Is a Pink Cow Still a Cow? Individual Differences in Toddlers' Vocabulary Knowledge and Lexical Representations

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Abstract

When a toddler knows a word, what does she actually know? Many categories have multiple relevant properties; for example, shape *and* color are relevant to membership in the category BANANA. How do toddlers prioritize these properties when recognizing familiar words, and are there systematic differences among children? In this study, toddlers viewed pairs of objects associated with prototypical colors. On some trials, objects were typically colored (e.g., Holstein cow and pink pig); on other trials, colors were switched (e.g., pink cow and Holstein-patterned pig). On each trial, toddlers were directed to find a target object. Overall, recognition was disrupted when colors were switched, as measured by eye movements. Moreover, individual differences in vocabularies predicted recognition differences: Toddlers who say fewer shape-based words were more disrupted by color switches. "Knowing" a word may not mean the same thing for all toddlers; different toddlers prioritize different facets of familiar objects in their lexical representations.

Keywords: Language development; Object recognition; Individual differences; Lexical representation; Vocabulary

1. Introduction

A central function of language is that it allows us to use words to communicate meaning to one another. However, it is unclear whether two people ever have identical interpretations of any given word. Do words have fixed meanings, or do our individual experiences shape our lexical representations? Consider the following exchange between

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Humpty Dumpty and Alice from Lewis Carroll's "Through the Looking Glass" (1993, p. 124):

"When *I* use a word," Humpty Dumpty said, in rather a scornful tone, "it means just what I choose it to mean—neither more nor less."

"The question is," said Alice, "whether you *can* make words mean so many different things."

Although our interpretations of word meanings may not vary as wildly as Humpty proposes, there may be predictable variability among individuals.

One likely place to observe differences in interpretation of word meanings is in early word knowledge. For example, most 24-month olds "know" the word COFFEE (Dale & Fenson, 1996)—that is, they use the word in a manner recognized as contextually appropriate by adults. However, given that most 24-month-olds presumably have little direct experience concerning its temperature or taste, it seems quite likely that toddlers do not mean the same thing as adults when they say COFFEE. This raises a question critical to our understanding of early language acquisition and the nature of lexical knowledge more generally: When a toddler knows a word, what does she actually know?

Just as all extant theories of language development presumably would agree that there is considerable convergence across speakers' understanding of words' meanings—how else could we communicate with each other?—they would arguably similarly predict that previous experience and knowledge should relate to differences in lexical representation of a given item. However, to the best of our knowledge, no theories have considered whether differences in knowledge might drive *systematic* differences in lexical representation across items.

In support of this idea is the fact that children's recognition of words is facilitated by presenting objects on a familiar or typical background (Meints, Plunkett, Harris, & Dimmock, 2004; Vlach & Sandhofer, 2011), or priming with typical contexts (Wojcik, Lew-Williams, & Saffran, 2014). Although these findings suggest children may prioritize information that adults tend not to, it is still unclear how children might differ from each other in their prioritization of properties. Thus, in the current paper, we pose a novel question: Do children differ in their interpretations of familiar words, in systematic and predictable ways?

1.1. Word-learning biases

To know a word, one must not only recall an individual label-referent association, but also generalize it to new instances (e.g., CUP refers to both mom's ceramic cup and dad's plastic cup). Importantly, to generalize a label-referent association, a toddler must learn which properties are relevant to category membership (for CUP, shape trumps material). With more experience, toddlers become biased to prioritize some properties over others, helping them recognize and generalize new words. For example, when toddlers know

many words within a domain (e.g., vehicles), they are quicker to recognize new words in that domain (Borovsky, Ellis, Evans, & Elman, in press). Furthermore, regularities across domains lead them to acquire general word-learning biases, like the shape bias: the tendency to prioritize shape when generalizing novel names to novel objects (e.g., Landau, Smith, & Jones, 1988). Because shape is critical to membership in many object categories (Samuelson & Smith, 1999), being able to represent an object using only a sparse shape caricature is important for visual object recognition (Biederman, 1995). This skill, which develops around 18–24 months, has previously been linked to language development (Borgström, von Torkildsen, & Lindgren, 2015; Pereira & Smith, 2009; Smith, 2003) and the acquisition of the shape bias (Yee, Jones, & Smith, 2012).

