Children's use of generic labels, discreteness, and stability to form a novel category

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Abstract

Children hold rich essentialist beliefs about natural and social categories, representing them as discrete (mutually exclusive with sharp boundaries) and stable (with membership remaining constant over an individual's lifespan). Children use essential categories to make inductive inferences about individuals. How do children determine what categories to consider essential and to use as an inductive base? Although much research has demonstrated children's use of labels to form categories, here we explore whether children might also use the observed discreteness or stability of a trait to form categories based on that trait. In the present study, we taught children about novel creatures and provided them with a cue (discreteness, stability, labels, or no cue) to form texture categories rather than shape or color categories. Experiment 1 found that children (4-6 years, $n = 140$) used labels but not discreteness or stability cues to form texture categories more often than at baseline. Experiment 2 (5-6 years, $n = 152$) found that children who later recognized the stability and discreteness cues used them to form categories more often than those who did not later recognize the cues, but were still overall less likely to use these cues than to use labels cues. Results underscore the unique importance of labels as a cue for category formation, and suggest that children do not readily rely on the stability and discreteness of a trait to form animate categories despite readily inferring that such categories are stable and discrete. Implications for natural and social category representations are discussed.

Keywords: Essentialism, labels, stability, discreteness

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From a young age, children carve the natural and social worlds into categories such as animals (Diesendruck, 2001; Taylor, Rhodes, & Gelman, 2009), genders (Bigler & Liben, 1993), races (Hirschfeld, 1995), and ethnicities (Ocampo, Knight, & Bernal, 1997), and use these categories as bases for making inductive inferences about individuals. For example, preschoolers who are taught about an individual animal (e.g., a Samoyed dog) and a property it holds (e.g., helps pull sleds) will extend that property to other Samoyeds, and to a lesser degree, other dogs, and other animals (Gelman, 2003; Waxman, et al., 1997). Children make property inferences based on social categories, such as gender, at similar rates (Taylor, Rhodes, & Gelman, 2009). Thus, children are able make inductive inferences about individuals based on their natural and social category membership.

Children's use of categories to make inductive inferences extends beyond relying on visual similarity. For example, Gelman and Markman (1987) taught three- and four-year-olds a property of an individual (e.g., a brown rabbit who eats grass), and then asked them whether that property was held by an individual who resembled the original one but was labeled differently (e.g., long-eared squirrel labeled as a squirrel), or by an individual who was labeled similarly to the original one but was visually distinct (e.g., a white rabbit labeled as a rabbit). Children made more inferences based on labels than based on appearances. Gelman and Coley (1990) demonstrated this effect with two-year-old children, finding that they too relied on category labels rather than visual similarity to make judgments about kind-relevant properties (i.e., diet), though not about other properties (i.e., age) (see also Davidson & Gelman, 1990; Gelman & Markman, 1986; Kalish & Gelman, 1992; see Baron, Dunham, Banaji, & Carey, 2014 for similar

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findings regarding social category formation). These studies suggest that, rather than relying on visual similarity alone, children use labels as cues to form inductively useful categories.

Essentialist intuitions

Extensive developmental research suggests that children's category-based inferences are part of a larger set of *essentialist* intuitions children hold about the structure of natural and social categories. According to these intuitions, in addition to sharing a common label, categories are also discrete (i.e. with sharp boundaries and within-group homogeneity), and category membership is stable over time (i.e., remaining constant over an individual's lifespan).¹ These intuitions guide children's category representations from at least the early preschool years (Gelman, 2003, 2004; Gelman, Coley, & Gottfried, 1994) through adulthood (Bastian & Haslam, 2006; Haslam, Rothschild, & Ernst, 2000; Medin & Ortony, 1989; Smiler & Gelman, 2008). Much research has focused on characterizing the component beliefs (e.g., stability, discreteness) that comprise children's essentialist intuitions, and the categories to which these intuitions apply. However, relatively less research has focused on investigating whether observing these components may cue children to form an essential category, rather than these components only being inferred based on existing essentialist category representations. This is the broad theoretical question motivating the present study. Specifically, in the present study, we investigate whether children use observed stability and discreteness to form a novel category,

¹ Discreteness and stability are two of many component beliefs involved in essentialist theories, including heritability (i.e., that category membership can be passed down from parent to child; Rhodes et al. 2017), entitativity (i.e., the belief that categories are "real" or "meaningful;" Haslam & Levy, 2006; McGarty, Haslam, Hutchinson, & Grace, 1995), group homogeneity (i.e., the belief that people in the same category are similar to each other, and different from people in other categories; Emmons & Kelemen, 2015; Yzerbyt, Rogier, & Fiske, 1998), and historical invariance (i.e., the belief that a category has always existed throughout history; No et al., 2008). Our focus on discreteness and stability in particular is discussed later.

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similar to their use of labels. Below, we review evidence that children believe categories are stable and discrete as part of their essentialist intuitions.

Children hold the intuitive essentialist belief that natural and social categories are discrete; in other words, mutually exclusive and distinct, rather than overlapping or graded. For example, five-year-old children consider atypical examples of natural categories (e.g., a penguin, which is an atypical member of the category “bird”) to still be full members of the category, whereas they may consider atypical examples of artifact categories (e.g., a tray, which is an atypical member of the category “table”) to be “sort of” or “partly” category members (Diesendruck & Gelman, 1999; Estes, 2003, 2004; Kalish, 1995; Rhodes & Gelman, 2009). This suggests that children represent natural category membership as all-or-nothing, such that an individual can't be “sort of” a bird or “partly” a tree. Children also apply their belief in category discreteness to social categories, such as race. Gaither et al. (2014) explored how children categorized racially ambiguous faces, and found that children who had essentialist beliefs about race (i.e., who reported that a person's race could not be voluntarily changed) categorized racially ambiguous faces as similar to Black faces. Essentialist beliefs, therefore, may involve a sharpening of the boundaries between racial category representations. (See also Roberts, Ho, Rhodes, & Gelman, 2017 for evidence that adults' essentialist beliefs about gender involve a conception of sharp gender category boundaries). Thus, research shows that children believe natural and social categories to be discrete, or mutually exclusive with sharp boundaries.

Children also hold the intuitive essentialist belief that natural and social category membership is stable; in other words, that individuals' category membership will not change over their lifespan, even despite superficial transformation or environmental influence (Giles & Heyman, 2003; Heyman & Dweck, 1998). For example, when told a story about a baby girl

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raised entirely by men, preschool-aged children report that the baby will nevertheless grow up to exhibit gender-stereotypical behaviors, such as collecting dolls (Gelman & Taylor, 2000).

Similarly, when told a story about a baby cow raised entirely by pigs, preschoolers report that the baby will grow up to exhibit species-typical behaviors, such as saying “moo” (Taylor, Rhodes, & Gelman, 2009). Again, children’s stability beliefs appear to reflect more than just visual similarity judgments; when three-year-old children are asked to predict what a child will look like as an adult, they select the adult whose race matches the child’s race rather than an equally-visually-similar other-race adult (e.g., one who is dressed the same) (Hirschfeld, 1995; Pauker, Ambady, & Apfelbaum, 2010; though see Roberts & Gelman, 2016 for mixed evidence of White children’s understanding of race stability). Thus, research shows that children believe natural and social category membership to be stable over the lifespan.

How do children determine which categories to consider essential?

