Attention to Explicit and Implicit Contrast in Verb Learning

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Abstract

Contrast information could be useful for verb learning, but few studies have examined children's ability to use this type of information. Contrast may be useful when children are told explicitly that different verbs apply, or when they hear two different verbs in a single context. Three studies examine children's attention to different types of contrast as they learn new verbs. Study 1 shows that 3 ½-year-olds can use both implicit contrast ("I'm meeking it. I'm koobing it.") and explicit contrast ("I'm meeking it. I'm not meeking it.") when learning a new verb, while a control group's responses did not differ from chance. Study 2 shows that even though children at this age who hear explicit contrast statements differ from a control group, they do not reliably *extend* a newly learned verb to events with new objects. In Study 3, children in three age groups were given both comparison and contrast information, not in blocks of trials as in past studies, but in a procedure that interleaved both cues. Results show that while 2 ½-year-olds were unable to use these cues when asked to compare and contrast, by 3 ½, children are beginning to be able to process these cues and use them to influence their verb extensions, and by 4 ½ years, children are proficient at integrating multiple cues when learning and extending new verbs. Together these studies examine children's use of contrast in verb learning, a potentially important source of information that has been rarely studied.

Attention to Explicit and Implicit Contrast in Verb Learning

In acquiring a language, learning the individual verbs used in that language appears to be a fairly challenging task. Researchers investigating early verb learning have focused on several mechanisms children may use to solve this difficult problem including attention to the syntax of the sentence in which a verb is embedded (e.g., Gleitman, 1990), attention to cues available in social interactions (e.g., Tomasello, 1995), and recently, the comparison of information across different situations in which a new verb is heard (e.g., Childers, 2011; Scott & Fisher, 2009). However, one source of information that is potentially useful but has not been explored much in the area of verb learning is contrast information.

For example, imagine a child playing in a sandbox with several other children. The child could hear several verbs in this same context including *pour*, *stir*, *give*, *play* and *stop*. To learn each of these verbs, children need to package transient, dynamic aspects of events and relate each appropriate set of actions to a single new verb, a problem researchers often refer to as 'the packaging problem' (e.g., Gleitman & Gleitman, 1992). In many experiments examining early verb learning, children are only exposed to one new verb at a time (e.g., Naigles, 1990; Olguin & Tomasello , 1993). However, in everyday life, children often hear more than one verb in a single situational context, and this experience could enhance early verb learning because it would imply that there are at least two "packages" or sets of elements within that context (e.g., one set for *pour* and a different set for *stir*). From this single experience a child would not be certain about which elements fit which verb, but he or she could begin to hypothesize about which key actions may fit each verb, and then could test these inferences in future contexts in which that particular new verb is heard (e.g., other instances of the verb *pour*).

This type of reasoning would require that children assume that when adults use two different verbs in the same situation, they are using different verbs to direct a listener's attention to different sets of elements within the overall event. In developmental accounts of noun learning, this kind of assumption has been described as a "mutual exclusivity bias" (e.g., Markman & Wachtel, 1988; Markman, 1990; see Golinkoff, Hirsh-Pasek, Mervis & Frawley, 1995 for a related view) or use of the Principle of Contrast (Clark, 1988; 1990). Linguists focusing on semantics also have discussed contrast in language. For example, in Lyons (1977) both opposition and contrast are described. Opposition is used to refer to sets of words that are directly related to each other, for example in terms of opposites (antonyms) or words related to each other in terms of hierarchical relations (hyponymy), while contrast is discussed as the most general type of relation between words, in which two words simply differ in meaning from each other (see Saji, Imai, Saalbach, Zhang, Shu & Okada, 2011, for further discussion of this and other linguistic views of contrast). All of these views suggest that theorists agree that contrast information is useful to speakers of a language, though they may differ in the precise mechanisms that are at work when speakers use contrastive information to learn new words.

Clark's Principle of Contrast may be easiest to extend to verb learning because it predicts that children assume that there are no true synonyms in language, or that all words differ in meaning in some way. In our view, if children use this principle in verb learning, they should assume that hearing two different verbs means that the speaker has different "packages" of elements in mind.

Studies of contrast in word learning: Nouns and adjectives

Early studies of children's use of contrast have mostly focused on their use of contrast in noun and adjective learning. One way to conceptualize these varied noun and adjective studies is to categorize them as examining children's use of *explicit* contrast because they include explicit statements with negation terms (e.g., "not x"), or as examining children's attention to *implicit* contrast because the studies include two different words within a single learning context.

As an example of studies examining explicit contrast, Au and Markman (1987) introduced new adjectives to 4-year-olds using explicit contrast (e.g., "See, this is not red (wood), and this is not green (cloth). This is mauve (rattan)." p. 222-3). At test, children needed to respond verbally to some questions and to point to one of several objects in other trials (sets ranged from 3 to 9 or 10 objects). They found that children were better at using these statements to learn a new material name, and were more consistent in their material name uses, than was true for new color terms. Au and Laframboise (1990) followed up on these findings by testing multiple age groups and by exploring the role the child's own vocabulary had on his or her attention to contrast. Children responded at test by choosing one of three objects in each set. They found that hearing a contrastive statement that included the child's own color term for a particular stimulus (e.g., "See, it's not gray; it's mauve") was more effective than were statements with familiar color words that the child had not produced (e.g., "See, it's not green; it's mauve") or no contrast statements (e..g "See, this is mauve."). Five-year-olds did well on these tasks even though the contrast statement was only heard once, four-year-olds could demonstrate comprehension of the new color term after two contrast statements, but three-year-olds needed three repetitions and a simplified set of choices at test. Overall, these two papers suggest that contrast information can be useful to preschoolers learning adjectives, but that their understanding of contrast is not robust.

This conclusion is supported by a study by Waxman and Klibanoff (2000) which suggests that children are better at using contrast information to learn a new adjective if the objects that are contrasted are similar to each other. In this study, three year-olds heard statements that referred to properties of objects that were either from the same basic level category (within-basic condition) or from different basic level categories (across-basic condition). Participants heard a novel adjective to describe the property of one stimulus item (e.g. "Gogi says this is a very blick-ish one"), and then heard an explicit contrast statement with the same novel adjective used to describe the second item (e.g., "He says this one is not blick-ish"). In their results, 3-year-olds could select the correct test object in a forced choice task when the objects that were contrasted were from the same basic level category but could not use contrast across different categories. In a related study, 14- and 18-month olds heard new nouns or adjectives while hearing contrast sentences presented with a disappointed tone of voice or a more positive sounding utterance (Booth & Waxman, 2009). They found that toddlers learning nouns could use explicit contrast information to guide their visual attention to new objects in the same category. Children's looking behavior in the adjective condition differed from the noun condition, but the results did not suggest that children in the adjective condition had a clear strategy they used when faced with contrast information. Taken together, all four of these studies suggest contrast information is useful for adjective learning but only under certain conditions.

Another way to describe contrast information is to ask whether children hearing two different words assume the adult has two different meanings in mind, or whether children attend to implicit contrast. Studies of mutual exclusivity suggest that young children who see a named object and hear a new word search for a salient part of that object to which to attach the new word (e.g., Hansen & Markman, 2009; Markman & Wachtel, 1988) or can assume the new word refers to a salient substance, for example (Markman & Wachtel, 1988). Many more studies of noun learning have examined this type of contrast, yet there are very few studies that have tested either explicit or implicit contrast in verb learning.

Studies of contrast in verb learning

To our knowledge, only one previous study has examined children's use of explicit contrast in verb learning. Twenty-four month-olds in this study saw dynamic video events with an agent performing an action on an inanimate patient (e.g., a man waving a balloon) (Waxman, Lidz, Braun & Lavin, 2009). For each word learned, four events were shown that could be compared (i.e., the man was shown waving four different balloons with varying shapes), then two more events were shown providing contrastive information before test (i.e., the man was shown playing a saxophone and shown waving a previously presented balloon). In the verb condition, children heard sentences with a positive intonation for the previously shown action (e.g., "Yay! He's larping that.") and sentences with a disappointed tone of voice for the contrast action (e..g, "Uh oh. He's not larping that."). At test, children saw the man waving that familiar balloon or performing a different action with it (e.g., tapping the balloon) while being prompted to make their visual response (e.g., "Which one is he larping?").

