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Creature feature: Preschoolers use verbal descriptions to identify referents

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ABSTRACT

Representations formed on the basis of verbal descriptions may be fleeting and relatively weak or robust enough to support identification of referents. We investigated these two possibilities. Children (2.5- and 3.5-year-olds) were read verbal descriptions of unusual animals and were asked to choose the described animal from a pair of items. Sometimes the features (prototypical color and prototypical location) were distinctive (only present for the target), and sometimes one feature was present for both animals (both were yellow or on leaves). Both age groups were best able to identify the described animal when the features were distinctive, and 3.5-year-olds identified the target when both color was distinctive and a delay was inserted between the description and test.

Introduction

Using language as a source of new information is a critical achievement that supports the acquisition of knowledge across a variety of domains (Harris, 2002). For example, children's knowledge of science and religion may be built, in part, on the testimony of adults (e.g., Harris & Koenig, 2006). A more mundane example comes from everyday conversations with parents and others that involve references to absent, not previously seen, entities such as a new sibling or distant relatives. The ability

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to use language to form representations of absent things is likely a critical first step in children's ability to use testimony as the basis of new knowledge. That is, using language to form representations without the support of a visual model will enable the generation of new knowledge that is not accessible directly. The current research investigates an early form of this skill by probing the specificity of the representations preschoolers form on the basis of verbal descriptions.

Although there is relatively little research on the representations children form on the basis of verbal descriptions, research with adults suggests that object labels can elicit detailed representations of referents (e.g., Barsalou, 1999; Kaschak & Glenberg, 2000; Stanfield & Zwaan, 2001; Zwaan, Stanfield, & Yaxley, 2002). Adults use verbal information to locate described items and form representations of objects that include rich information about the referents even when such information is not explicitly provided. For example, adults represent the shape and orientation of mentioned objects; those who hear a description of "an eagle in the sky" respond more quickly and more accurately to a line drawing of an eagle with outstretched wings than to a drawing of an eagle standing with wings folded down (Zwaan et al., 2002), and those who hear a sentence such as "John put the pencil in the cup" are faster to respond to a depiction of a pencil that is placed vertically (Stanfield & Zwaan, 2001). These findings are consistent with the possibility that adults' representations of referent objects are relatively rich and include perceptual information about the orientation and shape of mentioned objects (see also Barsalou, 1999; Kaschak & Glenberg, 2000).

Far less is known about the content and quality of the representations children build based on verbal descriptions. Several lines of research suggest that the building blocks of this ability should be available to preschoolers. A set of necessary skills for forming representations based on verbal information likely includes the ability to use language to access stored representations (i.e., to understand words in the absence of visual input) and to manipulate or modify formed representations based on subsequent linguistic input (i.e., verbal updating). Research on infants' understanding of references to absent things and their updating of existing representations supports the claim that preschoolers have the requisite skills to use verbal descriptions to build representations (Galazka & Ganea, 2014; Ganea, 2005; Ganea & Harris, 2010, 2013; Ganea & Saylor, 2013b; Ganea, Shutts, Spelke, & DeLoache, 2007; Osina, Saylor, & Ganea, 2013, 2014; Saylor, 2004).

As infants near their first birthday, they use labels to access representations of absent things (e.g., Ganea, 2005; Ganea & Saylor, 2013b; Osina et al., 2013, 2014; Saylor, 2004). A typical procedure involves a researcher introducing an infant to an object (e.g., a stuffed dog) and talking about it using its name ("dog") while the referent is in full view. The object is then hidden and mentioned ("What about the dog?"). The researcher then measures whether the infant orients to the hiding location when prompted with the verbal label. In these studies, babies are not asked to build representations of referents based on language alone. Instead, they use a label as a retrieval cue to access a prior representation that was formed via experience with a visually available object.

Retrieving representations of mentioned absent objects sets the stage for using language to update existing representations based on new verbal information (Ganea & Harris, 2013). In one study, toddlers were taught a proper name (Lucy) for a stuffed frog (Ganea et al., 2007). While Lucy was left to sleep, children were taken into another room and were told that Lucy got wet. When they were subsequently asked to choose between a wet frog, a dry frog, and a wet pig, 22-month-olds selected the wet frog. Because the only information children could use about the change of state was offered verbally (with the referent out of sight), the findings suggest that 22-month-olds used verbal information to modify their existing representation of the described item (see also Galazka & Ganea, 2014; Ganea & Harris, 2010, 2013). Altogether, this work suggests that preschoolers should have access to a set of skills that are necessary for building representations based on language alone; they should be able to use language to manipulate representations and use labels to retrieve representations of referent objects.

Research on verb learning provides some evidence that toddlers also use verbally presented information to guide their search for possible referents (e.g., Arunachalam & Waxman, 2010; Yuan & Fisher, 2009). For example, in Arunachalam and Waxman's (2010) study, 27-month-olds used syntactic information offered with a novel verb in the absence of visual information to infer that the verb referred to a causative event. In particular, when children heard a novel verb offered in a transitive frame, "The boy is going to moop the lady," and were prompted to find "mooping," they subsequently looked longer at a causative event (i.e., a man spinning the woman in a chair) than at a non-causative event (i.e., a man and woman spinning their arms). This research clarifies that children can use language to build representations with sufficient fidelity to identify the type of event being mentioned (i.e., causative vs. not). However, it is not clear whether they use language to identify a specific referent (e.g., to distinguish between two different types of causative events). That is, it is not clear whether children's representations contain sufficient specific detail to help them distinguish referents that share some features but not others. We investigated the emergence of this skill in the current study.

