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# Building theory-based concepts: Four-year-olds preferentially seek explanations for features of kinds ☆

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ABSTRACT

Is the structure of human concepts continuous across development, or does it undergo qualitative transformations? Extensive evidence with adults has demonstrated that they are motivated to understand why categories have the features they do. To investigate whether young children display a similar motivation—an issue that bears on the question of continuity vs. transformation in conceptual structure—we conducted three studies involving 4-year-olds ($N = 90$) and adults ($N = 124$). Experiments 1 and 2 suggested that 4-year-olds indeed display a strong motivation to explain why categories have the features they do. Specifically, when provided with the option of asking "why?" about features of novel categories vs. features of individuals from other novel categories, children preferred to ask "why?" about the category features. Moreover, children's explanatory preference was specific to facts about categories per se and did not extend to facts that were merely presented in the context of multiple category instances. Experiment 3 also ruled out the possibility that the category facts were preferred because these facts were more surprising. In sum, these three studies reveal an early-emerging motivation to make sense of the categories encountered in the world and, more generally, speak to the richness of children's conceptual representations.



## 1. Introduction

A fundamental characteristic of human cognition is its ability to group distinct objects in the world into equivalence classes. Although no two apples are exactly the same, for example, on many occasions we think of them as equivalent tokens of the same *category* or *kind*. The ability to represent unique objects as interchangeable members of these broader classes is essential for much of human activity, from the mundane (e.g., referring to distinct objects with the same count noun) to the esoteric (e.g., diagnosing different patients with the same illness). Despite the centrality of categorization to our thinking and behavior, and despite many decades of research, key questions about its operation are still subjects of debate (for a review, see Murphy, 2004): What are the processes that underlie our ability to categorize, and how are the resulting categories represented? Many of the early answers to these questions emphasized the role of similarity, usually defined as feature overlap (e.g., Medin & Schaffer, 1978; Nosofsky, 1986; Rosch & Mervis, 1975). For example, if an object shares a sufficient number of features with remembered exemplars of the apple category (or, on other

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accounts, with this category's prototype), then it would be categorized as an apple. Although the extent of feature overlap is no doubt important, more recent arguments have increasingly recognized that categorization is also deeply *theoretical*, in the sense that it is bound up with people's causal beliefs and explanations rather than relying solely on statistical facts about feature frequencies (e.g., Ahn & Luhmann, 2004; Carey, 1985; Gelman, 2003; Heit, 1994; Keil, Smith, Simons, & Levin, 1998; Medin, 1989; Murphy & Medin, 1985; Prasada & Dillingham, 2006, 2009; Rehder, 2003). For example, even if an object shared very *few* features with previously encountered exemplars of the apple category, it may nevertheless be categorized as an apple if it was picked from an apple tree or if an apple sapling sprouted from its seeds—information that connects with our intuitive theories about biological reproduction.

To elaborate, the main thrust of the claim that categorization is theoretical is that human concepts comprise not just information about *what* features are characteristic of each category but also information about *why* each category has the features it does. For example, beyond simply learning that apples have seeds, stems, and other such features, people might also invoke—often implicitly—their intuitive biological knowledge to arrive at some understanding of why apples have these features (how they came about, what functions they may serve, etc.). For our purposes here, it is important to note that these two conceptual components (*what* and *why*) differ not just in their content but also in how they are typically acquired. Although the features associated with a category can be learned more or less passively by exposure to exemplars of the category, the *reasons* for these features are never on display in the world and must instead be generated by means of additional, often self-initiated, processing (e.g., retrieving relevant knowledge from memory, searching through the retrieved information for plausible reasons). In light of the extra steps required to infer why categories have the features they do, it is apparent that humans must at some level be *motivated* to understand the categories they identify in the world (Kaplan & Murphy, 2000; Murphy, 2000; Gopnik, 1998); if they were not, it is unclear why they would routinely, and without prompting, attempt to find the reasons behind the features of categories.

The present research explored the developmental origins of this motivation to understand why categories have the features they do. We pursued the question of origins for two reasons. First, from a descriptive viewpoint, it is important to know whether this motivated aspect of human concepts is a sophisticated late addition or a basic, early-developing component. Does the motivation to ask "why?" about features of categories arise only after the bulk of cognitive development has already occurred—perhaps once people have accumulated a certain amount of general world knowledge and the neurocognitive processes involved in generating explanations have matured sufficiently? Or is this motivation present even in young children, despite their sparse knowledge and limited cognitive resources? A second reason to pursue the origins question is that the timing of the emergence of this motivation has strong implications for theories of conceptual development. Specifically, its timing would bear on current debates about whether early concepts consist entirely of perceptual associations or incorporate more abstract components such as explanations. Before we spell out the predictions of these two theoretical perspectives with respect to whether the motivation to explain category features would be present in childhood, we review some of the evidence that this motivation is present in adults.

