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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 non-human animals, or (b) all animate beings (human and non-human animals). In Indonesian, this category of animate beings has no dedicated name. Here, we ask whether this difference in naming has consequences for children's reasoning about humans and non-human animals. Results from English- and Indonesian-speaking children 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

In recent years, a great deal of research has been devoted to the study of folk-biology, 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 (Stavy and Wax, 1989; Hatano et al., 1993; Waxman, 2005; Anggoro et al., 2008). 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)

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

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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 (Waxman and Markow, 1995; Waxman, 1999; Fulkerson and Waxman, 2007).

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 non-human animals, excluding humans (glossed in Figure 1 as ANIMAL$_{contrastive}$) or to the category of all animate beings, including humans (ANIMAL$_{inclusive}$). In Indonesian, as in English, 'animal' can be applied to the category of non-human animals, excluding humans (ANIMAL$_{contrastive}$), but in contrast to English, there is no dedicated name for the overarching category of animate beings.

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 ANIMAL$_{contrastive}$ interpretation. In contrast, 26% of the English-speaking children responded in the affirmative, suggesting that they endorsed the ANIMAL$_{inclusive}$ interpretation. Despite this cross-linguistic difference in children's tendency to endorse the ANIMAL$_{inclusive}$ interpretation, children in both language communities favored the ANIMAL$_{contrastive}$ 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',

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

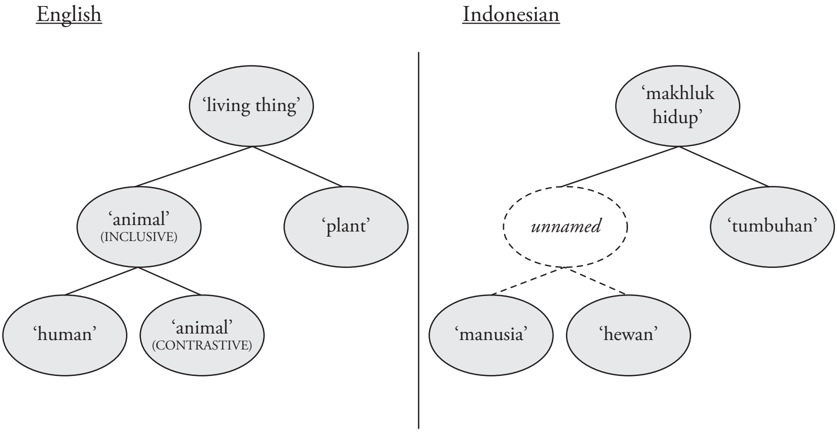

Figure 1. A schematic depiction of English and Indonesian names for fundamental biological concepts. Note that the node corresponding to ANIMATE or $\text{ANIMAL}_{\text{inclusive}}$ is unnamed in Indonesian.

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 $\text{ANIMAL}_{\text{inclusive}}$ 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 non-living 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 non-human 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 ($\text{ANIMAL}_{\text{inclusive}}$) and one that excludes them ($\text{ANIMAL}_{\text{contrastive}}$). 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 and 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 non-living 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, non-human 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 exclude 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 ANIMAL$_{inclusive}$ 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 et al., under revision): English-speaking parents tended to use 'die' to refer to humans, non-human animals and plants, but to use 'alive' to refer only to humans and non-human animals, excluding plants. Converging evidence for English-speaking children's tendency to align 'alive' with ANIMAL$_{inclusive}$ comes from English-speaking children's performance in a sorting task that included pictures of humans, non-human animals, plants, and nonliving things (Leddon et al., 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 non-human animals. This is consistent with the hypothesis that English-speaking children (mis)align 'alive' with ANIMAL$_{inclusive}$ (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; Ross et al., 2003; Herrmann et al., under review). 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 2.5 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 and Markman, 1986; Gelman, 1988; Kalish and Gelman, 1992; Waxman et al., 1997; see Gelman and 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 (Waxman and Booth, 2001; Graham et al., 2004; Keates and 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 inductions are asymmetric: Young urban children raised in the USA 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 and Waxman, 2007). Because we include children raised in urban US 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–non-human 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': ANIMAL$_{contrastive}$ and ANIMAL$_{inclusive}$. We suspect that when a non-human animal serves as the base, English-speaking children will favor the ANIMAL$_{contrastive}$ 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 ANIMAL$_{inclusive}$ category. Because this does include both humans and non-human animals, accessing this category should support their generalization from a human base to non-human animal targets. Put differently, when a property is attributed to a non-human 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 ANIMAL$_{contrastive}$ 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 ANIMAL$_{inclusive}$ 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 and Waxman, 2007, for a detailed account).