Under these conditions, toddlers were able to learn nouns and verbs equally well, and thus this study provides important evidence suggesting children attend to explicit contrast in verb learning. However, children also were given a comparison phase and thus studies are needed to test the separate contribution of contrast and comparison (access to multiple events). In addition, although children were able to direct their looking appropriately at test, the test trial was fairly similar to the event shown in the learning phase, thus further studies are needed to explore the depth of children's knowledge of these novel verbs.

There are also very few studies that have examined implicit contrast in verb learning. Merriman and colleagues (with Evey-Burkey, Marzita & Jarvis, 1996) conducted four studies in which 2-year-olds' were shown videos of adults performing a simple action in pairs, with one familiar and one unfamiliar action shown at a time, and were asked to point to the event in response to hearing a novel verb ("Can you point to the one of the man jiggering?") (see also Merriman, Marzita & Jarvis, 1993 for results with 4 year olds). Half of the events showed actions that included an object, and half showed actions that were body movements. In general, children showed a stronger disambiguation effect (choosing the unfamiliar event) when shown pairs of self actions showing body movements than they did for the (more complex) action pairs that included an agent and an object that was acted upon. Thus, fairly young 24-month-old participants could point to an unfamiliar event upon hearing a novel verb, but only if the actions shown were body movements (and not actions including an agent and one or more objects).

In a more recent study (Roseberry, Hirsh-Pasek, Parish-Morris & Golinkoff, 2009), an implicit contrast was presented in one of four test trials. In this preferential looking study, older 2-year-olds and 3-year-olds learned a novel verb (e.g., "Look at Cookie Monster wezzling!") and then were asked to extend the verb to events with a new actor ("Where is wezzling? Can you find wezzling? Look at wezzling!"). In an additional test trial, they heard a *second* novel verb that was not heard during the learning phase (e.g., "Where is glorping*?* Can you find glorping? Look at glorping!"), and their looking behavior was examined to determine whether their looking switched from looking to the event that had been labeled with the first novel verb to looking longer at a new event. Thus, in this trial, the experimenters provided an implicit contrast between the first novel verb and the event paired with that verb, and a second new novel verb and a new event only seen at test. Results showed that during this test trial, children looked equally to the new event and the previously labeled event, and this was a different pattern than was seen in other test trials in which children successfully looked at the key event when hearing the first novel verb. This finding suggests children are beginning to search out new actions when they hear an unknown verb, though a clear preference for the new action over the previously labeled action in this test trial would have provided more convincing evidence of this ability.

An additional way a child could use implicit contrast occurs when they hear a new word that is related to a word they know, as seen in the earlier Au and Laframboise (1990) study of color terms. Recall that in that study children in the condition in which they heard a term in their vocabulary performed better at test than did children in the other conditions. In a recent study, Saji et al. (2011) examined how Chinese-speaking children (and adults) applied verbs for holding and carrying events to videotaped events. One finding from this important study is that 3- to 7-year-olds produce a similar number of verb types, but the organization of how these verb types are mapped to events evolves to become more like adult-like between 3- and 7-years. One way the organization of verb meanings appears to change is through a process of contrast, or a focus on how a particular verb of holding (for example) differs from other verbs used for holding events.

In summary, given the inconclusive nature of these prior findings concerning implicit contrast, and only a single study of explicit contrast to date, additional studies of children's attention to contrast while learning new verbs are needed.

Our study

We began investigating children's use of contrast information in verb learning by hypothesizing that contrastive information could be especially helpful in verb learning when the objects in events are similar but the actions vary. In the first study, we presented children with explicit contrast information (e.g., "I'm meeking it." and "I'm not meeking it."), implicit contrast information (e.g., "I'm meeking it." and "I'm koobing it."), or a control condition, to begin to examine how hearing different contrastive statements may assist children learning new verbs.

There are at least two possible control conditions that could be included in these types of studies. In one type of control, children see the same events in the control condition as in the other conditions but do not hear a novel verb. In another, children see only one event with one novel verb and do not see the contrasting second event. We chose to use the first control condition in Study 1 and the second type of control condition in Study 2 because in Study 1, children act on objects they have seen the experimenter act upon. It seemed likely that if we designed the control condition in Study 1 to include a single event and then asked children to act on the same objects as those they had just see the experimenter manipulate at test, they could easily imitate the single event shown with those objects and thus succeed for a completely uninteresting reason. Of course children in the experimental conditions may imitate us as well, but at least in the experimental conditions, they see two events in the learning phase. We were less concerned with this issue in Study 2 because in that study, all children get new objects to act on at test, thus showing a single event without a contrasting event in the control condition seemed more acceptable in that case.

Given that very few studies have investigated either explicit or implicit contrast in verb learning, and no study has directly compared them, we first sought to examine whether children could use either of these types of contrast. We then conducted two follow-up studies, one in which children heard a contrast statement and were asked to *extend* the verb to new objects, and one in which children received both contrast information and multiple events they could compare before they were asked to extend the verb. This final follow-up study allows us to begin to disentangle the influences of comparison and contrast in verb learning (a topic we will return to in the Discussion).

Study 1: Examining Explicit and Implicit Contrast in Verb Learning

Method

Participants

Forty-one 3 1/2-year-old children (*M*= 3;7; range: 3;2– 3;10) participated in this study, 18 were girls and 23 boys. Of the ethnicities reported, 23 families self-reported their ethnicity/race as Caucasian, 9 were Hispanic, 1 self-described as Caucasian/ Hispanic, 2 were Caucasian/ African American, 1 was Hispanic/African American and 1 was Hispanic/Asian.

Children were included in the final sample if their parents reported minimal exposure to languages other than English. In addition, parents were asked to complete the verb vocabulary section of the MacArthur-Bates Communicative Development Inventory for Words and Sentences, and to list 3 sentences they had heard their child produce. Children's verb vocabulary was *M*= 97 verbs, range: 47-103 words (total verbs on the list = 103) and the *M* length of longest sentence (LLS) = 8.5 words, range: 3-20 words (n = 29 reporting). In the preschools, we excluded any children who were reported to be experiencing a speech delay or who were exposed to multiple languages in the home (see Table 1).

Insert Table 1 about here

To locate eligible families, parents with young children were identified using a national database, then a postcard was sent to them describing the study, and phone calls were made to schedule an appointment at an on campus laboratory. Some children also were recruited through local YMCA branches with postcards available at child care facilities, and through advertisements in a local children's newspaper ("Kidsville"). In addition, children were recruited through nearby preschools. In this case, letters were sent home to parents who returned signed consent forms to the child's teacher. Most children were from middle income or upper middle income homes. Additional children participated but were excluded from the final sample due to experimenter error (2), refusal to complete all 4 sets (3), experience watching a twin sibling participate first (1), and parent report that the child was autistic (1).

Materials

Warm-up toys were used to build rapport between children and experimenters. The experimental materials consisted of variously colored concrete objects designed to create 4 blocks of trials. Stimulus objects were chosen that could be used to complete two separate actions with the same objects (see Appendix). For example, one set ("blick") included a plastic shovel that could be used to manipulate colorful balls in a clear bowl (see Figure 1). One action used with these objects was to stir the balls using the shovel, and the second action was to scoop the balls up with the shovel. The objects presented at test included these objects and a distractor object that would be interesting to a young child but could be used to perform actions that were completely unrelated to the two key actions in each set. In addition to this set, three other sets of objects were created that could each be used to enact two different actions (see Appendix).

Insert Figure 1 about here

In the lab, a small round wooden table and two chairs were used for the experimental play session. In the day care centers, the experimenter and child sat on the floor. A video camera was used to record all actions of each child so that the data could be coded from videotape by a second experimenter.

