: Golinkoff, RM.; Hirsh-Pasek, K.; Bloom, L.; Smith, LB.; Woodard, AL.; Akhtar, N.; Tomasello, M., editors. Becoming a word learner: A debate on lexical acquisition. New York: Oxford University Press; 2000. p. 51-80.

Song, L.; Golinkoff, RM.; Seston, R.; Ma, W.; Shallcross, W.; Hirsh-Pasek, K. Action stations: Verb learning rests on constructing categories of action. Poster presented at the 31st Annual Boston University Conference on Language Development; Boston, MA. 2006.

Talmy, L. Lexicalization patterns: Semantic structure in lexical forms. In: Shoepen, T., editor. Language typology and lexical description: Vol 3 Grammatical categories and the lexicon. Cambridge: Cambridge University Press; 1985. p. 36-149.

Tardif, T. But are they really verbs? Chinese words for action. In: Hirsh-Pasek, K.; Golinkoff, RM., editors. Action meets word: How children learn verbs. New York, NY: Oxford University Press; 2006. p. 477-498.

Theakston AL, Lieven EVM, Pine JM, Rowland CF. Going, going, gone: The acquisition of the verb ‘go’. Journal of Child Language 2002;29:783–811. [PubMed: 12471973]

Tomasello, M. First verbs: A case study of early lexical development. Cambridge: Cambridge University Press; 1992.

Tomasello M. Do young children have adult syntactic competence? Cognition 2000;74:209–253. [PubMed: 10640571]

Tomasello M, Strosberg R, Akhtar N. Eighteen-month-old children learn words in non-ostensive contexts. Journal of Child Language 1996;23:157–176. [PubMed: 8733565]

Winner, E. The point of words: Children's understanding of metaphor and irony. Cambridge, MA: Harvard University Press; 1988.

Wynn K. Infants' individuation and enumeration of actions. Psychological Science 1996;7:164–169.