Additionally, toddlers give words different construals depending on the syntactic context in which they encounter them. For example, adjectives are often associated with properties such as color or texture and nouns with shape or overall similarity. Thus, toddlers learn to generalize novel words presented in adjectival syntax ("the daxy one") to novel objects that share color or texture, but novel words presented in count syntax ("a dax") to novel objects that share shape or overall similarity (Booth & Waxman, 2003; Waxman & Booth, 2001).

Taken together, these data suggest vocabulary regularities influence children's property prioritization. Knowledge about the structure of their language's vocabulary and about the structures within which words occur jointly influence interpretation of novel words and recognition of highly familiar objects.

1.2. Individual differences in word-learning biases

Given that experience with words and their contexts affects property prioritization, it is not surprising that there are individual differences in the biases learners bring to novel noun generalization tasks. For example, children classified as early-talkers develop different biases from those classified as late-talkers (Colunga & Sims, 2011, 2012; Jones & Smith, 2005). Additionally, word-learning biases are influenced by the structure of the toddler's native language (Smith, Colunga, & Yoshida, 2003). Even within a single language, differences in vocabulary structure relate to differences in toddlers' word-learning biases. For example, toddlers who say more names for categories organized by similarity in material (e.g., *ice*, *chalk*) are more likely to show a material bias than toddlers who say fewer material-based names (Perry & Samuelson, 2011). Thus, the specific regularities that characterize individual toddlers' vocabularies influence the properties they prioritize in novel noun generalization.

1.3. When shape is not all that matters

How far-reaching are these effects of vocabulary knowledge? It remains unclear whether differences in native-language vocabulary knowledge lead to differences in toddlers' interpretations of familiar objects' meanings—many of which have multiple relevant properties to learn. For example, shape *and* color are relevant to membership in the

category BANANA. It is one thing to be biased to prioritize shape in the moment of an ambiguous generalization task, but it is quite another to prioritize one property over others in service of recognition when multiple properties are relevant to category membership. Can vocabulary knowledge influence how toddlers prioritize the properties of bananas and other objects defined by multiple dimensions?

Research suggests that toddlers do encode properties other than shape, such as color; 24-month-olds preferentially look at a color-matched item when asked to find an absent referent associated with a prototypical color (e.g., when asked to find a strawberry, toddlers look more to a red airplane than a yellow airplane; Johnson, McQueen, & Huettig, 2011). Thus, while toddlers often prioritize shape, they do encode other relevant object properties. However, it remains unclear how toddlers prioritize the multiple category-relevant properties of familiar objects when they are pitted against each other in the recognition process, and whether vocabulary knowledge affects prioritization of these properties—questions critical to understanding toddlers' lexical representations and what it is that they know when they "know" a word. For example, toddlers whose vocabularies are dominated by shape (e.g., with a preponderance of shape-based noun categories) may show more reliance on shape when recognizing words than toddlers whose vocabularies are less dominated by shape. To address this question, it is necessary to examine recognition in the context of objects where shape and another feature (here, color) are both potentially central aspects of word knowledge.

1.4. Rationale for the current research

The current research was designed to address two questions: (1) Do toddlers differ in the properties they prioritize—shape, color, or both—when recognizing objects for which both shape and color are identifying properties, and (2) are differences predicted by the structure of toddlers' extant vocabulary knowledge? For example, does knowing the names of many categories for which shape is important (e.g., *cup*, *ball*) lead a toddler to prioritize shape over color when recognizing objects (controlling for overall noun vocabulary size)? To address these questions, we presented toddlers with pairs of familiar objects associated with prototypical colors and assessed the speed and accuracy with which participants fixated the target object after hearing its name. Crucially, we manipulated the colors of the objects across trials. On Color Typical trials, object pairs were displayed in their typical colors (e.g., a Holstein cow and pink pig). On Color Switch trials, the colors of the objects were swapped (e.g., a pink cow and Holstein-patterned pig). For these trials, the target word (e.g., cow) matched the target picture (pink cow) in shape but not color, and the distractor picture (Holstein-patterned pig) in color but not shape.