Children do not apply their essentialist intuitions indiscriminately to all categories. Rather, children construe natural categories (e.g., birds) as essential, but not artifact categories (e.g., tables) (Rhodes & Gelman, 2009; Kalish, 1995). Children’s essentialist construal of social categories is somewhere in-between (Gelman, 2003), and also varies from category to category (e.g., race, gender, ethnicity; Diesendruck, Goldfein-Elbaz, Rhodes, Gelman, & Neumark, 2013; Diesendruck & haLevi, 2006). Research with adults has shown that their social essentialist beliefs vary from gender and race (high in essentialism), to sexual orientation and religion (a bit lower), to personality (lower still) and interests (lowest) (Haslam, Rothschild, & Ernst, 2000). Even within a given category (e.g., gender, religion) research indicates that adults may hold essentialist beliefs to different degrees (e.g., stronger essentialist beliefs about moral goodness

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than moral badness, Heiphetz, 2019; stronger essentialist beliefs about masculinity than femininity, Smiler & Gelman, 2008; stronger essentialist beliefs about Jews than Atheists, Toosi & Ambady, 2011).

Given that essentialist beliefs are applied to some categories but not to others, how do children determine which categories to consider essential? Research on this question has mostly focused on children's use of labels to infer essential categories, as noted above. Children have been widely shown to use labels to form both natural and social categories. In the natural domain, Davidson and Gelman (1990) found that preschoolers relied on labels over visual similarity to generalize a property of a novel animal. Children were able to rely both on familiar labels (e.g., "a cow") and unfamiliar labels (e.g., "a wug"), so long as the labels corresponded to some visual trait and were not completely discrepant from visual information. In the social domain, Walton and Banaji (2004) referred to someone eating chocolate either by labeling her (e.g., "Susan is a chocolate-eater") or by simply describing the individual act (e.g., "Susan eats chocolate a lot"), and found that children who heard the category label perceived her preference for chocolate as more stable and resilient than children in the other condition (see also Gelman & Heyman, 1999). Similarly, Israeli researchers found that labeling ethnic categories ("Jew" and "Arab") increased children's beliefs about the inductive potential of ethnic categories, though all children visually recognized the different social categories (Diesendruck & haLevi, 2006). The effect even extends to completely novel categories; Rhodes, Leslie, and Tworek (2012) found that labeling a novel category with generic language (e.g., "Zarpies") rather than referring to it using specific language (e.g., "this Zarpie") led both four-year-olds and adults to hold essentialist beliefs about that category (see also Rhodes et al., 2018; see Davidson & Gelman, 1990 for preschoolers' use of labels to form novel animal categories). While even young children have

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been widely shown to use labels to form inductively potent categories, this ability increases over development (Gelman, Star, & Flukes, 2002; Gelman, Ware, & Kleinberg, 2010), and also varies based on context. For example, children's label use varies based on whether the label is provided on its own or alongside generic claims about the category (Gelman, Ware, & Kleinberg, 2010) and whether the labels correspond to kind-relevant and contrasting information between categories (Waxman et al., 1997).

Although a rich literature indicates children's use of labels to infer novel categories, in the current study we explore what other cues children might use to infer novel categories. Given children's construal of natural and social categories as stable and discrete, might children use the observed stability or discreteness of a trait to form their categories? In other words, might children notice whether the structure of a potential category aligns with their representations of the structure of essential categories, and then use that alignment to determine whether to form a category and use it as an inductive base?

Implications of children's use of stability and discreteness cues

The question of whether children use stability and discreteness cues to form their categories has both basic and applied motivations. First, this question is relevant for basic research characterizing essentialism as an intuitive theory. Having identified many component beliefs of essentialism (e.g., stability, discreteness, and others), researchers are now increasingly interested in how these components relate to one another (Haslam, Rothschild, & Ernst, 2000; Heiphetz, Gelman, & Young, 2017). Much of this research has focused on identifying which component beliefs covary with one another or are independent. For example, Haslam, Rothschild, and Ernst (2000) asked adults to rate forty social categories on nine different

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components of essentialism, and identified two underlying dimensions (“naturalness” and “entitativity”) that most accounted for ratings on all components. Heiphetz, Gelman, and Young (2017) compared children’s component beliefs about stability and biology, arguing that these components may be somewhat independent. In the present study, rather than identifying relationships among existing component beliefs, as previous work has done, we employ an experimental approach in order to understand whether inducing a belief in one component of essentialism (e.g., discreteness or stability) will then give rise to other components of essentialism (e.g., inductive potential) or to a category representation more broadly. By using novel rather than real-world categories, we can fully control the component beliefs that participants hold. This approach also allows us to investigate not just whether certain beliefs correlate with one another (i.e., varying along dimensions), but whether certain beliefs give rise to other beliefs. Sutherland and Cimpian (2019) used a similar experimental approach to investigate whether children’s belief in category inference (or children’s tendency toward intrinsic explanations for group features) gives rise to essentialist representations. By manipulating children’s intrinsic explanations, they found that inference beliefs not only correlated with essentialist beliefs, but also impacted them directly. In the current study, we focus on the component beliefs of stability and discreteness and how observing discreteness or stability information might give rise to category representations.

Understanding whether children use stability and discreteness cues to form their categories also has important implications for children’s natural and social category reasoning. In the social domain, many social categories are becoming increasingly less discrete or less stable, due to the increased prevalence or visibility of certain (still uncommon) identities. For example, multiracial identities (which may be understood as not discrete since they involve identifying

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with multiple racial identities) and transgender identities (which may be understood as not stable since they involve a transition from one expressed gender identity to another) are increasing in prevalence or visibility in the US population (Hoffman, 2016; Parker, Morin, Horowitz, Lopez, & Rohal, 2015). News articles have speculated that these demographic changes may give rise to “blended populations”, with racial categories becoming “blurred” (Frey, 2014), and gender being conceived as “not either/or binary but a spectrum” (Nichols, 2015). These articles argue that changes in the observed discreteness and stability of social categories will lead to changes in how these categories are represented and used as inductive bases for making judgments about individuals. These arguments implicitly assume that the traditional discreteness and stability of these categories have contributed to these categories being represented as essential and inductively useful. However, the roles of discreteness and stability in shaping category representations are not yet understood, and more research is needed to experimentally investigate how identities being more or less discrete or stable might impact social category representations.

In the natural domain, categories are similarly not always stable and discrete. Species evolve over time, and species category boundaries are also becoming “blurred” through the use of genetic engineering to create genetic hybrids. Essentialist beliefs have been shown to underlie children’s difficulty with understanding evolution (Evans, Szymanowski, Smith, & Rosengren, 2005) and adults’ aversion to Genetically Modified Organisms (GMOs) (see Wagner et al., 2010 for review). One might think that these difficulties with violations in the stability or discreteness of natural categories might attenuate with increased exposure to GMOs, for example, because this exposure might reduce essentialist representations of natural categories. However, we do not yet know how observing discreteness or stability shapes natural category representations in the first place. More research is needed to understand how the observed stability and discreteness of

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natural categories shapes natural category representations, and relatedly, how categories becoming less discrete might impact natural category representations.

The present study: Investigating the use of discreteness and stability cues with novel categories

Many of the challenges in investigating this question from an applied perspective emerge from the fact that the stability and discreteness of real-world categories (e.g., species, gender, race) cannot be experimentally manipulated. Real-world categories are commonly both discrete and stable (i.e., most people are cisgender or monoracial). Moreover, beliefs about their discreteness and stability often covary with other beliefs about categories and expectations around their inductive potential, making it difficult to understand the roles of discreteness and stability in isolation. The focus in the present study on novel categories – categories about which children hold no prior knowledge – allows us to experimentally isolate discreteness and stability cues and investigate their impact on category representations and use of the category as an inductive base.

