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FAST-TRACK REPORT

Essentialism in the absence of language? Evidence from rhesus monkeys (*Macaca mulatta*)

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Abstract

*We explored whether rhesus monkeys (*Macaca mulatta*) share one important feature of human essentialist reasoning: the capacity to track category membership across radical featural transformations. Specifically, we examined whether monkeys – like children (Keil, 1989) – expect a transformed object to have the internal properties of its original category. In two experiments, monkeys watched as an experimenter visually transformed a familiar fruit (e.g. apple) into a new kind of fruit (e.g. coconut) either by placing a fruit exterior over the original, or by removing an exterior shell and revealing the inside kind of fruit. The experimenter then pretended to place an inside piece of the transformed fruit into a box which the monkey was allowed to search. Results indicated that monkeys searched the box longer when they found a piece of fruit inconsistent with the inside kind, suggesting that the monkeys expected that the inside of the transformed fruit would taste like the innermost kind they saw. These results suggest that monkeys may share at least one aspect of psychological essentialism: They maintain category-specific expectations about an object's internal properties even when that object's external properties change. These results therefore suggest that some essentialist expectations may emerge in the absence of language, and thus raise the possibility that such tendencies may emerge earlier in human development than has previously been considered.*

Introduction

As adult humans, we think of the things around as more than mere collections of properties and features. We classify objects into different *kinds* of things, like apples, dogs, and people. We develop expectations not only about the observable properties that go with these kinds – the outer surface features we can see and experience – but also about their unobservable properties, a suite of hidden internal properties that are inferred in the absence of direct perceptual experiences. Our intuitions about unobservable features are so salient that they sometimes persist even in the face of major featural changes. For example, if we were to strip an apple of its peel or change its surface to resemble that of another fruit, we would still regard the transformed object as an *apple*, and correspondingly still expect it to maintain its internal properties (e.g. its taste) throughout this radical transformation. This example is but one illustration of our pervasive 'psychological essentialism', our belief that certain categories possess an intrinsic and unchanging nature that plays a causal role in category membership.

Researchers have devoted considerable empirical effort to examining how and when our essentialist tendencies develop. This work has revealed that our adult essentialist intuitions begin quite early in development (for a review, see Gelman, 2003, 2004). There is much evidence, for example, that young children use category membership to infer an object's unseen properties; 4-year-olds reliably impose the internal features of one category member on other category members, even when category members look different and possess different surface properties (Gelman & Markman, 1986, 1987). In addition to recognizing the inductive potential of category membership, children also believe that individuals demonstrate innate potential – that at least some of their properties are fixed from birth. Five-year-old children, for example, mistakenly think that a child who is switched at birth will speak the language of his birth parents rather than his adoptive parents (Hirschfeld & Gelman, 1997). Finally, children treat category membership as stable across major feature transformations. Keil (1989) presented 4- and 5-year-old children with transformation scenarios in which doctors took one animal and changed all of its surface features to those of another animal. In one scenario, a raccoon was shaved, painted black and white, and given a smelly odor, such that it looked and smelled like a skunk. Despite the changes in surface features, older children said that the animal was still a raccoon. These results suggest that children believe that simply changing an object's external features cannot change that object's internal essence.

These findings have led some developmental psychologists to argue that psychological essentialism may be a

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cognitive bias that emerges in the absence of much training or experience, perhaps as part of an innate core architecture that helps us to reason about the categorical structure of the world (e.g. Keil, 1989). In support of this view, cross-cultural work has demonstrated that essentialist thinking exists in a number of different cultures (see Gelman, 2004, for a review), as one might predict if some aspects of psychological essentialism were indeed part of an innate system. Similarly, recent work by Newman, Herrmann, Wynn and Keil (2008) suggests that the origins of psychological essentialism may emerge even earlier in infancy than previously believed. Newman and colleagues observed that infants as young as 14 months of age appear to appreciate that an agent's actions are causally generated by his inherent features, rather than more transient perceptual attributes. Again, even from a very early age, infants seem to display some biases consistent with psychological essentialism.