Design

This study included two experimental conditions-- an explicit contrast condition and an implicit contrast condition-- and a control condition. There were approximately 14 children in each condition. In addition, the particular event in each set that was used as the target event was counterbalanced in each condition. For example, for half of the children the stirring action in one set was the target action (see Materials and Appendix), while for the other half, the scooping action in that set was the target action. Thus, to succeed in this study, half of the children needed to reproduce one of the two actions shown, and the other half had to produce the other action. If children simply preferred one action over another and ignored the experimenter's statements, they would simply enact one action regardless of the types of sentences produced by the adult, which would be a correct answer for only half of the sample.

Procedure

Participants who came to lab initially played with one experimenter with warm-up toys while a second experimenter obtained informed consent and introduced the language questionnaires to the caregiver. When the necessary paperwork was completed, the first experimenter and participant moved to the small table and chairs to begin the experimental session while the second experimenter coded the participant's actions and videotaped the study. At day care centers, experimenters played for several days with the children in their classroom to build rapport, and then children were taken individually to a quiet room to participate in the study. Informed consent was obtained from parents before the experimental sessions were begun.

The experiment began with the experimenter introducing the test objects (2 key objects + 1 distracter object) by saying, "Look at these things. What can you do with these?" and letting the child play with the objects for a brief time. Then the experimenter took the objects back ("It's my turn now") and began to act on them. The experimenter showed the participant two separate, distinguishable actions using the same objects. In the explicit contrast condition, children heard a positive statement for one event (e.g. "Look! I'm meeking it!) and a negative statement for the other (Look! I'm *not* meeking it!"), in the implicit contrast condition, children heard one verb for one event (e.g., "Look! I'm meeking it") and a different verb for the other event (e.g., "Look! I'm koobing it."), and in the control condition, children heard sentences without a novel verb while they saw both events (e.g., "Look what I can do! See? Wow! Now look what I can do. See? Wow."). Each action and phrase was repeated once. Then the test objects were given to the child and, in the experimental conditions, the child was prompted to perform the action that corresponded to the verb in the positive statement ("Can you show me meeking? Can you play the game?") while in the control condition, children heard "Can you do it? Can you play the game?". This process was repeated until all four sets were presented; the sets were presented in a random order.

Coding. We coded the first action children produced following the test question. These enactments with the test objects were coded into one of following categories: Correct Event, Incorrect Event, and Other. Correct Events were defined as enactments that reproduced the event paired with the positive statement (explicit condition) or the event that was paired with the verb asked for at test (implicit condition). As described previously, as part of the design of the study, the particular event chosen as the correct event was counterbalanced across children so that a specific event served as a correct event for half of the sample and as the incorrect event for the other half. The control condition also included two orders of events: one that matched one order in the experimental groups and one that matched the other order. To code the control condition, the event that would have been counted as a correct event in each order of the experimental conditions was also coded as the correct response in each order of control condition.[1]

Actions were coded as an Incorrect Event when the child used the stimuli to perform the action paired with the negated novel verb (explicit condition) or the event paired with the novel verb that was not asked for at test (implicit condition); the action that was coded as an Incorrect Event in the experimental conditions was coded as incorrect in the control condition. Enactments were coded as Other when the child played with the test stimuli and/or distracter objects in any other way. The two actions designed for each set of objects were simple actions that were distinct (e.g., stirring vs. scooping), and thus coding these children's actions into these categories was a fairly straightforward process. An examination of the few discrepancies that did arise across coders revealed that no event set was more difficult for coders to agree upon than any other.

All of the experimental sessions were initially coded by an observer during the experimental session, however this coding was only entered into the final data set if the videotaped record could not be coded (n = 2 for this study). All participants who could be coded from videotape were coded by an independent observer not present during the experimental session, and were entered in a final data set. In addition, a third observer coded a randomly selected subset of the participants from videotape (n = 15 or 23%); there was 90% agreement between these two independent coders.

Results

Overview

To evaluate children's responses at test, we first computed the proportion of Correct Events children enacted by dividing Correct Event/ (Correct Event + Incorrect Event + Other responses). Incorrect Events were events the experimenter had modeled but not linked to the verb used at test, while Other responses were off task responses children produced at test. Following an overall ANOVA, pair-wise comparisons were used to test whether children as a group succeeded in each experimental condition compared to the control condition, and one sample t-tests were used to test whether the proportion correct in each condition exceeded the proportion expected by chance (.33). All t-tests reported herein are two tailed.

A separate question is whether children as individuals performed well in the contrast condition, or whether some children benefited from contrast and some did not. Pearson chi-square tests were used to test whether the number of children who were consistently correct (producing at least 3 or 4 of 4 responses correct) differed significantly across conditions. Binomial tests were then used to examine if these numbers of children who were consistently correct differed from chance.[2]

Overall analysis. A one way ANOVA computed with Condition (explicit contrast, implicit contrast, control condition) as the between subjects factor and proportion of correct responses as the dependent variable was suggestive, $F(2, 40) = 2.56$, $p < .10$, but a planned comparison comparing both experimental conditions to the control condition was significant, $t(38) = -2.26$, $p = .030$ (see Figure 2). Because we did not predict that the two contrast conditions would necessarily differ from each other, the key analyses of interest were to compare each experimental condition to the control condition and to chance to test whether children in each contrast condition were successful in ways that differed from chance responding or not.[3]

Implicit contrast condition analyses. Children in the implicit contrast condition produced a mean proportion of .61 (SD = .25) correct responses, whereas children in the control condition produced a mean proportion of .39 (SD = .25) correct responses; a planned pair-wise comparison was significant, $t(26) = 2.23$, $p < .05$. One sample t-tests showed that children in the implicit contrast condition differed from chance, $t(13) = 4.08$, $p = .001$, and children in the control group did not (see Figure 2).

A Pearson chi-square comparing the number of children who were consistently correct in the implicit contrast condition (7 of 14 children) with the control condition (1 of 14) also was significant, $\chi2 = (1, N = 28) = 6.30$, $p < .02$ (see Table 2). The binomial test showed that the number of children consistently correct in the implicit contrast condition differed significantly from chance ($p < .001$).

Explicit contrast condition analyses. Children in the explicit contrast condition produced a mean proportion of .60 (SD = .33) correct responses; (as noted, children in the control condition produced a mean proportion of .39 (SD = .25) correct responses); a planned pair-wise comparison was suggestive, $t(25) = 1.80$, $p < .09$. A one sample t-test comparing the proportion correct in the explicit contrast condition to chance (.33) was significant, $t(12) = 2.90$, $p < .02$ (see Figure 2).

The chi-square analysis comparing the explicit contrast condition (with 7 of 13 children consistently correct) with the control condition (1 of 14 consistently correct) was significant, $\chi2 = (1, N = 27) = 7.05$, $p < .01$ (see Table 2). A binomial test showed that the number of children consistently correct in the explicit contrast condition also differed significantly from chance ($p < .001$).

Insert Figure 2 and Table 2 about here

Children's verbal productions

To examine children's verbal productions, we excluded all imitative utterances (i.e., exact imitations following an adult production or prompt, e.g., "Can you say meeking?"), and examined the proportion of children at each age in the two experimental conditions that produced at least one of the novel verbs. (Children in the control condition never produced the novel verbs, as they were not presented.) In the implicit contrast condition, 7 of 14 (50%) of the children spontaneously produced at least one of the novel verbs and in the explicit contrast condition, 5 of 13 (38%) of the children produced at least one novel verb spontaneously at test.

Discussion

The main results in this study were that 3 ½-year-olds in an implicit contrast condition (in which the experimenter used two different verbs) differed from children in a control group (who learned no new verbs) and from chance. These children were also able to be consistently correct across trials, with the number of children who were consistently correct differing again from the control group and differing significantly from chance. Children's responses in the explicit contrast condition (in which the experimenter labeled one action as "not x-ing") exhibited more variability at test, but results in this condition still differed from those that would be expected by chance, and children's consistency in the explicit condition differed from the control condition.