However, one limitation of using novel categories, especially ones that are ambiguous with respect to their natural versus social domain as in the present study, is that it is unclear whether children's reasoning about them reflects their natural essentialism or social essentialism. After all, children's conception of natural versus social categories is distinct, with children essentializing natural categories more strongly than social categories (for review, Gelman, 2003), and children's reliance on cues (specifically, labels) also differing by domain (Diesendruck, 2003). For example, Diesendruck and Peretz (2013) found that children relied more on labels to categorize less-essentialized categories (artifacts) than more-essentialized categories (animals) (see also Diesendruck & Weiss, 2015). Therefore, the impact of a given cue might interact with

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children's construal of the domain of the category. We return to the question of how stability and discreteness cues might impact children's reasoning differently in the natural versus social domains in the General Discussion. However, by requiring children to form a completely novel category – rather than a new kind of animal or a new kind of ethnicity – we rely on children's intuitive category formation processes rather than on children's learned knowledge about what cues are useful in forming particular real-world categories.

In the present study, we introduced child participants to an array of novel creatures that varied in three traits: Their color (some were light blue and some were dark blue), their shape (some were circular and some were ovular), and their texture (some were fuzzy and some were smooth). Importantly, a participant attempting to sort the creatures into categories would not have one clear way to do so, as any of these three traits could be used to form a category. In four between-subjects conditions, we provided participants with a cue indicating that one trait aligned with essentialist representations of categories. Across conditions, this trait was always texture: In the Stability condition, texture was stable over the creatures' lifespan while color and shape were flexible. In the Discreteness condition, texture varied discretely while color and shape varied along a gradient. Texture was chosen as the target trait based on research suggesting children would not otherwise form texture-based categories, and would more likely form shape- or color-based categories (Diesendruck & Bloom, 2003; Jones, Smith, & Landau, 1991; Landau, Smith, & Jones, 1988). Thus, using texture provided a strong test as to whether children could use stability and discreteness cues to form a novel category.

In addition to these two experimental conditions, two other conditions were designed to provide information on the upper and lower bounds of children's performance in the particular task. Based on work discussed above, we expected that participants would use labels as a cue to

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form texture categories. Therefore, we included a Labels condition, in which creatures were referred to with generic labels according to their texture rather than according to their color or shape. We considered children's responses in the Labels condition to represent ceiling-level performance and compared responses in the Stability and Discreteness conditions to this condition in order to infer whether children used these cues to form a novel category. To capture floor-level performance, we also included a condition in which we did not expect children to form texture categories: a Control condition in which we did not provide children with any cue. We compared the two experimental conditions to performance in this condition as well.

In all four conditions, after familiarizing participants with the creatures and the cue (if any), we then taught participants a kind-relevant property about a creature. Finally, we assessed whether they generalized that property to other creatures based on texture, rather than based on color or shape, indicating that they had used the cue to form categories based on texture. We predicted that, if children used the discreteness or stability of texture as cues, then they would make texture-based generalizations at rates similar to the Labels condition and significantly higher than in the Control condition.

Experiment 1

Method

Participants. Between October 2016 and April 2017, 140 four- to six-year-old children (77 girls) participated in this study. Participants were randomly assigned to four between-subjects conditions, including Labels ($n = 33$, mean age = 5.0 years), Stability ($n = 33$, mean age = 5.2 years), Discreteness ($n = 36$, mean age = 5.2 years), and Control ($n = 38$, mean age = 5.3 years). A post-hoc power analysis indicated that the sample size in the current study was

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sufficient to achieve over 90% power in detecting differences between the Labels, Experimental, and Control conditions.

Participants were recruited from local museum settings. Although we did not collect demographic information on socioeconomic status or ethnicity, per standard museum policy for researchers, demographic information for the museum visitor population suggests that our sample was predominantly White and from middle- to upper-middle class families. All participants whose parents provided consent to participate completed this study.

Materials. The stimuli for this experiment were slides presented on Microsoft PowerPoint. Slides depicted creatures that were designed to be clearly animate, but otherwise novel and ambiguous with respect to their natural or social domain. Follow-up testing with a separate sample of children supported this conclusion.²

Slides always included a familiarization phase (1 array and 8 growth slides), a teaching phase (2 slides), and a test phase (6 slides); only the familiarization phase slides varied across conditions. Slides will be discussed further in the Procedure section.

Procedure. All procedures reported in this paper were approved by the university's Institutional Review Board, and parents or legal guardians provided informed consent allowing their child to participate in the study.

All participants completed a familiarization phase, a teaching phase, and a test phase. Only the familiarization phase varied across conditions. Below, we first describe the procedure in the Control condition, and then we describe deviations from this procedure in each of the other

² Children's conception of the stimuli as natural or social was assessed in an exploratory follow-up study with a new sample ($n = 20$ five- and six-year-olds) who viewed the familiarization slides from the Control condition of Study 1. Participants responded to free response, scale, and categorization tasks designed to determine if they viewed the creatures as more like animals or more like people. Across tasks, participants viewed the stimuli as neither firmly animal-like nor firmly person-like, instead seeming open-minded in their construal of the stimuli as either natural or social.

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conditions. A summary of the procedure as it differed across conditions is shown in Figure 1, and a video of the Control condition procedure can be found in the supplementary online materials.

In the familiarization phase (Fig. 1), participants were first shown an array of eight creatures. In the Control condition, these creatures were either circular or ovular, either light blue or dark blue, and either fuzzy or smooth. These three traits were crossed among the eight creatures such that each creature had a unique combination of traits, and no trait covaried with any other. The experimenter said, “These are called Flurps!” in order to indicate that these were novel creatures. Next, the experimenter said, “Guess what, Flurps are all different from each other! They’re different shapes, different colors, and different materials!” To ensure that the participant noticed each trait, the experimenter asked, “Can you show me some that are different colors? How about some that are different shapes? And which ones are different materials?” Participants responded by pointing. In cases where a participant needed to be taught what “materials” meant, the experimenter explained that it’s “what they are made out of and what they feel like.” Participants were prompted until they correctly identified creatures that were different in the requested way. This phase served to ensure that participants spent time visually engaging with the array of creatures and noticing their similarities and differences.

The subsequent eight familiarization slides showed a series of eight slow animations of each creature getting larger, representing its growth over the lifespan (Fig. 1). Participants were told, “Guess what, they are kids just like you! Now we’re going to see what they look like when they get bigger and become grown-ups. Ready?” Participants then viewed the slides in which each creature got older, and the experimenter said, “Here it is as a kid... and here’s what it looks like as a grown-up!” on each slide. In the Control condition, the creatures’ color, shape, and texture remained the same as they grew.

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In the teaching phase (Fig. 1), participants were taught a kind-relevant property held by an individual creature, and another kind-relevant property held by a different creature. One slide depicted a creature (who was light blue, ovular, and smooth) in the mountains eating berries, and a second slide depicted a creature (who was dark blue, circular, and fuzzy) on a beach eating crabs. Participants viewed these slides while the experimenter said, “This one lives in the mountains and eats berries ... and this one lives on the beach and eats crabs!”

Finally, in the test phase (Fig. 1), participants viewed six test slides which featured a target creature (the first creature from the teaching phase – a light blue, ovular, and smooth creature in the mountains eating berries), alongside two other creatures. The other two creatures were matched in the number of traits they shared with the target creature, but only one matched the texture of the target creature (see Table 1). On each slide, participants were reminded that “Remember, this one lives in the mountains and eats berries” and asked, “Which of these ones lives in the mountains eats berries, too?” and presented with the two options. Participants responded verbally or by pointing on each of the six test trials.

Recall that the above procedure describes the Control condition. Children could have spontaneously made texture generalizations even in this condition, given it was one of three traits (i.e., texture, shape, and color) available to children. As such, we considered performance in this condition to represent baseline rates of texture generalizations to which we compared all other conditions.

