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Generic language use reveals domain differences in young children's expectations about animal and artifact categories

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ABSTRACT

The goal of the present study was to explore domain differences in young children's expectations about the structure of animal and artifact categories. We examined 5-year-olds' and adults' use of category-referring generic noun phrases (e.g., "Birds fly") about novel animals and artifacts. The same stimuli served as both animals and artifacts; thus, stimuli were perceptually identical across domains, and domain was indicated exclusively by language. Results revealed systematic domain differences: children and adults produced more generic utterances when items were described as animals than artifacts. Because the stimuli were novel and lacking perceptual cues to domain, these findings must be attributed to higher-order expectations about animal and artifact categories. Overall, results indicate that by age 5, children are able to make knowledge-based domain distinctions between animals and artifacts that may be rooted in beliefs about the coherence and homogeneity of categories within these domains.

Cognitive processes differ substantially as a function of ontological type. Knowing whether something is an animal or a human-made artifact has important implications for how we categorize it, how we interact with it, and our expectations for its behavior. In this paper, we explore how young children represent categories within the animal and artifact domains. Specifically, by analyzing their production of category-referring generic noun phrases (e.g., "Frogs eat bugs"), we aim to shed light on domain differences in young children's expectations about the coherence and homogeneity of animal and artifact categories.

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A large body of research has demonstrated that there are important differences in how children think about animals and artifacts, beginning in infancy (see Opfer & Gelman, 2010; Rakison & Poulin-Dubois, 2001 for reviews). By preschool age, children display extensive domain-specific knowledge. They view animals as created by nature whereas they recognize that humans are involved in the creation of artifacts (Bloom, 1996; Gelman & Bloom, 2000; Gelman & Kremer, 1991). Preschoolers make domain-specific judgments about category immutability, believing that animals retain their identity across transformations whereas the identity of artifacts can change due to external transformations or changes in use (Keil, 1989). Finally, preschoolers infer that animals have different kinds of insides (Gottfried & Gelman, 2005; Simons & Keil, 1995), are capable of different causal processes (e.g., self-generated movement; Gelman, Durgin, & Kaufman, 1995; spontaneous growth; Rosengren, Gelman, Kalish, & McCormick, 1991; healing; Backscheider, Shatz, & Gelman, 1993), and are subject to different causal mechanisms (e.g., tiredness, hunger; Hatano & Inagaki, 1994) than are artifacts. Thus, data confirm that preschoolers use different causal frameworks to reason about animals and artifacts. Less is known, however, about the extent to which young children's domain knowledge reflects principled, theory-laden distinctions.

One important, principled way in which categories within the animal and artifact domains differ is in coherence and within-category similarity. Categories of naturally occurring objects, including basic-level animal categories, are generally tightly structured, coherent, and share many similarities (e.g., rabbits have similar internal parts, external structure, behaviors). In contrast, basic-level categories of human-made artifacts are typically more loosely structured, less homogeneous, and share fewer important features (e.g., chairs vary in their shape, color, what they are made of). Awareness of how categories vary on these dimensions plays an important role in promoting or constraining the kinds of inductive inferences one makes when learning new information about a category member. Given that much of human reasoning involves making category-based inferences that extend beyond the available evidence, when children are aware of how categories differ in their coherence and homogeneity is an important developmental question.

Existing work indicates that by second grade, children's representations of animal and artifact categories reflect an awareness that domains differ in coherence and homogeneity. Gelman and colleagues found that when generalizing novel information about familiar basic-level categories (e.g., this rabbit/chair has an X inside), adults and second graders appropriately drew many more inferences within animal categories than within artifact categories (Gelman, 1988; Gelman & O'Reilly, 1988). Preschoolers, however, did not show this domain effect: unlike older children and adults, they judged animal and artifact categories as equally inductively rich (Gelman, 1988; Gelman & O'Reilly, 1988). These data suggest that across development children may become increasingly aware of how animal and artifact categories differ in their coherence and homogeneity.

Nonetheless, there is some evidence to suggest that younger children, too, are aware of these principled ways in which animal and artifact categories differ. One indirect form of support comes from research examining when young children represent categories as real and objective vs. invented and subjective. Adults believe that animal categories mark true, objective distinctions that exist in the world (e.g., cows vs. horses), whereas they believe that artifact categories mark subjective, flexible distinctions dependent on convention (e.g., bowls vs. plates; Kalish, 1998; Malt, 1990; Rhodes & Gelman, 2009a). Adults likewise view membership in animal categories as absolute, whereas they view membership in artifact categories as graded (e.g., an animal either does or does not fall in the category "mammal", but a belt can partially belong to the category "clothing;" Diesendruck & Gelman, 1999; Estes, 2003, 2004; Kalish, 1995). Importantly for the present discussion, kindergartners also represent animal but not artifact categories as natural kinds. For example, Rhodes and Gelman (2009a) showed that 5-year-olds construe artifact categories as more subjective and conventionalized than animal categories: children judged conventional animal categories as objectively correct ways of organizing the world, whereas they judged conventional artifact categories as among several acceptable options. Five-year-olds also readily endorsed partial category membership for atypical members of artifact categories (e.g., a headband as "sort of" a piece of clothing) but denied it for atypical members of animal categories (e.g., an ostrich as "sort of" a bird; Rhodes & Gelman, 2009b). Thus, collectively, these studies provide initial evidence for principled, theory-laden domain distinctions in young children.