Using a new paradigm, in Experiment 1, we first established that 3.5-year-old children use verbal descriptions to construct representations of entities they have never seen and that their representations contain sufficient detail to distinguish between a target and another similar referent. In Experiment 2, we investigated which of two features of objects (prototypical color vs. prototypical location) is most useful for children when differentiating between possible referents. In Experiment 3, we investigated the developmental scope of this ability by investigating emerging skills in a group of younger, 2.5-year-old children. In Experiment 4, we investigated how robust this ability is at 2.5 and 3.5 years of age. In particular, we asked whether the representations can tolerate a brief delay between the description and target identification and whether the representations can support identification of items that had not been described.

To investigate each of these questions, we read children verbal descriptions of an object to which they had *not* been preexposed and then asked whether they could use the verbally presented information to guide their identification for the referent when items were visually available. Importantly, the verbal descriptions were offered when pictures of the referents were unavailable. If children correctly identify the referent during comprehension probes, they must be using information offered in the description to guide their search and identification of the described item.

Experiment 1

In the first experiment, 3.5-year-old children were read six short descriptions of novel creatures. The descriptions contained three pieces of information about the animals and could include information about properties (e.g., body shape, prototypical location, prototypical color) or a category label (e.g., "bug"). These features were chosen because previous research on children's categorization of living kinds suggests that preschoolers might use these features to support inductive inference about familiar and novel animals (e.g., Gelman & Markman, 1986, 1987; Greif, Kemler Nelson, Keil, & Gutierrez, 2006; Kelemen, Widdowson, Posner, Brown, & Casler, 2003). A novel label was also used during the description. During the test phase, children were shown two pictures—target and distractor—and were prompted with the novel label to identify the thing that had been described. The target picture matched the description on all three dimensions. Across three between-participants conditions, the level of overlap between the target and distractor items was manipulated. In particular, the distractor item had no features, one feature, or two features that matched the description. If children use the verbal descriptions to form representations of referents, they should be less successful at identifying the referent as the overlap between the target and distractor items increased. Therefore, we predicted a linear decrease in accuracy as the overlap between the target and distractor items increased.

Method

Participants

Participants were 54 3.5-year-old children (M_{age} = 45 months, 30 boys and 24 girls). Children were recruited from a database of families interested in research participation. All participants were monolingual English speakers who were typically developing with intact hearing (based on parent reports). Data from 1 additional child were excluded for a response bias (she chose only items presented on the right side, even for well-known practice items).

Materials

Materials included pairs of color photos of four familiar items that were downloaded from the Internet (penguin–llama and horse–elephant). Children were always asked about the penguin (which appeared on the left) and horse (which appeared on the right). In addition, color photos of 24 unusual animals and insects were downloaded from the Internet using a Google image search. Across three conditions, the unusual animals were presented in pairs so that a target creature (which was described) was paired with an item that had no overlapping features, one overlapping feature, or two overlapping features. Mentioned features included a category label, body shape, color, and location. See Table 1 for a list of items and the verbal descriptors that were used across the three experimental conditions.

Procedure and design

Children were randomly assigned to one of three between-participant conditions: *all features distinct* (M_{age} = 45 months, n = 18, 10 boys), *one feature overlap* (M_{age} = 45 months, n = 18, 10 boys), and *two features overlap* (M_{age} = 45 months, n = 18, 10 boys). Except for the pairing of the pictures, the procedure was identical for the three conditions.

Children were seated at a table across from the researcher. Test items were presented in a book so that the researcher could flip a page to reveal the target and distractor items at the appropriate time. The two familiar items were used for practice at the beginning of the experiment. As with the test items, children were read a brief description of one of the items (e.g., "Penguins are birds. Penguins have a beak. Penguins have flippers to help them swim.") and were then asked to choose the item ("Show me the penguin.") when they were shown the pictures. All children who were included in the experiment chose the described creature for both practice items.

After this, children were read a description of an unusual creature that was referred to with a novel label. The descriptions were structured according to the following format. Children were first told what they were going to learn about (e.g., "Now we are going to learn about *Grimps.*"). They were then offered three features of the item (e.g., "Grimps live in the ocean. Grimps have a long body. Grimps are gray."). Next, the researcher said, "Now we are going to see a Grimp." Two pictures were revealed, and children were asked to select the item: "Show me the Grimp." This procedure was repeated for each of the six novel pairs. The left/right position of the target items and the presentation order of the items and features were counterbalanced.

Coding

Children were read six stories. Children received a score of 1 for choosing the target and a score of 0 for selecting the distractor, so scores could range from 0 to 6. Children's object selections were largely unambiguous; children chose one item or the other. Responses were coded online by the researcher, and another experimenter checked the videotapes after participation. All initial online coding was accurate.

Table 1
Target and distractor items used in Experiment 1.

Target picture (features highlighted in description) *Novel label*	Distractor items (overlapping feature)		
	No feature overlap	One feature overlap	Two features overlap
Dumbo octopus (gray, long body, in ocean) *Grimp*	Fairy armadillo (none)	Yellow angelfish (in ocean)	*Pikaia gracilens* (in ocean, long body)
Giraffe weevil (yellow spots, long nose, live on land) *Lannie*	Ajolote mexicano (none)	Sea slug (yellow spots)	Yellow-spotted fish (yellow spots, long nose)
Katydid (pink, long legs, likes to sit on leaves) *Teki*	Pangolin	Pink frogfish (pink)	Pink dragon millipede (pink, on rocks)
Pandora sphinx caterpillar (kind of bug, red and white spots, likes to climb on plants) *Pandora*	Green parrot (none)	Three-toed sloth (on plants)	Leaf-footed bug (bug, on plants)
Horned fish (kind of fish, yellow, two spikes on head that look like horns) *Bibo*	Golden lion tamarin (none)	Hispaniolan tree frog (yellow)	Grass rockfish (yellow, fish)
Cuttlefish (can be spikey, likes to be in sand, sea animal) *Cuttle*	Kiwi bird (none)	Purple frog (in sand)	Octopus (orange, sea animal)

Results

Children's responses to the described items were analyzed with a one-way analysis of variance (ANOVA) that included a planned weighted linear contrast. Condition was the between-participants factor. The overall ANOVA produced a marginal effect, $F(2, 51) = 2.42$, $p = .099$, $\eta_p^2 = .087$. However, as predicted, the linear trend was significant, $F(1, 51) = 4.84$, $p = .03$. Children were less likely to select the target object as the number of overlapping features increased across conditions. This pattern was driven primarily by a difference between children's responding in the all features distinct condition ($M = 4.56$ out of 6, $SD = 0.92$) and the two features overlap condition ($M = 3.72$, $SD = 1.56$), $t(31) = 2.20$, $p = .03$.