We now describe deviations from this procedure in the Stability, Discreteness, and Labels conditions which correspond to the experimental manipulations for each condition, summarized in Figure 1. Unless otherwise noted, all procedures in the following conditions were identical to

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those in the Control condition. As can be seen from the descriptions below, all condition-specific manipulations occurred in the familiarization phase.

In the familiarization phase of the Stability condition (Fig. 1), the creatures changed in color and shape as they grew, but their texture remained constant. Thus, texture was stable, but color and shape were not. Color and shape did not always change to the opposite color or shape, but instead varied more naturalistically, with sometimes both, one, or neither trait changing (see Table 2). We ensured that equal numbers of light and dark blue creatures, of circular and ovular creatures, and of smooth and fuzzy creatures experienced each sort of change.

In the familiarization phase of the Discreteness condition (Fig. 1), the array featured eight creatures who were still distinctly either fuzzy or smooth, but whose color and shape varied along a gradient. Thus, texture was a discrete trait but shape and color were not. There were eight equally-spaced gradations in color between light and dark blue, and eight equally-spaced gradations in shape from circular to ovular. Again, traits were crossed so that color and shape were unrelated to texture – the average color ranking of the fuzzy and the smooth creatures were equal, and the average shape ranking of the fuzzy and smooth creatures were equal (see Table 3).

In the familiarization phase of the Labels condition, the experimenter pointed to each creature and said, “this one is a Wub” or “this one is a Weeb” depending on its texture. Thus, labels varied by texture rather than by color or shape. The creatures were not referred to as ‘Wubs’ or ‘Weebs’ at any other point in the procedure.

In sum, across conditions all children were introduced to an array of creatures that varied in color, shape, and texture. Across conditions, they were provided a cue during the familiarization phase (Labels, Discreteness, and Stability conditions) that highlighted texture, rather than color or shape – or they were not provided with any such cue (Control condition).

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Children were then taught a kind-relevant property about a target creature, and we assessed whether children's texture-based generalization of this property differed between the conditions.

Results

We coded the number of trials out of six on which participants generalized the property to the texture-matched creature. Preliminary analyses showed that the data were distributed bimodally, with the most common scores being 3/6 and 6/6. Given that the data did not meet the normality assumption of parametric tests, we chose to conduct binomial logistic regressions and chi-square analyses. We dichotomized participants into those who consistently generalized based on texture (i.e., on all six trials) and those who did not. Frequencies of participants who consistently made texture generalizations are shown in Figure 2a. Given that the Control condition assessed children's baseline tendency to make texture generalizations, comparisons across conditions speak to children's use of labels, stability, and discreteness cues to make texture generalizations above these baseline rates. However, this approach does not focus on children's absolute performance (i.e., relative to mathematical chance), a point we return to in the General Discussion.

To assess the impact of the conditions broadly, we first conducted a binomial logistic regression with texture generalization as the dependent variable (1 = consistent texture generalization across all 6 trials, 0 = all other response patterns), age (in months) as a covariate, and condition entered as fixed factors; the Control condition served as the reference category for dummy coding the Labels and experimental conditions. The overall model significantly predicted whether children would make consistent texture generalizations ($X^2(3) = 9.02, p = .03$). In line with our prediction, participants in the Labels condition (48.5%, 16/33 children) were significantly more likely, relative to participants in the Control condition (23.7%, 9/38 children),

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to make consistent texture generalizations ($Z = 2.27, p = .024$). However, participants were no more likely to make consistent texture generalizations in the experimental conditions, relative to the Control condition ($Z = .513, p = .61$). The analysis also revealed a marginal effect of age ($Z = 1.87, p = .06$); a subsequent block including the interactions between age and each condition did not explain significantly more variance in the dependent variable.

In order to determine whether performance in the experimental conditions also differed from performance in the Labels condition, we conducted follow-up chi-square tests comparing performance in each experimental condition (Stability and Discreteness) to performance in the Labels condition. Both tests revealed marginally significant relations between condition and performance (Stability: $X^2(1) = 3.16, p = .076$, Discreteness: $X^2(1) = 3.14, p = .076$). Taken together, these analyses suggest that performance in the experimental conditions was more similar to performance in the Control condition.

Although we did not make any a priori hypotheses about age differences in performance, the marginal age effect found in the primary analysis motivated additional exploratory analysis. To do so, we split our sample into participants under five years and those five years and older (based on a median age of 61 months), and then conducted the primary binomial logistic regression analyses, discussed above, separately within each age group. These analyses suggested that the effects discussed above were driven primarily by the performance of five- and six-year-old participants (see Fig. 2b). The overall model for the younger participants was not significant ($X^2(3) = 2.27, p = .519$). In contrast, the analyses on the older five- and six-year-old participants yielded a significant overall model ($X^2(3) = 10.6, p = .014$), with participants significantly more likely to make consistent texture generalizations in the Label condition relative to the Control condition ($Z = 2.78, p = .005$), but not in the experimental conditions

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relative to the Control condition ($Z = .318, p = .751$). Follow-up chi-square analyses also revealed that participants' performance in both the Stability and Discreteness conditions significantly differed from Labels conditions (Stability vs. Labels: $X^2(1) = 6.79, p = .01$; Discreteness vs. Labels conditions: $X^2(1) = 4.8, p = .03$), supporting the conclusion that performance in the experimental conditions was overall more similar to the Control condition than the Labels condition.

Discussion

In Experiment 1 we found that, although children used labels as cues to form texture categories, replicating previous work, children did not appear to use stability or discreteness cues to do so any more frequently than they did in the absence of any cues (i.e., in the Control condition). Despite the large body of research demonstrating that when children essentialize a category they then infer that it is stable and discrete, children do not readily make the inverse inference – they do not spontaneously use the observed stability and discreteness of a trait to form categories any more often than they do at baseline. Therefore, these findings suggest that inferences about the stability and discreteness of a property instead are consequences of children's category representations, not cues toward them.

While we did not make predictions about developmental changes, we found that only older children used labels to form texture categories. While research shows broadly that children can use labels to form novel categories (Chambers, Graham, & Turner, 2008; Rhodes, Leslie, & Tworek, 2012) and to override visual similarity when making inferences (Davidson & Gelman, 1990; Hollander, Gelman, & Raman, 2009; Jaswal & Markman, 2007), our finding is consistent with work suggesting developmental differences in this ability. For example, some research finds that use of labels to form categories is especially strong by five years of age (Diesendruck &

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Peretz, 2013), that four year old children may require more extensive input to use labels relative to adults (i.e., not just labels themselves, but labels in the immediate context of generic claims about the category; see Gelman, Ware, & Kleinberg, 2010), and more broadly, that use of labels to form inductively potent categories increases over development (Gelman, Star, & Flukes, 2002). Given that we did not make predictions about developmental changes, however, we caution against making strong interpretations of these effects.

One potential concern with this experiment may be that it was simply too difficult for children to form a novel category based on texture. Indeed, we expected texture to be much less salient than color and shape as traits. Strong shape biases early in development may have led children to not notice or to disregard other traits (Diesendruck & Bloom, 2003; Jones, Smith, & Landau, 1991; Landau, Smith, & Jones, 1988). Thus, using texture as the target trait may have created too difficult of a test to determine whether children can use certain stability or discreteness as cues to essentialize the category.