To examine more specifically whether children possess domain-specific beliefs about category coherence and homogeneity, in the present work we turn to evidence from studies examining how children talk about animals and artifacts and, in particular, the frequency with which they use category-referring *generic noun phrases* (hereafter, *generics*). Generics, such as "Frogs eat bugs" and "Knives are sharp," make claims about kinds (e.g., frogs as a category) rather than individuals (e.g., your pet frog, the frogs at the zoo) and express generalizations about shared properties of category members (Carlson, 1977; Carlson & Pelletier, 1995; Leslie, 2008). Generics appear frequently in natural speech, including conversation with young children (Gelman, Goetz, Sarnecka, & Flukes, 2008), and have been hypothesized to play a central role in human reasoning (Gelman, 2003; Prasada, 2000).

A growing body of research has demonstrated that children grasp the meaning and implications of generics from early in life. Children hear generics on a regular basis in natural conversation (Gelman et al., 2008), they spontaneously produce generics by at least 2 to 2½ years of age (Gelman et al., 2008; Pappas & Gelman, 1998), and children appropriately distinguish generic from nongeneric utterances during the preschool years (Brandone, Cimpian, Leslie, & Gelman, 2012; Gelman & Raman, 2003; Hollander, Gelman, & Star, 2002).

Of particular interest here are the unique semantics of generic statements. Generics refer to a category as a whole and convey information about properties that are widely shared by category members. Research confirms that people interpret generics as having especially powerful prevalence implications. For example, when given a generic statement about a novel animal kind (e.g., "Lorches have purple feathers") and asked to estimate the percentage of category members that display the target feature (e.g., "What percentage of lorches have purple feathers?"), adults interpreted the property as applying to nearly all category members—generating prevalence estimates in the range of 95% (Cimpian, Brandone, & Gelman, 2010; Gelman, Star, & Flukes, 2002). Young children also interpret generics as referring broadly—implying a scope that is more than "some", but less than "all" (Chambers, Graham, & Turner, 2008; Gelman et al., 2002; Hollander et al., 2002). Recent data suggest that hearing categories described using generic language may even play a causal role in conclusions children and adults draw regarding the coherence of those categories. For example, Gelman, Ware, and Kleinberg (2010) found that hearing a novel animal category ("Zarpies") described using generic language (e.g., "Zarpies love to eat tulips"; "Zarpies hop over puddles") led preschoolers to later assume that a new property attributed to a single "Zarpie" would extend to the category as a whole. The same effect of generic language has been found for novel social categories (Rhodes, Leslie, & Tworek, 2012).

As these findings suggest, there is consistent support for the relation between generic language and category homogeneity. Generics are uniquely suited to talking about categories that are tightly structured, coherent, and homogeneous. This leads to the following prediction: if animal categories are viewed as more coherent and inductively rich than artifact categories, they should elicit more generic language.

Existing research confirms that both children and adults consistently produce generics more for animals than artifacts (Gelman, Coley, Rosengren, Hartman, & Pappas, 1998; Gelman et al., 2008; Goldin-Meadow, Gelman, & Mylander, 2005). For example, in a study of naturalistic conversation, 2–4-year-olds used generics to refer to animals more than twice as often as they used them to refer to artifacts (Gelman et al., 2008; see also Goldin-Meadow et al., 2005). Importantly, these domain differences in generic use also generalize beyond discussions of familiar items (for which children may have differing amounts of generic knowledge) to conversations about novel stimuli. Brandone and Gelman (2009) presented preschoolers and adults with pictures of novel animals and artifacts regarding which they had no prior knowledge. Each item was labeled and the participant was asked to talk about it. Adults and children produced significantly more generics for novel animals than for novel artifacts. This was the case both when stimuli were real, yet unfamiliar items (controlled for familiarity and prior knowledge) and when they were matched pairs of maximally similar novel items (controlled for familiarity, prior knowledge, complexity, and number of features). Taken together, these findings suggest that children may in fact share adults' view of animal categories as more coherent and inductively rich than artifact categories.

However, further research is needed to address an alternative account of children's domain-specific pattern of generic language use. In particular, domain differences in children's generic use may be a product of prior associations between perceptual cues to domain and language input. Infants and young children are skilled at learning statistical regularities present in input (Saffran, Aslin, & Newport, 1996; Xu & Tennenbaum, 2007). Moreover, cues to domain are readily available in the perceptual world (e.g., animals typically have eyes, faces, and curvilinear contours whereas artifacts do not), and even infants can use these features to distinguish animals from artifacts (e.g., Rakison & Poulin-Dubois, 2001). Thus, by correlating regularities in the input language with regularities in the perceptual world, children could learn a rule relating domain to generic use. For example, children could learn that things with eyes are more commonly described using bare plural generic nouns (e.g., rabbits) than are things without eyes. Because perceptual cues to domain (e.g., eyes vs. no eyes) were available in Brandone and Gelman's (2009) stimuli, this simple rule could be sufficient to explain their pattern of results.