A different type of control condition would have included no sentences during the learning phase but the same sentences as used in the other conditions at test. A future study with this type of control condition would help to reveal the role language plays in the learning phase, which is an important question. At the same time, the control condition used in the study differed from the other conditions only in the omission of the novel verb and important differences between the experimental conditions and the control condition still emerged, suggesting children have different expectations in verb learning contexts than they have when they hear more general sentences.

Overall, these results are important because no previous study of verb learning has included both types of contrast. In addition, children were asked to perform a difficult task—enact events at test that corresponded to just the key event that corresponded to the new verb, and inhibit any tendency to enact events that were modeled by the experimenter but not paired with the new targeted verb (and inhibit any impulses to play with the distractor object). These results focus on children's first response at test because we found that, with enough time, children produced many actions. This in itself suggests that inhibiting wrong extensions or off task responses in this age was difficult, however, importantly, their initial response when prompted to enact the verb varied by condition. In some analyses, we also required children to be consistent in their responses, and the results clearly show that children hearing either type of contrast are able to be consistently correct at rates that exceeded chance.

Children could have had more difficulty when hearing two novel verbs (implicit contrast) than when hearing explicit contrastive statements because, as noted by one reviewer, explicit negation makes it clear that the new verb should not be extended to include the negated action, whereas access only to implicit contrast is ambiguous because it may indicate that one verb refers to a broad category of action while the other refers to a smaller set of actions, for example. In addition, other studies (e.g., Waxman & Klibanoff, 2000; Waxman et al., 2009) that have included explicit contrastive statements with affective excited or disappointed intonation contours suggest that contrast is useful, while previous studies that have included implicit contrast have revealed results that are less conclusive (Merriman et al., 1996; Roseberry et al., 2009). Thus, it is interesting that the results in the implicit condition and the explicit condition were similar. Why did this finding emerge? Because very few studies have examined either explicit or implicit contrast in verb learning, and no previous study has directly compared the two, additional studies are needed to support this result. However, if the finding is supported, it could be that children do not entertain hypotheses about verbs differing in scope that we can imagine as adults (and it is these types of hypotheses that make the implicit contrast ambiguous). In some ways, these results are encouraging because the implicit contrast condition presents a more accurate reflection of everyday life. Children in the world probably hear two novel verbs (e.g. "Mary is walking; Mary is running") more often than a novel verb and explicit contrast (e.g. "Mary is walking; Mary is not walking").

In sum, in Study 1, 3 1/2 year-old-children were able to use contrast to enact a key action when they were given access to objects that they had seen the experimenter use. These results are important because no previous verb study has examined both types of contrast in the same study, and few studies have tested either type of contrast in verb learning. However, to learn a verb, a speaker must go beyond the learning context and appropriately *extend* the verb to new instances. In Study 2, we sought to replicate and broaden the findings in Study 1 by focusing on children's use of explicit contrast, but by asking children to extend newly learned verbs to include new objects. Although the results from Study 1 suggest that implicit contrast could be even more helpful to children, it still seemed to us that children would be more likely to successfully extend a new verb if the adult explicitly marked some events as relevant and some as irrelevant. Further studies will be needed to examine whether these findings hold under conditions of implicit contrast.

A strength of the design of Study 2 is that children were given the same test objects as in Study 1, but saw different objects in the learning phase of the study. In the control condition in this study children saw only a single event and heard a novel verb, and thus this control examines children's learning of a new verb without contrast information. To summarize, Study 2 focuses on explicit contrast to explore further how contrast could influence verb learning and, in this study, verb extensions.

Study 2: Examining Contrast in Verb Extension

Method

Participants

Twenty 3 ½-year-old children (range: 3;1– 3;10; *M*= 3;7) participated in this study, 8 girls and 12 boys. Of the families who reported ethnicity information, 5 were Caucasian, 9 were Hispanic, and 4 were Caucasian/Hispanic. Participants were recruited for this study using the same procedures as used in Study 1. Parents who brought their children to the on campus laboratory reported minimal exposure to languages other than English. They also reported a mean number of 95 verbs (range 28-103), with a mean LLS of 10.1 words, range: 7-18 words (n= 13 reporting) (see Table 1). In the preschools, we excluded any children who were reported to be experiencing a speech delay or who were exposed to multiple languages in the home. Four additional children were excluded from the final data set because they did not complete all four test trials, one was excluded due to excessive parental involvement, and one was excluded due to experimenter error.

Materials and Design

In this study, there was an experimental condition (explicit contrast; n= 12) and a control condition (n= 8). The same warm-up toys and test objects used in Study 1 were used in Study 2.

The only difference in stimuli was that during the learning phase of the study, the experimenter demonstrated the action using a new set of objects. This meant that at test, children acted on the same objects as seen in Study 1, but in this study, they had not seen the experimenter manipulate these objects. For example, in one set ("blick"), the experimenter used a yellow fishnet tool to manipulate multicolored marbles in a plastic container (see Figure 3). One action used with these objects was to stir the marbles using the fishnet tool, and the second action was to scoop the marbles up with the fishnet tool. At test, as in Study 1, children were given a plastic shovel that could be used to manipulate colorful balls in a clear bowl, and a distractor object (see Appendix for details about the other 3 sets).

Insert Figure 3 about here

The counterbalancing of target events was the same in this study as in Study 1. Thus, for half of the sample, one action co-occurred with the target verb while for the other half of the sample, this action was linked to the non-target verb.

Procedure

As in Study 1, the experiment began with the experimenter introducing the test objects (saying, "Look at these things. What can you do with these?") and letting the child play with the objects for a brief time. Then the experimenter took the test objects back ("It's my turn now") and brought out different objects for the experimenter's enactments. As in Study 1, in the explicit contrast condition, the experimenter showed the participant two separate, distinguishable actions with a novel verb, one presented using a positive statement (e.g. "Look! I'm meeking it!) and one with a negative statement (Look! I'm *not* meeking it!"). In the control condition, children saw the same initial event as was shown in the explicit contrast condition, and they heard the same stimulus sentence (e.g. “Look! I’m meeking it!). They then saw that event repeated with the same stimulus sentence (e.g. “Look! I’m meeking it!). In both conditions, this demonstration of actions with accompanying sentences was repeated once. Then the test objects were given to the child who was prompted to perform the action that corresponded to the verb in the positive statement (“It’s your turn to play. Can you show me meeking? Can you play the game?”). This process was repeated until all four sets were presented; the four sets were presented in a random order.

Coding. Children’s behavioral enactments were coded using the same criteria as had been used in Study 1. Children’s responses in the experimental sessions were coded from videotape by an independent coder unless the videotape could not be coded (n = 2 in Study 2). These coding decisions were entered into a final data set. A second independent coder scored a randomly selected number of participants (n= 6 or 30% of the sample); there was 92% agreement between these two independent coders.

Results

Children in the explicit contrast condition produced a mean proportion of .21 (SD = .14) correct verb extensions, whereas children in the control condition produced a mean proportion of .06 (SD = .12) correct extensions. A pair-wise planned comparison testing whether the proportion of correct responses differed across conditions was significant, $t(18) = 2.39$, $p < .03$. However, one sample t-tests showed that children in both the contrast condition and the control condition performed at rates that were significantly *below* chance, $t(11) = -2.92$, $p < .02$, and $t(7) = -6.54$, $p < .001$ (see Figure 4). An examination of the pattern of responses in each condition showed that the most frequent response was to produce an Other (off task) response that did not fit either modeled action, in both the experimental and control groups (Other = .58, S.D.= .31; Other = .63, S.D.= .23, respectively). An independent samples t-test showed that children in the explicit contrast, extension task in Study 2 responded at rates that were significantly lower than was seen in this condition (no extension task) in Study 1, $t(23) = 3.74$, $p = .001$.

In this study in which children needed to extend a newly learned verb to include new objects at test, *none* of the 3 ½-year-olds in either condition were consistently correct on at least 3 test trials (see Table 3).