The question of interest was whether toddlers' looking behavior after hearing the target noun was affected by the color switch, as indexed by a comparison between Color Typical and Color Switch trials. In order to assess individual differences in looking behavior and vocabulary, we tested 21-month-olds. This age group is old enough to know many names for food and animal categories for which color and shape are both important (Dale & Fenson, 1996; Samuelson & Smith, 1999), but young enough that there is sufficient

variability in vocabulary knowledge to detect individual differences (Perry & Samuelson, 2011). To this end, we also assessed vocabularies via parental report and measured the size and structure of their noun vocabularies (degree of organization by shape).

We predicted toddlers who knew many shape-based nouns would prioritize shape in their lexical representations. For these toddlers, unusual colors should be less likely to impact word recognition. However, we expected toddlers who knew fewer shape-based nouns would be less likely to prioritize shape information in their lexical categories. If this is the case, then these toddlers should be especially disrupted by unusual colors when recognizing the referents of familiar words. Importantly, our predictions pertained to this specific dimension of toddlers' vocabularies, not their overall noun vocabulary size.

2. Method

2.1. Participants

Forty-five 21-month-old toddlers participated (23 female; M = 21 months, 1 day, range = 19 months, 28 days to 22 months, 21 days). Data from 18 additional toddlers were excluded (1 for equipment error, 1 for parent interference, 8 for fussiness, and 8 for not contributing enough useable data—see coding and analysis section for exclusion criteria).[1] Participants were recruited from a database of interested families and received a toy or $10 as a thank-you gift.

2.2. Stimuli

Line drawings of 12 familiar animals and foods that each had a prototypical color were used as stimuli (see Table 1 for complete list). Shape is arguably more diagnostic than color for adults' understanding of these stimuli. Members of many of these categories *could* have colors other than the one we used (e.g., an unripe green banana). To ensure that our materials had prototypical colors, 21 adults participated in a stimulus norming study in which they saw the name of each stimulus and listed its color (or colors in the case of multi-colored patterns). Participants were quite consistent in the colors they named. For 11 of the 12 stimuli, at least 75% listed the color(s) we defined as prototypical

Table 1
Object pairs used for each trial type

Color Typical Stimuli	Color Switch Stimuli
Pink pig; Holstein cow	Holstein pig; pink cow
Tan lion; gray elephant	Gray lion; tan elephant
Red strawberry; green peas	Green strawberry; red peas
Brown monkey; yellow duck	Yellow monkey; brown duck
Green frog; black and white zebra	Black and white frog; green zebra
Yellow banana; purple grapes	Purple banana; yellow grapes

Table 2
Proportion of adult participants listing the prototypical color(s) when asked what color(s) of each item

Stimulus	Typical Color (Used in Experiment)	Proportion Listing (%)
Cow	Black and white	81
Pig	Light pink	100
Lion	Golden brown	100
Elephant	Gray	100
Strawberry	Red	100
Peas	Green	100
Monkey	Brown	86
Duck	Yellow	29
Frog	Green	95
Zebra	Black and white	100
Banana	Yellow	100
Grapes	Purple	76

Note. that although few participants listed "yellow" for the word duck, 95% of participants in a separate study listed yellow when shown a black and white version of the rubber ducky drawing we used as the duck stimulus and asked what color it should be.

(for 7 of the 12 stimuli, 100% listed the same color; see Table 2).[2] Thus, colors appear to be consistently linked to adults' representations of these items.

Stimuli were presented in yoked pairs drawn from the same superordinate-level category (animals with animals and food with food). For each participant, half of the trials consisted of typically colored objects (*Color Typical trials*; e.g., yellow banana and purple grapes) and half had their colors switched (*Color Switch trials*; e.g., pink cow and Holstein pattern pig). Examples of Color Typical and Color Switch stimuli are depicted in Fig. 1. The assignment of object pairs to trial types (Color Typical vs. Color Switch) was counterbalanced across participants.

