*Research Report*

# Naming Practices and the Acquisition of Key Biological Concepts

## Evidence From English and Indonesian

**Florencia K. Anggoro, Sandra R. Waxman, and Douglas L. Medin**

*Northwestern University*

**ABSTRACT—***Children's acquisition of fundamental biological concepts (LIVING THING, ANIMAL, PLANT) is shaped by the way these concepts are named. In English, but not Indonesian, the name "animal" is polysemous: One sense includes all animate objects, and the other excludes humans. Because names highlight object categories, if the same name ("animal") points to two different, hierarchically related biological concepts, children should have difficulty settling on the scope of that term and its close neighbors (e.g., "alive"). Experiments with 4- to 9-year-old English- and Indonesian-speaking children revealed that "alive" poses unique interpretive challenges, especially for English-speaking children. When asked to identify entities that are "alive," older Indonesian-speaking children selected both plants and animals, but their English-speaking counterparts tended to exclude plants, which suggests that they may have misaligned "alive" with one of the "animal" senses. This work underscores the importance of considering language and cultural factors in studying the acquisition of fundamental concepts about the biological world.*

A considerable amount of research has focused on "folkbiological" knowledge, or people's everyday knowledge about living things. This work has revealed that an appreciation of the fundamental concept LIVING THING[1] (including plants and animals) is a late and laborious developmental achievement. Piaget (1937/1954) noted that young children mistakenly attribute life status to inanimate objects that appear to move on their own (e.g., clouds, bicycles). He interpreted this "childhood animism" as a reflection of children's inchoate grasp of concepts, including ANIMAL and LIVING THING. More recent evidence indicates that even 10-year-olds have difficulty understanding the scope of LIVING THING (Hatano et al., 1993).

In this article, we take a fresh look at children's apparent difficulty establishing the concepts ANIMAL, PLANT, and LIVING THING. To identify the antecedents to 10-year-olds' well-documented difficulties understanding these concepts, we examine the developmental trajectories of children from 4 to 9 years of age. We propose that the way in which these concepts are named within a given language shapes their acquisition. We pursue this proposal by comparing children speaking English and Indonesian, a pair of languages with intriguing differences in the names for key biological concepts.

Our focus on naming is motivated by extensive documentation that names, and nouns in particular, serve as a catalyst in object categorization from infancy (see Waxman & Lidz, 2006, for a review) through adulthood (Goss, 1961). By 12 months of age, children use names as invitations to form categories (Waxman & Markow, 1995). Infants' ability to form an object category (e.g., ANIMAL) when presented with a set of disparate exemplars (e.g., a dog, a horse, and a duck) improves dramatically when these exemplars are introduced with the same name. For infants as young as 9 months old, this facilitative effect is specific to words (and not tones), and by the age of 14 months, it is specific to nouns (and not adjectives or verbs; Balaban & Waxman, 1997; Waxman & Booth, 2001). If naming supports object categorization in infants and young children, then the names children learn for biological entities should influence their categorization of those entities.

There is also evidence suggesting that at least some basic folkbiological concepts (e.g., ANIMAL) emerge early, and well in

Address correspondence to Florencia K. Anggoro, Department of Psychology, University of Chicago, 5848 S. University Ave., Chicago, IL 60637, e-mail: f-anggoro@uchicago.edu.

[1]Small capital letters denote concepts; quotation marks denote their names; italics denote language-specific names.

advance of their names. Infants are especially interested in animate objects and are captivated by animate properties, including faces, eyes, and autonomous, biological motion (Bertenthal, 1993; Johnson, Slaughter, & Carey, 1998; Poulin-Dubois & Shultz, 1990). Infants distinguish between animate and inanimate objects (Woodward, Sommerville, & Guajardo, 2001) and between agents and nonagents (Leslie, 1994). Perhaps not surprisingly, then, notions of animacy are evident in preschoolers' reasoning (Gelman, 1990).