Still, we believe that the subtlety of texture alone is unlikely to account for the current findings. Recall that participants in the Labels condition *were* able to form categories based on texture, doing so significantly more than participants in the Control condition. Moreover, the labeling procedure itself was rather minimal (i.e., the experimenter did not instruct children that the labels corresponded to particular textures). In fact, compared to other conditions, children in the Labels condition experienced the briefest exposure to the cue and the most time elapsing between presentation of the cue and the test phase. Thus, we believe it is unlikely that performance in the Stability and Discreteness conditions reflects the overall difficulty of using texture as an inductive trait; rather, children's failure to form categories based on texture in these

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conditions appears to reflect the *conceptual* difficulty of using stability and discreteness cues to form categories.

However, as we did not include a manipulation check in our procedure, we cannot be certain that children encoded the stability and discreteness cues provided during the familiarization phase. As a result, it is not clear whether children's failure to form texture categories in the experimental conditions, relative to the Control condition, was because they did not *encode* discreteness and stability information during familiarization, or because they did not view this information as conceptually indicative of categories. In Experiment 2, we investigate whether either of these factors, or both, might have contributed to children's performance.

Experiment 2

In Experiment 2, we aimed to investigate whether children did not form texture categories in Experiment 1 because (a) they did not encode the stability or discreteness of this trait during the familiarization phase, and/or (b) they did not view discreteness and stability as conceptually indicative of categories. To explore this question, we made two procedural changes to Experiment 1: First, we increased participants' exposure to each cue, reasoning that this would increase the likelihood that participants encoded each cue. In particular, we spent more time familiarizing participants to the cues, and we also made the stability cue more apparent by making the creatures' shape and color change on all trials, while texture stayed constant. Second, we also checked whether participants could later recognize the cue that had been presented to them during the familiarization phase. This recognition check enabled us to assess (a) what proportion of participants encoded and then recognized each cue – data which could indicate participants' sensitivity to each cue, as well as (b) whether participants who did successfully

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encode and then recognize the cue used it to form texture categories – data which could indicate whether participants represent discreteness and stability as conceptually indicative of categories. While this recognition check did not directly assess participants' initial encoding of the cue through any perceptual measure, encoding the cue during the familiarization phase would be necessary to later recognize the cue during the recognition check.

We tested children in only the two experimental conditions, Discreteness and Stability. We also focused specifically on older five- to six-year-old children, given the age trend we found in Experiment 1.

Method

Participants. Between October 2017 and July 2019, 152 five- to six-year-old children recruited from local museum settings participated in this study. We recruited participants in each between-subjects condition (Discreteness and Stability) until at least 33 participants in each condition had passed the recognition check and 33 had not. A power analysis indicated that this sample size was sufficient to detect a medium effect size in a chi-square analysis comparing the performance of participants who passed the recognition check to the performance of participants in the Control and Labels conditions of Study 1 at a power level of at least 80%. We first collected all data for the Stability condition and then collected all data for the Discreteness condition. Within the Stability condition there were 77 participants (44 girls; mean age = 5.79 years; $n = 38$ who passed the recognition check), and within the Discreteness condition there were 75 participants (41 girls; mean age = 5.84 years; $n = 34$ who passed the recognition check).

Materials. Materials were identical to those used in the Discreteness and Stability conditions of Experiment 1, except for changes made to the familiarization slides and the addition of recognition check slides.

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The following changes were made to the familiarization slides of Experiment 1: Whereas in the Discreteness condition of Experiment 1, a single slide depicted an array of eight creatures, in Experiment 2 there were six such slides, each depicting a different array of the same eight creatures. In all arrays, as in the Discreteness condition of Experiment 1, texture was discrete (creatures were either fuzzy or smooth), but color and shape varied along a gradient. Whereas in the Stability condition in Experiment 1, eight slides showed slow animations of each creature getting larger, representing its growth over the lifespan, in Experiment 2 there were 16 such slides. Furthermore, although in Experiment 1 color and shape varied more naturalistically, in Experiment 2 color and shape always changed to the opposite trait while texture always stayed stable.

In addition to these changes to the familiarization slides, we also added two slides for the recognition check (see Fig. 3), placed after the test slides to enable direct comparison across experiments. Each recognition check slide showed one image from the familiarization slides (an array of creatures in the Discreteness condition, or a creature growing into an adult in the Stability condition) alongside an image that was not from the familiarization slides and did not indicate texture being uniquely discrete (Figure 3a) or stable (Figure 3b).

Procedure. The procedure was similar to the procedure of Experiment 1, except for the increased number of slides during the familiarization phase, as discussed above. We also included two recognition questions following the test phase, which comprised the recognition check. For each question, the experimenter asked the child, “Can you tell me which one(s) you saw at the very beginning of this game?” and presented a recognition check slide (Figure 3). The participant responded by pointing.

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Results

As in Experiment 1, we coded the number of trials out of six on which participants generalized the property to the texture-matched creature, and we found that in both conditions, these data were again distributed bimodally. Thus, as in Experiment 1, we dichotomized participants into those who consistently generalized based on texture (i.e., on all six trials) and those who did not. For the recognition check, we classified children as 'passing' the check when they correctly chose the image presented during the familiarization phase on both questions.

We first compared the overall performance of participants in the Discreteness and Stability conditions between Experiment 1 and Experiment 2. A binomial regression with texture generalization as the dependent variable (1 = consistent texture generalization across all 6 trials, 0 = all other response patterns), age (in months) as a covariate, and condition (Stability vs. Discreteness) and experiment (Experiment 1 vs. 2) entered as dummy-coded fixed factors. The overall model was not significant ($X^2(3) = .516, p = .915$), nor were there significant effects of Experiment or interactions between Experiment and Conditions in the model coefficients. Follow-up chi-square tests revealed that performance differed significantly between each experimental condition of Experiment 2 and the Labels condition of Experiment 1 (Discreteness vs. Labels: $X^2(1) = 7.53, p = .006$; Stability vs. Labels: $X^2(1) = 10.9, p < .001$). Together, these analyses show that despite the increased exposure to discreteness and stability information in Experiment 2, participants were overall no more likely to make texture generalizations, and that participants maintained significantly impaired performance relative to when the experimenter provided labels.

Next, we identified participants who passed the recognition check, and we descriptively assessed what proportion of participants in each condition did so. These data indicate children's

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baseline sensitivity to these cues, including their tendency to spontaneously encode the stability or discreteness of a trait. In the Stability condition, 49% of children (38/77 children) correctly chose the slides depicting creatures' textures as remaining uniquely stable as they grew older. Similarly, in the Discreteness condition, 45% of children (34/75 children) correctly chose the slides depicting texture as the only trait that varied discretely among an array of creatures. Binomial tests indicated that performance in both conditions was above chance (both p 's $< .001$, given a chance rate of 25% accuracy across two forced-choice questions), indicating that children could, overall, recognize the images from the familiarization slides based on these cues. However, interpreting these rates in the context of the lengthy experimenter-guided exposure to these cues during the familiarization phase, children overall still found it somewhat difficult to recognize stability and discreteness information.

Next, we assessed whether children's ability to form texture categories during the test phase was related to their performance on the recognition check. A binomial regression with condition (Stability vs. Discreteness) and recognition check performance (Pass vs. Fail) yielded an overall significant model ($X^2(2) = 15.7, p < .001$). Participants who passed the recognition check were significantly more likely to make consistent texture generalizations compared to participants who did not pass the check ($Z = 3.7, p < .001$). Neither condition, nor the interaction between condition and recognition check performance, contributed significantly to the model. Follow-up chi-square tests further showed that the impact of recognition check performance on texture generalization was consistent within each condition (Fig. 4). In the Stability condition, children were more likely to make consistent texture generalizations when they passed the recognition check (42.1%; 16/38 children) than when they did not (10.3%; 4/39 children) ($X^2(1) = 10.15, p = .001$) (see Fig. 4a). Similarly, in the Discreteness condition, children were more

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likely to make consistent texture generalizations when they passed the recognition check (47.1%, 16/34 children) than when they did not (19%, 8/41 children) ($X^2(1) = 6.48, p = .02$). (see Fig. 4b). Results indicate that children who later recognized the stability or discreteness cues that had been presented during familiarization were able to use these cues to form texture categories more consistently than children who did not recognize these cues.