Another type of evidence that could contribute greatly to our understanding of the origins of psychological essentialism is evidence from non-human primates. Studies of non-human primates could be helpful in determining the role that human-specific experiences, such as language, play in the development of this tendency. Unfortunately, primate researchers interested in studying psychological essentialism face a methodological problem: *what exactly counts as evidence for essentialism in a non-human (and thus non-linguistic) creature?* After all, many species of non-human primates (and other animals) can categorize objects into different kinds of things (for reviews, see Freedman & Miller, 2008; Jitsumori & Delius, 2001; Thompson, 1995), in some cases in the absence of training (e.g. Hauser, Pearson & Seelig, 2002; Santos, Hauser & Spelke, 2001). There is also growing evidence that primates represent and individuate objects using kind information (e.g. Munakata, Santos, Spelke, Hauser & O'Reilly, 2001; Phillips & Santos, 2007; Uller, Xu, Carey & Hauser, 1997; Santos, Sulkowski, Spaepen & Hauser, 2002). Santos and colleagues (2002), for example, presented free-ranging rhesus monkeys (*Macaca mulatta*) with a kind individuation task like that used to explore kind concepts in human infants (see Van de Walle, Carey & Prevor, 2000). Monkeys watched as an experimenter pretended to place one kind of food (e.g. a plum) into a box, and were then allowed to search the box. When the monkeys searched the box, they found either the same kind of food, or a different kind (e.g. a piece of coconut). Monkeys searched longer when they found a different kind of fruit from the one they saw enter the box, suggesting that they used kind information to track the number of objects inside the box.

Despite widespread evidence that primates categorize objects, only a few studies to date have investigated whether primates share the cognitive tendencies that have been marshaled in support of essentialist biases in children. One such tendency is children's early interest in the non-obvious properties of objects, such as an object's unobservable inside features. Phillips and Santos (2007) explored whether primates have a similar interest in an object's inside properties. In this study, monkeys watched as an experimenter held up one kind of fruit (e.g. an apple) and then pretended to remove an inside piece of this fruit and place it inside a box. The 'piece' the monkeys saw, however, was not a piece of the fruit, but instead was a small piece of white plastic. Monkeys were then allowed to search the box, which contained either a real piece of the fruit they saw or a visually similar piece of a different kind of fruit (e.g. a coconut piece). Monkeys searched longer after finding an inconsistent kind of inside, suggesting that monkeys know something about one non-obvious inside property of the original fruit, namely its taste. In this way, monkeys appear to share at least one primitive aspect of psychological essentialism – they represent the inside, unobservable properties of different kinds of objects in addition to just those objects' surface features.

In the present study, we take the question of monkey psychological essentialism one step further. Our goal was to explore whether monkeys share a second feature of children's essentialist reasoning: the notion that categories remain the same even across changes in their surface features. Following Keil (1989), we designed an experiment to test whether monkeys expect an object to maintain its inside properties even after being transformed into what looks like a different kind of object. In Experiment 1, monkeys watched as an experimenter appeared to visually transform one familiar fruit into a different kind of fruit (e.g. a coconut into an apple). To do so, the experimenter held up one kind of fruit (a coconut), and then slowly covered it with the shell of another kind of fruit (a plastic apple peel). The experimenter then showed the monkey the transformed fruit (an object that now looked like an apple), removed what appeared to be an inside piece of the transformed fruit, and then pretended to place that piece in a box. The question of interest was whether monkeys expected the inside piece to taste like apple or coconut. If monkeys represent an object's internal properties merely based on an object's outside surface features, then they should expect the piece they find to taste like the transformed kind of fruit. However, if monkeys reason like essentialist children, then they should expect the inside piece to retain its kind-specific features despite the object's new surface appearance. In the above case, monkeys should expect the transformed object to taste like coconut even though it looks like an apple.

Experiment 1

Method

Participants

Our subjects were 37 free-ranging adult rhesus macaques (*Macaca mulatta*) on the island of Cayo Santiago. Monkeys in this population have served as subjects in several other studies using a similar method (Santos *et al.*, 2002; Phillips & Santos, 2007). We approached additional monkeys for testing, but these trials were aborted due to inattentiveness towards the display (n = 3), failure to approach the box or find the piece of food (n = 47), interference from other monkeys who approached the box during the presentation and scared the subject monkey away (n = 108), previous testing (n = 7), or experimenter/camera error (e.g. battery malfunction, failure to preload the box, or other problems performing the transformation manipulation, n = 22). The camera-person who was blind to the experimental condition being performed decided whether to abort a particular trial. The decision to abort trials was made online while the trial was under way and was thus performed blind to the experimental condition. The rate of aborted trials was similar to that of previous studies using a similar method (e.g. Phillips & Santos, 2007).