2.3. Procedure

Toddlers were seated on a caregiver's lap in front of a 50″ wall-mounted LCD screen in a sound-attenuated booth with draped black walls; the caregiver wore blacked-out glasses. Toddlers saw drawings of two familiar objects on the screen (e.g., a cow and a pig) and heard infant-directed speech describing one object (e.g., *Where's the pig?*) followed by 1 s of silence, an attention-getting phrase (e.g., *Can you see it?*), and another 1s of silence. The target word (e.g., *pig*) occurred 2 s into each trial. Each trial lasted 6 s. A camera below the screen recorded toddlers' eye movements. Participants completed two test blocks. Each block consisted of two trials for each stimulus pair—one trial where each item was the target (12 trials in total per block). Left/right position of targets and distractors were counterbalanced across trials. Each stimulus appeared an equal number of times on the left and right. Stimuli were presented in one of the two pseudo-random orders, counterbalanced across participants. Both orders began with a Color Typical trial to acclimate toddlers to the task using typical items.

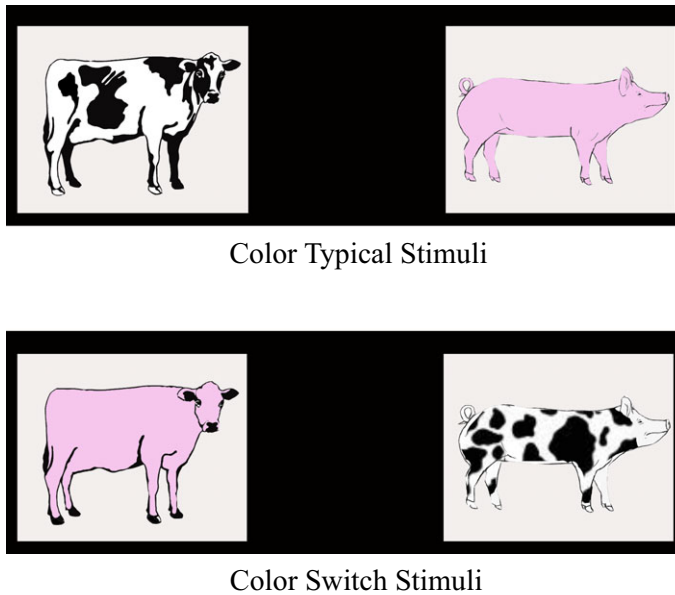Color Typical Stimuli

Color Switch Stimuli

Fig. 1. Examples of stimuli pairs used for each trial type.

Productive vocabulary was measured via parent report on the MCDI words and sentences form (Fenson et al., 1994). All target words are listed on the MCDI; we also measured comprehension of target words via parent report.

2.4. Coding and analysis

Eye movements were coded offline frame by frame (Fernald, Zangl, Portillo, & Marchman, 2008). To inspect participants' looking after hearing the target word, a critical time window was defined as 300–1,800 ms after target word onset; this window was chosen based on other studies with this age group (Fernald et al., 2008; Wojcik & Saffran, 2013). Individual trials were excluded if participants were looking away from the screen for over 500 ms, and participants were excluded if they had fewer than 6 of 12 usable trials of each trial type per blocks.

Each word in a participant's vocabulary was coded in terms of category organization based on established adult ratings (originally reported in Samuelson & Smith, 1999; Perry & Samuelson, 2011; Horst & Twomey, 2013). Category organization refers to whether a given category is organized by similarity in shape, material, or color. In other words, a category is organized by the property most important for category membership. Because only three object categories in the MCDI are organized by similarity in color, but not shape or material (i.e., carrots, pickle, and pumpkin; Samuelson & Smith, 1999), we did not include a color vocabulary predictor in our analyses and instead only included a shape vocabulary predictor. We did not include a material vocabulary predictor in our

analyses because the visual stimuli only differed in shape and color (they were two-dimensional drawings).