Insert Figure 4 and Table 3 about here

Children's verbal productions

Excluding imitative responses, in this study, we found that 2 of 12 (17%) in the contrast condition produced at least one of the novel verbs. This did not appear to differ from the explicit contrast condition in Study 1 (in which 5 of 13 produced at least one novel verb), and a Pearson chi-square analysis comparing the patterns across the two studies was not significant, $\chi 2$ (1, N=25) = 1.47, *ns.*

Discussion

Two main conclusions can be drawn from the results in Study 2. First, children benefited from contrast as compared to the control condition. Thus, although they had difficulty extending the new verbs overall, their performance after receiving contrast information was better than it was after merely hearing a single verb repeatedly. At the same time, children in the contrast condition in this study did not do as well as was seen in Study 1, suggesting that children in the same age range had trouble using contrast and *extending* a new verb at test. In both the experimental and the control groups in this study, children often resorted to responses that were off task, performing an irrelevant action on more than half of the trials. In some ways this difficulty extending verbs is not a surprising result because many other studies have shown that 2- and 3- year-old children have difficulty extending newly learned verbs (e.g., Olguin & Tomasello, 1993; Imai, Haryu & Okada, 2005). However, to become productive speakers of a language, children must discern how to use the verb in contexts that differ somewhat from the learning event. In a study by Childers (2011) in which 2 1/2-year-olds were asked to extend a verb, children seeing a single repeated event produced significantly fewer result extensions at test than did children who saw 3 different events that depicted the same result. In addition, in Childers & Paik (2009), both Korean- and English-speaking children extended verbs in a way that was consistent with a set of events they had seen in the learning phase of the study, producing responses that were more similar to the learning events when these events did not vary much from each other, and being more creative in their responding when they saw a wider range of events when learning a new verb.

Both of these previous studies by Childers suggest seeing multiple events during verb learning is helpful, but neither also included contrast information. Although adding contrast information and multiple events to a learning phase should be helpful, it is possible that children could be overwhelmed by the amount of information available. However, the previous study by Waxman et al. (2009) shows children learning new verbs attend to contrast, and these children had access to both contrast and multiple events. Yet children only needed to look longer at a matching event in this study, the intonation contours were excited or disappointed during the contrast phase, and the test itself provided two choices for children to consider that may have been fairly easy, both because these actions were fairly simple actions relying on larger body movements (e.g., waving a balloon vs. tapping it) and because the test event was fairly similar to the event seen in the learning phase (children saw an agent waving different balloons).

Interestingly, in a recent study of categorization, Namy & Clepper (2010) examined older children's (4-year-olds) use of comparison and contrast information when learning novel superordinate terms. They found that children performed better at test (i.e., made more taxonomic choices in a forced choice task) when they could compare multiple examples than was seen in conditions without comparisons. They did not show similar benefits across conditions in which contrast was present. In fact, children who only had access to contrast made more perceptual choices; only children with access to both comparison and contrast were able to show consistent taxonomic responding. Overall, these results suggest that seeing multiple examples was more useful on its own than was contrast. However, because children with access to both comparison and contrast were more consistent in the categorization task than were other groups, access to both types of information was useful.

In Study 3, we presented children with contrastive statements and 3 pairs of events before test. Our hypothesis was that children would be able to use the contrastive statements to focus their attention on one of two events, and then could compare events that co-occurred with that positive statement with each other. Thus, for children to succeed, they needed to use both contrast and comparison at the same time while processing the events. Again, this differs from earlier studies because comparison trials were not presented in a block before a set of contrast trials (as in Waxman et al., 2009). Because we hypothesized that using both comparison and contrast is difficult, especially when children are asked to consider both in a single set, in this study we included an older age group (4 ½ year olds) and a younger age group (2 ½ year olds).

Including three age groups allowed us to fully explore developmental change in children's ability to use these different types of information during verb learning.

Study 3: Disentangling the Influences of Comparison and (Explicit) Contrast

Method

Participants

Sixteen 2½ year-old children (range: 2;4– 2;11; *M* = 2;7), seventeen 3 1/2-year-old children (range: 3;4– 3;9; *M*= 3;7), and eight 4 ½-year-old children (range: 4;5-5;7; *M*= 4.9) participated in this study, with 19 girls and 22 boys (see Table 1). Of the families who reported ethnicity information, 18 were Caucasian and 11 were Hispanic. Participants were recruited for this study using the same procedures as used in the previous studies.

Parents who brought their children to the on campus laboratory reported minimal exposure to languages other than English. Most of the children in this study were recruited and participated at nearby day care centers, and thus there were fewer MB-CDIs that were completed In the youngest group, children's verb vocabulary was *M* = 82 verbs (range: 55-97) and the *M* length of longest sentence was 5.4 words (range 4-7 words, n = 5 reporting) (see Table 1). In the 3 1/2-year-old group, children's verb vocabulary was *M* = 99 verbs (range: 82-103) and the *M* length of longest sentence was 8.4 words (range 6-12 words, n = 6 reporting). The MB-CDI was not given to parents of 4 year olds, as it is inappropriate for that age group. As in previous studies, in the preschools, we excluded any children who were exposed to multiple languages in the home or who had a marked speech delay. Seven additional participants were excluded from the final data set because they refused to complete one or more of the trials, and three children were excluded due to an experimenter error.

Materials, Design and Procedure

The same materials and experimental set up used in Study 2 were used in this study. The counterbalancing of target events was the same as in Studies 1 and 2. New stimuli were added to be able to present 2 additional pairs of events after the target event for comparison. In this study, all of the children heard a positive and a negative statement with a single novel verb and then were asked to extend the verb at test.

For example, in one set, one action was to scoop colored rocks using a fishnet, and the other was to stir the colored rocks using the handle of the fishnet (see Figure 5). As in Study 2, half of the children saw one event labeled positively and the other half saw that event labeled negatively. Following the presentation of each of these initial events, children saw two pairs of new events. For example, in one pair, children saw the experimenter scoop buttons with a toy spoon and stir the buttons and saw the experimenter scoop toy flowers using a ladle and stir the flowers. At test, children were asked to extend the positively labeled event to new objects (which were the same test objects as used in Studies 1 and 2). Children also could perform off task actions using a distractor object (see Appendix). Besides the addition of comparison events, the procedure was the same as used in Studies 1 and 2.

Insert Figure 5 about here

Coding. Children's behavioral enactments were coded using the same criteria as had been used in the previous two studies. Children's responses in the experimental sessions were coded from videotape by an independent coder unless the videotape could not be coded (n = 0 in this study). These coding decisions were entered into a final data set. A second independent coder scored a randomly selected number of participants (n= 11 or 27% of the sample); there was 98% agreement between these two independent coders.

Results

Did children who are given both comparison and contrast information differ across age?

Two ½-year-old children with access to multiple events and contrast information produced a mean proportion of .20 (SD = .23) correct verb extensions, 3 ½-year-olds produced a mean proportion of .43 (SD = .28) correct verb extensions, and older 4-year-olds produced a mean proportion of .81 (SD = .22) correct verb extensions at test. A univariate ANOVA with Age group (3: 2 ½ years, 3 ½ years, 4 ½ years) as a between subjects factor and the proportion of correct responses as the dependent variable was significant, $F(2, 40) = 16.10$, $p < .001$. Post-hoc tests with Sidak adjustments for multiple tests showed that 2 ½ year-olds produced significantly fewer correct responses than both older age groups (ps< .05), and 3 ½ year-olds differed from 4 1/2-year-old children ($p < .01$). One sample t-tests showed that 2 ½ year old children as a group performed at rates significantly *below* chance, $t(15) = -2.23$, $p < .05$, 3 ½ year olds' responses did not differ from chance, and 4 1/2-year-olds exceeded chance $t(7) = 6.16$, $p < .001$ (see Figure 6). Additionally, an independent samples t-test showed that 3 ½ year-olds in the explicit contrast + comparison task in Study 3 responded at rates that were significantly greater than was seen in this age group (explicit contrast condition) in Study 2, $t(27) = 2.50$, $p < .02$.