Apparatus and stimuli

We modeled the present procedure on previous searching time studies with this population (see Phillips & Santos, 2007; Santos *et al.*, 2002). We used an open-topped flexible plastic lunchbox (15 cm × 25 cm × 15 cm) as the searching box. We filled this box with 15 medium-sized leaves, picked from a tree indigenous to the island. Leaves were placed such that they completely occluded any objects placed inside the box. Stimuli consisted of a whole coconut, a whole apple, a half coconut shell, a plastic half apple shell, a white piece of plastic-coated foamboard (2.5 cm × 2.0 cm × 1.5 cm), and real pieces of apple and coconut (2.5 cm × 2.0 cm × 1.5 cm). We used apples and coconuts as stimuli because these two have perceptually similar (white) insides and are familiar to the monkeys (see Phillips & Santos, 2007). The pieces of real fruit were stripped of any peel or rind and were identical in size and similar in color to the piece of plastic. The real fruit pieces were placed inside the experimental bin prior to presentation. Adult human observers looking at the plastic and real fruit pieces from the monkeys' presentation distance were unable to tell the difference between the different pieces.

Procedure

Two female experimenters – a presenter and cameraperson – ran each session. The presenter preloaded the box with a piece of food. The presenter then found an isolated monkey (a monkey by itself with no other monkey visible closer than 10 m) and stood in front of the monkey at a distance of 3–4 m. The cameraperson stood at a distance of 2 m behind the presenter and recorded the sessions using a Sony Digital-8 Handycam. The cameraperson attended only to the monkey and did not observe the experimental presentation, and therefore was blind to the condition.

Each monkey participated in only one session. Sessions began when the presenter kneeled, placed the box on the ground, and showed the monkey that the inside of the box was full of leaves. The experimenter then began the fruit transformation event (see Figure 1; see also http://www.yale.edu/caplab/supplemental/transformation movie.mov). To do so, she removed one of the whole

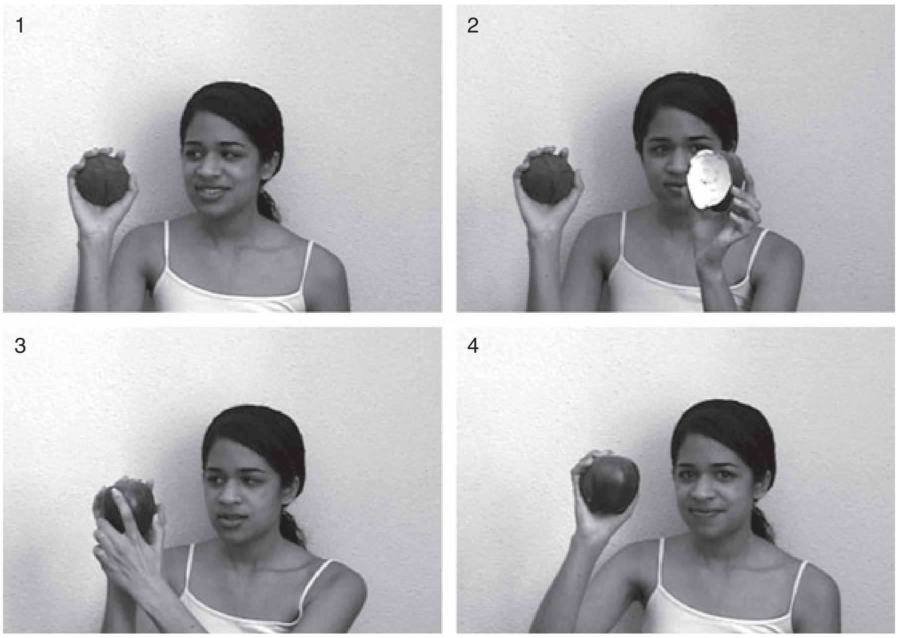

Figure 1 *A depiction of the experimental procedure. (1) The experimenter began by holding up a whole fruit, with a real inside piece of fruit already hidden inside a box. (2) She then held up the shell of the other kind of fruit and showed both sides of the shell. (3) She then transformed the whole fruit by covering it with the fruit shell. (4) She then displayed the whole transformed fruit, and then removed a piece from behind the fruit and pretended to place it in the box.*

fruits from her pouch and held it up at eye-level for the monkey to observe. Once the monkey had observed this fruit for 2 full seconds, the experimenter then removed the fruit shell of the opposite kind of fruit from her pouch, and held this up at eye-level using her opposite hand. She then turned this shell to the side to show that the shell was in fact, just hollow, with no real interior. While the monkey was watching, the experimenter then slowly and carefully wrapped the fruit shell over the whole fruit. Because the shell was a three-dimensional object, it was able to cover most of the inside fruit, and thus looked like a whole piece of fruit. Once the experimenter completely covered the old fruit, she held the transformed fruit up for the monkey to see, taking note that the monkey observed it for a full 3 seconds. She then removed the white plastic piece from behind the transformed whole fruit, pretended to place the plastic piece inside the box, and then walked away to a distance of 2–3 m. After the experimenter walked away, the monkey was allowed to search the box and find one of two kinds of fruit inside: a piece of coconut or a piece of apple.