The claim that adults actively seek reasons for category features finds support in studies in which undergraduate participants were asked to learn novel categories. If adults are motivated to make sense of the categories they are learning, rather than learning them by rote, then category learning should be faster when the circumstances facilitate explanation (and thus sense-making). Consistent with this prediction, categories whose features fit together in explainable ways (e.g., novel vehicle categories with thematically-related features such as "made in Norway," "drives on glaciers," and "heavily insulated") were learned faster than control categories whose features were equally predictive of category membership but lacked clear explanatory connections (e.g., "white," "automatic," and "cloth seat covers"; Murphy & Allopenna, 1994;Pazzani, 1991; Wisniewski, 1995; Wisniewski & Medin, 1994). Not only did subjects learn faster when they could generate explanations, but their learning was also more detailed and precise. For example, subjects' estimates of feature prevalence among the members of these theme-based categories were often more accurate than their analogous estimates for control categories (Spalding & Murphy, 1999).

Subsequent research expanded on this initial work, providing additional support for the argument that people are motivated to make sense of the categories they identify in the world. For example, this motivation seems to operate even when the theme-related features (e.g., "drives on glaciers") are relatively infrequent, making up only about 15% of the novel categories' features (Kaplan & Murphy, 1999, 2000) rather than the majority of them, as in some of the original studies (e.g., Murphy & Allopenna, 1994; Spalding & Murphy, 1996). The fact that category learning benefits from the theme information even in a context in which extra cognitive effort is required in order to identify and use the themes for this purpose is consistent with the claim of a background motivation to understand why categories fit together as they do.

In fact, participants often seem motivated to integrate *all* of a category's features into a sensible whole—even ones that do not have a straightforward explanatory fit with the themes (Kaplan & Murphy, 2000). For example, it is not obvious whether Norwegian-made vehicles used for glacier driving should have cloth seats or vinyl seats. Nevertheless, when subjects were randomly assigned to learn that these vehicles had one type of seat or the other, they often generated explanations that allowed them to make sense of that feature and link it up to the broader theme (e.g., a subject who learned that these vehicles had cloth seats reasoned that "cloth seat covers would be better in the arctic because vinyl would get too cold"; p. 842). Here again we see evidence for a strong motivation to fit all aspects of a category into a sensible, explainable whole.

In the present research, we investigate whether this motivation might be present early in development. As mentioned above, this question bears on a core debate in cognitive development—namely, the debate concerning the nature of early conceptual representations. One side of this debate suggests that children's thinking is item-specific, concrete, and perceptual (e.g., Samuelson & Perone, 2010; Sloutsky & Fisher, 2004a, 2004b; Sloutsky, Kloos, & Fisher, 2007). On this view, young children conceive of objects in the world as unique collections of perceptual features rather than as interchangeable tokens of abstract types or kinds. Two objects are "categorized" together (that is, treated similarly) only to the extent that their perceptual features overlap, and not because of any deeper understanding that they are instantiations of the same kind of thing. From the perspective of this account, there is little reason to expect that children would be particularly motivated to explain features of categories—after all, young children cannot conceive of such things in the first place. In fact, this account might be extended to make a different prediction: Since children's thinking is supposed to be item-specific and concrete, we might expect them to be most interested in explaining the features of the specific objects in front of them (rather than the features of the categories to which these objects belong).

According to an alternative theoretical perspective, early concepts incorporate a fair amount of abstraction (e.g., Cimpian & Erickson, 2012a; Gelman & Davidson, 2013; Keates & Graham, 2008; Markman, 1989; Waxman & Gelman, 2007, 2009). On this view, for instance, children are able to entertain thoughts about abstract kinds of things (e.g., apples in general) rather than being limited to thinking about concrete sets of objects (e.g., the apples in front of me; Brandone, Cimpian, Leslie, & Gelman, 2012; Gelman, 2004; Leslie, 2008; Waxman, 1999). Moreover, children's thinking about these abstract kinds is hypothesized to rely on more than just information about correlated perceptual features; among other things, early concepts may include causal-explanatory information that connects a concept's features with one another and with the concept itself (e.g., Barrett, Abdi, Murphy, & Gallagher, 1993; Carey, 1985; Gelman & Koenig, 2003). As may already be apparent, this view allows for considerable continuity across development in the structure of concepts. Although there is undoubtedly growth in the amount and quality of conceptual content between childhood and adulthood, the underlying infrastructure is not thought to undergo major changes. Thus, if adults have a deep-seated motivation to understand why categories have the features they do, this account licenses the prediction that, just like adults, children would be motivated to ask "why?" about features of categories. In fact, this theoretical perspective could be extended to make an even stronger prediction. Given recent evidence that children's cognition may in fact *privilege* information about kinds—for example, in terms of comprehension (e.g., Hollander, Gelman, & Star, 2002) and memory storage (Cimpian & Erickson, 2012a)—one could predict that children would be *particularly* motivated to explain features of categories, perhaps even more so than features of the specific objects in front of them. That is, even though in an absolute sense children may be interested in finding out the reasons for all sorts of things (e.g., Callanan & Oakes, 1992; Frazier, Gelman, & Wellman, 2009), including features of particular objects (e.g., Hood & Bloom, 1979; Kagan, 1981; Legare, Gelman, & Wellman, 2010), their explanatory curiosity might be drawn to categories and their features above and beyond many of these other aspects of experience that also call out for an explanation. This prediction is in direct opposition to the prediction of the "concrete beginnings" view, allowing us to tease the two apart.

