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Language and Experience Influence Children's Biological Induction

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Abstract

Children's reasoning about biological concepts is influenced not only by their experiences in the natural world and in their classrooms, but also by the way that these concepts are named. In English, 'animal' can refer either to a) exclusively nonhuman animals, or b) all animate beings (human and nonhuman animals). In Indonesian, the term for 'animal' refers only to nonhuman animals; the category that includes all animate beings has no dedicated name. Here, we ask whether this difference in naming practices has consequences for children's use of these concepts in reasoning about human and nonhuman animals. Results from 6- and 9-year-old native speakers of either English or Indonesian reveals differences in reasoning at age 6, differences that become attenuated by age 9. These results suggest that not only naming practices, but also biologically-relevant formal and informal learning experiences, influence children's reasoning about biological concepts.

KEYWORDS: naming, conceptual development, folkbiology, induction

Language and Experience Influence Children's Biological Induction

In recent years, a great deal of research has been devoted to the study of folkbiology, or people's everyday knowledge of living things. One goal of this endeavor has been to discover how young children acquire fundamental biological concepts such as ANIMAL, PLANT, and LIVING THING[1]. It has been proposed that children's acquisition of these biological concepts is shaped by the naming practice in their language community (Anggoro, Waxman, & Medin, 2008; Hatano, Siegler, Richards, Inagaki, Stavy, & Wax, 1993; Stavy & Wax, 1989; Waxman, 2005). This proposal is consistent with extensive evidence that naming supports the formation of object categories from infancy (see Waxman and Lidz, 2006, for a review) through adulthood (Goss, 1961). For example, when infants are presented with a set of disparate exemplars (e.g., a dog, horse, duck) of a given object category, they have difficulty noticing the category-based relation among them (e.g., animal). But when the same exemplars are introduced in conjunction with a common name, their categorization improves dramatically (Fulkerson & Waxman, 2007; Waxman, 1999; Waxman & Markow, 1995).

If naming supports object categorization in infants and young children, and if object categories serve as a basis for inductive inference, then the names children learn for biological entities should influence the categories they establish and their inductive strength. To address this possibility, Anggoro et al. (2008) considered whether and how cross-linguistic differences in naming practices associated with biological entities influence children's categorization. This work focused on two languages—English and Indonesian—because there are cross-linguistic differences in the way that fundamental biological categories are named (see Figure 1). In English, the word ‘animal’ can be applied to the category of nonhuman animals, excluding humans (glossed in Figure 1 as $\text{ANIMAL}_{\text{contrastive}}$) or to the category of all animate beings, including humans ($\text{ANIMAL}_{\text{inclusive}}$). In Indonesian, as in English, ‘animal’ can be applied to the category of nonhuman animals, excluding humans ($\text{ANIMAL}_{\text{contrastive}}$), but in contrast to English, there is no dedicated name for the overarching category of animate beings.

---Figure 1 about here---

Anggoro and colleagues demonstrated that children are sensitive to the use of the term ‘animal’ in their respective languages. They presented 6- and 9-year-old English- and Indonesian-speaking children with a photograph of a human and asked, “Could you call this an ‘animal’?” (“Mungkinkah ini ‘hewan’?” in Indonesian). Only 3% of the Indonesian-speaking children responded in the affirmative, suggesting that they overwhelmingly endorsed the $\text{ANIMAL}_{\text{contrastive}}$ interpretation. In contrast, 26% of the English-speaking children responded in the affirmative, suggesting that they endorsed the $\text{ANIMAL}_{\text{inclusive}}$ interpretation. Despite this cross-linguistic difference in children’s tendency to endorse the $\text{ANIMAL}_{\text{inclusive}}$ interpretation, children in both language communities favored the $\text{ANIMAL}_{\text{contrastive}}$ interpretation[2].

This cross-linguistic difference converges well with other evidence that English-speaking children are willing to apply ‘animal’ to humans. In a survey of children’s conceptions of animals, Bell and Barker (1982) asked 5- to 14-year-old English-speaking children in New Zealand whether an X is an ‘animal’, where X was either a living or nonliving thing (e.g., person, worm, spider, fire). Children’s spontaneous responses revealed that 40% of the 5-year-olds, 74% of the 9- to 10-year-olds, and 68% of the 14-

year-olds agreed that a person is an animal. This provides converging evidence that the ANIMAL$_{inclusive}$ interpretation is accessible to English-speaking children.

The difference between English and Indonesian naming practices is evident not only in children's explicit judgment tasks, but also in their spontaneous categorization. Anggoro et al. (2008) presented 6- and 9-year-old English- and Indonesian-speaking children with a set of cards depicting various living and nonliving things, and asked them to put "the things that go together in the same pile." Performance on this free-sorting task mirrored their explicit judgments (described above): Only 5% of the Indonesian-speaking children placed a human and nonhuman animal in the same sorting pile, but 36% of their English-speaking counterparts did so.