On either of the above descriptions, human–non-human 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 NON-HUMAN ANIMAL ('hewan') refer to mutually exclusive categories. Therefore, children's tendency to generalize from either a human or non-human animal base should be associated with the distinctive category of the target (HUMAN or NON-HUMAN ANIMAL). By the same logic, when a property is introduced on a non-human animal base, English- and Indonesian-speaking children should perform comparably for both human and non-human 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 et al., 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

Materials were 15 colored photographs depicting a range of living and nonliving entities. 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.

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?"

Table 1
Complete list of items

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

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 category (e.g., from the dog base to other mammal targets; from the bee base to the other insect targets). In contrast, generalizations to non-living 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 non-human animal target categories varies as a function of the base on which the property was introduced. We predicted that when a non-human 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 non-human animal requires crossing a named category boundary.

Table 2
Mean generalizations (SD values in parentheses) from each base to each target category

Base	Target						
	Human	Mammal	Bird	Insect	Fish	Plant	Non-living
Age 6							
English							
Human	–	0.52 (0.46)	0.51 (0.49)	0.38 (0.43)	0.43 (0.50)	0.13 (0.34)	0.09 (0.28)
Dog	0.22 (0.42)	0.69 (0.47)	0.57 (0.44)	0.36 (0.42)	0.52 (0.50)	0.07 (0.26)	0.02 (0.10)
Bird	0.20 (0.41)	0.40 (0.46)	0.89 (0.32)	0.41 (0.44)	0.59 (0.50)	0.06 (0.23)	0.05 (0.18)
Bee	0.22 (0.42)	0.35 (0.41)	0.94 (0.16)	0.78 (0.42)	0.44 (0.50)	0.17 (0.38)	0.09 (0.23)
Indonesian							
Human	–	0.28 (0.42)	0.32 (0.43)	0.24 (0.39)	0.30 (0.47)	0.13 (0.34)	0.10 (0.27)
Dog	0.30 (0.47)	0.57 (0.50)	0.47 (0.49)	0.41 (0.46)	0.43 (0.50)	0.11 (0.32)	0.11 (0.28)
Bird	0.24 (0.43)	0.35 (0.45)	0.91 (0.28)	0.45 (0.45)	0.37 (0.49)	0.20 (0.40)	0.12 (0.24)
Bee	0.20 (0.40)	0.39 (0.43)	0.95 (0.16)	0.67 (0.47)	0.39 (0.49)	0.15 (0.36)	0.09 (0.24)
Age 9							
English							
Human	–	0.63 (0.44)	0.47 (0.46)	0.33 (0.37)	0.34 (0.49)	0.23 (0.43)	0.12 (0.29)
Dog	0.21 (0.41)	0.79 (0.41)	0.49 (0.42)	0.35 (0.42)	0.51 (0.51)	0.18 (0.39)	0.04 (0.13)
Bird	0.18 (0.39)	0.44 (0.45)	0.85 (0.37)	0.32 (0.39)	0.38 (0.49)	0.28 (0.46)	0.04 (0.18)
Bee	0.08 (0.27)	0.32 (0.41)	0.90 (0.23)	0.92 (0.27)	0.33 (0.48)	0.21 (0.41)	0.08 (0.22)
Indonesian							
Human	–	0.50 (0.47)	0.39 (0.46)	0.30 (0.39)	0.35 (0.48)	0.31 (0.47)	0.08 (0.24)
Dog	0.20 (0.41)	0.69 (0.47)	0.39 (0.45)	0.30 (0.41)	0.37 (0.49)	0.08 (0.28)	0.05 (0.15)
Bird	0.20 (0.41)	0.37 (0.42)	0.94 (0.24)	0.54 (0.44)	0.39 (0.49)	0.18 (0.39)	0.10 (0.25)
Bee	0.12 (0.33)	0.27 (0.40)	0.97 (0.12)	0.65 (0.48)	0.33 (0.47)	0.16 (0.37)	0.04 (0.17)

We calculated each child's tendency to generalize the novel property from each base to each of the non-human 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.