If names serve as invitations to form categories, then the names that children hear for biological entities should bolster any concepts for such entities that young children may have already discovered (e.g., ANIMAL) and should support the acquisition of related concepts they have yet to discover. Decades of ethnobiological research provide insights into how biological entities are named across diverse languages (Berlin, 1992), and the evidence is surprising. The overarching concept LIVING THING rarely, if ever, is named with a single, dedicated noun. Reference to this concept is almost always accomplished by means of a phrase (e.g., *living thing* in English). Thus, although in principle a dedicated name could support the acquisition of this abstract concept, this support rarely is present. In contrast, most languages name the concept ANIMAL. This, coupled with an early appreciation of animacy, likely supports the early acquisition of ANIMAL.

There is, however, one potentially important complicating factor (see Fig. 1). In many languages, including English, the name "animal" is polysemous: It can refer to all animate objects ($\text{ANIMAL}_{\text{inclusive}}$), but can also refer to the more restrictive concept that excludes humans ($\text{ANIMAL}_{\text{contrastive}}$).

This polysemy could have adverse consequences: If nouns support the formation of object categories, and if the same name "animal" points to two different, but hierarchically related concepts, then it should be difficult for children to settle on its meaning. This is a testable hypothesis, because this polysemy is not universal. In Indonesian, for example, "animal" refers only to the more restrictive $\text{ANIMAL}_{\text{contrastive}}$ concept (see Fig. 1). The $\text{ANIMAL}_{\text{inclusive}}$ concept is unnamed. Neither a dedicated noun nor a commonly used phrase is associated with this unnamed concept.

To test this hypothesis, we recruited children acquiring either Indonesian or English in monolingual households in Jakarta and Chicago, respectively. The children in the two cities were recruited from urban elementary schools that served families of comparable relative socioeconomic status. Jakarta, Indonesia's capital, is a diverse city with a rich mixture of cultural practices and serves as the center for political and economic activity. Both majority- and minority-culture children were included (children from Native- and Chinese-Indonesian families in Jakarta and children from families of European and non-European descent in Chicago). No detectable differences in task performance were associated with this variable.

In preliminary experimentation, we asked whether children's interpretations of "animal" accord with those of adults in the same linguistic community. We presented 95 English-speaking 6- and 9-year-olds and 102 Indonesian-speaking 6- and 9-year-