These findings suggest that in English, but not Indonesian, the word 'animal' is polysemous: It can refer to two hierarchically-nested concepts, one that includes humans (ANIMAL$_{inclusive}$) and one that excludes them (ANIMAL$_{contrastive}$). What consequences, if any, does this have on children's acquisition of the biological concept LIVING THING? We know that children tend to avoid polysemy, as evidenced by their preference for a "one word–one concept" approach in word learning (Markman & Wachtel, 1988). Thus, it is possible that in an attempt to circumvent the polysemy of 'animal', English-speaking children would (mis)align a different word—'alive'—to the ANIMAL$_{inclusive}$ category, reserving the term 'animal' for ANIMAL$_{contrastive}$.

In a subsequent study, Anggoro et al. found support for this hypothesis. They asked 4- to 9-year-old English- and Indonesian-speaking children to sort living and nonliving things based on the predicates 'alive', 'die', and 'grow'. By age 6, English- and Indonesian-speaking children applied the predicates 'die' and 'grow' appropriately to humans, nonhuman animals, and plants, suggesting that children appreciate the overarching biological category LIVING THING. In contrast, children's mastery of 'alive' was more protracted: Half of the English- and Indonesian-speaking 6-year-olds applied 'alive' to systematically excluded plants. By age 9, however, a cross-linguistic difference emerged: Although most English-speaking 9-year-olds continued to exclude plants, aligning 'alive' with the $\text{ANIMAL}_{\text{inclusive}}$ category, Indonesian-speaking children applied 'alive' broadly to all living things.

Additional support for the influence of language-specific naming practices comes from a corpus analysis of parent-child conversations in English and Indonesian (Leddon, Waxman & Medin, under revision): English-speaking parents tended to use 'die' to refer to humans, nonhuman animals, and plants, but to use 'alive' to refer only to human and nonhuman animals, excluding plants. Converging evidence for English-speaking children's tendency to align 'alive' with $\text{ANIMAL}_{\text{inclusive}}$ comes from English-speaking children's performance in a sorting task that included pictures of humans, nonhuman animals, plants, and nonliving things (Leddon, Waxman, & Medin, 2008). When they were instructed to sort using the predicate 'alive', even 9- and 10-year-olds tended to exclude plants. But when 'alive' was replaced with 'living thing', even 6-year-olds included plants along with the humans and nonhuman animals. This is consistent with the hypothesis that English-speaking children (mis)align 'alive' with $\text{ANIMAL}_{\text{inclusive}}$ (which permits them to circumvent the polysemy of 'animal'). Taken together, these findings suggest that the names children hear influence the acquisition and organization of fundamental biological concepts.

In the current paper, we take this hypothesis one step further. If naming practices have consequences for children's conceptual organization, then we should observe systematic differences between English- and Indonesian-speaking children's use of biological categories in reasoning. To address this question, we employed a *category-based induction* task that has been instrumental in developmental investigations of biological reasoning (e.g., Carey, 1985; Gelman, 1988; Herrmann, Waxman, & Medin, under review; Ross, Medin, Coley, & Atran, 2003). In this task, children are introduced to a novel property of an entity (the *base*), and then asked whether this property can be generalized to other entities (the *targets*). For example, children may be taught that dogs have a novel biological property (e.g., an omentum), and asked whether other entities (typically including a range of animals, plants, and artifacts) share this property.

Children as young as 2½ years of age use categories as an inductive base in this task: They are more likely to generalize a novel property to other members of the same category than to members of a different category (e.g., Gelman, 1988; Gelman & Markman, 1986; Kalish & Gelman, 1992; Waxman, Lynch, Casey, & Baer, 1997; see Gelman & Kalish, 2006 for a review). This naming effect is robust: It holds up whether the categories are familiar or unfamiliar, and the effect is evident not only in children but also in adults (Carnaghi et al., 2008) and infants as young as 13 months of age (Graham, Kilbreath, & Welder, 2004; Waxman & Booth, 2001; Keates & Graham, 2008).

Moreover, children's patterns of induction may be sensitive to which category serves as the base and which as the target. For example, there is considerable evidence that children's induction are asymmetric: Young urban children raised in the U.S. are more likely to generalize a novel property from a human (base) to a dog (target) than from a dog (base) to a human (target) (Carey, 1985; Ross et al., 2003; Medin & Waxman, 2007). Because we include children raised in urban U.S. communities in the current study, and because we suspect that this asymmetry may be related to the polysemy of ‘animal’ in English, we consider the potential sources of this human-nonhuman animal asymmetry in some detail here.