Only 1 of 16 2 ½-year-olds was consistently correct at test, 4 of 12 3 ½ year-olds were consistently correct, and 7 of 9 4 1/2-year-olds were consistently correct at test. A Pearson chi-square analysis examining the number of children who were consistently correct across age was significant, $\chi 2$ (2, N=41) = 14.47, p= .001 (see Table 4). Although only one-third of 3 1/2-year-olds were consistent in this study, because using this level of consistency sets a relatively high bar and is highly unlikely to emerge by chance, their binomial test was significant, $p = .0053$. Not surprisingly given the level of consistency seen in the oldest age group, the binomial test applied to their results was highly significant ($p < .001$).

Insert Figure 6 and Table 4 about here

Children's verbal productions

In this study, we found that 5of 16 (31%) 2 ½-year-olds produced at least one of the novel verbs, 7 of 17 (40%) 3 1/2 year olds produced at least one novel verb, and 8 of 8 (100%) 4 ½-year-olds spontaneously produced at least one novel verb.

Discussion

In this study, children were shown multiple events, some of which were relevant for learning a specific verb and some of which needed to be ignored. We asked children to focus on the relevant events and compare them to each other. We hypothesized that children who could compare events would use information about the range of events they saw that were positively associated with a new verb to extend the verb. The results show that 2 ½-year-olds had difficulty extending a new verb under these conditions, but by 3 ½ years, children were often succeeding and by 4 ½, they were near ceiling in their responding. These developmental changes show an important emerging ability to use comparison and contrast information, in this study to learn new verbs.

The order in which comparison trials and contrast examples are presented appears to be important. Interestingly, Namy & Clepper (2010) showed that in a categorization task contrast was most useful when it followed comparison trials. And this order of presentation matches the order in which these types of information were presented in the previous study showing attention to contrast (Waxman et al., 2009). In the present study, we interleaved these cues, with children seeing pairs of events that contrasted with each other from the beginning of the learning phase, which likely was more challenging.

At the same time, the analyses suggest that access to multiple events that can be compared helps children begin to extend new verbs, at least by 3 ½ years. Three ½-year-olds in this study, with access to multiple events, differed significantly from children in Study 2 in which only a single pair of events was shown. We have no direct evidence to show that children compared the multiple events to each other, but these data suggest that seeing additional examples of an event in Study 3 appeared to help some 3 ½-year-olds succeed in Study 3, whereas none of the children at this age consistently succeeded in Study 2. In Namy & Clepper (2010), children with access to both comparison and contrast were more consistent in a categorization task than were other groups. In our study examining children's ability to extend new verbs, we also found better performance when children had access to events to compare and had contrast information.

General Discussion

The present set of studies examines children's use of explicit contrast, implicit contrast, and their ability to compare events while attending to contrast. Study 1 investigated children's attention to explicit and implicit contrast, and showed that children at 3 ½ years who are learning new verbs can attend to contrast of either type. This provides important new evidence of the role contrast information could play in verb learning. Although we have used Clark's Principle of Contrast (1988; 1990) because it predicts that children will assume that hearing a new verb must refer to a new meaning, there are other similar ideas that have been proposed for noun learning, such as Markman's Mutual Exclusivity principle (e.g., Markman, 1990). Thus, it may be best to describe our study as investigating a novel verb disambiguation effect (Merriman et al., 1996). It seems obvious that children hearing two verbs in a single situation likely would attempt to discover two different ways to package different elements of events, to begin to guess about the separate meanings of each verb, but little experimental evidence has shown they can do so. The results from Study 1 in particular are important because they demonstrate that this ability is robust—children can envision their own response and enact that response consistently across sets—and this is evident in a fairly young age group.

Interestingly, in the prior studies that have included contrast with this age group, children performed best when they were shown body movements as opposed to more complex actions involving agents acting on objects (Merriman et al., 1996). Thus, children in the present set of studies may have demonstrated an even greater ability to use contrast if the actions shown had been simpler actions. Given the small number of studies of contrast in verb learning, additional studies are needed and could explore further how children may differ in their processing of different types of events.

The present studies also suggest some important changes across age. One important change appears to be in children's ability to keep from enacting the wrong event (an event modeled but not linked to the specific verb) or an irrelevant (off task) event. This ability to inhibit responses is likely related to children's executive function abilities, and could have played an important role in these studies. Future studies could examine children's executive function abilities separately and test whether executive function tasks correlate with verb responses in this type of task. In addition, children's memory of the links between particular events and verbs likely develops, and thus studies investigating how changes in memory over development affects verb learning are needed. A third major developmental change could center on children's ability to integrate multiple cues, especially when cues needed to be processed simultaneously. By 4 ½ children were quite able to use multiple cues, and by 3 ½ years, there was evidence that a good number of children were beginning to be able to integrate cues. Children must have some ability to integrate comparison and contrast to succeed in Waxman et al.'s (2009) study, but there are procedural differences between those studies and the studies reported here, as well as questions about whether children in the previous study were integrating cues or were relying on one cue or another.

One theory of how children would perform this comparison is Gentner's structural alignment and comparison view (1983; 1989) which predicts that children will align events based on their underlying relational structure, and that this process will direct attention to relational information. This theory describes the mental process children may use to compare the events that all co-occur with a single new verb. Specifically, children could analyze the initial event relationally and thus attend to the agent in the event, the instrument or tool and the affected objects, and then would seek out and align their representation of an entity in the first event, with the corresponding elements of the subsequent events (e.g., agent with agents, instruments with instruments). Although our studies do not directly demonstrate this mental process at work, our results are consistent with this view. Furthermore, children improve in their ability to align and compare instances if they have exposure to similar pairs before they are given more varied ones (e.g., Gentner, Lowenstein & Hung, 2007). If this process of 'progressive alignment' helps learners learn how to compare events, then giving children experience with similar comparisons should lead to better learning in tasks with comparison and contrast information; this prediction could be addressed in future studies.

Learning a new verb requires children to discover how speakers use words to refer to a particular package of elements within a larger event, packages that have no apparent starting or ending point, and that include elements that change over time. It is likely that children use many cues in this process. This paper shows that children as young as 3½ can use contrastive information when solving the difficult problem of learning a new verb. In addition, these results show that having access to multiple events that can be compared is helpful to children for understanding how to use a new verb in a new context.

Footnotes

[1]A child could perform a correct event with the "wrong" objects, for example using the distractor object to enact the key action. This happened rarely. Specifically, 2 children stretched the cord using their hands instead of the target object, 3 children used the cord to encircle a distractor or multiple objects instead of 1 target object, and 1 child inserted a target object into the top of the distractor object instead of into a second target object; these were counted as showing a Correct Event. In addition, once a child performed the "wrong" action *and* verbally noted that they were performing the "wrong" action (i.e., saying "I'm not meeking it"), and we counted this response as correct.

[2]Calculations for the binomial test were performed as follows. In this task, there were 3 possible responses at test thus, the probability that a child would perform a correct event on a single test trial by chance was .33 (or smaller given that they had to enact an action and not just choose an object). The probability of performing a correct event by chance on at least 3 sets is .33 x .33 x .33= .0359, the probability of a correct event by chance across all 4 sets is .33 x .33 x .33 x .33 = .0119, and the joint probability of performing the correct event on either 3 or 4 events is .0359 + .0119 = .0478.

[3]See Rosenthal, Rosnow & Rubin (2000) for justification for performing focused contrast analyses instead of relying on omnibus analyses when experimental predictions are focused on specific questions.

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Table 1

Studies 1, 2 and 3: Demographic Information.

Study	Ages mean (range)	Gender m, f	MCDI results mean (range)
Study 1	3;7 (3;2-3;10)	23, 18	97 verbs (47-103)
Study 2	3;7 (3;1-3;10)	12, 8	95 verbs (28-103)
Study 3	2;7 (2;4-2;11)	8, 8	82 verbs (55-97)
	3;7 (3;4-3;9)	11, 6	99 verbs (82-103)
	4;9 (4;5-5;7)	3, 5	

Table 2

Study 1: Number of Children who were Consistently Correct.