In the present study, we aimed to further probe the nature of young children's expectations regarding animal vs. artifact categories. Following Brandone and Gelman (2009), we presented 5-year-olds and adults with pictures of novel animal and artifact stimuli and invited them to talk about the pictures to a naïve listener. To help tease apart the role of perceptual properties and conceptual information in children's responses, we followed the strategy used by Booth and Waxman in research examining the role of perceptual and conceptual information in word learning (Booth & Waxman, 2002; Booth, Waxman, & Huang, 2005): We held constant the perceptual properties of the stimuli while manipulating their conceptual status as animals or artifacts. Stimuli were stripped of all perceptual cues to domain and the same ambiguous stimuli served as both animal and artifact items. Information regarding domain was presented to children linguistically via labeling the item's ontological category (e.g., "This is an animal called a dax").

We reasoned that if young children share adults' view of animal categories as more coherent and homogeneous than artifact categories, they should produce more generics when the stimuli are described as animals than when they are described as artifacts. Moreover, we predicted that even in the absence of perceptual cues to domain, the knowledge and expectations captured by the superordinate category label "animal" should be enough to trigger these domain differences. In contrast, if young children do not yet possess domain-specific expectations about the coherence and homogeneity of animal and artifact categories, or if their generic language use is driven by perceptual features of the stimuli, children should produce an equivalent number of generics regardless of whether the stimuli are described as animals or artifacts.

1. Method

1.1. Participants

Eighteen children ranging from 54.0 to 66.0 months of age (M = 60.10 months, SD = 3.57 months; nine males, nine females) and 16 adults (eight males, eight females) participated. Two additional children were tested and excluded from the final sample, one because of an inability to focus on the task and another because he did not provide any interpretable utterances. Participants were predominantly European-American and from middle-income homes. Children were recruited from local preschools. Adults were undergraduates recruited from an Introduction to Psychology participant pool at a large public university.

1.2. Materials

Materials included 12 color drawings of complex novel figures presented against a white background. Items were designed to be ambiguous with respect to domain such that they could conceivably be interpreted as either animals or artifacts depending on the context (see Fig. 1). Ratings from an independent sample of adults confirmed that overall the items were equally plausible as animals and artifacts. In this pretest, participants were told a brief story about a new planet discovered by scientists containing a number of novel artifacts and life forms. They were asked to evaluate on a scale from 1 (Not at all) to 7 (Extremely) how plausible it is that each item is an animal or a machine/tool/toy/vehicle/piece of furniture/musical instrument, depending on the item. Twelve participants rated the stimuli as animals and 12 rated the stimuli as artifacts. Results revealed that

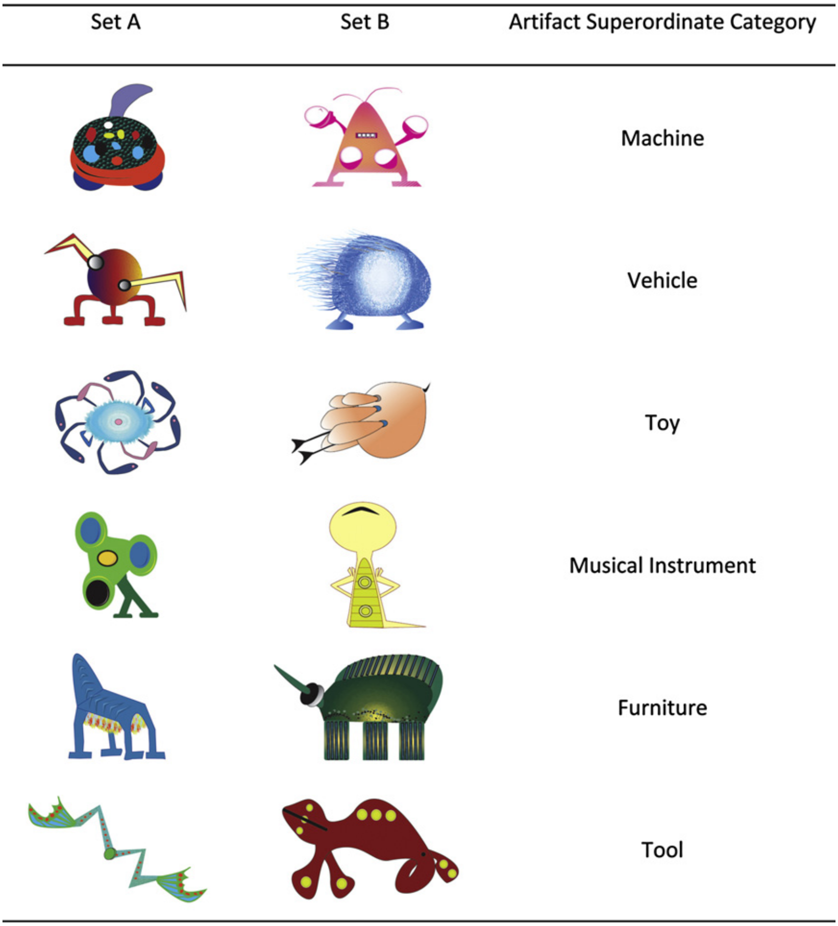

Fig. 1. Perceptually identical animal and artifact stimuli with superordinate category labels.

overall items were equally plausible as animals ($M = 4.41$, $SD = .85$) and artifacts ($M = 4.55$, $SD = .79$), $t(22) = -.44$, $p = .67$.