Medin and Waxman (2007) review evidence suggesting that distinctive features of target categories (including their category names) limit generalization from a base to a target. Notice that English-speaking children may be influenced by the two possible meanings of the name ‘animal’: $\text{ANIMAL}_{\text{contrastive}}$ and $\text{ANIMAL}_{\text{inclusive}}$. We suspect that when a nonhuman animal serves as the base, English-speaking children will favor the $\text{ANIMAL}_{\text{contrastive}}$ category. Because this does not include humans, they should be relatively unlikely to generalize to the human target. In contrast, when a human serves as the base, English-speaking children may access the $\text{ANIMAL}_{\text{inclusive}}$ category. Because this does include both human and nonhuman animals, accessing this category should support their generalization from a human base to nonhuman animal targets. Put differently, when a property is attributed to a nonhuman animal base and a human appears as the target, English-speaking children may be reluctant to generalize on grounds that “people are not animals” (this is the $\text{ANIMAL}_{\text{contrastive}}$ interpretation). But when the direction of inference is reversed, children should be less likely to make the appeal that “animals are not people”. In sum, English-speaking children’s access to the $\text{ANIMAL}_{\text{inclusive}}$ category (a category that should be less available to Indonesian-speaking children) may account for their asymmetries favoring generalizations from humans than from nonhuman animals (see Medin & Waxman, 2007, for a detailed account).

On either of the above descriptions, human-nonhuman animal asymmetries should be attenuated in Indonesian-speaking children, if they are evident at all. After all, as we have pointed out, the Indonesian names for HUMAN ('manusia') and NONHUMAN ANIMAL ('hewan') refer to mutually exclusive categories. Therefore, children's tendency to generalize from either a human or nonhuman animal base should be associated with the distinctive category of the target (HUMAN or NONHUMAN ANIMAL). By the same logic, when a property is introduced on a nonhuman animal base, English- and Indonesian-speaking children should perform comparably for both human and nonhuman animal targets.

Finally, because factors other than naming practices alone shape children's biological reasoning, we expect that the differences between English- and Indonesian-speaking children's patterns of induction will become less pronounced over development, as children from both communities gain access to other sources of information about biological phenomena. That is, cultural practices (including naming and belief systems) may have the strongest effects on the youngest children; as children get older and are exposed to a broader range of biologically-relevant information, these cultural effects may be attenuated (see Waxman, Medin, & Ross, 2007, for evidence to this effect).

One other design feature bears mention: Because our primary goal is to focus on language differences, we sought to minimize other differences between our English- and Indonesian-speaking populations. We therefore selected children living in urban communities (Chicago and Jakarta, respectively) and attending schools in which the curriculum was based on a Western scientific model. These schools served families with comparable relative socioeconomic status and religious affiliations (predominantly

Christian). As urban residents, these children had roughly comparable interactions with the natural world.

Method

Participants

Participants were 6-year-olds (English N = 56, *M* = 6.25; Indonesian N = 52, *M* = 6.38) and 9-year-olds (English N = 39, *M* = 9.41; Indonesian N = 51, *M* = 9.31) recruited from public schools in greater Chicago and a combination of public and private schools in Jakarta. At each age and site, approximately 57% of the children were girls. The Chicago sample was comprised of 32% White, 22% Black, 16% Hispanic, 12% Multiracial, 11% Middle Eastern, and 8% Asian. All children were proficient in English, and most (72%) spoke English as their first language. The highest education level among Chicago parents in our sample was 14% master's or higher, 33% bachelor's, 20% some college, 19% high school, and 2% less than high school. The Jakarta school population was comprised of approximately 58% Native Indonesian and 42% Chinese Indonesian. All children spoke Indonesian as their first language. The highest education level among the parents in the Jakarta school population was approximately 4% master's or higher, 23% bachelor's, 54% high school, and 19% less than high school.

All children completed a category-based induction task. We included in our analyses only those children who generalized the novel property from its base to a target of the same kind (e.g., from a human base to a human target; from a dog base to a dog target) on at least three of the four trials. Ten children failed to reach this criterion (eight 6-year-olds (2 English, 6 Indonesian) and two 9-year-olds (both Indonesian)).

Materials

Fifteen colored photographs depicting a range of living and nonliving entities served as stimuli. Four of the entities served as bases; the remaining 11 served as targets. See Table 1. We selected items that were deemed familiar to both Chicago and Jakarta children. Each photograph was presented on an 8.5 inch by 5.5 inch laminated card.

---Table 1 about here---

Procedure

Children were tested individually in a quiet place in their school. As a warm-up, and to ensure children's familiarity with the depicted entities, the experimenter first showed each of the photographs and asked the child to name it. If the child named an entity incorrectly, the experimenter corrected the child by saying, for example, "It may *look* like a [fly], but it's actually a [bee]." At this point, the induction task began. All children completed the induction task across four trials, each trial using a different base, presented in one of three random orders. For each trial, the targets were shuffled and presented in random order.