To test whether children are more motivated to understand the features of individuals or the features of categories, and thus adjudicate between the predictions of the two accounts above, we devised the following procedure. On each of several trials, children were introduced to two novel kinds of animals and then given a choice: They could find out the reason for a feature of an individual (e.g., why "*this one glippet* collects shiny objects"), or they could find out the reason for a feature of a category (e.g., why "*blins* always sleep on their backs"). In the context of this task, the "concrete beginnings" view of development might predict that—to the extent that children are interested in obtaining any explanations[1]—they should choose to receive explanations for an individual's features more often than a category's features. If, however, children choose to receive explanations for the category features more often than the individual features, then such a preference would speak to the strength of their curiosity about why categories have the features they do, and more generally to the richness of conceptual representations in childhood.

In terms of age, this research focused on 4-year-olds. Two considerations motivated this choice. First, this age falls squarely within the range about which the "concrete beginnings" and "abstract beginnings" accounts make contrasting claims (roughly, up to 6 or 7 years of age; e.g., Fisher & Sloutsky, 2005). Second, we judged that 4-year-olds are probably the youngest age group in this disputed range that would possess the language skills and working memory capacity required for our relatively verbal forced-choice task.

Across three studies, we found consistent support for the prediction that children are motivated to explain why categories have the features they do. In particular, Experiments 1 and 2 provided direct evidence for this prediction, while Experiment 3 clarified the mechanism underlying children's choices.

## 2. Experiment 1

### 2.1. Method

#### 2.1.1. Participants

Forty preschool-aged children ($M_{age}$ = 4.79 years; $SD_{age}$ = 0.52; 20 boys and 20 girls) were recruited in a small Midwestern city. Participants were socioeconomically diverse, and a majority were European American, although

[1] Another possible prediction of the "concrete-beginnings" account could be that children should simply have no preference. The predictions of the two accounts are still different even in this case, and can thus be teased apart.

demographic information was not collected formally. One additional child was tested but excluded from the sample because she refused to complete the task. Children were randomly assigned to an experimental condition ($n = 20$) or a control condition ($n = 20$).

*2.1.2. Materials, procedure, and design*

Children were tested in a quiet room, either in a laboratory or in their school. To simplify the forced-choice procedure and make it more child-friendly, children were introduced at the beginning of the testing session to the Why Box—a shoebox covered in colorful question marks:

> Okay, so now we are going to play a game with this special box called the Why Box. And it's called the Why Box because we're supposed to put in it things that make us ask, "Why is that?"—things that make us wonder why. So, in this game, if I tell you something, and it really makes you want to find out *why*, you can put it in the box, and at the end of the game you can find out why it is. But I can only tell you about the things you put in the Why Box. Those are the rules of the game—I can only explain the things that are in the Why Box.

The children were also told that they would hear two facts and that would have to "listen very carefully to both of them because you will have to choose which one to put in the Why Box." The experimenter then administered the six trials of the main task.

*2.1.2.1. Experimental condition.* On each of the six trials, the experimenter presented children with one fact about a category and one fact about an individual; these two facts involved members of two different novel kinds. The category fact was accompanied by a picture of four members from the relevant category, which were identical in appearance. For example, children saw a picture of four *blins* and heard, "These are blins. And blins always sleep on their backs." We used what are known as *generic statements* (e.g., "blins always sleep on their backs") to express the category facts (e.g., Carlson & Pelletier, 1995). Prior evidence suggests that young children are able to differentiate between the meaning of these statements and the meaning of statements about specific individuals (e.g., Cimpian & Markman, 2008; Cimpian, Meltzer, & Markman, 2011; Gelman & Raman, 2003; Graham, Nayer, & Gelman, 2011). Moreover, children understand generic statements to make claims about categories per se rather than about plural sets (Brandone et al., 2012).

The individual fact presented on each trial was accompanied by a picture of one member from the relevant category. For example, children saw a picture of a *glippet* and heard, "This is a glippet. And this one glippet collects shiny objects." The difference in the number of animals in the pictures (four for the category fact vs. one for the individual fact) was meant to avoid confusion: We reasoned that children may find it difficult to keep in mind which fact was true of a category and which was true of an individual when looking at two pictures that both contained a single animal. (The control condition, described below, was designed to address the potential confound introduced by this difference in the pictures.)

After introducing the two facts, the experimenter asked children to choose one for the Why Box: e.g., "Okay, so what do you want to find out more? Why blins always sleep on their backs, or why this one glippet collects shiny objects?" As she said each fact, the experimenter pointed to the relevant picture. Once children made a choice, they were allowed (and helped, if necessary) to put the picture that accompanied the chosen fact into the Why Box. This procedure was repeated on each trial. Any facts that were chosen for the Why Box were explained by the experimenter at the end of the session, not immediately. The explanations provided at the end were the same regardless of children's choice (e.g., "They sleep on their backs because it's the most comfortable position for them").

We used twelve novel animal kinds, all referred to by novel names (e.g., "blin"). Fig. 1 contains examples of the black-and-white illustrations used to depict animals from these kinds. These illustrations were adapted from those used by Cimpian, Gelman, and Brandone (2010). Each kind was paired with a novel property. The twelve properties (see Table 1 for full list) were chosen so as to be relatively plausible both when they were said to characterize a category (e.g., blins always sleep on their backs) and when they were said to characterize an individual (e.g., this one blin always sleeps on his back). Each property was presented in category form to half of the children and in individual form to the other half; no child heard a property in both forms.