3. Results

Overall, toddlers were very accurate in fixating the target picture (see Fig. 2). As can be seen in the figure, toddlers were generally more accurate on Color Typical than Color Switch trials. We used growth curve analyses to examine the effect of trial type on looking (Mirman, 2014). We modeled the overall time course of target fixations with a second-order (quadratic) orthogonal polynomial and fixed effects of trial type (Color Typical vs. Color Switch) on all time terms. For models that include orthogonal polynomials, the intercept represents the average curve height, that is, the mean accuracy or proportion looking to the target, across the time window. Because mean accuracy is the statistic traditionally used in an ANOVA with this type of data (Bion, Borovsky, & Fernald, 2013), the effects of the intercept term are equivalent to the results of the traditional ANOVA. The current model also included time terms that represent more nuanced characteristics of
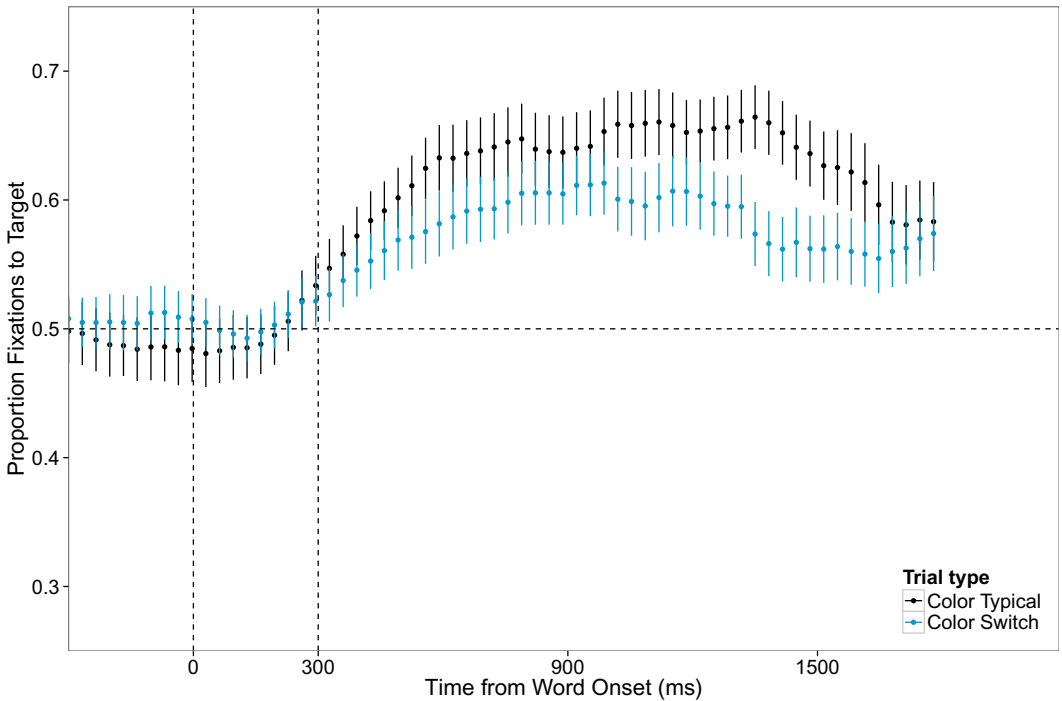

Fig. 2. Mean proportion of looking to the target after the word onset. Error bars represent standard error of the mean. The horizontal dotted line represents .5, or chance looking between the two images. The solid vertical lines indicate the period from the onset of word until the beginning of the critical time window used in the analysis.

looking across the critical window. Our analyses included random effects of participant on all time terms. To determine the best-fit model, we used chi-square tests comparing models with and without the factor of interest.

Model comparison revealed a significant effect of trial type on the intercept term, $b = .04$, 95% CI = (.03,.05); $\chi^2(1) = 122.14$, $p < .001$, indicating lower overall target fixation proportions for the Color Switch trials relative to the Color Typical trials. This result can be interpreted similarly to a main effect of trial type on accuracy in an ANOVA. Model comparison revealed no significant interaction between trial type (Color Typical vs. Color Switch) and the time terms, $\chi^2(1) = 1.60$, $p > .250$, indicating no differences in slope between the Color Typical and Color Switch trial curves. This result indicates that children's changes in looking behavior across the critical window were similar for both trial types. Thus, as a group, toddlers were more accurate in looking to the target on Color Typical than Color Switch trials. The presence of the wrong color impaired recognition, suggesting that, in addition to shape, color is also an integral aspect of early lexical representations, at least for these words.