Finally, we calculated the test trial performance of only the participants in Experiment 2 who passed the recognition check, across both conditions, and we compared it to the performance of participants in the Control and Labels conditions of Experiment 1. Similar to the results from Experiment 1, a binomial regression with conditions entered as fixed factors, dummy coded with the Control condition as reference, yielded a significant model ($X^2(2) = 8.65, p = .013$). Participants were more likely to make consistent texture generalizations in the Labels condition than in the Control condition ($Z = 1.53, p = .005$), but this was not the case for those in the Stability and Discreteness conditions ($Z = 1.53, p = .126$). Follow-up chi-square tests revealed that performance of participants who passed the recognition check was marginally different from performance in the Labels condition ($X^2(1) = 3.43, p = .06$), but not from performance in the Control condition ($X^2(1) = 2.54, p = .11$). These results suggest that the subset of children who later recognized the discreteness or stability cues from the familiarization trials nevertheless did not make texture generalizations as frequently as those who had received labels cues.

In sum, despite substantial increases to the exposure and salience of each cue, children overall continued to be unlikely to form texture categories after receiving these cues. This performance can be partially attributed to children's difficulty with initially encoding these cues; children later who recognized these cues, which required having encoded them initially, relied on

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these cues to form texture categories more frequently than those who did not recognize the cues.

While it is possible that children may have encoded the cues initially but not recognized them later, a possibility we return to in the General Discussion, results also show that even the participants who recognized the cues still formed texture categories at only modest rates in comparison to participants who heard labels. This suggests that performance can also be partially attributed to children representing these cues as weak conceptual indicators of categories.

Discussion

In Experiment 2, we investigated participants' reluctance to rely on stability and discreteness cues to infer a novel category. We increased the salience of each cue and also assessed participants' recognition of each cue.

Despite substantial increases to discreteness and stability information, participants were overall no more likely to form texture categories than participants in the Control condition of Experiment 1, and still less likely to do so than participants in the Labels condition of Experiment 1, indicating children's persistent overall reluctance to use stability and discreteness information to form categories.

Overall, participants were able to later recognize the discreteness and stability information that had been presented during familiarization; they passed the recognition check at above-chance rates. However, less than half of participants passed the recognition check (i.e., passed both questions). Compared to children's 69% rate of forming categories after receiving the procedurally brief labels cues, these rates of passing the recognition check were not strong. Recall that participants spent considerable time being exposed to each cue during the familiarization phase; those in the Discreteness condition viewed six slides and made color, shape, and texture judgments about each one (making 18 judgments overall), and those in the

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Stability condition viewed 16 slides and texture was uniquely stable on each. Participants who encoded a cue during this familiarization phase and relied on the cue during the test phase should have been easily able to pass the recognition check, which immediately followed the test phase and used a format that closely resembled the familiarization phase slides. In sum, participants' cue recognition was above chance, but not at ceiling.

We also found that participants who did recognize the cue were more likely than others to have used the cue to form categories, suggesting that children are capable of interpreting the cue as conceptually indicative of a category. However, these participants' performance was also not at ceiling; in other words, their performance was not as strong as performance in the Labels condition of Experiment 1, which included all participants from that condition.

Together, these findings demonstrate participants' continued reluctance to use stability and discreteness cues, and they also shed some light on the factors underlying this reluctance. Children's performance may partly reflect their difficulty with encoding the cues, given that those who later recognized the cues (which required having encoded them initially) were more likely to form categories than those who did not recognize the cues. However, encoding issues are unlikely to account entirely for participants' performance, given that even participants who did recognize the cues (and, therefore, had also encoded the cues) still did not form categories as readily as those who received labels as cues. Therefore, children's performance may also reflect a view of these cues as only modestly conceptually indicative of categories, relative to labels.

General Discussion

In this study, we investigated children's ability to use the discreteness or stability of a trait as cues to form a novel category. We introduced child participants to novel creatures who

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varied in color, shape, and texture, and we cued children to form categories based on texture rather than based on color or shape. We then assessed children's use of texture as an inferential base to make judgments about individuals. Experiment 1 compared participants' use of discreteness and stability cues to their use of generic labels (a cue we expected children to use, based on previous research) and their performance when given no cue. Compared to participants' performance in the absence of any cue, participants were able to use labels to inform their judgements, in line with previous research. However, children did not use discreteness or stability cues to form texture-based judgments any more often than they did at baseline.

Experiment 2 increased participants' exposure to each cue and found that participants who did recognize these cues were more likely to use them to form categories. However, children overall continued to not readily use these cues to form categories above baseline rates, and even children who later recognized these cues did not use them as readily as those who received labels cues in Experiment 1. Thus, we find that children are capable of using discreteness and stability as cues to form a novel category when they encode these cues – a novel contribution to the essentialism and categorization literature. However, interpreting the results of both studies holistically, we also find that children are overall reluctant to use these cues, a reluctance driven by both an insensitivity to the cues as well as a construal of these cues as only weakly conceptually indicative of categories, at least with respect to texture categories. These results underscore the unique power of labels as a cue toward category formation, and also suggest that despite children's tendency to infer that animate categories are stable and discrete, children may not readily use stability and discreteness to infer animate categories. In other words, stability and discreteness may largely be inferences *from*, but not *toward*, category representations.

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Across conditions, the relevant cue always highlighted texture rather than color or shape. Previous research indicates that children are likely to form categories based on shape more easily than texture or color (Diesendruck & Bloom, 2003; Jones, Smith, & Landau, 1991; Landau, Smith, & Jones, 1988). Building off of this research, we chose to have the cues highlight texture because children would not otherwise consider texture indicative of a category. Although we were not interested in comparing the category-inducing potential of color, shape, and texture, we acknowledge that highlighting a different trait may have produced different results. Nevertheless, we believe that the subtlety of texture as a trait is unlikely to account for children's reluctance to use discreteness and stability cues. Recall that children who heard generic labels did form texture categories despite the procedural brevity of this cue (i.e., participants heard creatures labeled only once, at the beginning of the procedure). Although changing the highlighted trait may impact children's categorization abilities, we expect this change would impact performance similarly across conditions. Thus, the findings reported in the current study still suggest that children find it difficult to use the stability and discreteness of a trait to form a novel category.

While children are less likely to form texture categories at baseline relative to forming color or shape categories at baseline, children may still have been more likely to use texture when making their generalization judgments than to make their judgments completely at random. Indeed, a child who made truly random judgments would have less than a 2% chance of making consistent texture generalizations across all six test trials. Comparing performance to this rate of absolute chance, performance in all conditions was above-chance. This suggests that participants in the Control condition did not make completely random choices on the test trials, but instead relied on the traits visible to them (color, shape, and texture) to inform their judgments. For this reason, we compared children's performance in the Labels and experimental conditions to the

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Control condition, rather to rates of absolute chance. As such, our results speak to children’s use of cues to form texture categories more frequently than their baseline tendency to do so, in the absence of any cue.