The order in which the category facts and the individual facts were introduced (that is, whether the category or the individual fact was first) was constant across trials for any one participant but was counterbalanced across participants. The two stimuli used on each trial were drawn randomly from the set of 12, with two constraints. First, no stimuli were repeated within a session. That is, children heard each of the 12 novel kind/property combinations listed in Table 1 only once across the six trials. (Also, as noted above, six were presented in category form and six in individual form—one of each on each trial.) Second, any stimulus pairing randomly selected for one child (e.g., blins vs. this one glippet) was presented to another child as well, except in the opposite form (e.g., this one blin vs. glippets). This constraint ensured that that each property appeared equally often in its category and individual forms across children.

*2.1.2.2. Control condition.* In addition to the experimental condition just described, Experiment 1 also included a control condition. This condition was designed to address the possibility that children might simply choose the facts associated with more things. (Recall that the category facts were accompanied by pictures of four animals, whereas the individual facts were accompanied by pictures of a single animal.) The key procedural difference between the experimental and control conditions was that, in the control condition, both of the facts presented on each trial were about an individual. That is, rather than providing a category fact when she brought out the four-animal picture (as in the experimental condition), the experimenter instead said, "These are blins. And *this one blin over here* always sleeps on his back." As she said the fact, the experi-

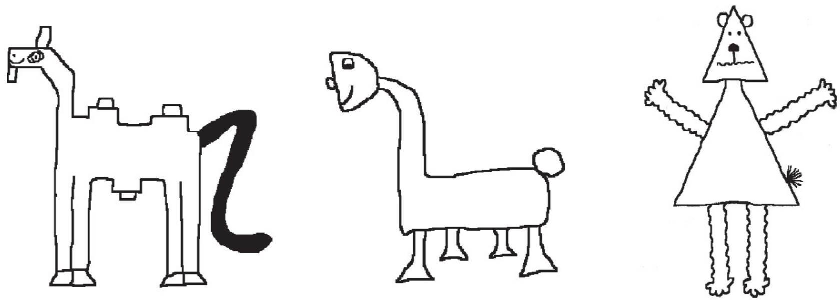


**Fig. 1.** Sample pictures of the novel animals used in Experiments 1 and 2.

**Table 1**
The items used in Experiments 1–3, in their category and individual forms.

| |
|---|
| Blins always sleep on their backs.<br>This one blin always sleeps on his back. |
| Cheebas never eat apples.<br>This one cheeba never eats apples. |
| Daxes have very few babies.<br>This one dax has very few babies. |
| Glippets collect shiny objects.<br>This one glippet collects shiny objects. |
| Kweps never make any sounds.<br>This one kwep never makes any sounds. |
| Lorches only have two teeth.<br>This one lorch only has two teeth. |
| Mooks are really, really dirty.<br>This one mook is really, really dirty. |
| Ollers cannot walk very well.<br>This one oller cannot walk very well. |
| Reesles like to hang upside down all the time.<br>This one reesle likes to hang upside down all the time. |
| Sapers really like the color yellow.<br>This one saper really likes the color yellow. |
| Stups hate the smell of bananas.<br>This one stup hates the smell of bananas. |
| Zorbs have many broken bones in their bodies.<br>This one zorb has many broken bones in his body. |

*Note:* The control condition of Experiment 1 pitted the individual items listed above with individual items phrased as, "This one *x* over here …." The latter items were accompanied by pictures of four animals.

menter pointed to the first animal in the row of four. The trial then proceeded as in the experimental condition, with the experimenter asking the child to choose one of the two facts for the Why Box, and so on.

The predictions for this condition were as follows: If children are responding just on the basis of the number of animals associated with the facts (in this case, the number of animals in the pictures), they should display a significant preference for the individual facts that are accompanied by four-animal pictures. However, if children's selections are driven by their differential curiosity about the reasons for features of categories vs. individuals, then they should not differentiate between the individual-specific facts accompanied by four- vs. one-animal pictures.

At the end of the sessions, children received explanations for the facts they had chosen for the Why Box and were then thanked for participating.

### 2.1.3. Data analysis

Our dependent measure was binary: children's category or individual fact selections on each trial. These data were analyzed with a hierarchical cross-classified logistic regression model with random effects for both subjects and items. This model was computed using the *xtmelogit* command in Stata 12 (StataCorp, 2011). We used an intercept-only model to test whether children selected a type of fact more often than expected by chance (50%). An additional indicator variable for condition (experimental vs. control) was added to the model to test whether the category facts (from the experimental condition) were selected more often than the individual facts accompanied by the four-animal pictures (from the control condition).[2] Standard errors for the coefficients in these regression models were computed by bootstrapping the data using 1000 resamples clustered by subject. As summary statistics, we reported mean percentages, standard deviations, and Cohen's *d*s.

## 2.2. Results and discussion

Our main prediction was that children would be particularly motivated to understand why categories have the features they do. Consistent with this prediction, children in the experimental condition chose to receive explanations for the category facts significantly more often than would be expected by chance (50%), $M = 61.7\%$, $SD = 19.6$, $z = 2.44$, $p = .014$, $d = 0.60$.