Tests against chance revealed that children were above chance in their selections of the target in the all features distinct condition ($M = 4.56$ out of 6, $SD = 0.92$) and the one feature overlap condition ($M = 4.11$, $SD = 0.76$), $ts(17) \geqslant 6.22$, $ps \leqslant .001$. Children's responding was only marginally different from chance in the two features overlap condition ($M = 3.72$, $SD = 1.56$), $t(17) = 1.96$, $p = .07$.

Discussion

Experiment 1 provides suggestive evidence that children use information offered in verbal descriptions to form a representation of a described creature. They were able to subsequently identify the referent when prompted. Their ability to identify the referent was related to the level of overlap between the target and distractor items. However, we were not able to test which features children were using to settle on the referent. Because the main goal of Experiment 1 was to determine whether overlap between features mattered, the features that overlapped between the target and distractor items varied across conditions.

In the next experiment, we asked what features of living things 3.5-year-old children rely on when identifying previously described items. We focused on two features that may be diagnostic of living kinds: what they look like (i.e., prototypical color) and where they can be found (i.e., prototypical location). Although there have been relatively few studies that include measures of preschoolers' understanding of where animals are typically found, there is some evidence that early during the preschool period children view prototypical location as an important feature of biological kinds. For example, they make predictions about animal habitats based on functional features (e.g., webbed feet) of animals (Kelemen et al., 2003), and they are more likely to ask about niche or location when faced with novel animals versus novel artifacts (Greif et al., 2006).

In the case of color, previous research provides a conflicting picture of whether children might reliably use color as a diagnostic feature. In describing this conflict, we draw on research examining both linguistic representations and non-linguistic object representations because success at our task may involve both types of representations. On the one hand, research on children's online language comprehension demonstrates that 3-year-olds use the prototypical color (e.g., pink) of referent objects (e.g., pig) to guide their attention when the referents are absent (see Huettig, 2013, for a review of relevant work). As one example, Johnson and Huettig (2011) asked 3-year-olds to "find the pig" when two non-pig objects were available. One of the objects was in a color typically associated with pigs (e.g., a pink car), and the other was in a different color (e.g., a blue car). Their findings suggest that children used the prototypical color of the referent object to guide their attention by looking more at the pink car than at the blue car. A second experiment suggested that children may focus attention on the pink car not because they had accessed the label *pink* but rather because they had accessed a representation of *pig* that included its prototypical color as a visual feature (Johnson, McQueen, & Huettig, 2011). In this second experiment, toddlers who participated did not yet understand color terms, so the only way they could succeed by looking more toward the pink truck than toward the blue truck was by activating a representation of the referent (when prompted to look for a pig).

In contrast to these studies suggesting that preschool children might use information about prototypical object colors to guide their attention, research from other areas suggests that color may be a relatively weak cue to object identity. First, in research on object individuation and categorization with infants, a common result is that babies find color to be a relatively less salient feature than object location and shape (e.g., Wilcox, 1999; Wilcox & Chapa, 2004; Wilcox, Woods, Chapa, & McCurry, 2007; Xu, 1999; Xu, Carey, & Quint, 2004). In many of these studies, infants view events in which objects disappear and reappear from behind an occluder. Their looking behavior is measured to determine whether they compute one or two objects moving behind the screen. During their first year, infants are more likely to use shape over size and color to individuate objects moving behind the screen (see Xu, 2007, for a review of relevant studies). A second piece of evidence for the possibility that color may be a less useful cue is that in search tasks with toddlers and preschoolers, object color is vulnerable to decay when children must combine information about object color with other features to succeed at search tasks (e.g., in feature conjunction tasks) (Dessalegn & Landau, 2008; Hermer & Spelke, 1994, 1996; Nardini et al., 2008). Altogether, this research suggests that information about object color might not be privileged relative to other object features.

Given that previous research provides a somewhat mixed picture of the relative utility of color in children's object representations, a critical question guiding Experiment 2 was whether children use prototypical color or prototypical location when they are asked resolve a conflict. One difference between color and location as it applies to living kinds is that prototypical color is a feature that is in some sense an internal or intrinsic feature of the object, whereas prototypical location is an external or extrinsic feature of the referent. One possibility is that if children are building an image of the referent in their mind, they may construct the image from the inside out, thereby privileging those features that are part of the object over those features that exist externally to the referent. This claim is consistent with research on adults' feature binding in visual working memory, which suggests that intrinsic features of objects (i.e., color) are retrieved from memory automatically, whereas extrinsic features (in this case the background against which an object appears) are not (Ecker, Maybery, & Zimmer, 2013; Ecker, Zimmer, & Groh-Bordin, 2007). A central claim from this work is that there is a qualitative difference in the manner in which intrinsic versus extrinsic object features are represented (Ecker et al., 2007). In addition, children's use of color in Johnson and colleagues' (2011) study is consistent with this account because children appear to use color as a part of their representation of the referent (rather than relying on the lexical term for the color separately). If this is how children build representations of referents, they may rely on prototypical color over prototypical location. On the other hand, research on non-language object representations suggests that color would be among the first features to be lost if children are put in the position of considering multiple object features simultaneously. This would mean that information about prototypical location would be privileged over information about prototypical color.