The current study contributes to research on children’s essentialist beliefs about natural and social categories by exploring how children form their categories initially. A wealth of research indicates that, when children represent a category as essential, they infer that it has sharp, discrete boundaries and that category membership is stable over the lifespan (see Gelman, 2003 for review). However, research has not explored whether children also use these cues to make inferences in the “other” direction – inferring a category from a trait’s observed stability and discreteness. The present study finds that, while children are capable of using discreteness and stability as cues to form a novel category more frequently than they would form this category at baseline, children are overall unlikely to use these cues to do so, despite a demonstrated ability to use labels do so. Thus, despite the large body of research on essentialism demonstrating that children expect a variety of categories to be stable and discrete, results suggest that children do not readily expect stable and discrete traits to indicate categories.

In particular, we find that children’s reluctance to use stability and discreteness may be dually driven by a reluctance to encode these cues as well as by a reluctance to represent them as strong indicators of a category when they are encoded. Both of these mechanisms suggest a lack of conceptual focus on stability and discreteness as useful for carving the world into categories. First, regarding children’s reluctance to encode discreteness and stability cues: We did not assess children’s encoding of the cues directly, at the time of familiarization, limiting our ability to draw direct conclusions about children’s encoding of the cues. However, initial encoding of the cues was required to pass the recognition check. Despite ensuring that children received lengthy

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exposure to discreteness and stability information, we found that children's rates of passing the recognition check were not at ceiling (i.e., were not as high as children's rates of using labels, which required having encoded labels), suggesting that children found it relatively difficult to encode stability and discreteness information. Alternatively, given that the recognition check did not capture encoding directly, perhaps children encoded but found it difficult to remember this information. If so, then children's performance should have been hindered on both the test trials as well as the recognition check. Thus, the results suggest that children's overall difficulty with encoding and/or remembering the cues may have contributed to their reluctance to use these cues to inform their judgments on the test trials.

Results suggest that children may not spontaneously track these cues or expect them to convey kind-relevant information (unlike labels). Previous research shows that children do generally choose to learn information that will be informative about a category (Foster-Hanson & Rhodes, 2019), demonstrating that they have ideas about what information will be informative for their category learning and choose to learn that information. However, the present findings suggest that children may not learn discreteness and stability information in a similar way, suggesting that children may not expect these cues to convey kind-relevant information. These findings align with research showing that young children tend to ignore the diversity of a sample when learning about familiar natural categories (Gutheil & Gelman, 1998; Lopez, Gelman, Gutheil, & Smith, 1992; Rhodes, Gelman, & Brickman, 2008). For example, young children view a diverse sample of mammals (a lion and a mouse) as no more useful than a non-diverse sample (a lion and a tiger) for making generalizations about mammals. Here we extend these findings, demonstrating that children similarly ignore sample diversity information (specifically,

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information about whether a sample varies discretely or along a gradient) when it comes to initially forming their categories.

We also found that, among children who did encode and then recognize the cues, children *can* use them to form categories above baseline rates, demonstrating that children are capable of representing these cues as conceptually indicative of categories. However, recall that children's performance here was not at ceiling; children who noticed these cues still did not use them to form categories as readily as children who had heard labels. Moreover, even though children overall recognized the cues at above-chance rates, they did not overall make texture generalizations at rates different from the Control condition. Together, these findings suggest that children do not construe discreteness and stability as strong indicators of an essential category. This is surprising in light of proposals that labels convey essentialism *because* they highlight category boundaries (Foster-Hanson, Leslie, & Rhodes, 2016; Lupyan, 2006) or within-category coherence (Davidson & Gelman, 1990). Here, we find that labels are inductively powerful even when isolated from the category boundary or coherence information they map onto, and moreover that category boundaries and coherence themselves are not interpreted as strongly indicative of essential categories. These findings align with work showing that labels serve as an inductively useful cue even beyond the category distinctions they highlight (Lupyan, Rakison, & McClelland, 2007). We build on this work by demonstrating that children do not readily use a category's discreteness or stability to make category-based inferences.

One important difference between the labels cue and the discreteness and stability cues was the inherent communicative nature of labels. It is possible that the experimenter's role in communicating labels may have signaled something to children beyond the label itself -- perhaps that the experimenter saw these labels as worth mentioning. After all, research shows that

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children's category judgments are sensitive to communicative factors, such as the confidence with which a speaker uses generic language (Stock, Graham, & Chambers, 2009) and whether the generic language was used in a pedagogical context (Gelman, Ware, Manczak, & Graham, 2013). More broadly, children's generalizations are sensitive to whether information is presented in an intentional, pedagogical, or accidental manner (Butler & Markman, 2012, 2013). Therefore, the communicative nature of the labels cue may have supported its impact. It is possible that, had discreteness and stability similarly been communicated, these cues could also have led children to form categories more than in the Control condition. Future research should explore why, precisely, generic labels are such a powerful cue toward category formation.

The present findings also contribute to research on how different component beliefs of essentialism relate to one another. While some research has focused on how component beliefs covary with one another (Haslam, Rothschild, & Ernst, 2000) or has compared children's beliefs in different components of essentialism (Heiphetz, Gelman, & Young, 2017), the present study used an experimental design with novel social categories to explore whether different component beliefs can give rise to a novel, inductively potent category representation. The results suggest that discreteness and stability may be consequences of essentialist beliefs about categories, but that observed discreteness and stability may not give rise to category representations initially.

As noted in the Introduction, the theoretical question motivating the current study was whether stability and discreteness beliefs are merely consequences of essentialist representations, or whether they might also be cues toward initially forming essential categories. However, we did not assess essentialist category representations directly in this study, limiting our ability to address this question directly. Inductive inference tasks indicate category representations broadly (Baron, Dunham, & Banaji, 2006; Stock, Graham, & Chambers, 2009), but not necessarily

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essentialist category representations, which entail a richer set of beliefs not only about inductive potential, but also about heritability, historical invariance, an inner causal essence, and more.

Given that children's default representation of categories in the natural and social domains is an essentialist one, we believe it is likely that in the absence of any prior information, the inductively potent animate categories children formed on our task may be essential categories.

However, given that we did not confirm essentialist representations in their entirety, the question of how discreteness and stability cues impact other components of essentialist beliefs, beyond inductive potential, warrants further investigation. For example, given recent research indicating that labels may indicate kinds but not always essences (Noyes & Keil, 2019), it is possible that that discreteness and stability may indicate essences but not always kinds, and therefore that a task assessing beliefs about internal causal essences would have yielded different results. The present findings represent a first step in understanding how observing certain components of essentialist representations may give rise to other components of essentialist representations. Future research should continue to investigate this broad question by exploring different cues (beyond stability and discreteness) and different outcomes (beyond inductive potential).

While inductive potential is only one element in the constellation of beliefs comprising essentialist representations, we chose an inductive inference task because of its long history in studies on children's formation of essential categories, and specifically in studies on children's use of labels to do so (Davidson & Gelman, 1990; Gelman & Coley, 1990; Gelman & Markman, 1986; Walton & Banaji, 2004). We wanted to explore children's use of discreteness and stability cues in a way that was parallel to classic research on children's use of labels as cues. Our finding that children are reluctant to (but able to) use stability and discreteness cues to form inductively potent categories builds on this foundational work. We show that, relative to labels, children do

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not view readily discreteness and stability as indications of animate categories, despite their view of animate categories as discrete and stable.