Moreover, it is unlikely that children's choices were driven simply by the low-level cues concerning the number of animals that accompanied the facts: In the control condition, children did *not* show a similar preference for the individual facts associated with the four-animal pictures, $M = 40.0\%$, $SD = 26.7$, $z = 1.32$, $p = .187$, $d = 0.37$. In fact, children's selections tended to favor the facts accompanied by pictures of a single animal. To speculate, the reason for this trend may be that children differentiated between the facts

[2] The data from Experiments 1 and 2 were also analyzed with *t* tests, which revealed the same pattern of significant findings.

provided on each trial in terms of how idiosyncratic they were likely to be: When only one of the four animals in a picture was said to possess the relevant property (e.g., "this one blin over here always sleeps on his back"), it was clear that the property was restricted to that animal. The facts introduced via a picture of a single animal lacked this contrastive information and may thus have appeared more generalizable[3]—more likely to apply to an entire category. On this interpretation, the trend to ask "why?" about the facts accompanied by one-animal pictures is compatible with the argument that children are motivated to understand why categories have the features they do.

Finally, comparing the two conditions to each other revealed that, as predicted, children were significantly more likely to want an explanation for the category facts than for the individual facts accompanied by four-animal pictures, $z = 2.98$, $p = .003$, $d = 0.93$.

In summary, the results of Experiment 1 were consistent with the claim that children are motivated to understand, via explanations, the categories they encounter in the world. This conclusion is based on the fact that, in this study, children preferred to find out why categories displayed certain features even when they also had the option of finding out why specific individuals displayed certain features. Given that idiosyncratic, individual-specific features have been previously shown to elicit much curiosity from children (e.g., Kagan, 1981), this study seems to provide evidence for an even higher level of curiosity about the reasons why categories have the features they do.

## 3. Experiment 2

In Experiment 2, we sought to provide additional, and stronger, evidence for the early presence of the predicted motivation. In the first study, the form of the facts presented to children (category vs. individual) was confounded with the number of animals in the pictures (four vs. one). Although the results of the control condition suggested that children were not simply drawn to facts presented in the context of more animals, it would be compelling to show that children preferentially seek explanations for category facts even when this confounding variable is eliminated. To do so, we modified the procedure so as to avoid showing children any pictures. Would children still prefer to ask "why?" about features of categories even in this stripped-down context?

### *3.1. Method*

#### *3.1.1. Participants*

Fifty preschool-aged children ($M_{age} = 4.95$ years; $SD_{age} = 0.62$; 25 boys and 25 girls) were recruited in a small Midwestern city. None of the children had participated in Experiment 1, but they were demographically similar to those who did.

[3] In the experimental condition, however, these facts were most likely perceived as specific to an individual because they contrasted with the category facts.

#### *3.1.2. Materials, procedure, and design*

The method was the same as in Experiment 1, with a few key exceptions. Children were not allowed to see any of the pictures (all of which were of a single animal in this study) until the end of the sessions, when the experimenter provided explanations for the contents of the Why Box. On each trial, the experimenter placed the two pictures on two separate cardboard tents that faced away from the children (and toward the experimenter). To introduce a category fact, the experimenter said, for example, "I'm looking at a picture of a blin. And you know what? Blins always sleep on their backs." The script for introducing an individual fact was, for example, "I'm looking at a picture of a glippet. And you know what? This one glippet collects shiny objects." The experimenter then asked the forced-choice question just as in Experiment 1, except she pointed at top of the two tents as she said each fact rather than at the pictures (which children could not see). Children indicated their choice by pointing to the tent associated with the fact for which they wanted an explanation. Finally, we should note that the control condition from Experiment 1 was not included in the present study, as it was no longer necessary.

#### *3.1.3. Data analysis*

As in Experiment 1, the data were analyzed with a hierarchical cross-classified logistic regression model with both subject and item random effects. Since our main prediction was that children would select the category facts more often than expected by chance, we fitted an intercept-only model.

### *3.2. Results and discussion*

As predicted, children requested explanations for category facts significantly more often than expected by chance, $M = 55.3\%$, $SD = 18.6$, $z = 2.00$, $p = .046$, $d = 0.29$. This result provides further evidence for the claim that children are motivated to understand why categories have the features they do: Even in a context where the category and individual facts were presented in an otherwise identical manner, without confounding visual or numerical information, children still preferred to receive explanations for features of categories.

Although this finding replicated the results of Experiment 1, the magnitude of the predicted effect was smaller here than in the first study. One possible reason for this difference may be that the numerical information supplied in Experiment 1 actually factored into children's responses, inflating their preference for the category facts. However, given that the numerical information had the opposite effect in the control condition of Experiment 1 (with the four-animal pictures eliciting somewhat *fewer* selections than the one-animal pictures), this possibility seems remote. More likely, the smaller effect in Experiment 2 was due to the increased information-processing demands of the task: Being unable to see any of the animals that the experimenter talked about undoubtedly imposed an additional burden on children's working memory relative to the task used in Experiment 1. In turn, this extra processing load is likely to have introduced extra variability in children's responses, leading to a smaller effect.