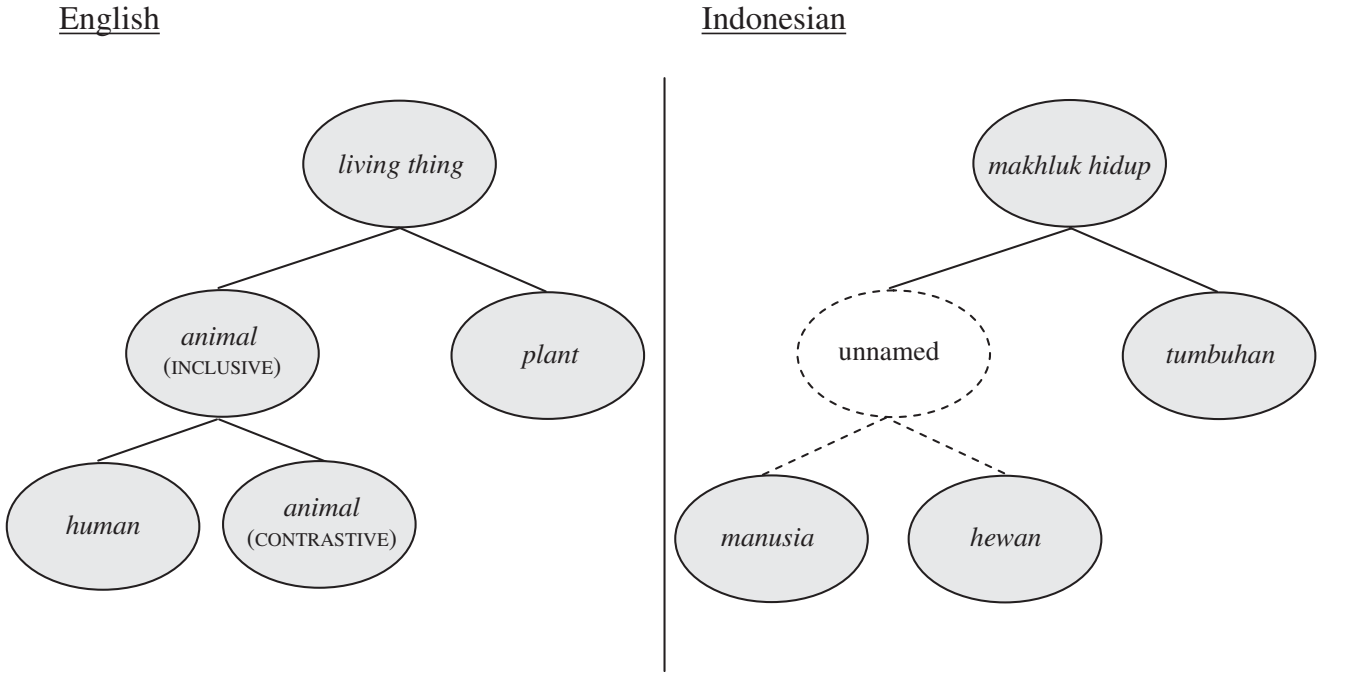


**Fig. 1.** A schematic depiction of English and Indonesian names for fundamental biological concepts. Notice that the node corresponding to ANIMATE, or $\text{ANIMAL}_{\text{inclusive}}$, is unnamed in Indonesian.

olds with a photograph of a human, asking, "Could you call this an 'animal'?" ("Mungkinkah ini 'hewan'?" in Indonesian). The children's responses mirrored those of adult speakers. Indonesian-speaking children overwhelmingly endorsed the $\text{ANIMAL}_{\text{contrastive}}$ interpretation, with only 3% asserting that a human could be included in the category named "animal." English-speaking children endorsed the $\text{ANIMAL}_{\text{inclusive}}$ interpretation significantly more often (26%) than the Indonesian children.

In another preliminary study, we examined whether children's categorization of human and nonhuman animals mirrored their naming practices. We presented 60 English-speaking 6- and 9-year-olds and 65 Indonesian-speaking 6- and 9-year-olds with a set of cards depicting various living and nonliving things, and asked them to place "the kinds of things that belong together in the same pile." Performance on this free-sorting task indeed reflected the children's naming practices: Indonesian-speaking children were less likely than their English-speaking counterparts to place a human with a nonhuman animal. Only 5% of the Indonesian-speaking 6- and 9-year-olds placed a human with a nonhuman animal, whereas 36% of the English-speaking 6- and 9-year-olds did so, $\chi^2(1, N = 123) = 17.89, p < .001$.

These preliminary findings establish that children's interpretation of "animal" accords with the naming practices of their ambient linguistic community, and that this interpretation is reflected in their performance in a free-sorting task. Children acquiring Indonesian are sensitive to one unambiguous interpretation of "animal," but children acquiring English are sensitive to two interpretations ($\text{ANIMAL}_{\text{contrastive}}$ and $\text{ANIMAL}_{\text{inclusive}}$). These insights provided the foundation for a more detailed experimental investigation.

The main experiment was designed to address two issues. First, we wanted to know whether the difference between English and Indonesian would persist in a more structured task that was specifically designed to tap into the overarching concept LIVING THING. Second, we considered the consequences of the polysemy of "animal" in English. Preliminary work had established that Indonesian-speaking children endorsed one meaning, almost exclusively applying the $\text{ANIMAL}_{\text{contrastive}}$ interpretation to "animal," but that, in contrast, English-speaking children endorsed either the $\text{ANIMAL}_{\text{contrastive}}$ or the more abstract $\text{ANIMAL}_{\text{inclusive}}$ interpretation. This observation, coupled with evidence that children favor a "one word–one concept" approach in word learning (Markman & Wachtel, 1988), suggests that English-speaking children should be open to aligning a word other than "animal" with the $\text{ANIMAL}_{\text{inclusive}}$ concept, should a suitable candidate arise.