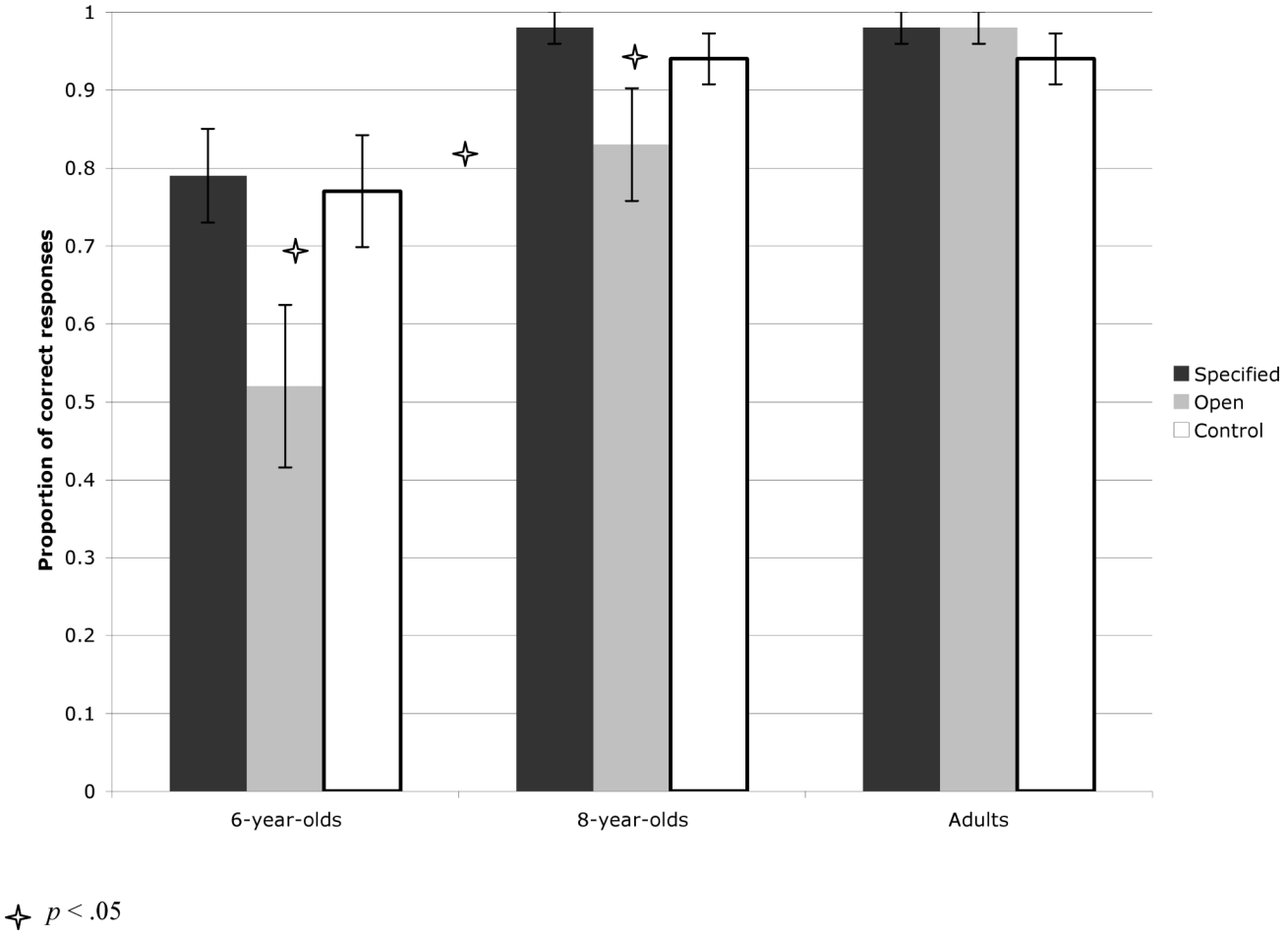

Figure 1.
Proportion of correct responses on specified and open verb extensions as well as control sentences as a function of age group and verb type.

Table 1

Stimulus Sentences: Verb Extensions, Controls and Fillers

Type	Verb	Sentences
Specified	Vacuum	When Taylor spilled his milk on the table, he *vacuumed it up with his mouth*.
	Shovel	In order to build a sand castle, Jenna *shoveled the sand with her hands*.
	Comb	In order to get the knots out of her long hair, Amy *combed her hair with her fingers*.
	Hammer	While baby John was waiting for dinner, he *hammered the table with his fork.*
Open	Chop	Becca was making a mudpie when her older brother came and *chopped it up with his stick.*
	Scrub	Baby Chris' mom was very happy because she didn't need to clean the floor today. Baby Chris had already *scrubbed it with his diaper*.
	Sweep	Melissa had tracked in dirt when she came inside, and before her mother saw it, she *swept it away with her feet.*
	Write	Andy had just learned how to spell his name and in order to practice he was *writing it with his finger*.
Control	Steal	The alarms were going off and the police cars were driving into the jewelry store parking lot. There had been a robbery! The *thief had stolen a necklace from the jewelry store*.
	Search	Timmy loves playing in the woods. He had already found a lizard, caterpillars, and many chipmunks! But Timmy still really wanted to see his favorite animal, so *he searched all day for a frog.*
	Chase	Patty was sitting in the backyard when her cat, Sandy, came up to her and started purring at her feet. But this didn't last for long! A big crow came flying by, and *the cat chased the bird up a tree.*
	Lick	Hannah had been a really good girl today. To thank Hannah for being such a good girl, her mom bought her ice cream! She didn't want the ice cream to melt on her fingers, so *she licked her ice cream cone.*
Filler		Cookies and cake are good. Chocolate and pudding are tasty too. But I think that *apple pie is the best food in the world.*
		The circus! The clowns had just come out and Amanda was laughing with glee because *the clown had a funny face*.
		It was such a beautiful day. The sun was shining and the sky was bright blue. There was a cool breeze and *the leaves moved in the trees.*
		Sophie was amazed at the size of her puppy, Peaches. She was almost as big as Sophie. *The puppy had grown really fast*.

Note. Italics indicate the part of the sentence participants were asked to paraphrase

Table 2

Imageability ratings and proportion correct by verb.

			Proportion Correct		
Type	**Verb**	**Imageability**	**6-year-olds**	**8-year-olds**	**Adults**
Specified	Vacuum	5.15	.83	1.00	1.00
	Shovel	5.15	.83	.92	1.00
	Comb	4.96	.75	1.00	1.00
	Hammer	5.50	.75	1.00	.92
Open	Chop	4.54	.67	.92	1.00
	Scrub	4.42	.64	.91	.92
	Sweep	4.77	.36	.83	1.00
	Write	5.08	.42	.64	1.00

Note. Imageability was rated on a 1-7 scale where 1 = least imageable and 7 = most imageable.