## 4. Experiment 3

The last study in this paper was designed to disambiguate the mechanism leading to children's preference for explaining category facts. One possibility is that children's preference reveals a basic feature of the human mind, namely its motivation make sense of the categories it encounters in the world. However, a potential alternative explanation for the results so far is that children asked "why?" about the category facts simply because they were more surprising. The probability that multiple animals display a certain feature (e.g., sleeping on their backs) is in principle lower than the probability that any single animal displays that feature, just as the probability of flipping multiple tails in a row is lower than the probability of flipping a single one. On this alternative explanation, children may have judged the category facts to be more unexpected or surprising. Thus, children's behavior in the first two studies may have been driven simply by an eagerness to explain anomalous events (e.g., Kagan, 1981; Legare et al., 2010).

This alternative interpretation rests on a questionable premise, however. Children do not think about the features possessed by the members of a category as if they were determined by random coin flips. Rather, from a very young age, children expect members of a category to *share* multiple features (e.g., Gelman & Coley, 1990; Gelman & Davidson, 2013; Graham, Kilbreath, & Welder, 2004). Given this prior expectation, then, they should not find it surprising when we tell them that the members of a category display a certain feature (e.g., blins always sleep on their backs)—perhaps not any more surprising than when we tell them that a particular individual displays that same feature (e.g., this one blin always sleeps on his back).

Nevertheless, it is possible that the particular set of features we used in our studies (see Table 1) sounded anomalous when said to be true of a category. Recall that we had to select features that would alternate well between category and individual form, so that we could present them in both forms to children. Because of this constraint, the features may have sounded somewhat surprising in category form, and perhaps that is what accounted for children's tendency to ask "why?" about them. If this argument is correct, then the features that showed the greatest advantage for their category over their individual forms in the first two studies should also be the features that sound most surprising in their category form relative to their individual form. For example, the item in Experiment 2 that showed the greatest difference in the predicted direction was the one involving *sapers*: When children heard that sapers really like the color yellow (category form), they selected this fact for the Why Box on 56% of trials. In contrast, they selected it on only 24% of trials when they heard its individual-specific form. Would this item also be one for which the category version sounds much more surprising than the individual version?

To test this alternative, we obtained a set of surprisingness ratings for our stimuli, in both of their forms. Given that there is some doubt as to whether preschoolers' metacognitive judgments are entirely reliable (e.g., Flavell, Friedrichs, & Hoyt, 1970; but see Ghetti, Hembacher, & Coughlin, 2013), we obtained these ratings from a sample of adults. Although adults know more about the world than children do (and may thus find our properties less surprising on the whole), there is little reason to suspect that their relative ratings of surprisingness for the various items would depart in systematic ways from the ratings 4-year-olds would give if we could easily probe their intuitions on this matter. That is, it seems likely that the features adults find most surprising in our set (e.g., having many broken bones in one's body) are the ones children would find most surprising as well.

The main predictions for this study are as follows. If the alternative tested here is valid, the features that sound most surprising in their category form relative to their individual form should also be the ones that were selected most often for the Why Box in their category form relative to their individual form in Experiments 1 and 2. In contrast, if children's selections in the previous studies were driven by their curiosity about why categories have the features they do, and not by the supposed low probability of these category features, then surprisingness ratings should be unrelated to children's responses in Experiments 1 and 2.

### *4.1. Method*

#### *4.1.1. Participants*

Participants ($N = 124$; $M_{age} = 35.69$ years; $SD_{age} = 12.40$; 53 men, 70 women, 1 not reporting gender) were recruited via Amazon's Mechanical Turk platform.

We took the following steps to safeguard against noise in the data. First, we prescreened participants so as to restrict our sample only to residents of the United States and to native English speakers. Second, we verified that participants' IP addresses were indeed from within the United States. Three were not, and so the corresponding participants were excluded from the sample. Third, we verified participants' native speaker status at the end of the study by asking them to indicate their overall ability with English (native [learned from birth] vs. not native but fully competent vs. limited but adequate competence). One participant indicated she was not a native English speaker, so she was excluded from the sample. Fourth, we excluded any participants who provided exactly the same response across all trials, which could signal they were not taking the survey seriously. Ten participants were excluded on this basis. (The results described below, however, remain the same if these participants are retained.) Finally, at the very end of the study, we asked participants if they had been paying attention while completing the survey. To encourage honesty, we made it clear to participants that they would not be penalized in any form for responding "no," and that it is crucial to the success of our study that they provide truthful responses. No further participants were excluded on the basis of this criterion.

After these exclusions, our final sample included 110 participants ($M_{age} = 34.61$ years; $SD_{age} = 12.10$; 49 men, 61 women). Of these participants, 57 had been randomly assigned to rate the surprisingness of the category facts and 53 to rate the surprisingness of individual facts.

#### 4.1.2. Materials and procedure

At the beginning of the task, participants received the following instructions:

> In this task, you will be presented with a series of facts about species of animals [individual animals] recently discovered on a remote island. Your job is to rate how surprising or unexpected each fact seems. Please read the facts carefully and do your best to answer the rating questions.

Participants then rated the 12 features used in Experiments 1 and 2 (see Table 1), in either their category versions (e.g., "Blins always sleep on their backs") or their individual versions (e.g., "This one blin always sleeps on his back"). For each item, participants were asked, "How surprising does this fact seem to you?" and had to indicate their response on a nine-point Likert scale (1 = not at all surprising; 9 = extremely surprising). The order of the 12 features was randomized for each participant.