Items were divided into two sets of six. For half of the participants, items in Set A served as animal stimuli and items in Set B served as artifact stimuli. For the other half, the reverse was true. Animal and artifact stimuli were presented in blocks such that participants saw all six artifacts followed by all six animals or vice versa. The order of the blocks was counterbalanced across subjects. Within each block, items were presented in one of two random orders. Each item was assigned a novel label.

1.3. Procedure

1.3.1. Children

Children were tested individually in a quiet room. They were asked to look at a series of pictures and to describe them to a puppet named Poppy. Poppy was described as an alien who cannot see because he comes from a very dark planet. The motivation for using a blind puppet was to indicate that Poppy was completely ignorant about the stimuli and to encourage children to talk about both visible and non-visible properties.

The session began with two practice trials involving familiar foods. Children were shown a picture of an apple and were told, “This is an apple. What can you tell Poppy about *apples*?” The second practice trial had the same structure as the first but involved a picture of a cookie.

In the test phase children were introduced to each item individually and prompted to generate generic language about it. Domain was indicated in two ways. First, domain was specified at the beginning of each block of items. Children heard “These pictures are all going to be different kinds of *animals/objects*, ok? These pictures are all *animals/objects*.” (Because children were thought to be unfamiliar with the superordinate category “artifact,” the more familiar term “object” was used.) Second, domain was specified as each item was introduced. Items serving as animals were introduced as “a kind of animal” (e.g., “This is a kind of animal called a modie”). Items serving as artifacts were each assigned a different superordinate category. Artifact superordinate categories included furniture, tools, musical instruments, toys, vehicles, and machines (Fig. 1). For example, children were told, “This is a kind of machine called a modie.” The decision to use multiple superordinate artifact categories was motivated by the fact that no single artifact category label covers the whole class of artifacts while also being familiar to children and conveying a rich set of expectations. Rather, the artifact labels most analogous to the label “animal” would be a set of distinct artifact terms. By using familiar artifact categories that are meaningful and structured, our goal was to enable children to apply their knowledge about these categories to interpret the ambiguous, novel stimuli. Further, by using multiple artifact categories, we minimized the possibility that a lack of knowledge about one artifact category could influence children’s responses for the entire domain. Finally, the artifact superordinate labels were more likely to prime generic knowledge than were the ontological label of “artifact” or “object”, and thus provided a strong test of our hypothesis.

After each item was introduced, children were asked to talk about it using a generic prompt (e.g., “What can you tell Poppy about *modies*?”). The experimenter allowed children to speak freely about each stimulus item. When they paused, the experimenter encouraged further responses by asking, “What else can you tell Poppy?” The experimenter continued such prompting until children explicitly indicated that they had finished discussing that item (e.g., “Nothing else” or “That’s it”). Conversations were audiorecorded for subsequent transcription.

1.3.2. Adults

The procedure for adults was comparable to that for children, with some modifications. For ease of data collection, adults were tested in a group setting using a written format. They were instructed to, “Look at each picture individually and list as many attributes as you can think of.” Item labels and prompts were printed on each page and were identical to those given to children except that the alien puppet was not referenced. For example, adults read, “This is a kind of animal/machine called a modie. What can you tell me about modies?” They were given 90 s to respond to each item. Adults were instructed to write their responses using complete sentences to ensure that responses could be coded reliably as generic or not.

1.4. Transcribing and coding

Children’s audiorecorded sessions were transcribed by the experimenter. Utterances were divided such that each utterance contained no more than a single subject noun phrase. For example, compound utterances such as “They are black and they live in trees” were divided into two distinct utterances, “They are black” and “They live in trees.” Adults’ written responses were divided into utterances using the same criteria.

Transcripts of children’s verbal responses and adults’ written responses were coded according to the following system. First, off-task responses (e.g., “I’m hungry”) and those that could not be interpreted (e.g., those that were unintelligible or nonsensical) were discarded. The remaining responses were then coded as picture-relevant or not. Non-picture-relevant responses included on-task statements or questions that were not related to the animal or artifact in the picture (e.g., “I don’t know anything else”; “What’s the next one?”). Picture-relevant utterances included those containing the name of the item (e.g., “I don’t know what a rem is”; “Reesles don’t have any feet”), a pronoun referring to the item (e.g., “They have wings”; “It looks like it’s nailed together”; “That looks really weird”), a possessive pronoun (e.g., “His feathers are sticking out”; “Their legs are upside-down”), and those referring to a specific part of the item without the use of the item’s name or a pronoun (e.g., “Is that a stinger?”; “There’s a blue dot”).

