Categorization Inside and Outside the Laboratory

Essays in Honor of Douglas L. Medin

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Why Is the Concept "Living Thing" So Elusive? Concepts, Languages, and the Development of Folkbiology

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> Curiosity is one of the permanent and certain characteristics of a vigorous mind.
>
> —Samuel Johnson (1709–1784)

In 1992, I moved to Northwestern University with my first grants in hand. I was delighted to find that Medin would be joining the faculty at the same time, and would be my new colleague. But at the same time, I was terrified at the prospect of coming face-to-face, day-to-day encounters with this once and future king of cognition, categories, and concepts. It is always best, in circumstances such as these, to hide your terror; and so, I focused instead on my main program of research: to discover how infants and young children, across the world's communities, develop the complex, sophisticated linguistic and conceptual systems that are the hallmark of the human mind. The plan was to act locally (building a new research program in the greater Chicago area to study early language and conceptual development) and to think globally (considering the universality of the phenomena we discovered here, and asking whether and how human development is shaped by the language and culture in which infants are raised).

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Medin has influenced every aspect of my work, from the local to the global, from design issues to theoretical perspectives, somehow balancing his role as master critic with that of star cheerleader. But as a colleague, his greatest gift of all is his genuine and infectious curiosity. He kept me informed about his research, including his ideas about categorization and reasoning about the biological world, and I kept him informed about my thoughts on early language and cognitive development. Eventually, we launched a collaboration.

Forging a New Collaboration: The Acquisition of Folkbiological Knowledge

This chapter describes the evolution of a collaborative research project, one that includes myself, Medin, and anthropologists Scott Atran and Norbert Ross and that focuses on the acquisition of folkbiological knowledge from a developmental and cross-cultural perspective. Our interest was motivated by decades of research in cognitive psychology, cultural psychology, and anthropology suggesting that the very concepts that Western-educated adults hold as central to the domain (e.g., "alive," "animal") may be represented in an altogether different fashion among adults from other cultures and even among children from our own culture (Carey, 1985; Carey & Spelke, 1994; Johnson & Carey, 1998; Piaget, 1929; Solomon, Johnson, Zaitchik, & Carey, 1996). The phenomenon known as *childhood animism* serves as an excellent example. The claim is that children erroneously attribute animacy (life) to inanimate objects and that this leads them to reason in ways that are antithetical to the reasoning of adults. For example, children tend to tell us that the moon follows us because it wants to, and that bicycles breathe (Piaget, 1929).

The overarching goal for our research is to discover how children and adults from different cultural milieus construe the biological world, how they identify biological entities (e.g., animals, plants) and biological processes (e.g., life, birth, death), and how their early notions evolve over development. As it turns out, these are challenging questions. Unlike the (rapid) acquisition of language, knowledge and reasoning about the biological world emerges rather slowly in development. It seems to take years for children to construe the biological world in a way that approximates that of their elders. From the perspective of the researchers, matters are no less challenging. After decades of dedicated work, deep theoretical and empirical controversies abound (Astuti, 2001; Carey, 1985; Carey & Spelke, 1994; S. Gelman & Hirschfeld, 1999; S. Gelman & Wellman, 1991; Hatano & Inagaki, 1999; Hirschfeld & Gelman, 1994; Inagaki & Hatano, 2003; Johnson & Carey, 1998; Keil, Levin, Richman, & Gutheil, 1999; Kelemen, 2003; Massey & Gelman, 1988; Medin & Atran, 1999; Piaget, 1929, 1954; Slaughter & Lyons, 2003; Solomon et al., 1996). Despite these controversies, however, there seems to be strong consensus on at least one point: that the concept *alive* or *living thing*[1] is a difficult one to grasp.

[1]I adopt the following notational convention: *Italicized names* refer to a concept; "*italicized names*" in quotations refer to the name of that concept.

In this chapter, I focus squarely on this point of convergence, asking why this is the case. Why is the essential biological concept *alive* or *living thing* so elusive and so difficult for children to grasp? In answering this question, I consider the concept *living thing* as well as its two daughters (or constituents), *animal* and *plant* (Figure 4.1).

Structure of the Chapter

I begin by asking whether there may be core principles, inherent in the mind of the learner, to support the acquisition of the concepts *living thing, animal,* or *plant*. Next, I consider whether there are features of human language, and especially in the names for these biological concepts, that might support their acquisition. These analyses add a new perspective to the difficulties that children encounter as they establish these fundamentally biological concepts, and provide insights into the factor(s) that may underlie these difficulties. Turning next to our collaborative project, I consider these insights in light of preliminary evidence from children growing up in three different cultural pockets in