### 4.2. Results and discussion

Contrary to the surprisingness alternative tested here, participants did not rate the category versions of the items ($M = 4.40$, $SD = 1.44$) as being significantly more surprising than the individual versions ($M = 4.25$, $SD = 1.33$), $t(108) = 0.60$, $p = .551$, $d = 0.11$. Thus, it seems unlikely that children's preference for requesting explanations for the category facts in the first two studies was simply a byproduct of the greater surprise value of these facts relative to the individual ones.

For a more direct test of the alternative hypothesis investigated in this study, we next analyzed the relationship between surprisingness and Why Box selections across the 12 items. The first step in this analysis was to calculate two difference scores for each of the items: (1) the difference between the surprisingness rating of the category version and the individual version, and (2) the difference between the percentage of Why Box selections for the category version and the individual version (separately for Experiments 1 and 2; see Table 2). The key prediction was then tested by computing the correlation between these two difference scores: Were the items' suprisingness difference scores positively correlated with their Why Box difference scores, as the present alternative hypothesis would predict?

The data revealed no such correlation. For Experiment 1 (the experimental condition), the items with higher surprisingness scores actually tended to have *lower* Why Box scores, $r(10) = -.25$, $p = .424$, although this negative relationship was not significant. The analogous correlation for Experiment 2 was not significant either, $r(10) = .11$, $p = .742$. In sum, even when looking at the level of the individual items, there was no evidence that children's tendency to ask "why?" about category more than individual facts was driven by the former's being more surprising than the latter. Thus, the results of this experiment are consistent with the argument that children's responses stem from an early-emerging motivation to make sense of the categories they are learning about.

## 5. General discussion

Adults seem inherently motivated to understand the categories they identify in the world, which is part of the reason why the theory-based account of human concepts holds so much promise. Here, we tested whether this motivation is present in children as well. Two major views of conceptual development make opposing predictions with respect to this question. According to the view that early concepts are entirely perceptual and item-based, there is no reason to expect that children would be particularly motivated to ask "why?" about the features of kinds. In fact, to the extent that children want to explain anything, this view seems more likely to predict that they would want to explain features of individuals, since children's

**Table 2**
The difference scores calculated in Experiment 3.

| Item (in category form) | Surprisingness difference score[a] | Experiment 1 Why Box difference score (%)[b] | Experiment 2 Why Box difference score (%)[b] |
|---|---|---|---|
| Blins always sleep on their backs | −0.12 | 40 | 4 |
| Cheebas never eat apples | 0.13 | 50 | 12 |
| Daxes have very few babies | 0.19 | 40 | 24 |
| Glippets collect shiny objects | −0.36 | 30 | −8 |
| Kweps never make any sounds | 0.31 | 10 | 8 |
| Lorches only have two teeth | 0.64 | 30 | −12 |
| Mooks are really, really dirty | 0.68 | 0 | 16 |
| Ollers cannot walk very well | −0.24 | 30 | 4 |
| Reesles like to hang upside down all the time | −0.01 | −10 | 4 |
| Sapers really like the color yellow | −0.59 | 20 | 32 |
| Stups hate the smell of bananas | 0.37 | 30 | 12 |
| Zorbs have many broken bones in their bodies | 0.90 | 10 | 32 |

[a] This score was calculated as the difference between adults' surprisingness ratings for the category version of an item and the analogous ratings for the individual version of the same item.
[b] This score was calculated as the difference between the percentage of Why Box selections for the category version of an item and the analogous percentage for the individual version of the same item.

conceptual representations are at the level of specific items and their perceptual features. According to the contrasting view of conceptual development, the structure of human concepts is relatively stable across development. Thus, children's concepts should be much richer than the other view allows, incorporating even the more abstract elements that characterize adults' concepts (e.g., causal-explanatory links between a concept's features). In light of the hypothesized continuity in the structure of conceptual representations, this view licenses the prediction that children would display a motivation to understand the features of kinds that is parallel to adults'. The results of the three experiments described here were consistent with this latter prediction.

We go on to briefly summarize our results. In Experiment 1, children were significantly more likely to request explanations for novel features when these features were said to characterize a category than when they were said to characterize an individual. However, this comparison also confounded the form of the facts with the number of animals in the pictures that accompanied these facts. To demonstrate that children were not simply requesting explanations for facts associated with more animals, we included a control condition in which the number of category instances associated with each fact was varied as before (one vs. four animals) but the content of the facts was held constant (both facts were about an individual). In this condition, children did not have a consistent preference for either fact, which suggests that their preference for the category facts in the experimental condition was not due to the greater number of animals on the accompanying pictures. If anything, actually, children in the control condition were slightly (but non-significantly) more likely to select the individual-specific facts accompanied by a *single* animal. We speculated that one reason for this trend may be that, of the two individual-specific items provided on each trial in this control condition, the one accompanied by a picture of a single animal was potentially more generalizable (i.e., more likely to apply to an entire category).