To investigate preschoolers' use of prototypical color versus prototypical location, we used a procedure that was identical to the first experiment except that only color and location were included in the verbal descriptions. Across conditions, the target and distractor either had no overlapping features, had location as an overlapping feature (both items appeared on leaves), or had color as an overlapping feature (both items were red). In this experiment, we tested whether preschool children rely on color or location when they are asked to identify a previously described item.

Experiment 2

Method

Participants

Participants were 36 3.5-year-old children (M_{age} = 45 months, 20 boys and 16 girls). Participants were recruited as in Experiment 1, and all were typically developing and full-term at birth, with normal hearing, and from English-speaking families.

Materials, design, and procedure

Children were randomly assigned to one of three between-participants conditions: *all features distinct* (M_{age} = 44 months, n = 12, 6 boys), *location distinct* (M_{age} = 45 months, n = 12, 7 boys), or *color distinct* (M_{age} = 45 months, n = 12, 7 boys). As in Experiment 1, pictures of familiar animals were used as practice items at the beginning of the experiment. We also included additional familiar items. These familiar items appeared every two pairs of unusual animals. The familiar pictures were downloaded from the Internet using a Google image search and included the following pairs (the item that was asked about is listed first): giraffe–peacock, horse–elephant, whale–dog, dolphin–flamingo, starfish–tiger, and penguin–llama. As with Experiment 1, a brief description of the target was read first, and then children were prompted to select the described item. The pairs of familiar items were always presented in the order listed above. The left/right position of the target for the familiar pairs alternated across items. All children who participated chose the correct item for the familiar pictures, with the exception of 1 child who initially chose the dog and flamingo but subsequently corrected his response.

A total of 12 pictures of unusual animals were used in this experiment. Of these 12 pictures, 11 were selected from the set used in Experiment 1. One of the pictures (of the grass rockfish) was modified so that the fish was changed from yellow to brown (so that it could be a color match for a different item). The 1 additional item was selected using a Google image search. The *same* pictures were used in each of the three conditions, but the way they were paired differed. Across the conditions, the pictures were paired such that in the all features distinct condition both location and color were distinct between the target and the distractor, in the color distinct condition color was distinct and location was the same (e.g., both animals on leaves), and in the location distinct condition only location was distinct and color was the same (e.g., both animals were yellow). The same novel labels were used, but they were sometimes paired with different animals than in Experiment 1. In addition to color and location, we also included a general feature that was not perceptually available but could apply to either the target or the distractor (e.g., is rare, eats all day, hides at night) to ensure that the stories were interesting for our preschool participants.

To give one concrete example, when the Pandora Sphinx caterpillar (red and in a bush) was a target in the all features distinct condition, children were told that Grimps are red (color), are found in bushes (location), and are rare (general feature), and then they were shown pictures of a Pandora Sphinx caterpillar (red and in a bush, target) and a yellow spotted fish in water (not red and not in a bush, distractor). In the color distinct condition, children were offered the same verbal description but were shown a picture of the Sphinx caterpillar in a bush (target) and a gray leaf bug (not red but in a bush). In the location distinct condition, children were told the same information but then were shown the Sphinx caterpillar (target) and a sea slug in water (red but not in a bush). Importantly, in contrast to Experiment 1, each of the animals served as the target and as the distractor equally often across children. To accomplish this, the stories mentioned different features depending on which animal was the target. The position (left/right) of the target, the order that the information was offered in the stories (color, location, and general), and the order of items were counterbalanced. Coding was conducted as in Experiment 1.

Results

Children's responses to the described items across the three conditions were analyzed with a one-way ANOVA. The analysis revealed a significant main effect of condition, $F(1, 34) = 4.31$, $p = .02$, $\eta^2_p = .20$. Planned comparisons revealed that children were more likely to select the target in the all features distinct condition ($M = 4.92$, $SD = 1.08$) than in the location distinct condition ($M = 3.67$, $SD = 1.23$), $t(22) = 2.77$, $p = .009$. Children were also more likely to choose the target in the color distinct condition ($M = 4.58$, $SD = 1.00$) than in the location distinct condition, $t(22) = 2.03$, $p = .05$. See Fig. 1.

Tests against chance revealed that children's selection of the target was significantly greater than chance in the all features distinct and color distinct conditions, $ts(11) \geqslant 5.51$, $ps < .001$. Children's selection of the target item was only marginally different from chance in the location distinct condition, $t(11) = 3.67$, $p = .09$.

Discussion

Altogether, these findings indicate that children relied on prototypical color offered in verbal descriptions. When location was shared across items, children were able to use color to identify the described item. In contrast, when color was shared across items, children were not able to use location information to help them settle on the described item. These results are consistent with the possibility

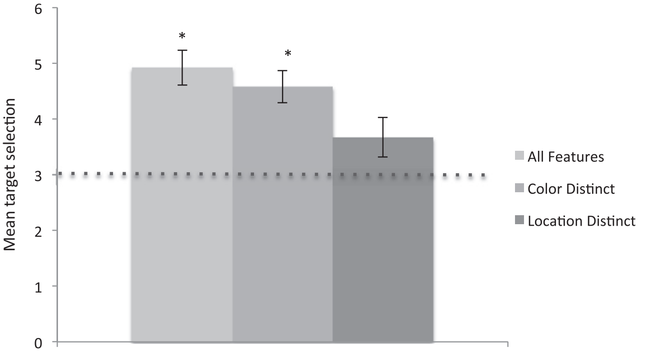

Fig. 1. Mean target selection in Experiment 2 (3.5-year-olds). Error bars represent standard errors. Asterisk (*) indicates that responding was different from chance at $p < .05$. Dotted line indicates chance-level performance.

that 3-year-olds include the prototypical color of novel creatures as part of their representation. As children build their representations of novel creatures based on verbal descriptions, they may construct images of the referents and privilege those features that are a part of the described things over those associated features that exist externally to the referents. Children were best able to use the information when there were no overlapping features across the target and distractor or when color information remained distinctive (even if location was shared).