To begin, the experimenter showed the first base (e.g., a dog) and said, for example, "Dogs have some stuff inside them, and it is called *sacra*. *Sacra* is inside some kinds of things, but it is NOT inside some other kinds of things." She then presented each target picture (e.g., a bear) and asked, "Do you think bears have *sacra* inside like dogs do?"

Results and Discussion

Table 2 presents the proportion of generalizations from each base to each of the target categories in each language and age group. Notice that generalizations were uniformly high when the base and target were of the same kind (e.g., from the dog base to other mammal targets; from the bee base to the other insect targets). In contrast, generalizations to nonliving things were uniformly low. These indices suggest that children understood the demands of the category-based induction task and were responding systematically. In the analyses that follow, we consider more precisely their patterns of inductive inference.

Generalization to nonhuman animal target categories

In the first analysis, we ask whether children's tendency to generalize a novel property to nonhuman animal target categories varies as a function of the base on which the property was introduced. We predicted that when a nonhuman animal serves as the base, English- and Indonesian-speaking children should perform comparably, but when a human serves as the base, English-speaking children should be more likely than their Indonesian-speaking counterparts to generalize the novel property to the remaining animal targets. This is because for Indonesian-speaking children, but not English-speaking children, generalizing a novel property from a human to a nonhuman animal requires crossing a named category boundary.

We calculated each child's tendency to generalize the novel property from each base to each of the nonhuman animal target categories. (Because our goal is to discover children's tendency to generalize the novel property to animals other than the biological kind on which it was introduced, we excluded from this analysis children's responses when the target and base were of the same kind (e.g., generalization from dog to dog was excluded from the proportion of generalization from dog to mammal).) We submitted these proportions to an ANOVA with Language (2: English, Indonesian) and Age (2: 6

years, 9 years) as between-subject variables and Base (4: Human, Dog, Bird, Bee) and Target Category (4: Mammal, Bird, Insect, Fish) as within-subject variables.

---Table 2 about here---

This analysis revealed the predicted Base x Language interaction, $F(3, 552) = 2.69$, $MSE = .19$, $p < .05$, $\eta_p^2 = .01$. Specifically, when a human served as the base, English-speaking children were more likely than Indonesian-speaking children to generalize a novel biological property to nonhuman animal target categories, $F(1, 186) = 6.60$, $MSE = .10$, $p < .05$, $\eta_p^2 = .03$, but when a nonhuman animal served as the base, English- and Indonesian-speaking children performed comparably (*F*s < 3.30, *ns*).

The analysis also revealed the anticipated Base x Target Category x Age interaction, $F(9, 1656) = 2.13$, $MSE = .10$, $p < .05$, $\eta_p^2 = .01$. We pursued this interaction by examining performance at each age. Consider first the 6-year-olds. When a human served as the base, English-speaking children were more likely to generalize a novel property to nonhuman animal target categories ($M = .46$, $SD = .40$) than were their Indonesian-speaking counterparts ($M = .29$, $SD = .37$), $F(1, 98) = 7.40$, $MSE = .10$, $p < .01$, $\eta_p^2 = .07$. Yet when any nonhuman animal served as a base, English- and Indonesian-speaking children performed comparably (*F*s < .80, *ns*). This is consistent with the prediction that the distinct naming practices of English and Indonesian have consequences on children's reasoning, especially when it pertains to the relation between human and nonhuman animals.

Consider next the 9-year-olds, for whom the difference between the two communities is no longer obvious. These children performed comparably whether the base was a human or a nonhuman animal (*F*s < 2.20, *ns*)[3]. This is consistent with the prediction that, even in the absence of a dedicated name for the category that includes human and nonhuman animals, children are able to bring human and nonhuman animals into closer correspondence. This is also consistent with the proposal that children's biological reasoning is shaped by more than naming practices alone, and that differences that likely originated in distinct naming practices become attenuated with experience (either from biologically-related activities or from exposure to Western-inspired curricula). Further support for this interpretation comes from an analysis of children's generalization to the plant target category[4].

Asymmetries in generalization between human and nonhuman animals

In the next analysis, we test the hypothesis that English-speaking children will show more asymmetric generalization, favoring humans over nonhuman animals as the inductive base, than Indonesian-speaking children. In order to test for this asymmetry, we focused specifically on generalizations to the individual targets that are of the same kind as the bases (human, dog, bird, bee). We calculated each child's generalizations from the human base to each of the nonhuman animal targets (human-dog, human-bird, human-bee), and their generalizations from each of the nonhuman animal bases to the human target (dog-human, bird-human, bee-human). These proportions were submitted to an ANOVA with Language (2: English, Indonesian) and Age (2: 6 years, 9 years) as between subject variables, and Base (2: Human base, Nonhuman base) and Target (3: Dog, Bird, Bee) as within-subject variables.