3.1. Vocabulary structure

Our second question pertained to individual differences: Did all toddlers show an advantage for Color Typical over Color Switch trials, or are there meaningful differences in relative accuracy for the trial types related to vocabulary knowledge? As previous studies have demonstrated a relationship between generalization and vocabulary structure above and beyond vocabulary size (Perry, Axelsson, & Horst, 2015; Perry & Samuelson, 2011), we examined the effect of vocabulary structure on children's property prioritization. (We report the details of an analysis of vocabulary size in the supplementary materials.) Here we want to know—regardless of noun vocabulary size—whether the *particular* nouns a child knows relate to looking behavior on the different trial types. For example, if two children each know 10 nouns, and all 10 of Child 1's nouns name shape-based categories, but only 5 of Child 2's nouns do, we would expect Child 1 to prioritize shape information more than Child 2 would. Child 1 should be relatively unaffected by color switches—to her, a cow-shape represents a cow, no matter its color.

We examined vocabulary structure by calculating a measure of shape-based nouns controlling for noun vocabulary size (a measure previously used in Perry & Samuelson, 2011; Perry et al., 2015). According to adult judgments (see Samuelson & Smith, 1999), shape-based nouns name categories of solid objects organized by similarity in shape (e.g., ball), categories organized by shape that use count noun syntax (e.g., sweater), and categories for solid objects that use count syntax (e.g., camera). Because the MCDI is dominated by shape-based words, there is a correlation between noun vocabulary size (as measured by the MCDI) and the number of shape words in a child's vocabulary ($r = .99$ in our sample). To obtain a measure of each toddler's noun vocabulary structure independent of their noun vocabulary size, we regressed out the total number of object nouns each toddler produced from the shape-based nouns they produced. The correlation between this measure of shape-based nouns and children's noun vocabulary size was $r = .02$.

As can be seen in Fig. 3, toddlers who produced fewer shape-based nouns were less likely to look at the target picture on Color Switch than Color Typical trials. In contrast, toddlers who produced more shape-based nouns had a similar proportion of looks to the target regardless of trial type. We added this vocabulary measure to our growth curve analysis to examine how differences in vocabulary knowledge contribute to differences in looking patterns for these two conditions. Model comparison revealed a significant interaction between vocabulary structure and trial type, $b = -.24$, 95% CI = $(-.31, -.16)$; $\chi^2(1) = 36.72$, $p < .001$: the magnitude of the effect of shape vocabulary on accuracy was stronger on Color Switch trials ($b = .22$) than on Color Typical trials ($b = -.01$). This pattern of results suggests that individual differences in vocabulary were not predictive of accuracy on Color Typical trials but were predictive on Color Switch trials. Importantly, it was not the case that toddlers with larger shape vocabularies were overall more accurate at the task (regardless of trial type) relative to toddlers with smaller shape vocabularies. Model comparison revealed no main effect of vocabulary structure on overall looking, $\chi^2(1) = .68$, $p > .250$.

Together, these results suggest that vocabulary structure on its own does not predict ability to recognize familiar objects. If this were true, then toddlers with smaller shape
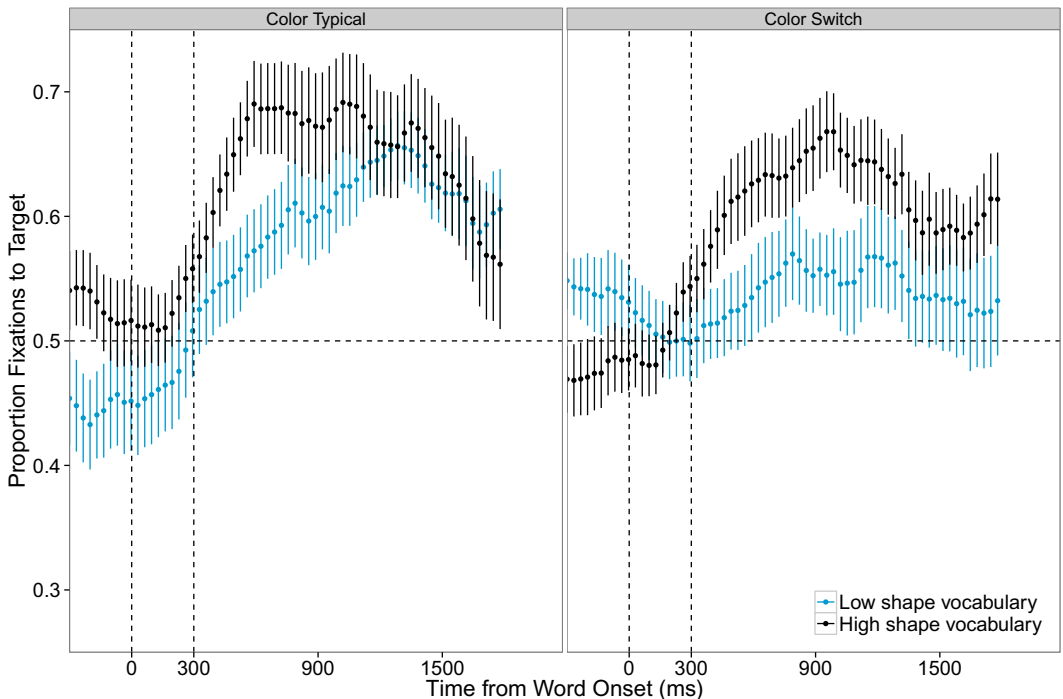