In the next experiment, we addressed the developmental scope of this ability in a younger group of children. We focused on 2.5-year-olds because their understanding of language may support the use of verbally presented information to identify referents. As one example, research by Ganea and colleagues revealed that although children as young as 19 months can update representations of objects on the basis of language (Galazka & Ganea, 2014; Ganea et al., 2007), this ability is not robust until 2.5 years of age (Ganea & Harris, 2010, 2013). In Ganea's work, children at 2.5 years use language offered in the absence of a recently seen referent to update their existing representation and to guide their search for it after a brief delay. This suggests that 2.5-year-olds in the current investigation may have the basic set of language and representational skills to succeed at our task. In particular, 2.5-year-olds may be capable of building representations based on language alone that support their identification of referents.

However, there is reason to believe that children at 2.5 years of age may show limits in their ability to use verbally presented information to form representations of novel entities. Previous research on children's ability to form and access memories points to a developmental change in children's reliance on language. In particular, Hayne and colleagues (e.g., Simcock & Hayne, 2003; see Hayne, 2004, for a review of relevant work) found that children's ability to encode and access memories in a verbal form increases across the preschool period. In addition, they found that children consistently perform better on nonverbal than verbal tests of memory across the early preschool period. Altogether, these findings suggest that early during the preschool period, children's ability to access memories in a nonverbal form may be more robust. This raises the possibility that 2.5-year-olds in the current study may show limits in their ability to access relevant information from memory (novel creature's color and location) when presented with verbal descriptions.

In pilot work, we tested a group of 2.5-year-old children ($n = 12$) in the all features distinct condition from Experiment 2. They were not able to select the described item at above-chance levels ($M = 2.83$ out of 6). As a result of this weak performance in the condition that was the most straightforward for our older age group, we modified our procedure and stimuli to make it easier for the younger participants. First, we chose different pairs of familiar items for practice and as filler items because several of our pilot work participants were not able to identify the giraffe, starfish, or dolphin. Next, we used fewer colors in the hope that a more limited set of colors would increase the chance that our participants would understand the color words we used. We did this because several parents in our pilot sample reported that their children did not know all of the color terms we used. We also shortened the procedure by including fewer items: four pairs of described items (rather than six) and four familiar pairs (rather than six). For each of these, we also simplified the language in the descriptions by shortening the sentences and mentioning only color and location (in Experiment 2 we included a filler sentence with a general property, e.g., "Grimps are rare."). We also included a color posttest to assess children's knowledge of the color terms used in the experiment.

With these changes in place, we were able to investigate whether 2.5-year-old children use verbal descriptions to identify referents. Children were tested in a revised all features distinct, color distinct, or location distinct condition.

Experiment 3

Method

Participants

Participants were 39 2.5-year-old children (M_{age} = 33 months, 22 boys and 17 girls). Participants were recruited as in previous experiments, and all were typically developing and full-term at birth, with normal hearing, and from English-speaking families. One additional child participated but was not included because he refused to answer questions about which colors he knew.

Materials, procedure, and design

To simplify the procedure for 2.5-year-old children, we chose a different set of familiar items: frog–bird, cat–dog, horse–pig, and cow–bear. The first item listed was the item children were asked about. Four out of six pairs of unusual animals were selected from the pool used in Experiment 2. Pictures of unusual animals were chosen so that a smaller set of colors were used: yellow, red, orange, and pink. Stories were also shortened such that only color and location were mentioned. For example, in the description of a Grimp, the general feature (Grimps are rare) was left out and children only heard that Grimps are red and live in bushes. At the end of the experiment, children's color term knowledge was tested. For the color test, the four target colors (yellow, red, orange, and pink) were paired such that each color served as the target and the distractor once. Children were asked to point at the mentioned color.

The procedure, design, and coding were the same as in Experiment 2. Children were randomly assigned to one of three between-participants conditions so that ages were equivalent across conditions: *all features distinct* (M_{age} = 34 months, n = 13, 8 boys), *color distinct* (M_{age} = 33 months, n = 13, 7 boys), and *location distinct* (M_{age} = 33 months, n = 13, 8 boys).

Results

Before moving to children's responding to the described animals, we report children's responding to the familiar items and color posttest. Children were highly accurate in their selection of the familiar items, and there were no differences across the three conditions. Children's selection of the familiar items was above chance in the all features distinct condition (M = 3.92 out of 4, SD = 0.28), the location distinct condition (M = 3.92, SD = 0.28), and the color distinct condition (M = 3.76, SD = 0.44), $ts(12) \geqslant 14.55$, $ps < .001$. Children were also very accurate in their selection of colors on the color posttest. There were no differences across conditions, and children's selection of the mentioned color was above chance in the all features distinct condition (M = 3.69, SD = 0.63), the location distinct condition (M = 3.61, SD = 0.96), and the color distinct condition (M = 3.76, SD = 0.60), $ts(12) \geqslant 6.06$, $ps < .001$.