The results are depicted in Figure 2. There were two significant interactions involving Base, both of which shed light on the role of naming practices and experience in shaping children's reasoning about the relation between human and nonhuman animals. First, the Base x Language interaction, $F(1, 184) = 8.44$, $MSE = .18$, $p < .01$, $\eta_p^2 = .04$, indicated that when a human served as the base, English-speaking children ($M = .47$, $SD = .39$) were more likely than Indonesian-speaking children ($M = .36$, $SD = .40$) to generalize the novel property to a nonhuman animal, $F(1, 186) = 5.64$, $MSE = .11$, $p < .05$, $\eta_p^2 = .02$, but when a nonhuman animal served as the base, children in the two language communities performed comparably ($M_{U.S.} = .19$, $SD = .30$; $M_{Indo} = .21$, $SD = .33$) ($F < .19$, *ns*). This is consistent with the hypothesis that for Indonesian-speaking children, but not English-speaking children, extending a novel property from a human to a nonhuman animal requires crossing a named category boundary. Second, the analysis showed a Base x Age interaction, $F(1, 184) = 10.41$, $MSE = .18$, $p < .01$, $\eta_p^2 = .05$. As predicted, when a human served as the base, 9-year-olds ($M = .46$, $SD = .39$) were more likely to generalize a novel property to a nonhuman animal than were 6-year-olds ($M = .37$, $SD = .41$) (although the effect was marginal), $F(1, 186) = 3.35$, $MSE = .11$, $p = .07$, $\eta_p^2 = .01$, but when a nonhuman animal served as the base, there was no difference between the age groups in generalizations to a human target ($M_6 = .23$, $SD = .35$; $M_9 = .17$, $SD = .27$), $F(1, 186) = 1.71$, $MSE = .11$, *ns*, $\eta_p^2 = .01$. That is, we observed asymmetries favoring humans as the inductive base in every group except the 6-year-old Indonesian-speaking children[5].

---Figure 2 about here---

These results are consistent with the prediction that differences attributable to naming are stronger in young children, and that with additional experience (such as biologically-relevant activities or exposure to Western science curricula), humans and nonhuman animals come into close correspondence, even in Indonesian-speaking children for whom this correspondence is not lexicalized. This correspondence strengthens the ANIMATE or $\text{ANIMAL}_{\text{inclusive}}$ category, resulting in more asymmetric generalizations favoring humans as the inductive base among older Indonesian-speaking children.

Further evidence: Order effects

We interpret these results as evidence that when English- and older Indonesian-speaking children are introduced to a novel property on a human base and asked to generalize to a particular nonhuman animal target, their access to the $\text{ANIMAL}_{\text{inclusive}}$ category results in asymmetries favoring humans. If this is the case, then perhaps the salience of this category will influence performance on subsequent trials. If on the child's first trial, a human happens to serve as the base, then their use of the $\text{ANIMAL}_{\text{inclusive}}$ category could carry over to subsequent trials when a human serves as the target. But if on the child's first trial a nonhuman animal happens to serve as the base, then their use of the $\text{ANIMAL}_{\text{contrastive}}$ category could carry over to subsequent trials.

Analyses of order effects revealed that when a human serves as the base in their first trial, English-speaking 6- and 9-year-olds and Indonesian-speaking 9-year-olds generalized strongly from a human to nonhuman animals (overall $M = .67$, $SD = .35$), but when the human base was introduced later in subsequent trials (after a human had served as a target), they were much less likely to do (overall $M = .37$, $SD = .37$) (Fs > 5.80, ps < .05, η_p^2s > .13). That is, for these groups of children—all of whom showed the asymmetries in the previous analysis—the human-nonhuman animal asymmetries are stronger if a human serves as the initial base.

Summary and Conclusions

In the current study we asked whether and how children's reasoning about biological entities—in particular their reasoning about the relation between human and nonhuman animals—is mediated by the naming practices of their language community. The evidence reported here indicates that young children's reasoning about this biological relation is influenced by naming practices. It also suggests that this influence is attenuated over development, an outcome that is consistent with the view that children's biological reasoning is influenced by factors other than language alone.

When a novel biological property was introduced on a nonhuman animal, children in both language communities performed comparably, systematically extending that property to other nonhuman animals. But when the property was introduced on a human, cross-linguistic and developmental differences emerged. First, English-speaking 6-year-olds were more likely than their Indonesian-speaking counterparts to generalize the novel property, and therefore to exhibit asymmetries favoring humans over nonhuman animals. Second, the difference between English- and Indonesian-speaking children, evident in 6-year-olds, was virtually absent in 9-year-olds.

What might account for these findings? To answer this question, we appeal not only to the intriguing differences in naming practices between English and Indonesian, but also to the influence of learning experiences in both formal and informal settings. Although the U.S. and Indonesian children in the current study spoke different languages, in many other ways, their experiences were comparable. They all lived in urban communities and attended schools that had adopted a Western science curriculum, and their families were comparable in relative socioeconomic status and religious affiliation.