Next, picture-relevant utterances were examined for whether they expressed a property that was inherited from participants’ knowledge of the superordinate category (e.g., “You play with them” for a toy; “It eats” for an animal). Since our goal was to present participants with unfamiliar items about which they lacked prior knowledge, we planned to eliminate from further analyses all utterances expressing properties true of the broader category to which the item belonged. However, no utterances meeting these criteria were identified.

On-task, picture-relevant utterances containing more than a single word were then coded as generic or non-generic. Generics have two key properties. First, there is a general category the speaker refers to. The speaker is not referring to any particular individual or instance. Second, the statement or question is not tied to a particular situation or point in time. In this study, utterances that met these criteria were coded as generic and those that did not were coded as non-generic. Generic responses were additionally coded as bare plural (e.g., “Morseths have lots of stripes”; “They have funny feet”; “Their tails are orange”) or indefinite singular (e.g., “A zoller is kind of greenish”; “What do you do with a scobbit?”). Examples of generics observed in this study are: “Modies have long hairs on them”; “They can spin around”; “We can sit on them”; “Their tails are orange.” Examples of non-generics are: “It has fuzz on the bottom”; “He looks like an alien”; “That looks really weird”; “Crullet has horns on him”; “There’s red and black.”

Finally, all generic and non-generic utterances were coded for the type of attribute they described. Utterances mentioning attributes clearly visible in the picture (e.g., external parts, color, size, shape, texture) were categorized as *surface*; utterances mentioning unseen properties (e.g., traits, behavior, function, use, internal parts) were categorized as *non-obvious.* Utterances mentioning both surface and non-obvious properties (e.g., “You press the red button”) were counted in both categories.

A second coder coded 100% of children’s and adults’ responses. Agreement was above 97%. All disagreements were resolved by discussion.

2. Results

2.1. Was the experimental manipulation successful in eliciting generic language?

Overall, the experimental manipulation was successful in eliciting generic language. Seventeen of 18 children and 13 of 16 adults produced at least one generic. Frequencies of generic utterances per participant ranged from 0 to 44 for children ($M = 17.61$, $SD = 11.81$) and from 0 to 60 for adults ($M = 26.31$, $SD = 18.24$). The vast majority of adults’ generic utterances (92.6%) and all of children’s generic utterances were of the bare plural form. Thus, we focus our analyses on bare plural generics.

Children produced a range of generic properties in response to the animal and artifact stimuli. These properties mainly described surface-level features ($M = 83.3\%$ of utterances, $SD = 14.1$), including color (e.g., “They’re all yellow”), parts (e.g., “They have 3 legs”), shape (e.g., “Modies are rectangles”), size (e.g., “They’re big”), and texture (e.g., “They have fur under them”). All but one child also generated non-obvious properties, including behavior (e.g., “They can walk”), function/use (e.g., “You blow in them”), and habitat (e.g., “They look like they’re from outer space”); however, these non-obvious properties were less frequent ($M = 20.1\%$ of children’s utterances, $SD = 20.0$).

2.2. Did domain influence the number of generic and non-generic utterances produced across participants?

Our central question was whether children and adults produced more generic utterances when perceptually ambiguous stimuli were described as animals than when they were described as artifacts. To address this question, for each participant we calculated the total number of bare plural generic and non-generic utterances produced within each domain. Data were entered into an analysis of variance (ANOVA) with domain (animal vs. artifact) and genericity (generic vs. non-generic) as within-subject factors, and age group (children vs.

adults) and block order (animals first vs. artifacts first) as between-subjects factors. Results revealed significant main effects of age group, $F(1, 30) = 6.27$, $p = .018$, $\eta_p^2 = .17$, and domain, $F(1, 30) = 13.57$, $p < .01$, $\eta_p^2 = .31$. Overall, adults produced significantly more utterances ($M = 9.67$; $SD = 2.72$) than preschoolers ($M = 7.33$; $SD = 2.74$), and participants produced more utterances for items in the animal ($M = 9.59$; $SD = 3.70$) than in the artifact domain ($M = 7.40$; $SD = 2.69$).

Most importantly, results also revealed the predicted interaction of genericity by domain, $F(1, 30) = 4.45$, $p = .043$, $\eta_p^2 = .13$. For generic utterances, there was a significant effect of domain, $F(1, 30) = 12.82$, $p = .001$, $\eta_p^2 = .30$: participants produced significantly more generics about animals ($M = 12.71$; $SD = 10.14$) than about artifacts ($M = 8.03$, $SD = 7.46$). This domain difference did not emerge for non-generic utterances, $F < 1$: participants produced equal numbers of non-generic utterances about animals ($M = 6.26$; $SD = 6.30$) and artifacts ($M = 6.53$; $SD = 6.50$). Crucially, the interaction of genericity by domain also held when examining each age group separately. As illustrated in Fig. 2a, both preschoolers, $F(1, 30) = 4.71$, $p = .038$, $\eta_p^2 = .14$, and adults, $F(1, 30) = 8.28$, $p = .007$, $\eta_p^2 = .22$, produced significantly more generic utterances about animals than about artifacts; however, they produced equal numbers of non-generic utterances in both domains, Fs < 1.