This procedure led to the following four possible presentation conditions:

Coconut-consistent: The monkey saw a coconut transformed into an apple, and then found a piece of coconut in the box.
Coconut-inconsistent: The monkey saw a coconut transformed into an apple, and then found a piece of apple in the box.
Apple-consistent: The monkey saw an apple transformed into a coconut, and then found a piece of apple in the box.
Apple-inconsistent: The monkey saw an apple transformed into a coconut, and then found a piece of coconut in the box.

As in previous studies (Phillips & Santos, 2007; Santos *et al*., 2002), we expected monkeys to search until they found the fruit piece that they expected to find. We therefore measured how long monkeys continued searching after they found the piece of fruit. We hypothesized that any continued searching after finding this initial fruit piece would indicate that the kind of fruit found in the box did not match the monkey's expectations. The cameraperson (who was blind to condition) filmed the monkey's search behavior and determined that the subject had finished searching when the subject either (1) turned and walked away from the box or (2) stopped searching for 1 minute. Timing was performed using the clock inside the camera's viewfinder.

Analysis

An experimenter blind to condition coded videos using iMovie software. Search was defined as the time each monkey searched after finding the real piece of fruit, such as looking into the box or through its contents. A second blind experimenter coded a subset of trials to establish reliability ($r = 0.93$).

Results

We performed an ANOVA with outcome (consistent or inconsistent) and fruit type (coconut or apple) as factors. We observed a significant main effect of outcome ($F(1, 33) = 4.28$, $p = .047$). Subjects searched longer on inconsistent (Mean = 53.22 s) than consistent trials (Mean = 11.93 s) (see Figure 2). Non-parametric tests confirmed this result (Mann-Whitney: Z = 3.22, $p = 0.001$). There was no main effect of fruit type ($F(1, 33) = 0.09$, $p = .77$) and no interaction between fruit type and condition ($F(1, 33) = 0.03$, $p = .85$).

Discussion

The goal of Experiment 1 was to explore whether monkeys track an object's inside properties across changes to that object's surface features. After watching a scene in which one kind of fruit was visually transformed into another kind of fruit, monkeys expected to find a piece of fruit that tasted like the original kind, searching longer when the piece tasted like the post-transformation kind of fruit. In other words, when monkeys saw an apple transformed into a coconut, they expected that transformed fruit to taste like apple, not coconut. This result builds on previous work suggesting that monkeys make expectations about objects' inside properties (e.g. Phillips & Santos, 2007), but further suggests that such expectations remain even after an object undergoes a *radical visual transformation*. Even when the immediately available external features should convince them otherwise, monkeys appear to represent an object in terms of its *original* category membership. In this way, monkeys appear to share at least one aspect of human psychological essentialism: they expect an object's kind and

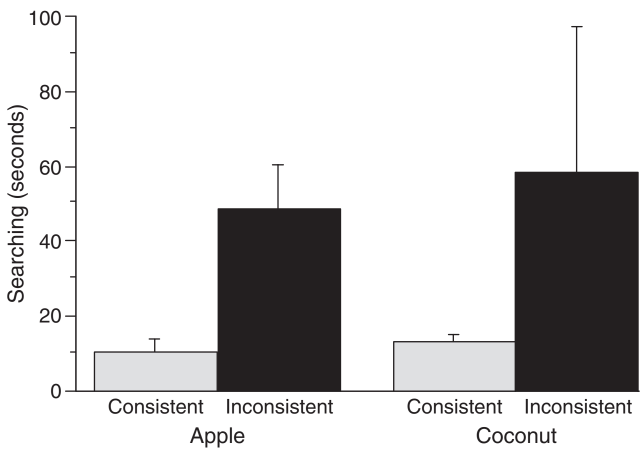

Figure 2 *Mean (± standard error) duration of time (in seconds) that subjects spent searching across consistent and inconsistent test trials for both the apple and coconut conditions in Experiment 1.*

inside properties to stay the same even when its outside properties change.