Below, we discuss the implications of these findings for children's natural and social category reasoning. However, as creatures in this study were construed by children as neither firmly natural nor firmly social, both sets of implications should be interpreted with some caution. It is possible that, had we shifted children toward conceiving of the creatures as either firmly animal-like or firmly person-like, children's encoding of or reliance on discreteness and stability cues might also have shifted, just as research shows that children's reliance on labels varies by domain and even by category. For example, Diesendruck and Weiss (2015) found that children relied most on labels to categorize the least-essentialized social category (shirt color), and relied the least on labels to categorize the most-essentialized social category (gender). Similarly, Diesendruck and Peretz (2013) found that children relied more strongly on labels to categorize (less-essentialized) artifact categories than to categorize (more-essentialized) animal categories. Together, these studies suggest that labels are most useful as a cue for carving out categories that are cultural constructions (i.e., less essentialized), rather than for those that are construed as natural kinds (i.e., essentialized). In the present study, children had no firm preconceived essentialist construal of the category; however, the broader point remains that children's willingness to use a given cue might interact with their construal of the domain of the category. Future research should explore how children's use of discreteness and stability cues might vary by domain, which could shed valuable light on children's reasoning in each domain, as well as on broader questions about whether children conceive of social categories *as* natural kinds (Atran, 1990; Rothbart & Taylor 1992).

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In the social domain, the findings contrast with the assumption that demographic changes in social categories' discreteness and stability may affect social category representations. If the observed discreteness and stability of a social category does not give rise to category representations in the first place, changes in the discreteness and stability of a social category may be of little consequence to these representations. Several studies find that individuals who are multiracial or transgender themselves hold reduced essentialist beliefs (Fast & Olson, 2018; Olson & Gülgöz, 2018; Pauker & Ambady, 2009). However, research is more mixed on how cisgender and monoracial individuals' essentialist beliefs are affected by exposure to others' multiracial and transgender identities: One study found that living in Hawaii, an environment with a large multiracial population, was related to lower racial essentialism among White adults (Pauker, Carpinella, Meyers, Young, & Sanchez, 2017); however, other research suggests that these effects may be best explained by social tuning (i.e., that monoracial Whites adjust their own essentialist beliefs to align with their expectations about multiracials' reduced essentialist beliefs), rather than reflecting deeper conceptual change (Gaither, Toosi, Babbitt, and Sommers, 2018). Similarly, Olson and Gülgöz (2018) found that cisgender siblings of transgender children showed reduced essentialist beliefs about gender compared to cisgender peers from other families. However, confounding differences between families (i.e., their beliefs about gender or how they talk about gender) cannot be perfectly controlled for. In the present study, by using an experimental design with novel categories, we ensured that participants held no prior beliefs about the categories in the study. Results suggest that the observed discreteness and stability of a trait alone might not strongly contribute to social category representations. Therefore, demographic changes in the discreteness or stability of a social category might not have dramatic impacts on essentialist beliefs, because these cues may not have driven the original essentialist

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representation of a social category. In other words, changes in social category representations, based on living in an area with a large multiracial population or living in a family with a transgender sibling, might not be driven directly by exposure to non-discrete or non-stable identities, but might instead be driven by how the region or family talks and thinks about those identities – in line with our findings about the powerful impact of labels.

In the natural domain, our results can similarly support speculations about how exposure to natural category fluidity and flexibility might affect natural category representations – or not. Children and adults struggle to understand natural phenomena that appear to violate their essentialist beliefs in the stability and discreteness of natural categories. For example, children's essentialist intuitions make it difficult for them to understand metamorphosis (Evans, Szymanowski, Smith, & Rosengren, 2005; Rosengren, Gelman, Kalish, & McCormick, 1991) and evolution by natural selection (Emmons & Kelemen, 2015; Shtulman & Schulz, 2008). Essentialist intuitions have also been shown to underlie adults' aversion to genetic hybrids, such as Genetically Modified Organisms (GMOs), which violate discreteness beliefs about natural categories (for review, see Wagner et al., 2010). One might assume that children's and adults' thinking about these topics might be shaped, in part, by their familiarity with categories being discrete and stable, and their lack of exposure to categories that are fluid or flexible. However, the present studies suggest that children, at least, do not readily rely on observed stability or discreteness to form their category representations. Therefore, increased exposure to metamorphosis or GMOs may not foster conceptual change in children's natural category representations, because these representations may not have formed in response to observed stability or discreteness information initially.

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In sum, the findings from the current study inform our understanding of how children initially carve their world into categories. We replicate previous work on the importance of generic labels in this process, and we show that children rely comparatively less on discreteness and stability cues. Despite wide evidence that children believe natural and social categories are discrete and stable, they do not readily notice traits' discreteness or stability, nor do they readily use these cues to form their categories.

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Tables

Table 1. Test trials (all conditions).

Target creature: Light blue, ovular, smooth (shared traits in bold)	
Creature on left	Creature on right
Light blue , ovular , fuzzy	Dark blue, ovular , smooth
Dark blue, ovular , smooth	Light blue , ovular , fuzzy
Dark blue, circular, smooth	Light blue , circular, fuzzy
Dark blue, ovular , fuzzy	Dark blue, circular, smooth
Light blue , circular, smooth	Light blue , ovular , fuzzy
Light blue , circular, fuzzy	Dark blue, circular, smooth

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Table 2. Familiarization slides from the Stability condition.

Creature as baby	Creature as adult (changed properties in bold)
Light blue, ovular, smooth	Dark blue, circular , smooth
Light blue, circular, fuzzy	Light blue, ovular , fuzzy
Light blue, ovular, fuzzy	Dark blue , ovular, fuzzy
Light blue, circular, smooth	Light blue, circular, smooth
Dark blue, ovular, fuzzy	Dark blue, ovular, fuzzy
Dark blue, circular, smooth	Light blue , circular, smooth
Dark blue, ovular, smooth	Dark blue, circular , smooth
Dark blue, circular, fuzzy	Light blue, ovular , fuzzy

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Table 3. Familiarization slides from the Discreteness condition.

Color (1 = lightest blue, 8 = darkest blue)	Shape (1 = maximally ovular, 8 = maximally circular)	Texture
6	2	Fuzzy
7	3	Fuzzy
2	6	Fuzzy
3	7	Fuzzy
5	1	Smooth
8	4	Smooth
1	5	Smooth
4	8	Smooth

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Figures

Figure 1.

	Control condition	Stability condition	Discreteness condition	Labels condition
Familiarization phase	<p>Shown array of eight creatures. Their color, shape, and texture vary discretely.</p>	<p>Shown array of eight creatures. Their color, shape, and texture vary discretely.</p>	<p>Shown array of eight creatures. Their texture varies discretely but color and shape vary along a gradient. See Table 3.</p>	<p>Shown array of eight creatures. Their color, shape, and texture vary discretely. Creatures are labeled according to their texture.</p>
	<p>Shown creatures growing older. Their color, shape, and texture remain stable.</p>	<p>Shown creatures growing older. Only their texture remains stable. See Table 2.</p>	<p>Shown creatures growing older. Their color, shape, and texture remain stable.</p>	<p>Shown creatures growing older. Their color, shape, and texture remain stable.</p>

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Teaching phase	<p data-bbox="340 199 1339 232">Taught a property of one creature; taught another property of another creature.</p> <div data-bbox="415 245 1104 760"> </div> <div data-bbox="1199 245 1887 760"> </div>
Test phase	<p data-bbox="340 784 1304 816">Asked to generalize property to new creatures in six test trials. See Table 1.</p> <div data-bbox="810 833 1497 1351"> </div>

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Figure 2.

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Figure 3.

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Figure 4.

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Figure captions

Figure 1. Summary of procedure across conditions. Differences between conditions, in bold, occur in the familiarization phase only.

Figure 2. Texture-based generalizations in Experiment 1, by (a) condition and (b) age and condition.

Figure 3. Example recognition check slides from the (a) Stability condition and (b) Discreteness condition.

Figure 4. Texture-based generalizations in Experiment 2, by those who passed and did not pass the recognition checks, in the (a) Stability condition and (b) Discreteness condition.