2.3. Did domain influence the number of generic and non-generic utterances produced across item pairs?

Because the same images served as both animal and artifact stimuli, we were also able to explore whether the effect of domain held across items pairs. To address this question, we calculated the total number of bare plural generic and non-generic utterances produced for each item within each domain. Data were entered into an ANOVA with domain (animal vs. artifact) and genericity (generic vs. non-generic) as within-subject factors. Results revealed main effects of genericity, $F(1, 11) = 26.00$, $p < .001$, $\eta_p^2 = .70$, and domain, $F(1, 11) = 11.27$, $p = .006$, $\eta_p^2 = .51$, that are best interpreted in light of a significant interaction of genericity by domain, $F(1, 11) = 19.47$, $p = .001$, $\eta_p^2 = .64$. As in the analyses by participant, for generic utterances there was a significant effect of domain, $F(1, 11) = 28.26$, $p < .001$, $\eta_p^2 = .72$. Participants produced more generics when items were described as animals ($M = 37.33$; $SD = 6.44$) than when they were described as artifacts ($M = 23.92$; $SD = 7.52$). This domain difference did not emerge for non-generic utterances, $F < 1$ (animals: $M = 19.42$; $SD = 4.72$; artifacts: $M = 20.92$; $SD = 6.44$). This pattern of results also held when examining preschoolers and adults separately (Fig. 2b).

3. Discussion

The goal of the present study was to examine patterns of generic language use in children's conversations about novel animals and artifacts in order to shed light on whether young children share adults' view that animal categories are more coherent and homogeneous than artifact categories. Because generics are used to express generalizations about shared properties and are uniquely suited to talking about categories that are tightly structured, coherent, and homogeneous, we predicted that if children share adults' view of animal categories as more coherent and inductively rich than artifact categories, they should produce more generics about animals than about artifacts. Crucially, exactly the same stimuli served as both animal and artifact images and, thus, stimuli were perceptually identical across domains. Domain differences were cued exclusively by language.

Our results revealed systematic domain effects in generic production: both preschoolers and adults produced more category-referring generic utterances when items were described as animals than when they were described as artifacts. Because perceptual cues to domain (e.g., eyes) were unavailable in the stimulus images, any domain differences observed in children's language production must be attributed to their general knowledge and expectations about these two abstract domains. Thus, results rule out the possibility that domain differences in children's generic use observed here and previously (Brandone & Gelman, 2009; Gelman et al., 1998, 2008; Goldin-Meadow et al., 2005) reflect a simple rule relating perceptual cues to domain and use of bare plural generics. Statistical or associative processes may indeed have been involved in the development of children's knowledge and expectations about animals and artifacts. Nevertheless, our findings demonstrate that at least by the