We interpret the cross-linguistic differences at age 6 as reflections of differences in the naming practices for biological concepts, especially ANIMAL. The developmental difference—in which Indonesian-speaking children's induction patterns become more asymmetric and more closely aligned with those of their English-speaking counterparts—likely reflects the influence of learning experiences beyond community-wide naming practices alone. For example, as Indonesian-speaking children are exposed to Western science-based curricula in biology, they receive explicit information about the correspondences between human and nonhuman animals, and as a result, the $\text{ANIMAL}_{\text{inclusive}}$ category becomes available for reasoning about biological properties. Of course, the children in Jakarta are exposed not only to a Western curriculum, but also to Western-inspired media, including stories, cartoons, and movies that adopt an anthropocentric model of nonhuman animals (Herrmann et al., under review). Together, these influences from formal and informal environments likely highlight the ANIMATE ($\text{ANIMAL}_{\text{inclusive}}$) category and support its inductive potential.

This outcome is consistent with other recent evidence that community-wide influences have their strongest effects in young children, and become attenuated over development. Waxman et al. (2007) examined European American and Native American (Menominee) children and adults' intuitions about property inheritance and the mechanisms underlying the transmission of kindhood. Menominee tribal membership is based on blood quantum, and blood quantum measures have significant consequences for important activities such as hunting and fishing. Thus, there is a great deal of community-wide discourse about blood quantum in the Menominee population. Waxman et al. found that unlike the youngest European American children who strongly favored the birth parent in the face of a blood transfusion, the youngest Menominee children strongly favored the adoptive parent. That is, Menominee 5- to 6-year-olds believed that kindhood is determined by the sharing of blood—a belief consistent with the discourse emphasis on blood quantum in their community. Interestingly, this difference between the Menominee and European American children was attenuated with age, and disappeared by age 9 to 10 (Waxman et al., 2007).

In closing, the work reported here provides a window into the way in which children's experiences shape their reasoning about the biological world. We suspect that early in development and in advance of considerable additional biology-relevant experience, children's biological induction may be quite sensitive to the ways in which biological categories are named, but that with additional experience, the influence of naming is attenuated. In future work, it will be important to pursue more closely the interaction between naming practices and these learning experiences.

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Author Note

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Footnotes

1) Small capitals denote CONCEPTS; single-quotes denote their 'names'.

2) Indeed, when elementary school, junior high, and college students were asked to name five animals, they never listed humans (Trowbridge & Mintzes, 1985).

3) After the study was completed, we distributed language-background questionnaires and obtained information on about half of the English-speaking children. At each age, there were no differences in generalization patterns between English-speaking children whose native language was English versus those whose native language was not English (*F*s < 1.90, *ns*). Further analyses revealed that among the Indonesian-speaking 9-year-olds, private-school children ($M = .55$, $SD = .05$) made more generalizations overall than their public-school counterparts ($M = .36$, $SD = .06$), $F(1, 47) = 5.54$, $MSE = 1.10$, $p < .05$, $\eta_p^2 = .11$. However, at each age, there were no differences in preference for a human or nonhuman animal base between private- and public-school children (*F*s < 1.58, *ns*).

4) See Table 2. The proportions of generalization from each base to a plant target category were analyzed with an ANOVA using Language (2: English, Indonesian) and Age (2: 6 years, 9 years) as between-subject variables, and Base (4: human, dog, bird, bee) as a within-subject variable. A main effect of Age, $F(1, 184) = 4.14$, $MSE = .27$, $p < .05$, $\eta_p^2 = .02$, indicated that 9-year-olds ($M = .20$, $SD = .03$) were more likely than 6-year-olds ($M = .13$, $SD = .02$) to generalize a novel biological property from a human or a nonhuman animal to a plant. These results provide further suggestive evidence of the effects of formal and informal learning experiences in bringing animals and plants together in closer correspondence as living things.

5) Further analyses revealed that at age 6, private-school children generalized more from a human to a nonhuman animal ($M = .28$, $SD = .38$) than from a nonhuman animal to a human ($M = .21$, $SD = .33$) (although this effect was marginal), $F(1, 33) = 3.85$, $MSE = .08$, $p = .06$, $\eta_p^2 = .11$, but public-school children did not show this asymmetric tendency ($F < 2.21$, *ns*). In Indonesia, private-school children are taught English earlier (starting in 1st grade) than public-school children (starting in 2nd grade). Thus, the 6-year-olds in our sample either have not or are just starting to learn English in school. We suspect that a more likely contributor to this difference is that private-school children come from families of higher socioeconomic status than public-school children. As such, private-school children may be more exposed to

biologically-enriching activities (such as going to zoos, aquaria, etc.) that might help bring humans and nonhuman animals into closer correspondence earlier on.

Table 1

Complete list of items.