One alternative explanation for this finding concerns the effectiveness of our exterior 'shell'. Perhaps monkeys ignored the shell because it did not look realistic enough. This explanation, however, is extremely unlikely for several reasons. First, although we were forced to use a plastic apple shell, the coconut shell used here was a real coconut exterior, the same object used for the real coconut stimulus. For this reason, it is unlikely that monkeys treated this same object differently when it was the original 'real' fruit versus the exterior shell. Second, even our plastic apple fruit appeared to be a real apple when presented to human observers. We anecdotally presented both the original and transformed fruits to human observers, and all agreed that the transformed fruits looked like the post-transformed kind of fruit. Third, a previous study (Phillips & Santos, 2007) successfully used the same coconut shell to explore monkeys' intuitions about coconut kinds. In this study, monkeys who watched a white object taken from behind the coconut shell and placed in a box expected to find a coconut piece inside the box. This provides evidence that the coconut shell, at least, was convincing enough to create an expectation of the appropriate food kind.

A second, and more troubling, alternative explanation is that monkeys' predictions about what to expect inside the box are always based on what they originally see. Under this view, monkeys may expect the piece to taste like the original food they saw because of a simplistic primacy bias – after seeing some category of fruit, they make an initial expectation about that fruit's taste and expect to find that taste inside the box regardless of the events they see after that. To deal with this alternative, Experiment 2 reversed the temporal order of the transformation event: monkeys were presented with one kind of fruit that had the shell of the other kind of fruit already around it. The monkey then watched as this shell was removed, revealing the inside kind of fruit beneath. If monkeys are merely attending to whatever kind of fruit they see first, then they should search longer after finding a kind of fruit inconsistent with the original outside shell they saw. In contrast, if monkeys are able to track a fruit's innermost kind category over time, then they should ignore the shell they see first, and expect to find a piece that tastes like the fruit they saw beneath the shell.

Experiment 2

Method

Participants

We tested 73 macaques from the same population. We approached additional monkeys for testing, but aborted these trials due to inattentiveness (n = 34), failure to approach the box or find the piece of food (n = 23), interference (n = 101), previous testing (n = 13), experimenter error (n = 40), or other reasons (e.g. rain, n = 8).

Procedure

We used the same procedure as in Experiment 1 with a few differences. First, in contrast to Experiment 1, a male experimenter served as presenter. More important, however, was a critical change to the procedure. Specifically, we counterbalanced the order of the two events. Half of the trials (n = 40) were conducted identically to the original Experiment 1 procedure (replication). The other half of trials (n = 33) reversed the order of the two events, revealing a real fruit from inside the shell. In this event (reveal), the experimenter began by showing the monkey the outer fruit shell. He then slowly manipulated the shell, opening it to reveal both that it was merely a hollow casing and that there was a true actual fruit on the inside. After taking off the shell, he then performed the same actions as in Experiment 1, removing what appeared to be an inside piece of the fruit and placing it inside the plastic box.

Results

We performed an ANOVA with outcome (consistent vs. inconsistent), fruit type (coconut vs. apple), and condition (replication vs. reveal) as factors. We observed only a significant main effect of outcome ($F(1, 65) = 5.02$, p = .029). Subjects searched longer on inconsistent (18.1 seconds) than consistent trials (11.4 seconds; see Figure 3). Non-parametric tests also confirmed this result (Mann-Whitney: Z = 2.44, p = .015). There was no significant main effect of fruit type ($F(1, 65) = 0.28$,

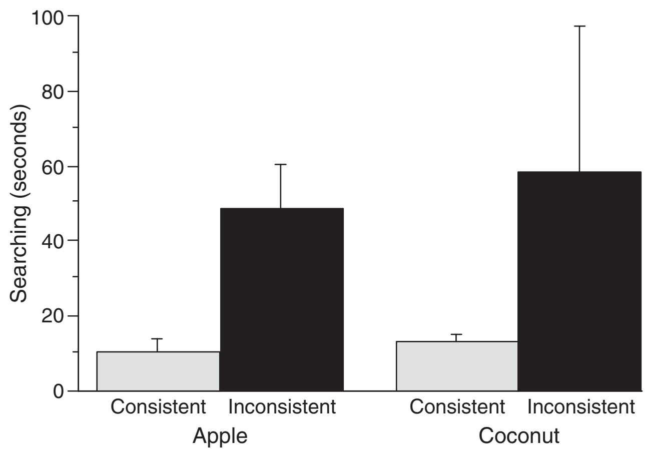

Figure 3 *Mean (± standard error) duration of time (in seconds) that subjects spent searching across consistent and inconsistent test trials for both the apple and coconut conditions in Experiment 2.*

p = .60), or condition (reveal vs. replication, $F(1, 65)$ = 2.22, p = .14), and no interactions between these effects.