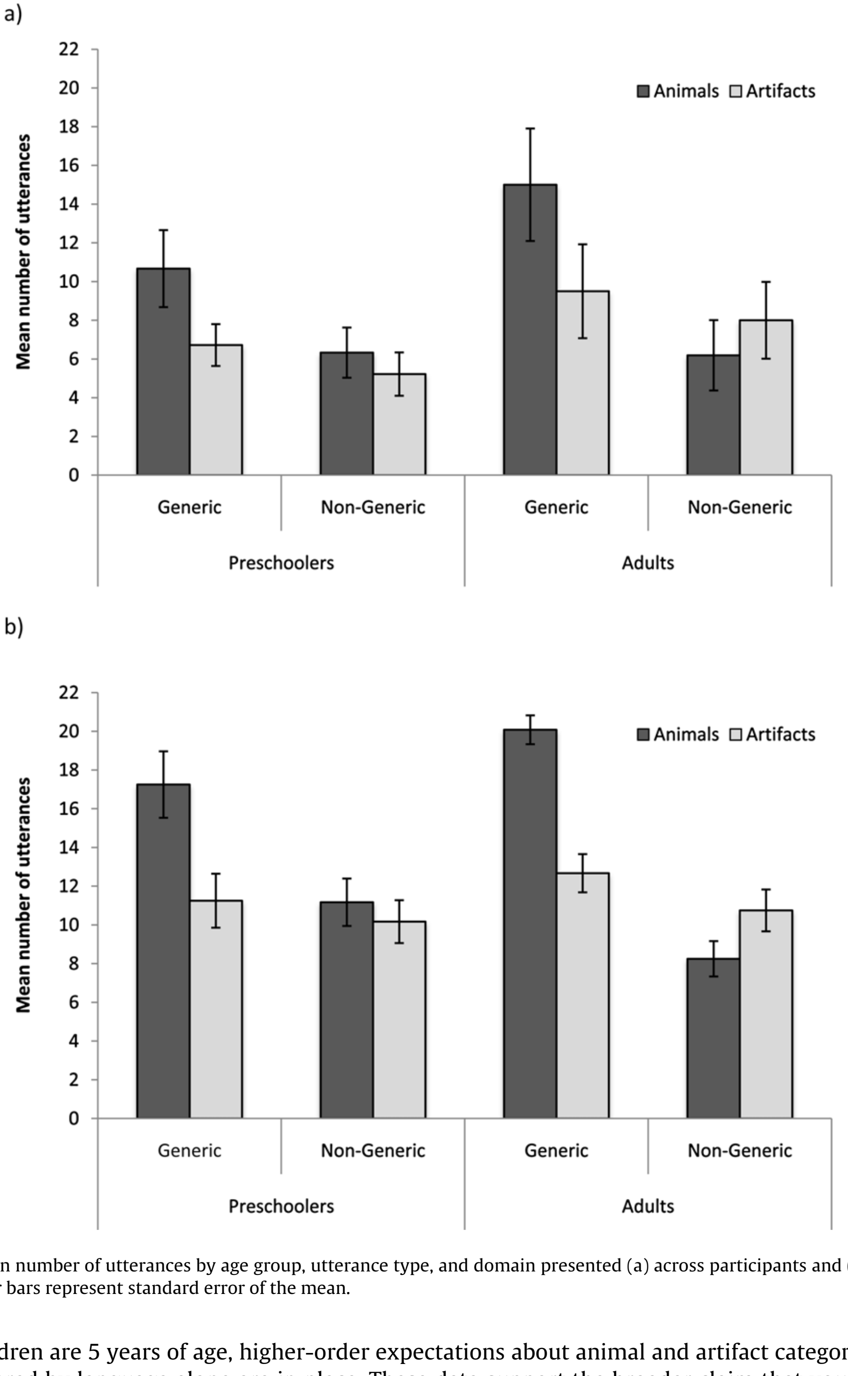

Fig. 2. Mean number of utterances by age group, utterance type, and domain presented (a) across participants and (b) across items. Error bars represent standard error of the mean.

time children are 5 years of age, higher-order expectations about animal and artifact categories that are triggered by language alone are in place. These data support the broader claim that young children's categories incorporate abstract conceptual content—including principled, theory-laden domain distinctions—from early in development (Carey, 2009; Gelman, 2003; Gopnik & Meltzoff, 1997).

In particular, our findings support the view that one key component of children's higher-order expectations about animal and artifact categories concerns their beliefs about the coherence and homogeneity of categories within these domains. Given the support in the literature for the relation between generic language and category homogeneity, we argue that patterns of generic language use in the present study suggest that 5-year-olds, like adults and older children (Gelman, 1988; Gelman & O'Reilly, 1988), view animal categories as more richly structured, coherent, and homogeneous than artifact categories. These data are consistent with recent research showing that 5-year-olds are aware of other principled ways in which animal and artifact categories differ—including naturalness (Rhodes & Gelman, 2009b) and flexibility (Rhodes & Gelman, 2009a, 2009b). Taken together, results suggest that by 5 years, children believe animal categories mark absolute distinctions made by nature, are richly structured, and include members that share many important similarities, whereas artifact categories reflect flexible, subjective, and more heterogeneous groupings.

An important question is whether abstract conceptual expectations guide children's generic language use (as suggested above), or whether instead methodological differences can explain the observed domain effects. Although the stimuli in our study were perceptually identical across domains—ruling out the possibility that the observed domain differences reflect a learned association between perceptual cues to domain and the use of bare plural generics—there was a substantive domain difference in how the items were introduced: Items serving as animals were introduced with a single superordinate term (animal), whereas items serving as artifacts were introduced with multiple superordinate categories (e.g., tool, machine). Our reasons for using multiple artifact categories were threefold: (1) there is no label that would be familiar to young children that unambiguously captures the full range of the artifact domain; (2) the use of multiple superordinate labels minimizes the possibility that a lack of knowledge about one artifact category could influence children's responses for the entire artifact domain; (3) the use of multiple superordinate labels was assumed to prime and facilitate children's knowledge about artifacts and thus provide a stronger test of our hypothesis.

We believe that this methodological difference (multiple superordinate labels for artifacts) could not account for the results obtained in the present study. If hearing the same superordinate multiple times was responsible for children's producing more generics for animals, we would expect to see order effects in children's responses—specifically, an increase in the number of generics produced about animals between the first and second half of the animal items. This prediction was not supported: Children produced equal numbers of generics about animals in the first and second halves of the testing session (*M*s = 5.28 and 5.39, respectively). Another possibility is that the consistent category "animal" is better at eliciting generics because it is more general than the artifact superordinates. Perhaps with a superordinate label, participants feel they do not need to provide generics because the superordinate label provides sufficient generic information. If this were the case, we would expect to see fewer generics for the relatively specific category "musical instrument" and more for the more general category "machine." We found no evidence that this was the case: The varying artifact labels, although ranging from specific to general, did not elicit differing amounts of generics. Thus, we argue that the differences observed here could not result from a methodological difference in how the animal and artifact stimuli were introduced.