This analysis revealed the predicted base×language interaction, $F_{3,552}=2.69$, MSE=0.19, $P<0.05$, $\eta_p^2=0.01$. 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 non-human animal target categories, $F_{1,186}=6.60$, MSE=0.10, $P<0.05$, $\eta_p^2=0.03$, but when a non-human animal served as the base, English- and Indonesian-speaking children performed comparably (F values<3.30, ns).

The analysis also revealed the anticipated base×target category×age interaction, $F_{9,1656}=2.13$, MSE=0.10, $P<0.05$, $\eta_p^2=0.01$. 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 non-human animal target categories ($M=0.46$, SD=0.40) than were their Indonesian-speaking counterparts ($M=0.29$, SD=0.37), $F_{1,98}=7.40$, MSE=0.10, $P<0.01$, $\eta_p^2=0.07$. Yet when any non-human animal served as a base, English- and Indonesian-speaking children performed comparably (F values<0.80, 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 non-human 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 non-human animal (F values<2.20, ns).[3] This is consistent with the prediction that, even in the absence of a dedicated name for the category that includes humans and non-human animals, children are able to bring humans and non-human animals into closer correspondence.

[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 values<1.90, ns). Further analyses revealed that among the Indonesian-speaking 9-year-olds, private-school children

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 Humans and Non-human 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 non-human animal targets (human–dog, human–bird, human–bee), and their generalizations from each of the non-human 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, Non-human 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×language interaction, $F_{1,\,184}$=8.44, MSE=0.18, P<0.01, η_p^2=0.04, indicated that when a human served as the base, English-speaking children (M=0.47, SD=0.39) were more likely than Indonesian-speaking children (M=0.36, SD=0.40) to generalize the novel property to a non-human animal, $F_{1,\,186}$=5.64, MSE=0.11, P<0.05, η_p^2=0.02,

(M=0.55, SD=0.05) made more generalizations overall than their public-school counterparts (M=0.36, SD=0.06), $F_{1,47}$=5.54, MSE=1.10, P<0.05, η_p^2=0.11. However, at each age, there were no differences in preference for a human or non-human animal base between private- and public-school children (F values<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=0.27, P<0.05, η_p^2=0.02, indicated that 9-year-olds (M=0.20, SD=0.03) were more likely than 6-year-olds (M=0.13, SD=0.02) to generalize a novel biological property from a human or a non-human 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.