To analyze children's responses to described items, a one-way ANOVA was conducted. The ANOVA revealed a significant main effect of condition, $F(2, 36) = 4.94$, $p = .013$, $\eta_p^2 = .20$. Planned comparisons revealed that children were more likely to select the target item in the all features distinct condition (M = 3.31 out of 4, SD = 0.85) than in either the color distinct condition (M = 2.23, SD = 1.01) or the location distinct condition (M = 2.39, SD = 0.96), $ts(24) \geqslant 2.49$, $ps \leqslant .018$. There were no differences in responding in the color distinct and location distinct conditions. See Fig. 2.

One-sample *t*-tests revealed that children's responding was greater than chance in the *a*ll features distinct condition, $t(12) = 5.52$, $p < .001$. Children's responding did not differ from chance in either of the other two experimental conditions.

Discussion

These findings indicate that 2.5-year-old children are also able to use verbal descriptions to identify described animals as long as the available items are not confusable on any dimension. In contrast to 3.5-year-olds, younger children were unable to tolerate overlap of *either* color or location. Even though they are clearly able to form representations based on verbal descriptions, these results are consistent with the possibility that 2.5-year-olds' ability to form and access verbal memories may be less robust than that of older children (as in Simcock & Hayne, 2003). To test this possibility directly, in the next experiment we investigated differences in 2.5- and 3.5-year-olds' ability to use verbal descriptions to identify referents. In doing so, we probed the durability of representations of the described referents by testing children in a more challenging task. Using the revised all features distinct condition from Experiment 3, we tested whether children's representations are robust enough to tolerate a delay and to use the newly acquired information to make an inference about a creature that had not been described.

Testing whether children can hold the information in mind over a brief delay when tasked with identifying the referent will provide information about the durability of representations formed based on verbal information. We predicted that older children would outperform younger children on this task because previous work demonstrates age-related increases in children's ability to rely on language to access stored memories (e.g., Hayne, 2004; Simcock & Hayne, 2003). The contrast task requires children to select a creature other than the one described in a story. This test will clarify whether children can use their newly formed representation to make an inference. Children will need to mentally manipulate a newly formed representation and inhibit it to select a picture that does not match the description. Our claim is that children's representation will need to be relatively robust to enable them to perform such mental operations.

The type of contrast where children need to use an existing representation of a familiar object to make an inference about something new has been used widely in research on children's word learning (e.g., Carey & Bartlett, 1978; Gelman & Markman, 1985; Hollich et al., 2000; Rice, Buhr, & Nemeth, 1990). As one example, when presented with a familiar object and an unfamiliar object, even 2-year-olds can map a novel label to the unfamiliar object (e.g., via mutual exclusivity; Markman, Wasow, & Hansen, 2003). In our contrast task, instead of relying on their prior knowledge of words, children need to rely on a verbal description of a novel animal and later make an inference about another novel animal that was not described. Therefore, our prediction was that younger children

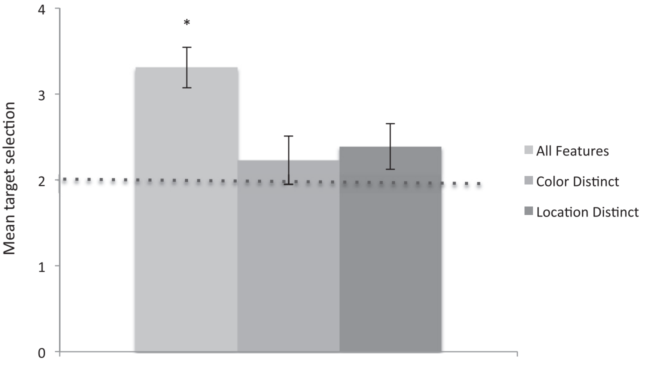

Fig. 2. Mean target selection in Experiment 3 (2.5-year-olds). Error bars represent standard errors. Asterisk (*) indicates that responding was different from chance at $p < .05$. Dotted line indicates chance-level performance.

would not be able to cope with this task as well as older children because they are less able to form durable representations from verbal information (which includes not only feature information but also information about a creature's name).

Experiment 4

Method

Participants

Participants were 54 children: 28 2.5-year-olds (M_{age} = 33 months, 15 boys and 13 girls) and 26 3.5-year-olds (M_{age} = 44 months, 12 boys and 14 girls). An additional 7 children participated, but their data were not included because of refusal to answer the color comprehension questions (1 2.5-year-old), non-compliance (1 2.5-year-old and 1 3.5-year-old), experimenter error (1 2.5-year-old), and inability to complete the experiment (3 2.5-year-olds).

Materials, procedure, design, and coding

The materials used were the same set used in the all features distinct condition from Experiment 3. Children were randomly assigned to either the *delay* condition (M_{age} for 2.5-year-olds = 33 months, 10 boys, n = 14; M_{age} for 3.5-year-olds = 44 months, 5 boys, n = 12) or the *contrast* condition (M_{age} for 2.5-year-olds = 33 months, 5 boys, n = 14; M_{age} for 3.5-year-olds = 44 months, 7 boys, n = 14).

The procedure in the delay condition was identical to that in the all features distinct condition from Experiment 3 with the following exception: A 9- 10-s delay was inserted after the researcher read the description for the unusual animals. This delay length is more than sufficient to lead to decay of language-based memory representations in preschoolers. In tests of the quality of phonological representations, for example, degradation is seen when children are asked to repeat back strings of digits or nonwords immediately after hearing the information (e.g., Adams & Gathercole, 1995; Gathercole, Willis, Baddeley, & Emslie, 1994). During the delay, the experimenter maintained eye contact with children, nodded her head, and said, "yeah" or "uh huh." Children mostly repeated the researcher's actions and verbalizations.

The contrast condition was identical to the all features distinct condition from Experiment 3 except that, after the description for the unusual animal was read, the researcher told children they would see the described animal (e.g., *Teki*) and another animal (e.g., "Now we're going to see a Teki and a *Modi.*"). Children were subsequently asked to select the Modi.