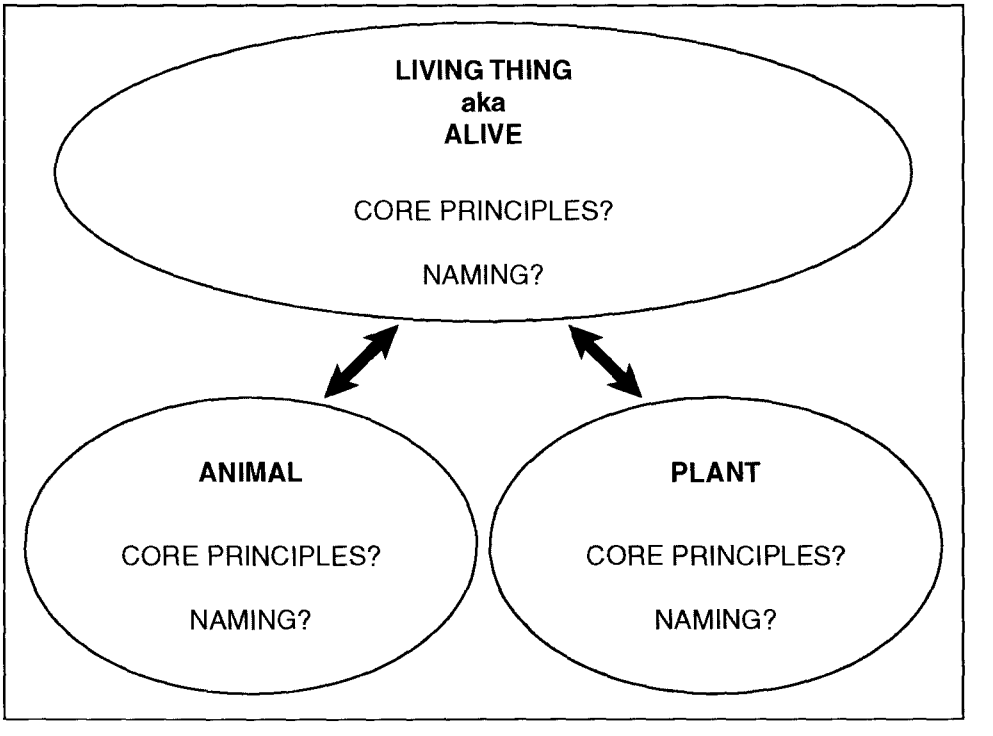

Figure 4.1. Fundamental biological concepts *living thing, animal,* and *plant.*

the American Midwest (urban Chicago, suburban Chicago, and rural Native American [Menominee Tribal Nation]).

Taken together, the work suggests that although the overarching biological concept *living thing* is indeed rather fragile, it is available as early as 5 or 6 years of age. Perhaps more intriguing, the fragility and elusiveness of the concept *alive* may be due, at least in part, to the fact that it is so readily eclipsed by its conceptually more powerful and linguistically more polysemous daughter, *animal*.

Are There Core Principles to Support the Acquisition of Folkbiology?

In recent years, developmental researchers have examined seriously the possibility that learning in some domains is guided from the start by domain-specific principles that direct the learner's attention to particular aspects of experience and in this way support the rapid acquisition and organization of knowledge in that domain (For an excellent review of this position, see R. Gelman & Lucariello, 2002.) What core principles (if any) might serve to structure acquisition of the concepts *animal*, *plant*, and *living* thing?

The Case for Animal

Claude Levi–Strauss once remarked that ". . . animals are good to think with" (Levi–Strauss, 1962). This now-famous observation reveals that like psychologists, anthropologists take seriously the notion that the concept *animal* is inductively rich and well-structured. How does this richly structured system of knowledge evolve? Psychological research with infants suggests that there may be core principles, inherent in the mind of the human learner that support the acquisition of the concept *animal* or *animate kinds* (R. Gelman, 1990). Within the first months of life, infants devote special attention to faces (Carey, Diamond, & Woods, 1980; Mondloch et al., 1999), and to eyes in particular (Hood, Willen, & Driver, 1998; Johnson, Slaughter, & Carey, 1998). In addition to these early preferences for static properties of animate objects, infants are also quite sensitive to dynamic properties of animate objects. Infants as young as 3 months of age are able to distinguish biological from mechanical motion (Bertenthal, 1993). They are also sensitive to the distinction between motion that is self-initiated (as is the case for animate objects only) and motion that is initiated by an external force (Poulin–Dubois & Shultz, 1990). These early perceptually based sensitivities, however rough they may be, likely support infants' ability to tease apart the animate from the inanimate objects in their world of experience. Infants are also exquisitely sensitive to an apparently abstract notion of intentionality. They distinguish intentional from nonintentional beings and intentional from nonintentional acts (Carpenter, Akhtar, & Tomasello, 1998; Johnson, 2000; Meltzoff, 1995; Rochat, Morgan, & Carpenter, 1997; Woodward, 1999; Woodward, Sommerville, & Guajardo, 2001).