An examination of parental input to English-speaking children suggests one such candidate. A recent analysis (Leddon, Waxman, & Medin, 2007) of parent-child conversations in the CHILDES database (MacWhinney, 2000) revealed that English-speaking parents apply "die" and "grow" to all living things, but use "alive" more restrictedly, applying it almost solely to animals (human and nonhuman), and excluding plants. This usage offers English-speaking children an opportunity to (mis)align "alive" with $\text{ANIMAL}_{\text{inclusive}}$ and thus to circumvent the polysemy of "animal." Notice that if children adopt this interpretation, then when they are asked about "alive" (as in most experiments probing biological knowledge), they should exclude plants. Indeed, when English-speaking children are asked to sort objects on the basis of the predicate "alive," they systematically exclude plants (Carey, 1985; Opfer & Siegler, 2004; Piaget, 1926/1929; Waxman, 2005). Moreover, in Japanese and Hebrew—two other languages in which the word for ANIMAL is polysemous—children also tend to deny that plants are alive (Hatano et al., 1993; Stavy & Wax, 1989).

If in attempting to resolve the polysemy of "animal," English-speaking children (mis)align "alive" with the less-preferred $\text{ANIMAL}_{\text{inclusive}}$ sense, then their tendency to include plants when sorting on the basis of "alive" should be attenuated relative to their tendency to include plants when sorting on the basis of other biological predicates. Moreover, this interpretive difficulty with "alive" should be more pronounced for English- than Indonesian-speaking children, as the latter presumably have no such polysemy to resolve.

## METHOD

### Participants

Participants were 4-year-olds (56 American: mean age = 4.52 years; 46 Indonesian: mean age = 4.72 years), 6-year-olds (70 American: mean age = 6.49 years; 46 Indonesian: mean age = 6.28 years), and 9-year-olds (53 American: mean age = 9.42 years; 48 Indonesian: mean age = 9.08 years) from urban elementary schools in greater Chicago and Jakarta. At each age and site, approximately 53% of the children were girls.

### Materials

Each of 17 items was depicted in a photograph presented on a laminated card measuring 8.5 in. by 5.5 in. (see Table 1).

**TABLE 1**
***List of Experimental Stimuli***

| Category | | | | |
|---|---|---|---|---|
| Human | Animal | Plant | Nonliving natural kind | Artifact |
| person (child) | bear<br>squirrel<br>bird<br>fish<br>beetle<br>worm | maple tree<br>cranberry bush<br>dandelions | sun<br>clouds<br>water<br>rocks | bicycle<br>scissors<br>pencil |

### Procedure

Each child was instructed to sort the 17 cards three different times, on the basis of three different predicates ("alive," "die," and "grow"). To begin, the experimenter and child identified each photograph. The experimenter then shuffled the cards and initiated the sorting task, beginning with the predicate "alive." Presenting the cards individually, she instructed the child to "put the ones that are 'alive' here" (indicating one side of the table) and "the ones that are not 'alive' here" (indicating the other side of the table). Next, she shuffled the cards and instructed the child to sort them on the basis of one of the other predicates. When that sort was completed, she shuffled the cards and gave instructions for the third sort. The order in which "die" and "grow" were presented was counterbalanced across participants.

### Coding

We assigned each child's sort to one of the following patterns, permitting one error of omission and one of commission:

- ANIMAL$_{inclusive}$: humans and nonhuman animals sorted together, with plants and all others excluded
- LIVING THING: all living things sorted together, with all others excluded
- NATURAL KIND: all living things and natural kinds sorted together, with others excluded
- other: no discernible pattern

## RESULTS

As Figure 2 shows, by the age of 6 years, English- and Indonesian-speaking children appreciate an overarching concept LIVING THING, as evidenced by their performance with the predicates "die" and "grow," but their interpretation of "alive" follows a more protracted developmental trajectory.