Coding was conducted as in the previous experiments.

Results

Before examining children's selection of the described animals, we first discuss their responding to the familiar items and color posttest. Both 2.5- and 3.5-year-olds were highly accurate in their selection of the familiar items. Responding across age and condition did not differ for the familiar items. Responding for both age groups in the delay condition (M for 2.5-year-olds = 3.71, SD = 1.07; M for 3.5-year-olds = 3.92, SD = 0.29) and the contrast condition (M for 2.5-year-olds = 3.92, SD = 0.27; M for 3.5-year-olds = 4.00, SD = 0.00) was greater than chance, $ts \geqslant 6.00$, $ps \leqslant .001$.

Children were also highly accurate for the selection of the named color on the color posttest. The 3.5-year-olds were at ceiling in both conditions (Ms = 4.00 out of 4.00). Because older children's responding was at ceiling, we did not compare responding across age groups. Younger children (2.5-year-olds) were highly accurate, and their responding was greater than chance in both the delay condition (M = 3.21, SD = 1.19) and the contrast condition (M = 3.64, SD = 0.84), $ts(13) \geqslant 3.21$, $ps \leqslant .002$. Their responding did not differ across conditions.

To analyze children's selection of the described items, a 2 (Age Group: 2.5-year-olds vs. 3.5-year-olds) × 2 (Condition: contrast vs. delay) ANOVA was conducted. The analysis revealed a main effect of condition, $F(1, 50) = 7.23$, $p = .01$, $\eta_p^2 = .13$, and a significant Age × Condition interaction, $F(1, 50) = 5.11$, $p = .03$, $\eta_p^2 = .09$. The age effect was only marginal, $F(1, 50) = 3.36$, $p = .07$, $\eta_p^2 = .06$. An analysis of simple effects examining the age effect within each condition separately revealed a significant difference in responding in the delay condition, with 3.5-year-olds ($M = 3.58$, $SD = 0.79$) selecting the described item more frequently than 2.5-year-olds ($M = 2.21$, $SD = 1.12$), $t(24) = 2.84$, $p = .007$. There was no difference in responding in the contrast condition for 3.5-year-olds ($M = 1.93$, $SD = 1.59$) and 2.5-year-olds ($M = 2.07$, $SD = 1.21$). Only 3.5-year-olds in the delay condition selected the target at above-chance levels, $t(11) = 6.92$, $p < .001$. In all other conditions, children's responding was at chance. See Fig. 3.

Discussion

The findings from this experiment reveal that only older children were able to tolerate a delay between a description and their identification of a referent. These findings are consistent with the prediction that children's ability to use and form verbal memories increases with age. However, older children's ability to use the verbal information to make an inference about a novel creature that was not described was limited in a way that looked quite similar to the younger children. In particular, neither group of children could use the description to make an inference about a second novel creature. This latter finding suggests that 3-year-old's ability to use information offered in the context of a description as the basis of an inference about new information may still be emerging.

However, one important caveat is that the test of contrast we used in the current experiment was a difficult implicit contrast procedure in which the two labels were not explicitly contrasted with each other (e.g., by saying "a Modi NOT a Teki"). It is possible that children might have been able to use one label to guide inferences about another label if explicit contrast had been provided. Examining the circumstances that support children's acquisition and use of labels provided in the context of verbal description is a worthy focus of study for future investigations.

General discussion

The results of the current studies provide important new information about preschoolers' ability to use verbal descriptions to guide their identification of referents. By 2.5 years of age, children were able to use verbal descriptions of unusual animals to identify referents. They were subsequently able to identify the referent in a pair of items if the two items did not share any features. By 3.5 years of age, children were able to identify the referent if one feature was shared (provided that the feature was not the color of the items) and were also able to tolerate a delay between a verbal description and their identification of the referent. In contrast, the younger children's skills seemed more limited in several ways; they were able to identify the referent only if there was no overlap between features in target and distractor items and only if the verbal description came immediately before the identification task.

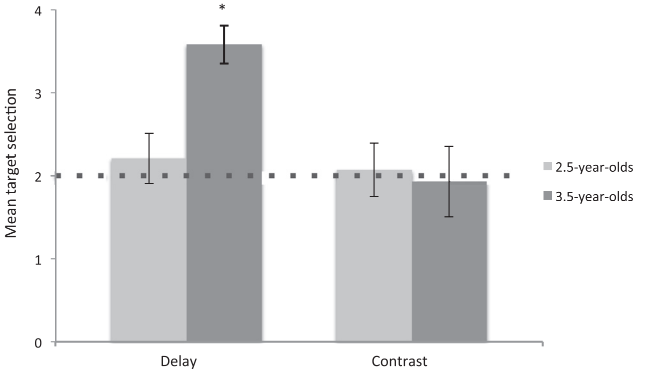

Fig. 3. Mean target selection in Experiment 4 by condition and age group. Error bars represent standard errors. Asterisk (*) indicates that responding was different from chance at $p < .05$. Dotted line indicates chance-level performance.

The developmental differences we observed are consistent with the possibility that nascent representation skills limit children's ability to use language as the basis of new knowledge (e.g., Ganea & Saylor, 2013a). The proposal is based on arguments from a graded representation account—that representations of referent objects will be stronger with more experience or contact with the objects in question (Shinskey & Munakata, 2005, 2010). Because these representations are more established, retrieval and maintenance processes are also more practiced and, thus, more efficient. As infants and children age, their representations become more robust, enabling more efficient and accurate use of representations in the service of language comprehension (see, e.g., Galazka & Ganea, 2014). Applied to the current study, preschoolers' ability to form representations of unusual entities improved with age. In contrast to younger children, older children were able to tolerate potential confusability between referents and could identify an item after a brief delay. Both of these skills require maintaining a newly formed representation in memory to guide inferences about the referent. It seems possible that older children's more robust representation skills enabled their success.