Discussion

As in Experiment 1, rhesus monkeys tested in Experiment 2 searched longer when they found a piece of fruit whose kind was inconsistent with the innermost fruit that they had seen. In contrast to Experiment 1, however, the pattern of performance observed in Experiment 2 cannot be explained by a simplistic bias in which monkeys merely expect to find a piece of food consistent with the object they initially saw. In Experiment 2, monkeys ignored the kind of fruit they initially saw, and instead set an expectation based on the true fruit they saw after the shell was removed. The results observed in Experiment 2 therefore extend the findings observed in Experiment 1, providing further support that monkeys can correctly track category membership across radical featural transformation.

One potential criticism of Experiment 2 is that the overall searching times in this experiment are smaller than those of Experiment 1, and perhaps as a consequence, the difference between consistent and inconsistent conditions was also smaller. This result is most likely due to an unanticipated effect of presenter – the use of a male experimenter in Experiment 2 may have caused the monkeys to be more wary of approaching the box for long periods of time (e.g. see Flombaum & Santos, 2005). Even with this effect, however, we observed the predicted pattern of performance across the consistent and inconsistent conditions of Experiment 2, thereby replicating and extending the findings of Experiment 1.

General discussion

The goal of these studies was to explore whether monkeys share one component of psychological essentialism, the ability to track category across featural transformations. We borrowed insight from developmental studies (e.g. Keil, 1989) in which children were asked about one kind of object whose external features were manipulated to make it look like a new kind of object. Here, we explored how monkeys treat a fruit from one category that was transformed to look like a different kind of fruit. Like older children, monkeys treated the transformed fruit as though its internal properties remained the same over a significant change in surface features. Monkeys who saw an apple's outside features changed to look like a coconut still expected this fruit to taste like an apple. We interpret this pattern of performance as evidence that monkeys share at least one cognitive capacity that is critical for the emergence of human-like psychological essentialism – they track kind membership even across substantial changes in an object's observable properties. Indeed, monkeys succeed in tracking category membership even when all available observable properties should convince them otherwise. Furthermore, since our macaque subjects lack the linguistic competence of human participants, our results demonstrate that human language is not necessary for the emergence of this capacity. As such, it appears that at least one critical component of psychological essentialism can exist in the absence of linguistic capacities.

Although we interpret our findings as evidence that macaques share this one primitive aspect of psychological essentialism, the present work is, of course, silent on whether macaques possess any other components of psychological essentialism. It would be of particular interest in future work to explore whether macaques share those aspects of psychological essentialism that have been purported to rely most heavily on human language. For example, how do macaques learn which categories are merely feature-based and which are ontologically richer, i.e. categories which human learners would naturally essentialize? For developing children, linguistic cues – particularly count nouns – often demarcate categories with rich inductive potential. For example, children exhibit more of an essentialist bias when learning about an individual who is referred to with a count noun (e.g. she is a carrot eater) than one who is referred to merely with a verbal phrase (e.g. she eats a lot of carrots); children assume the former but not the latter category will continue to eat carrots despite changes in environment and across time (Gelman & Heyman, 1999). Similarly, children who hear facts about categories labeled with generic noun phrases (e.g. bears have three layers of fur) will apply these facts to most or all category members (Gelman, Star & Flukes, 2002). These findings suggest that linguistic information can effect children's inferences about the stability of a category and its members, and thus raise the question of how a non-verbal creature is able to learn which categories are and are not stable. Language also offers an extremely salient cue to category boundaries, one that non-linguistic creatures by definition lack. For example, children are known to attend to category labels even when those labels conflict with other salient perceptual features (e.g. Gelman & Markman, 1986). One open question is how non-linguistic creatures reason about categories whose members lack similar observable perceptual features. Lacking language, can macaques perceive perceptually diverse objects as belonging to the same category?

Although the present studies alone cannot provide conclusive evidence that monkeys share all aspects of an adult human psychological essentialism, our goal is to pave the way for future studies exploring these issues. The observation that monkeys can track some category-based unobservable properties over time suggests that not all aspects of human essentialism are unique to our species. Our hope is that future studies will be able to elucidate whether other aspects of human psychological essentialism are shared by other species, providing further evidence that psychological essentialism is something we inherited from our non-linguistic primate ancestors.

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