In Experiment 2, we sought to provide stronger evidence for the presence of the hypothesized motivation to make sense of categories by eliminating the visual confound altogether. Children never saw any of the pictures, which were placed on cardboard tents facing the experimenters. (Moreover, since the pictures used in this study were all of a single animal, children could not derive any useful information from them even if tried to sneak a peek at the experimenter's side of the tents.) Despite the fact that this task context was more demanding of children's working memory, the results nevertheless replicated those of Experiment 1, providing further support for the predicted motivation.

Experiment 3 was designed to investigate an alternative interpretation of these results. Specifically, we tested whether children might ask "why?" preferentially about the category versions of our items because these versions perhaps seem more improbable and thus more surprising than their individual counterparts. This alternative was not supported by the data. First, surprisingness ratings elicited from a sample of adults showed no significant difference between the category and individual facts. Second, the items that had the highest surprisingness ratings for their category relative to their individual versions were not also those that were selected most often to receive explanations for their category relative to their individual versions (in either Experiment 1 or Experiment 2). Thus, it seems unlikely that children's preference for explaining the category facts could be a byproduct of the surprise value of these facts relative to the individual ones.

To consider one more alternative, is it possible that children's explanatory curiosity about categories emerges simply as a byproduct of schooling[4] rather than being a naturally-occurring component of human cognition? According to this alternative, children who have been in school longer should show a greater tendency to ask "why?" about the category facts. To explore this idea, we used children's age as a proxy for the extent of their exposure to school,[5] and we also combined the data from the experimental condition of Experiment 1 with the data from Experiment 2 (total $n = 70$) so as to maximize the likelihood of detecting the relationship predicted by the alternative hypothesis. There was, however, no trace of the predicted correlation between the age proxy and the percentage of category features selected for the Why Box, $r(68) = .04$, $p = .618$. Thus, there is little support in our data for the idea that children's preference to ask "why?" about the features of categories is simply due to their exposure to school.

One important thing to keep in mind about the present studies is that they relied on a forced-choice task that compared category and individual facts. Thus, strictly speaking, our evidence suggests that children's motivation to ask "why?" about category features is high *relative to* their motivation to ask "why?" about features of individuals. Inferences about the *absolute* level of their motivation to explain features of categories must rest on further assumptions about whether features that are restricted to an individual and thus more idiosyncratic are generally something that children are motivated to explain. In light of previous evidence, though, it seems likely that children are indeed drawn to the more idiosyncratic aspects of their experiences (e.g., Kagan, 1981; Legare et al., 2010). For instance, many of children's earliest "why?" questions contain negations, usually in reference to the idiosyncratic absence of certain features of objects or events (Hood & Bloom, 1979). Evidence such as this suggests that our individual-specific facts may have set a high bar for comparison and thus that the motivation to explain features of categories is probably high in absolute terms as well.

At a broader theoretical level, the finding that children are particularly motivated to ask "why?" about features of categories fits well with the view that abstract kind representations are central, perhaps even *privileged*, in early

[4] For example, one of the early-education benchmarks currently recommended by the Illinois State Board of Education (2013) is to "investigate and categorize living things in the environment" (p. xvi).

[5] Although we did not formally collect information about children's schooling, 44.4% of the children in Experiments 1 and 2 were actually tested in a school. We could thus be confident that school exposure was relatively prevalent in our sample.

human cognition. Evidence for this view has been accumulating rapidly in recent years. For example, children's memory for novel information about categories is more accurate than their memory for identical information about individuals (Cimpian & Erickson, 2012a). There is also evidence that children are particularly eager to learn what features characterize a category (Cimpian & Park, 2014)—evidence that dovetails nicely with the present finding that they are also interested in finding out the *reasons* for these characteristic features. Interestingly, children's own explanations for category information might also speak to the privileged status of this information. For example, when children are provided with a novel generic fact such as that trees have *foliage* on them, they are likely to explain this fact as pertaining to some deep aspect of the world—as if the foliage were somehow essential to trees' constitution (Cimpian & Markman, 2009; see also Cimpian & Cadena, 2010; Cimpian & Erickson, 2012b; Cimpian & Markman, 2011). In contrast, when children are provided with the same information in the context of a particular individual (e.g., a particular tree has foliage on it), their explanations usually reveal that they understand this information as pertaining to more superficial or accidental aspects of the world (e.g., something happened to the tree). Speculatively, this difference may also be linked to the present findings: If children assume that category features have deep explanations, perhaps that may be a reason to seek or request explanations for such features. Finally, category representations may be privileged in development in an information-processing sense as well (e.g., Hollander et al., 2002; Leslie & Gelman, 2012). That is, children reach adult-like levels of competence in reasoning about categories (e.g., judging whether *books* have color pictures) at an earlier age than they do for reasoning about similarly broad quantified sets (e.g., judging whether *all books* have color pictures). In conjunction with the present findings, this evidence paints a picture of early cognition in which rich, theory-based category representations are ubiquitous and powerful, guiding conceptual growth in childhood and beyond.

To conclude, the present findings suggest that, from a young age, humans are motivated to make sense of the categories they identify in the world—to understand the reasons why categories have the features they do and the reasons why their features fit together as they do. The fact that this motivation seems to be operative even early in development may suggest that it is a fundamental feature of our cognitive systems that serves as an engine of conceptual development and enrichment throughout our lives.

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