An alternative explanation for this developmental change concerns the nature of children's memory representations. In particular, this result is also consistent with research on children's encoding of and access to early verbal and nonverbal memories. For example, Hayne and colleagues have demonstrated that across the early preschool period children's ability to encode and access memories in a verbal form increases (Simcock & Hayne, 2003). One intriguing implication of this result is that during the early preschool period children may encode knowledge in a nonverbal form and, therefore, have difficulty in accessing and reporting memories using language. One way to investigate how this applies to children's learning from descriptions would be to present children with images of features of novel animals (e.g., a swatch of yellow fabric, a photo of water) versus offering them verbal information about the features (as we did in the current study). This would enable a test of whether younger children's representations of novel creatures might be more durable when information is presented in a nonverbal versus verbal format.

Regardless, the current findings clearly demonstrate that under some circumstances both age groups of children were able to use information offered in a verbal format to construct representations of absent things. In addition, the results of Experiment 2 provide information about the types of features children make the best use of. Previous research on children's use of color versus other types of object features provided a somewhat mixed picture of whether color would function as a diagnostic cue to object identity. On the one hand, research from children's online language comprehension suggested that even 2.5-year-olds use the prototypical color of referents to guide their attention when named referents are absent (e.g., Johnson & Huettig, 2011; Johnson et al., 2011). On the other hand, research on children's individuation and categorization of objects (Wilcox, 1999; Wilcox & Chapa, 2004; Wilcox et al., 2007; Xu, 1999; Xu et al., 2004) and their use of color in feature conjunction tasks (Dessalegn & Landau, 2008; Hermer & Spelke, 1994, 1996) suggested that color would function as a relatively weak cue to object identity. Our findings from 3.5-year-olds are more consistent with the first line of work because they were most affected by feature overlap when prototypical color, rather than prototypical location, was shared across the test items. One intriguing possibility is that as children constructed representations of the described animals, they privileged features that existed as part of the referent over those that existed external to the animal. This may have been the result of constraints on the manner in which object representations are formed. Object internal features may be privileged obligatorily (e.g., Ecker et al., 2007, 2013). However, it is also possible that children in the age range we sampled simply do not view prototypical location as central to an animal's identity (possibly because they do not yet understand concepts related to habitat and ecological niche). It will be important to examine these possibilities more fully in future work by investigating children's perception of and beliefs about intrinsic and extrinsic object features.

One additional reason why older children may have relied more on prototypical color than on prototypical location concerns the meaning-based representations of the verbal labels used to name color versus location. In particular, it could be that the impression of the described object they formed based on verbal information alone included a more useful representation of color (relative to location) because they had a more precise understanding of color terms used. This may have arisen from greater variability in how referents of the location terms are represented compared with how color terms are represented. The privileged status of color information would make discounting distractor items that shared the color used in the description more difficult than discounting items that shared the more variably represented location information. This would occur if children's representation of color was a better match for the depicted referents than their representation of location. If prior exposure leads to precise versus variable representations of named object features, one could manipulate children's exposure to prototypical color versus prototypical location to directly test this possibility.

One of the findings of the current research is that children use verbal labels referring to color and location to construct representations of novel creatures and to guide their identification of referent objects. This finding complements results from the online language comprehension studies (e.g., Johnson & Huettig, 2011; Johnson et al., 2011; Mani, Johnson, McQueen, & Huettig, 2013). Recall that in these studies children are prompted with an object label (e.g., frog, strawberry) and are presented with test items that match the referent's prototypical color. These previous studies used familiar well-known referent objects, and in one study children even succeeded at the task in the absence of any knowledge of color labels (i.e., Johnson et al., 2011). Using familiar well-known items was necessary for Johnson and colleagues' (2011) task because they could not measure online comprehension of labels if participants did not know the object labels. Children may succeed at these tasks by using pre-existing associations between named referents and their prototypical colors. Our research clarifies that children also use new verbal information in the form of a novel label and a verbal description to guide their identification of referents.

Previous research suggests that adults go beyond the information offered in the context of verbal descriptions to represent unmentioned object features, including the shape and orientation of referents (Stanfield & Zwaan, 2001; Zwaan et al., 2002). In one study, adults were read the following sentence: "He hammered the nail into the wall." After reading the sentence, they were faster and more accurate at identifying a nail oriented horizontally versus vertically, even though the orientation of the nail was not mentioned explicitly (Stanfield & Zwaan, 2001). This and similar findings have been seen as evidence that adults have relatively rich representations of referents that include information about shape, orientation, and even the relative distance of referent objects (Borghi, Glenberg, & Kaschak, 2004; Huettig & Altmann, 2007, 2011; Yee & Sedivy, 2006). At this point, we do not know whether children's meaning-based representations include rich information about features of referents in a way that is similar to those of adults. In particular, it is not clear whether children's representations of the described animals in the current study would support inferences about associated but unmentioned features. It is possible that children succeeded at our task by relying on an image or a verbal list that included the set of the described features, with some information being privileged (e.g., color for older children) but no additional information about other unmentioned but associated features (e.g., fins or scales for creatures living in the water).

The current study provides information about young children's ability to use verbal descriptions as the basis of new knowledge. The findings suggest that preschoolers are able to use verbal information about new entities to form a mental representation of what the entity might look like. This ability may lay the foundation for reasoning about abstract and hypothetical entities—which are described but rarely seen. The ability to reason about unobservable entities may also eventually support scientific reasoning in the form of theory building and hypothesis testing (e.g., Klahr & Dunbar, 1988; Schauble, 1996). Preschoolers' ability to use verbal descriptions to form representations of new referents may be a building block of this important skill.

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