Bases
Human (A)
Golden Retriever
Robin
Bee
Targets
Human (B)
Bear
Black Lab
Bluejay
Eagle
Trout
Bee
Mosquito
Maple Tree
Rock
Pencil
Properties
sacra
tyro
belga
olar

Table 2

Mean generalizations (and Standard Deviations) from each base to each target category.

	Human target	Mammal targets	Bird targets	Insect targets	Fish target	Plant target	Nonliving targets
Age 6							
English							
Human base	X	.52(.46)	.51(.49)	.38(.43)	.43(.50)	.13(.34)	.09(.28)
Dog base	.22(.42)	.69(.47)	.57(.44)	.36(.42)	.52(.50)	.07(.26)	.02(.10)
Bird base	.20(.41)	.40(.46)	.89(.32)	.41(.44)	.59(.50)	.06(.23)	.05(.18)
Bee base	.22(.42)	.35(.41)	.94(.16)	.78(.42)	.44(.50)	.17(.38)	.09(.23)
Indonesian							
Human base	X	.28(.42)	.32(.43)	.24(.39)	.30(.47)	.13(.34)	.10(.27)
Dog base	.30(.47)	.57(.50)	.47(.49)	.41(.46)	.43(.50)	.11(.32)	.11(.28)
Bird base	.24(.43)	.35(.45)	.91(.28)	.45(.45)	.37(.49)	.20(.40)	.12(.24)
Bee base	.20(.40)	.39(.43)	.95(.16)	.67(.47)	.39(.49)	.15(.36)	.09(.24)
Age 9							
English							
Human base	X	.63(.44)	.47(.46)	.33(.37)	.34(.49)	.23(.43)	.12(.29)
Dog base	.21(.41)	.79(.41)	.49(.42)	.35(.42)	.51(.51)	.18(.39)	.04(.13)
Bird base	.18(.39)	.44(.45)	.85(.37)	.32(.39)	.38(.49)	.28(.46)	.04(.18)
Bee base	.08(.27)	.32(.41)	.90(.23)	.92(.27)	.33(.48)	.21(.41)	.08(.22)
Indonesian							
Human base	X	.50(.47)	.39(.46)	.30(.39)	.35(.48)	.31(.47)	.08(.24)
Dog base	.20(.41)	.69(.47)	.39(.45)	.30(.41)	.37(.49)	.08(.28)	.05(.15)
Bird base	.20(.41)	.37(.42)	.94(.24)	.54(.44)	.39(.49)	.18(.39)	.10(.25)
Bee base	.12(.33)	.27(.40)	.97(.12)	.65(.48)	.33(.47)	.16(37)	.04(.17)

Figure Captions

Figure 1. A schematic depiction of English and Indonesian names for fundamental biological concepts. Notice that the node corresponding to ANIMATE or $\text{ANIMAL}_{inclusive}$ is unnamed in Indonesian.

Figure 2. Mean generalizations between humans and nonhuman animals in each age and language community.