A second possible explanation for our domain effects is that children's generic language use is less about their expectations about the coherence and homogeneity of animal and artifact categories and more about how likely individuals within these domains call to mind the category to which they belong. On this view, an individual animal (e.g., a frog) may readily call to mind the larger category to which it belongs (e.g., frogs in general) whereas an individual artifact (e.g., a hammer) may call to mind the context in which it is used (e.g., hammering a nail)—not other category members. This differential tendency to think about items as kinds vs. individuals could derive from the varying types of experience people have with animals and artifacts (e.g., interacting regularly and directly with individual artifacts vs. experiencing animals largely indirectly through books and generic testimony). Such a difference in construal could manifest itself in differential patterns of generic use (i.e., more generics about animals than artifacts). Support for this general perspective comes from data showing that the less one can interact directly with an item, the more likely one is to produce generics about that item (Gelman, Chesnick, & Waxman, 2005).

Although broad differences in how people construe animals and artifacts could well contribute to the observed domain differences, we argue that this explanation is unlikely to fully explain our findings for three reasons. First, the stimuli used in the present study were completely novel items that infrequently called to mind a specific context of use. Second, when children did talk about artifact use, the majority of the time (58.3%) they did so in generic form. Thus, it is not the case that thinking about an artifact's use necessitates thinking about the artifact as an individual. Finally, if there is a relation between ability to interact directly with the items and language used to talk about them, artifacts that come from superordinate categories that are relatively less manipulable (e.g., furniture, vehicles, machines) should be more likely to elicit generics than those that are relatively more manipulable (e.g., tools, toys, musical instruments). We found no evidence that this was the case: Different types of artifacts did not elicit differing amounts of generics. Thus, we argue that the best interpretation of the results obtained here is that 5-year-olds view animal categories as more richly structured, coherent, and homogeneous than artifact categories.

The present data raise three important questions for future research. First, based on the present data we can infer that children expect animal categories to be more richly structured, coherent, and homogeneous than artifact categories overall. However, it remains to be seen whether children have more fine-tuned expectations. For example, previous research has shown that object function is viewed as a central aspect of artifact concepts even for young children (Bloom, 1996; Greif, Kemler Nelson, Keil, & Gutierrez, 2006; Kemler Nelson, Egan, & Holt, 2004) and that children expect objects of the same kind to share functional features (Davidson & Gelman, 1990; Gelman, 1988; Welder & Graham, 2001). Thus, children may view object function as a feature that is particularly likely to be homogeneous in artifacts. In the present experiment, although function information was not directly available, participants did occasionally infer functional features of the ambiguous artifact stimuli (e.g., "You blow in them"; "It can fix toys"). However, for both children and adults, the percentage of references to function that occurred in generic form was statistically equivalent to the percentage of surface properties of artifacts expressed as generics (children: 58.3% and 54.7% for function and surface properties, respectively; adults: 57.7% and 61.9% for function and surface properties, respectively). Thus, patterns of generic language use did not show that children expected functional but not surface features of artifacts to be homogeneous. It is important to note, however, that the number of references to function was quite low. Children produced an average of 2.78 references to function across the artifact stimuli ($M_{\text{Generic}} = 1.61$, $M_{\text{Nongeneric}} = 1.17$). Given these small numbers, it is difficult to draw conclusions regarding participants' expectations about the homogeneity of artifact function. Further research is necessary to examine whether children's expectations about category coherence and homogeneity vary depending on the type of property as well as the domain under consideration.

Second, although the results presented here demonstrate an important difference in children's expectations about animal and artifact categories, it remains an open question which aspects of the animal/artifact distinction are the most relevant for children's differing domain expectations. Animals and artifacts differ on a number of important dimensions, including living vs. non-living, animate vs. inanimate, and natural vs. non-natural/conventional. By the preschool years, children are sensitive to factors such as animacy, naturalness, conventionality, and objectivity when making category judgments (Rhodes & Gelman, 2009a, 2009b). Thus, any or all of these variables may have factored into participants' thinking. Future research exploring children's generic use about other types of categories may help pinpoint the relevant factors underlying this domain distinction.

Third, how does the present distinction emerge and develop? Although our data clearly suggest that by 5 years of age, children can make a knowledge-based domain distinction between animals and artifacts, the developmental question of how these intuitions arise remains unanswered. One possibility, reminiscent of Goodman's proposal (1955/1983), is that learners form "overhypotheses"—inferences that go beyond the specific categories and properties they have learned (e.g., Birds fly)—in order to make principled generalizations about contrasting categories and properties of a given type (e.g., animals of the same kind share the same type of movement; Shipley, 1993). In particular, having learned from experience that the categories *dogs*, *birds*, and *frogs* are coherent and share many similarities, children could form the abstract generalization that animal categories in general—including novel ones—also follow this pattern. The opposite generalization regarding the variability of artifact categories could also be inferred. Overhypotheses such as these provide one plausible explanation for the domain effects observed in the present study.

In conclusion, the question of how children acquire categorical knowledge and when it becomes abstract and conceptual in nature remains at the heart of the study of cognitive development. By examining differences in children's use of category-referring generic language about novel animal and artifact categories, the present study demonstrates that by age 5, children make principled domain distinctions between animals and artifacts that may be based on their beliefs about the coherence and homogeneity of categories within these domains. These data support the broader claim that young children's categories incorporate abstract conceptual content from early in development (Carey, 2009; Gelman, 2003; Gopnik & Meltzoff, 1997). Further, the present findings highlight the important role of domain in how young children organize their knowledge.

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