Consider first the predicates "die" and "grow." Four-year-olds in both language communities produced a large proportion of "other" sorts, which suggests that they found this task difficult. Those who did produce a discernible pattern favored the LIVING THING pattern (or, in the case of Indonesian-speaking children sorting on "die," the LIVING THING and ANIMAL$_{inclusive}$ patterns). Among 6-year-olds, this pattern predominated, and by age 9, the majority of children produced it. Nonparametric analyses of the proportion of children producing each of the three patterns revealed that at each age and in each language community, the distribution differed significantly from expected chance values, $\chi^2$s(1) $> 9.22, ps < .01$ (*N*s for these tests ranged from 16 to 52). Thus, by the age of 6 years, most children appreciate a concept of living things and apply the biological predicates "die" and "grow" to this inclusive concept.

A very different trajectory was observed for "alive." Again, 4-year-olds produced a large proportion of "other" sorts. But an analysis of the distribution of the remaining patterns revealed that in both language communities, 4-year-olds who produced a discernible pattern favored the ANIMAL$_{inclusive}$ pattern (excluding plants), $\chi^2(1, N = 33) = 18.82, p < .001$, for English-speaking children and $\chi^2(1, N = 31) = 12.78, p < .01$, for Indonesian-speaking children. Six-year-olds' responses were distributed evenly among the three patterns, $\chi^2(1, N = 53) = 5.30$, n.s., for English-speaking children and $\chi^2(1, N = 34) = 2.56$, n.s., for Indonesian-speaking children; this suggests that children in both language communities have difficulty settling on the scope of this term. Among 9-year-olds, however, performance in the two language communities diverged: English-speaking children continued to distribute their responses evenly, $\chi^2(1, N = 51) = 2.26$, n.s., but Indonesian-speaking children strongly favored the LIVING THING pattern, $\chi^2(1, N = 48) = 50.89, p < .001$. The ANIMAL$_{inclusive}$ pattern (corresponding to a concept unnamed in their language) virtually vanished.

## DISCUSSION

In the current work, we explored how the acquisition of biological concepts is influenced by the naming practices of children's linguistic communities. Preliminary evidence revealed that some English-speaking, but no Indonesian-speaking, children endorse two different meanings of "animal," and that this difference is mirrored in children's free sorting.

More detailed experimental work revealed the conceptual consequences of the polysemy of "animal." Although children from both language communities appreciated an abstract LIVING THING concept, as witnessed by their interpretation of "die" and "grow," their interpretation of "alive" varied as a function of language. Indonesian-speaking 9-year-olds successfully applied this term to LIVING THING. However, their English-speaking counterparts showed a persistent and pernicious difficulty, as would be expected if they had (mis)aligned "alive" with the ANIMAL$_{inclusive}$ concept, and not the more abstract LIVING THING concept. This suggests that the term "alive" poses unique interpretive challenges for English-speaking children.

These results open several avenues for future work. It will be important to learn more about how children represent the (often covert) ANIMAL$_{inclusive}$, or ANIMATE, concept. There is strong evidence that infants are sensitive to this concept, even in advance of language. What is less clear is the developmental fate of this concept for individuals who acquire languages, like Indonesian, in which the concept remains unnamed. This issue relates directly to investigations concerning the role of language in preserving sensitivity to unnamed concepts (Hespos & Spelke, 2004; Levinson, Kita, Haun, & Rasch, 2002; Li & Gleitman, 2002).

It will also be important to discover how (and how deeply) representations of this concept are affected by language. Clearly, language does matter. English-speaking children, who are sensitive to the polysemy of "animal," have difficulty interpreting the closely related predicate "alive." Children who