Condition	Not Consistently Correct	Consistently Correct
Explicit contrast	6	7*,*
Implicit contrast	7	7*,*
Control	13	1

Note: Consistently correct meant children produced a Correct Action at test for at least 3 of 4 or 4 of 4 verbs. The overall chi-square revealed significant differences across all three conditions. Chi-square analyses showed that the explicit contrast and implicit contrast condition differed from the control condition, *$p < .05$. Binomial tests comparing the proportion of children consistently correct in each contrast condition to chance also were significant, *$ps < .01$.

Table 3

Study 2: Number of Children who were Consistently Correct.

Condition	Not Consistently Correct	Consistently Correct
Explicit contrast + extension	12	0
Control	8	0

Note: Consistently correct meant children produced a correct action at test for at least 3 of 4 or 4 of 4 verbs.

Table 4

Study 3: Number of Children who were Consistently Correct.

Age group	Not Consistently Correct	Consistently Correct
2 ½ years	15	1
3 ½ years	12	4*
4 ½ & 5 years	2	7*

Note: Consistently correct meant children produced a correct action at test for at least 3 of 4 or 4 of 4 verbs. The overall chi-square analysis shows a significant difference across the three conditions, $\chi 2 = (2, N = 41) = 14.47$, $p = .001$. Binomial tests examining the proportion of children consistently correct in the two oldest age groups showed each age group differed significantly from chance, *ps< .01.

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Figure Captions

Figure 1. Example stimulus set used in Study 1.

Figure 2. Study 1 Results by Condition.

Figure 3. Example stimulus set used in Study 2.

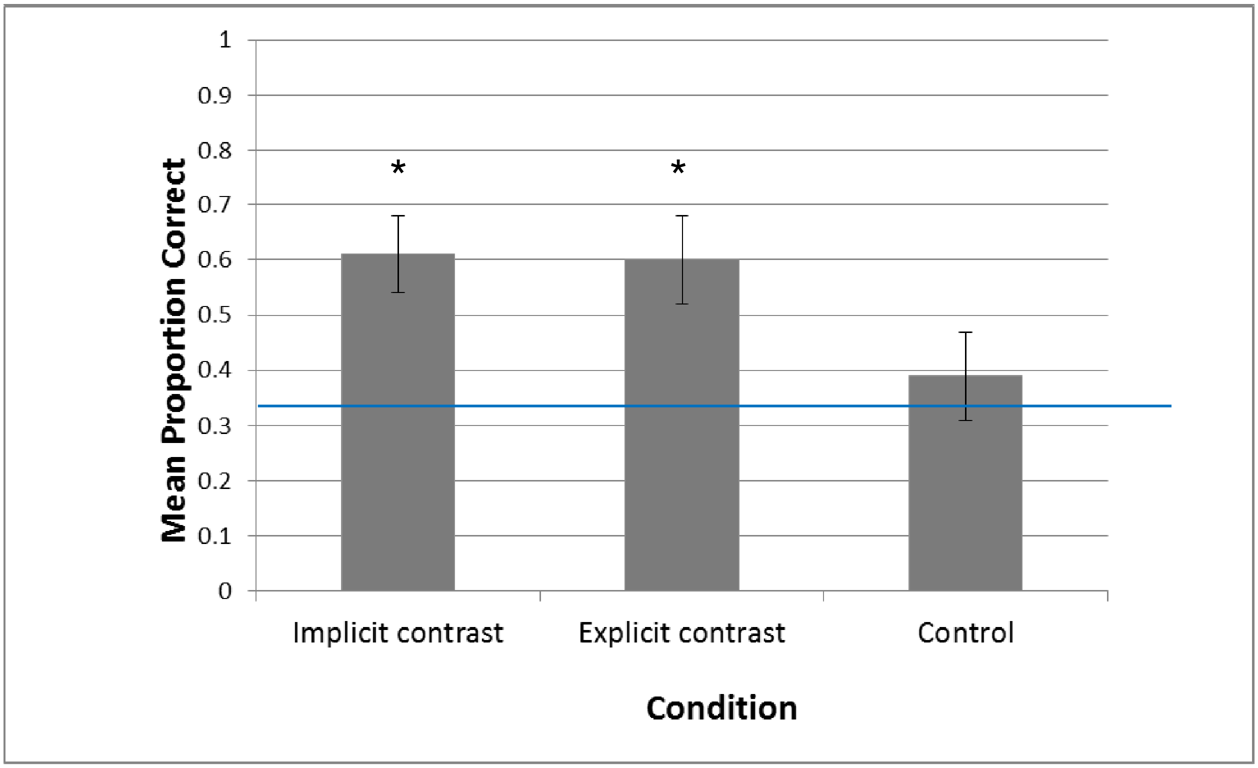
Figure 4. Study 2 Results by Condition.

Figure 5. Example stimulus set used in Study 3.

Figure 6. Study 3 Results by Age Group.

Learning phase

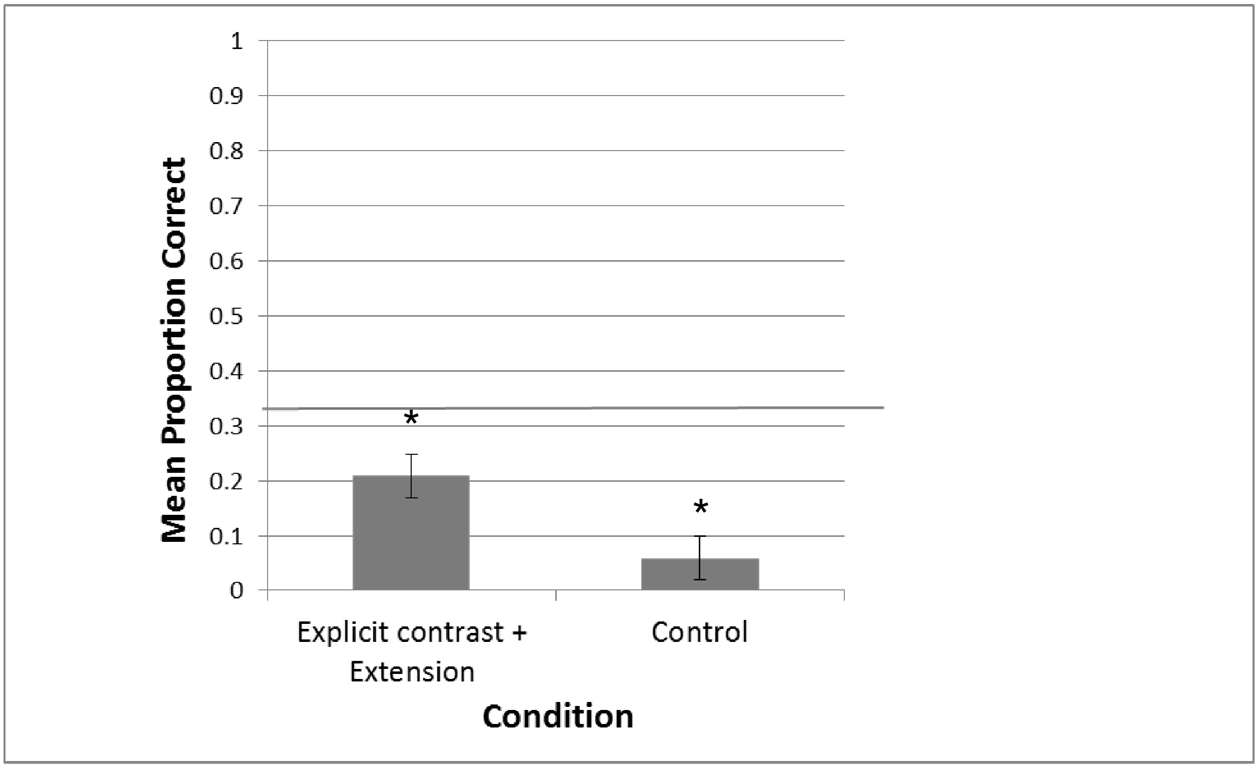
Test objects (L to R): distractor, tool, objects to act on