Fig. 3. Mean proportion of looking to the target after the word onset for each trial type. Toddlers are grouped based on a median split in shape-based nouns in productive vocabulary (statistical analyses are based on continuous data). Error bars represent standard error of the mean.

vocabularies would be impaired in recognizing *all objects*, regardless of trial type. Instead, we observed an interaction between vocabulary structure and trial type, suggesting that toddlers with smaller shape vocabularies were only impaired in recognizing objects whose colors had been switched. Toddlers with larger shape vocabularies were not affected by a change in the color of the target object. Crucially, these effects were obtained after controlling for the overall number of nouns in children's vocabularies, suggesting it was differences in vocabulary structure, rather than size, that led children to prioritize properties differently.

4. General discussion

This study explored (a) how toddlers prioritize color and shape in their online recognition of objects that have *both* prototypical colors and shapes, and (b) whether there are systematic differences between toddlers in their prioritization of properties related to vocabulary knowledge. We found toddlers were more accurate in recognition when objects' colors were typical than when they were switched. More important, differences in word recognition related to differences in vocabulary structure (even after controlling for vocabulary size): Participants who knew many shape-based nouns more accurately looked to the target regardless of whether the objects' colors were typical or switched. This finding suggests that these toddlers prioritized shape in their lexical representations. On the other hand, participants who knew fewer shape-based nouns were less accurate in looking to the target when colors were switched than when they were typical, suggesting they need both shape and color information to recognize the objects.

Previous research suggests toddlers' vocabulary knowledge influences their ability to recognize and generalize new words (Borovsky et al., in press; Perry & Samuelson, 2011). Our findings add significant new insights into the nature of lexical representation by showing vocabulary structure influences how toddlers resolve competing cues to word identity, systematically, across multiple words. Additionally, we move beyond previous work by showing that vocabulary knowledge influences not only the properties children attend to during novel noun generalization—a measure of their online similarity comparison—but also influence how they represent individual words over a longer timescale. Toddlers' word learning is not typically characterized by one-shot "fast-mapping" (Horst & Samuelson, 2008), but rather they learn to associate a word and referent over an extended slow-mapping process (McMurray, Horst, & Samuelson, 2012). Although biases demonstrated in novel noun generalization are certainly relevant for learning words over a longer timescale (cf. Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002), it is important to examine the influence of vocabulary on *both* the online similarity comparison of novel noun generalization and recognizing a word from memory. Thus, this study was necessary for understanding the effects vocabulary knowledge has on children's learning and behavior.

However, the causal directionality between vocabulary and behavior remains unclear—did intrinsic differences between toddlers' initial prioritizations of properties cause them

to more readily learn some words than others, or did idiosyncratic differences in the words toddlers happened to learn first lead to differences in their subsequent interpretations of meaning? A growing body of work suggests that vocabulary regularities *drive* attentional biases, rather than the reverse (Perry, Samuelson, Malloy, & Schiffer, 2010; Samuelson, 2002; Smith et al., 2002). Nevertheless, a direction for future research will be to explore the causality between vocabulary knowledge and property prioritization.