Figure 1

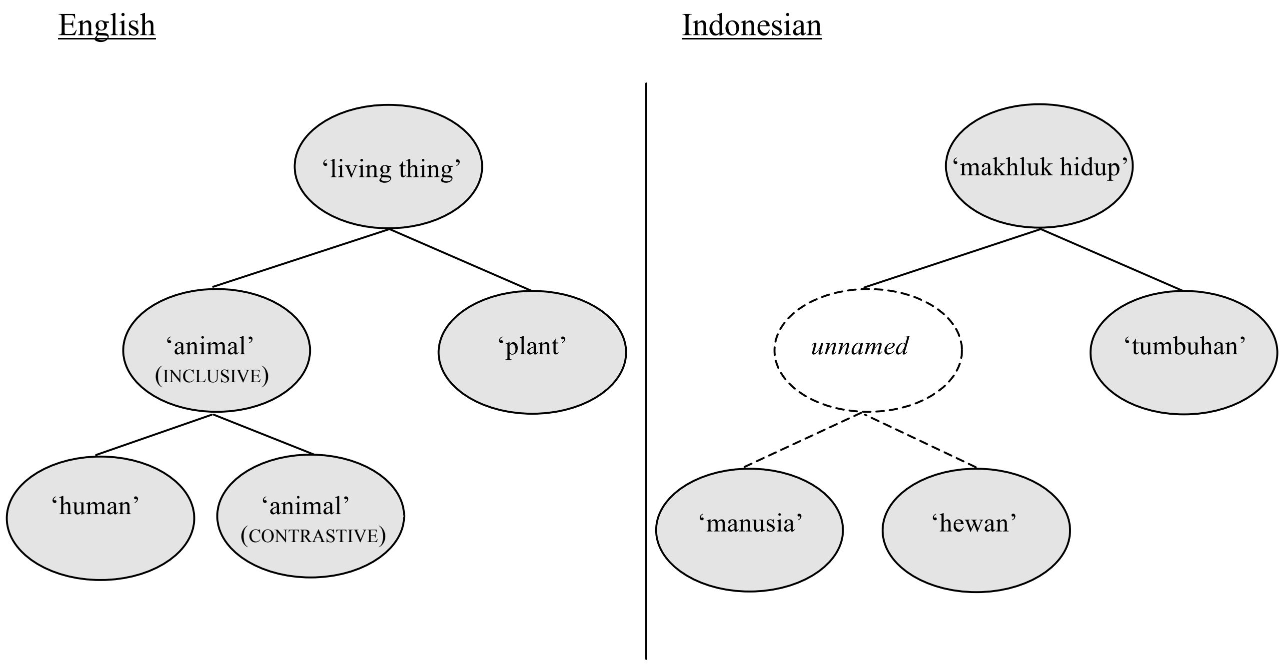
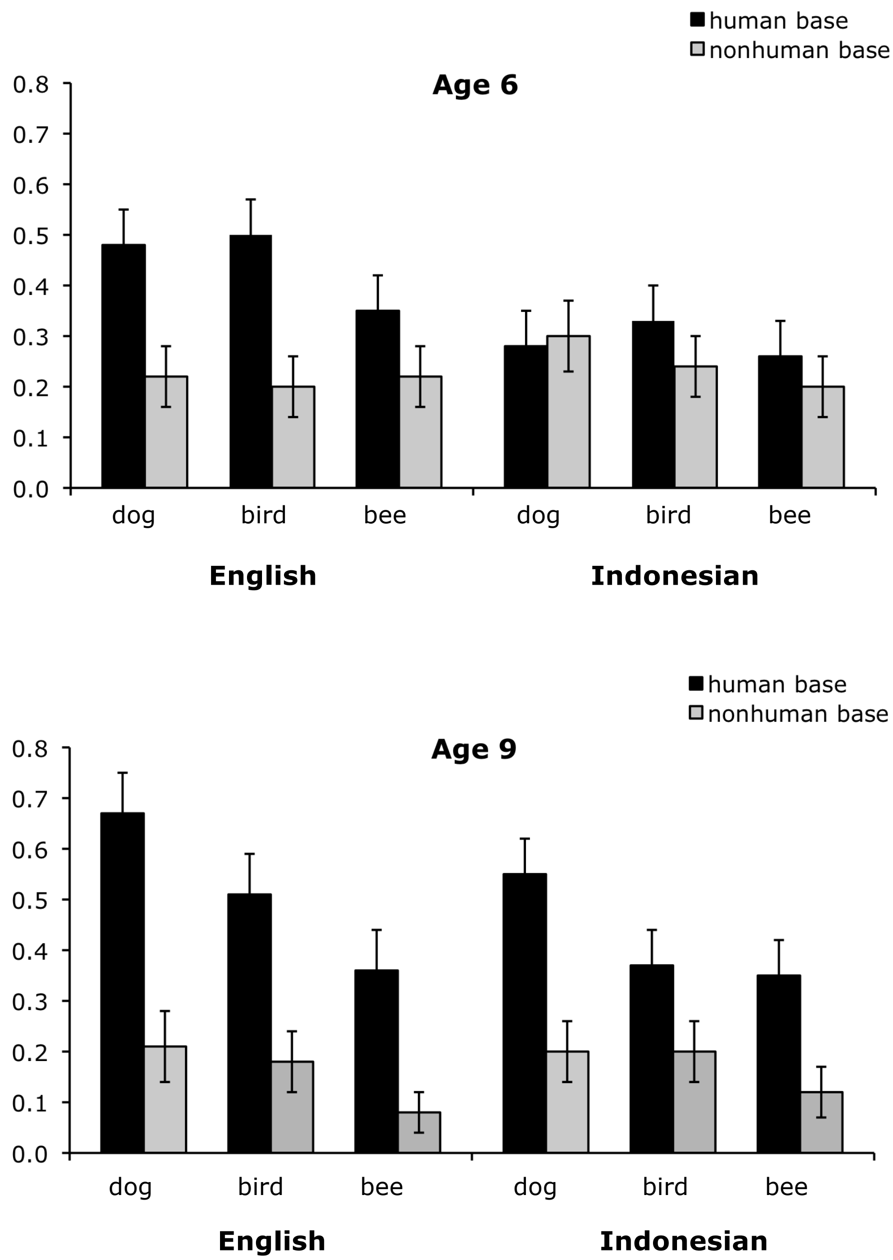

English
Indonesian
'living thing'
'animal'
(INCLUSIVE)
'plant'
'human'
'animal'
(CONTRASTIVE)
'makhluk hidup'
unnamed
'tumbuhan'
'manusia'
'hewan'

Figure 2


human base
nonhuman base
Age 6
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
dog
bird
bee
dog
bird
bee
English
Indonesian
human base
nonhuman base
Age 9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
dog
bird
bee
dog
bird
bee
English
Indonesian