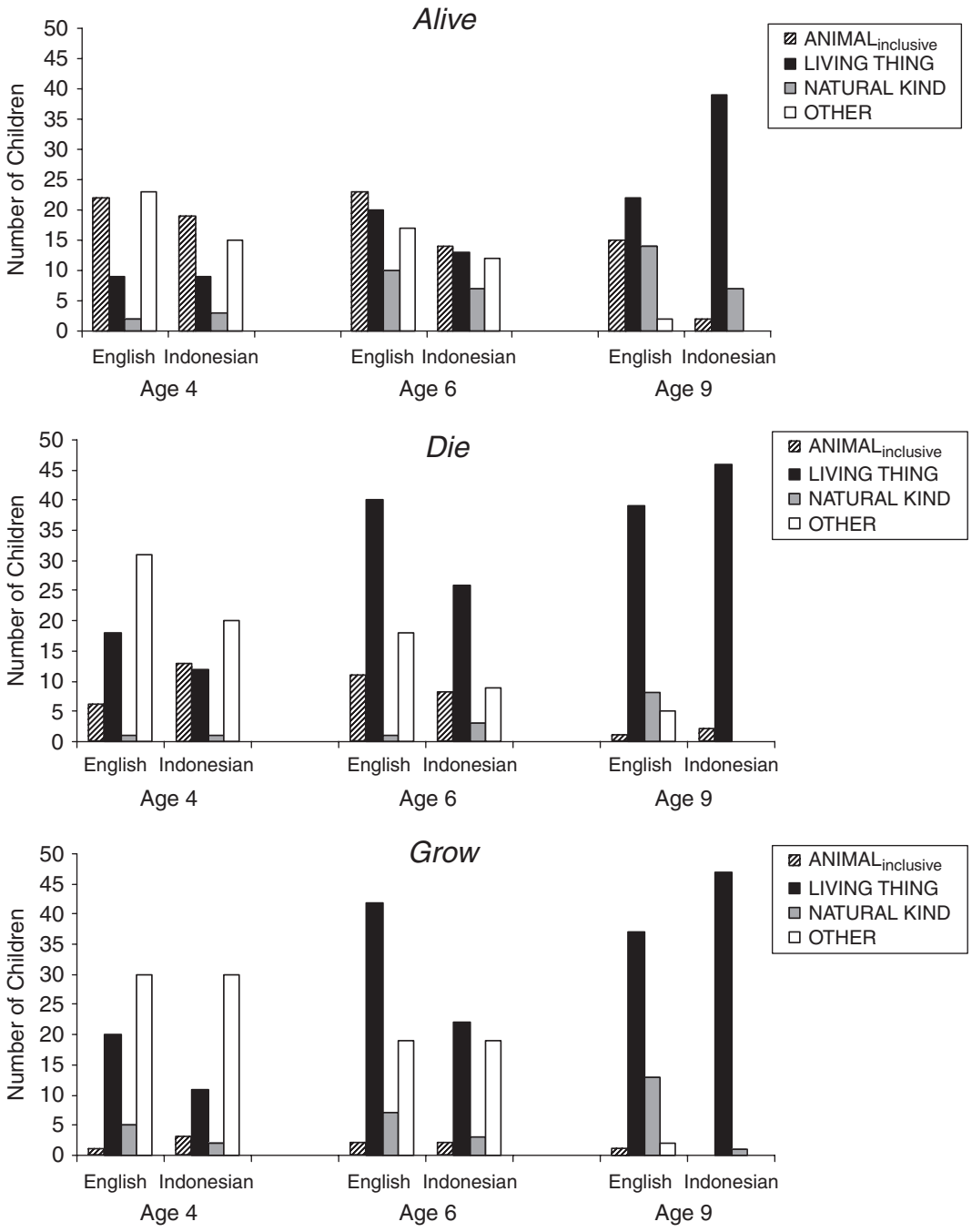


**Fig. 2.** The number of children producing each sorting pattern (or no discernible pattern) as a function of age and language community. From top to bottom, the graphs show results for three predicates: ''alive,'' ''die,'' and ''grow.''

speak Indonesian, which has no such polysemy, establish the scope of the term "alive" more readily, and by 9 years of age overwhelmingly attribute life status to plants, as well as animate beings. Finally, it will be important to discover whether this difference is attributable to the polysemy of "animal" in English or the unnamed status of ANIMAL$_{inclusive}$ in Indonesian. To answer this question, researchers will need to look to languages in which the ANIMATE node has a name and the name is not polysemous. Czech appears to be one such language: ANIMAL$_{inclusive}$ is named (*živočich*), and this name is distinct from that for ANIMAL$_{contrastive}$ (*zvíře*).

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