An additional unanswered question is how lexical representations change over developmental time with the acquisition of new vocabulary. Just as children's reliance on background in object recognition decreases as they gain experience (Vlach & Sandhofer, 2011)—suggesting lexical representations change to prioritize objects over backgrounds—children's lexical representations may change to prioritize some properties over others as they learn more about specific types of words. If children's vocabulary leads them to prioritize shape at one time, do they continue to prioritize shape even after learning, for example, that color was also relevant from some of those lexical representations? In our paper we take a critical first step toward assessing how vocabulary acquisition might change existing lexical representations by establishing that vocabulary knowledge at one point in development relates to lexical representations at that same particular point in development.

4.1. Integral versus separable features

Another remaining question is whether toddlers with smaller shape-based vocabularies looked less to the target on Color Switch trials because (a) the presence of the wrong color interfered with recognition of the familiar shape, (b) the correct color was not present on the familiar shape to contribute to recognition, or because (c) the presence of the correct color on the distractor object drew their attention away from the target. Given that participants were not significantly worse than chance on Color Switch trials, it is not the case that they were impaired because they were totally drawn to the correct color (e.g., that toddlers fixated the pink cow when they heard "pig" because they prioritize color over shape). Instead, toddlers with smaller shape-based vocabularies might be torn between the two objects as each shared a feature (shape or color) with their lexical representation.

Regardless of whether recognition is impaired by incorrect color information or lack of correct color information, our results suggest toddlers with fewer shape-based words require *both* correct shape and color information to recognize these words. Perhaps, then, color and shape information are not initially separable in children's lexical representations. Indeed, there is considerable evidence that young children have difficulty separating dimensions of similarity when they classify objects, instead perceiving properties as integral wholes (e.g., Smith & Kemler, 1977). Toddlers cannot selectively attend to a single property in category learning or similarity comparison. Learning words for which only one property is relevant (e.g., shape) arguably trains children to selectively attend to that property and to prioritize it in their representations (cf Perry & Samuelson, 2013; Smith et al., 2002). Future research will be needed to examine the extent to which properties

are, in fact, integral in toddlers' initial lexical representations and whether incorrect color or lack of correct color information is responsible for disrupting recognition.

4.2. Specificity of properties

One caveat for interpreting the results of our research is that we only focused on shape and color. For now, our conclusions are limited to these particular properties and lexical categories. It is unclear whether children who know fewer shape-based nouns would prioritize all properties equally, or whether they specifically are prioritizing color information. We selected shape and color for our study because (a) shape has been established to be highly relevant for visual object recognition, (b) children know many words for categories associated with prototypical shapes and colors, and (c) color is a particularly easy property to manipulate in static two-dimensional drawings (unlike material or size). Thus, another direction for further research will be to investigate other categories and properties; for example, utilizing different stimuli that would make it feasible to pit shape against a feature other than color. A related caveat is that in our study, stimuli were all animals or food. In some novel noun generalization studies, children have shown a stronger shape bias when objects are given an artifact construal than when they are given an animate construal (Booth, Waxman, & Huang, 2005). An interesting issue for exploration will be to see how children vary in the properties they prioritize in recognizing other categories, including artifacts.

4.3. Conclusions

When a toddler knows a word, what does she actually know? As researchers, we take it for granted that when the parents of two different toddlers check off a word as "known" on a vocabulary inventory, the toddlers must know the same thing. Contrary to these assumptions, toddlers clearly vary in what they know about even highly familiar words. Our results demonstrate that regularities in toddlers' vocabulary structure influence the properties they prioritize in object recognition, and possibly what they "know" about familiar objects. Thus, at least early in language development, words do not have fixed meanings across individuals. Rather, words vary slightly in meaning from person to person, because our unique experiences and knowledge work together to create word meanings.

Notes

1. Children whose data were excluded did not differ from those who were included in terms of overall noun vocabulary size, $t = -0.23$, $p = .82$, nor in the proportion of words they knew in naming shape categories, $t = -0.15$, $p = .88$.
2. The only stimulus for which the participants did not tend to agree with our prototypical color was duck. The duck that we used for the study was a line drawing of a rubber ducky that would be most familiar to toddlers. Rubber ducks are prototypically yellow, but real ducks are not. In a follow-up norming study, we presented an additional 20 adults with a black and white version of the duck drawing we used in our study and asked what color it should be; 95% said it was yellow.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:

Data S1. Effects of vocabulary size on word recognition.