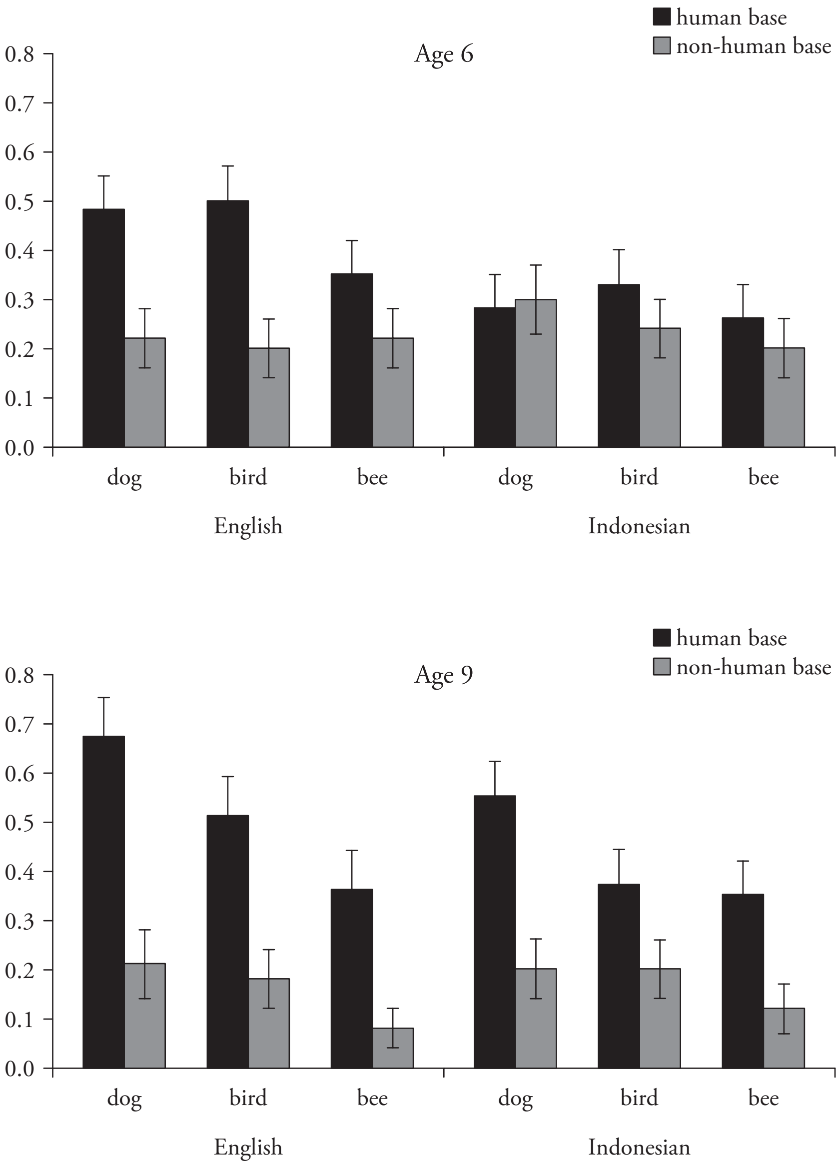

Figure 2. Mean generalizations between humans and non-human animals in each age and language community.

but when a non-human animal served as the base, children in the two language communities performed comparably (M_{US}=0.19, SD=0.30; M_{Indo}=0.21, SD=0.33) (F<0.19, 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 non-human animal requires crossing a named category boundary. Second, the analysis showed a base×age interaction, $F_{1, 184}$=10.41, MSE=0.18, P<0.01, η_p^2=0.05. As predicted, when a human served as the base, 9-year-olds (M=0.46, SD=0.39) were more likely to generalize a novel property to a non-human animal than were 6-year-olds (M=0.37, SD=0.41) (although the effect was marginal), $F_{1, 186}$=3.35, MSE=0.11, P=0.07, η_p^2=0.01, but when a non-human animal served as the base, there was no difference between the age groups in generalizations to a human target (M_6=0.23, SD=0.35; M_9=0.17, SD=0.27), $F_{1, 186}$=1.71, MSE=0.11, ns, η_p^2=0.01. That is, we observed asymmetries favoring humans as the inductive base in every group except the 6-year-old Indonesian-speaking children.[5]

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 non-human animals come into close correspondence, even in Indonesian-speaking children for whom this correspondence is not lexicalized. This correspondence strengthens the ANIMATE or $\text{ANIMAL}_{inclusive}$ 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 non-human animal target, their access to the $\text{ANIMAL}_{inclusive}$ category results in asymmetries favoring humans. If this

[5] Further analyses revealed that at age 6, private-school children generalized more from a human to a non-human animal (M=0.28, SD=0.38) than from a non-human animal to a human (M=0.21, SD=0.33) (although this effect was marginal), $F_{1, 33}$=3.85, MSE=0.08, P=0.06, η_p^2=0.11, 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 non-human animals into closer correspondence earlier on.

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 non-human 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 non-human animals (overall M=0.67, SD=0.35), 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 so (overall M=0.37, SD=0.37) (F values>5.80, P values<0.05, η_p^2 values>0.13). That is, for these groups of children – all of whom showed the asymmetries in the previous analysis – the human–non-human 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 humans and non-human 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 non-human animal, children in both language communities performed comparably, systematically extending that property to other non-human 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 non-human 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 US 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 humans and non-human 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 non-human 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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