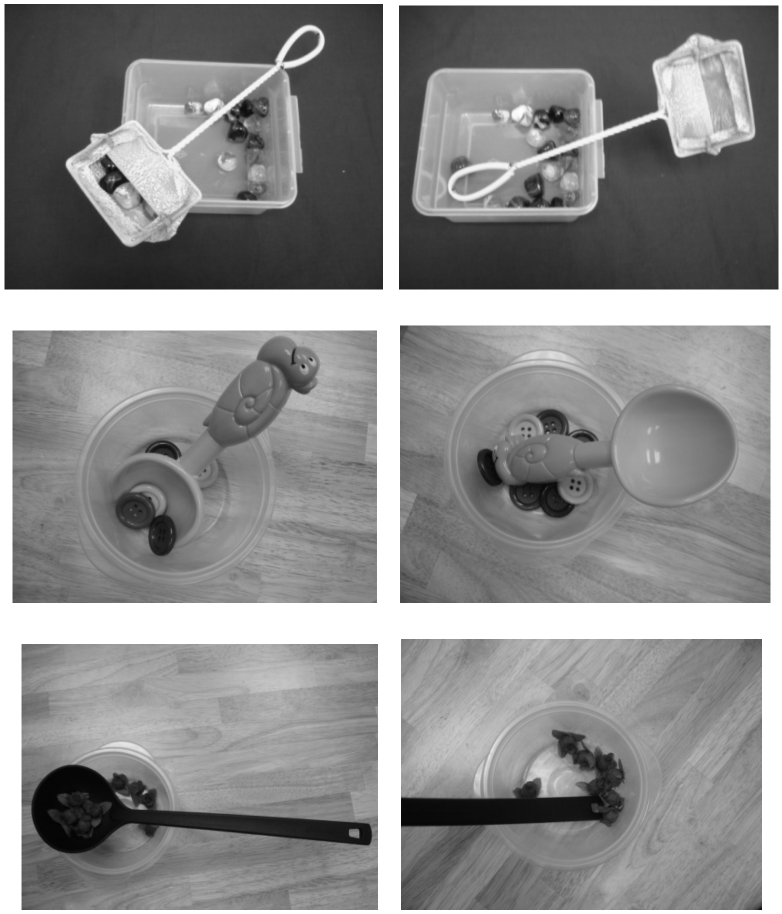
Note: Graph shows mean proportion correct by condition, error bars = SEM, *p< .05. Dark blue line shows chance levels of responding. One sample t-tests show both the implicit and explicit contrast condition results differ from chance (*ps*< .05).

Learning phase

Test objects (L to R): distractor, tool, objects to act on

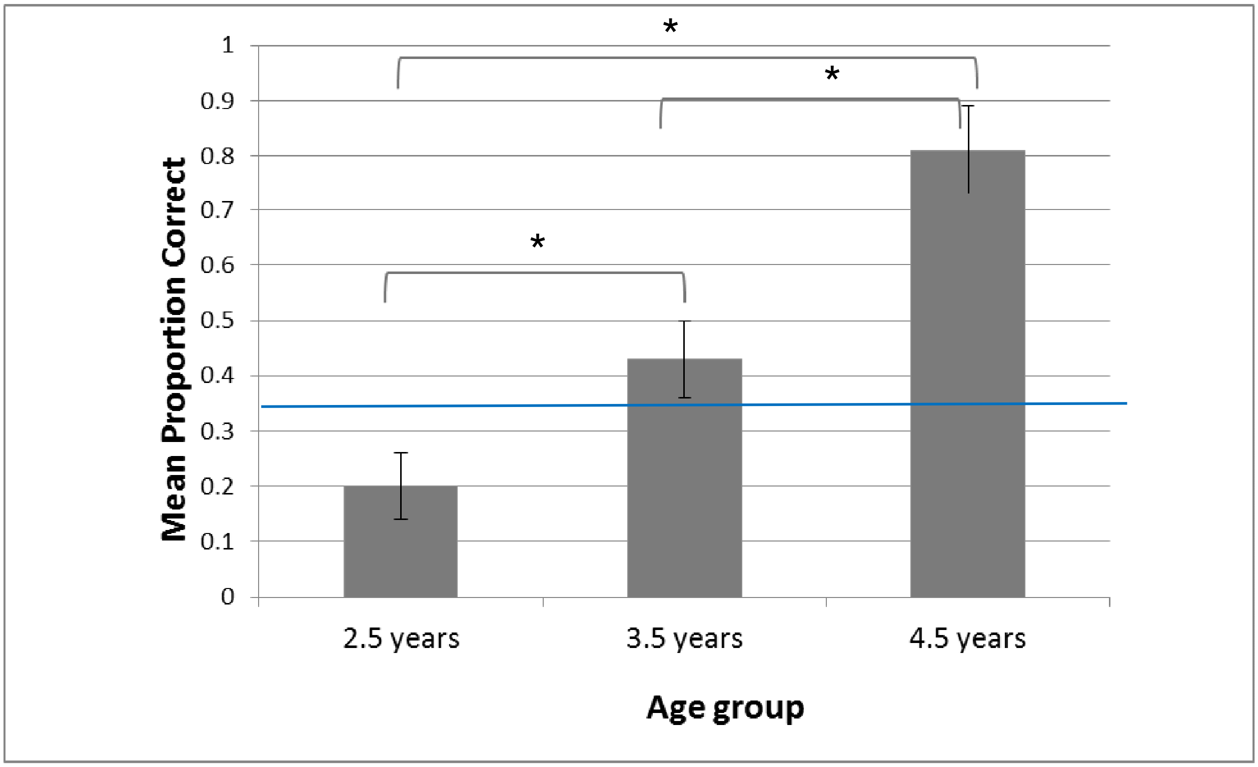


Note: Graph shows mean proportion correct by condition, error bars = SEM. Dark blue line shows chance levels of responding. One sample t-tests show responding in both conditions is significantly below chance, **p*s< .05.



Learning phase: Comparison events

Test objects (L to R): distractor, new shovel, new objects for action



Note: Graph shows mean proportion correct by condition, error bars = SEM, *p< .05. Dark blue line shows chance levels of responding. Post-hoc tests show responding differs across age groups. One sample t-tests show only children in the oldest age group performed at a level that was significantly greater than chance (*p*< .05).

Appendix

Novel verb	Learning phase: objects, events	Comparison: objects, events (S3 only)	Test
blick	objects: colored balls in container, red shovel (S1 only) or colored rocks in container, yellow fishnet actions: scooping balls/rocks up with tool, or stirring balls/rocks with handle of tool	objects: small silk flowers, ladle actions: scooping & stirring flowers objects: plastic buttons, pink shovel actions: scooping & stirring buttons	objects: colored balls in container, red shovel, toy car (distractor) actions: scooping, stirring or other (off task)
wug	objects: yellow cord, wooden block (S1 only) or white stretch cord, orange ring actions: stretching cord with block/ring, or encircling block/ring using cord	objects: red string, blue tube actions: stretching string with tube, encircling tube with string objects: black belt, banana actions: stretching belt with banana encircling banana with belt	objects: yellow cord, wooden block, blue mitt (distractor) actions: stretching, encircling or other (off task)
meek	objects: orange bowl, blue bowl (S1 only) or purple pot, green pot actions: put one bowl/pot inside another, stack one bowl/pot on top of another	objects: red cylinder, yellow cylinder actions: putting one inside another, stacking objects: white bowl, decorated bowl actions: putting one inside another, stacking	objects: orange bowl, blue bowl, white bear (distractor) actions: putting one in another, stacking, other (off task)

pud	objects: short pink pool noodle, spatula (S1 only), or cylinder with open center, stick actions: rolling noodle/cylinder using spatula/stick, or inserting noodle/stick in center of noodle/cylinder	objects: white PVC tube, hammer actions: roll tube with hammer, insert hammer into center of tube objects: black spool, red spoon actions: roll spool with spoon, insert spoon into spool	objects: short pink pool noodle, spatula, toy pet carrier (distractor) actions: rolling, inserting or other (off task)