Thus it is quite possible that infants' knowledge and representation of the concept *animal* is guided by principles, or natural preferences, that ensure that infants devote special attention to animate objects and facilitate the ability to tease apart animate from inanimate objects in the environment. These preferences, however sketchy at the outset, likely facilitate the apprehension of the concept *animal* and support the evolution of a stable base of knowledge that can support reasoning about animate objects. Thus core principles that organize and support the acquisition of the concept *animal* may indeed exist.

The Case for Plant

The concept *plant* appears to enjoy no such principles or early preferences. Although Bloch (1998) once argued that "... *trees* are good to think with," to the best of my knowledge, no one has ever made this claim for the more general concept, *plant.* For most adults and children alike, the concept *plant* is inductively meager and understructured (Hatano & Inagaki, 1999), at least compared with its sister, *animal.* To be sure, there are communities in which knowledge of the plant kingdom is richer than is typically the case in majority-culture individuals in the U.S. population, and even within majority U.S. culture, certain individuals possess expert knowledge about certain plants or about the plant kingdom in general (Lynch, Coley, & Medin, 2000; Proffitt, Coley, & Medin, 2000; Wolff, Medin, & Pankratz, 1999). Yet most people's knowledge and reasoning about plants falls short of their knowledge and reasoning about animals. This state of affairs may be related to the fact that apparently no core principles, conceptual preferences, or perceptual sensitivities support the acquisition of *plant* as a cohesive concept. To the best of my knowledge, none of the core principles that have been identified in infants and young children could support a systematic distinction between plants on the one hand and other (nonliving) inanimate objects on the other.

The Case for Living Thing

The concept *living thing*, the overarching parent concept that includes all members of both the *plant* and *animal* kingdoms, is the holy grail of any coherent theory of biology, be it a naïve or a scientific theory. Yet none of the core principles identified to date appear to support its acquisition. In brief, there appears to be no evidence for any kind of conceptual or perceptual architecture that unites the concepts *plant* and *animal* and excludes inanimate objects. It is perhaps no surprise, then, that the concept *alive* appears to be a relatively late developmental acquisition, and knowledge about this essential biological concept appears to be fragile. Thus in the (apparent) absence of core principles to support and structure acquisition, *living things* are not good to think with.

In sum, there appear to be core principles to support the early acquisition of the concept *animal*, but no such principles or preferences to support the concepts *living thing* or *plant.* This analysis is consistent with the view that

the concept *animal* is developmentally privileged, at least compared with the concepts *living thing* or *plant*.

Does Naming Support the Acquisition of Folkbiological Concepts?

> "What's the use of their having names," the Gnat said, "if they won't answer to them?"
>
> "No use to *them*," said Alice, "but it's useful to the people that name them, I suppose. If not, why do they have names at all?"
>
> —Carroll (1972)

In this section, I ask whether there are features of human language that might support children's acquisition of the concepts *animal*, *plant*, and *living thing*. The very idea that this might be the case derives from rich research traditions in psychology, linguistics, and anthropology, traditions that suggest that our linguistic and conceptual systems of organization are implicitly and powerfully linked. Indeed, considerable evidence now suggests that these links are available to infants who are just on the verge of producing their first words.

Infants as young as 9 and 10 months of age pay more attention to objects that have been named than to those presented in silence (Baldwin & Markman, 1989). Moreover, and perhaps more important, we know that object naming has powerful conceptual consequences as well. Naming a set of distinct objects (e.g., a dog, a horse, a fish) with the same name (e.g., *"animal"*) highlights the commonalities among them, supporting the acquisition of categories and concepts (Waxman, 2002; Waxman & Booth, 2001; Waxman & Markow, 1995). This facilitative effect of naming on categorization is evident in infants as young as 9 months of age (Balaban & Waxman, 1997). This "invitation" appears to be specific to naming and not to a more general facilitative effect of auditory input. Tones, unlike words, do not have this same facilitative effect on categorization (Balaban & Waxman, 1997). Moreover, naming appears to support the discovery of additional, perhaps deeper, commonalities shared by members of a category (S. Gelman & Markman, 1987; Waxman & Booth, 2001; Welder & Graham, 2001). On the basis of such results, we have proposed that names serve as *invitations to form categories* (Brown, 1958; Waxman & Markow, 1995).

In principle, then, object naming could serve as precisely the invitation that children need if they are to discover the fundamental biological concepts *alive*, *plant,* and even *animal*. Naming could serve as an especially powerful guide wherever there is an (apparent) absence of core principles to support acquisition. To evaluate this possibility, we turn to the field of ethnobiology, a formal discipline within anthropology whose goal is to identify the linguistic systems created by people from diverse cultures to describe the natural world (Berlin, 1992; Berlin, Breedlove, & Raven, 1974; Brown, 1977; Dougherty, 1979; Hunn, 1977; Stross, 1973).

The ethnobiological record offers a wealth of information regarding whether and how the biological concepts *living thing, plant,* and *animal* are named. This information is quite striking. In many languages, these fundamental biological concepts remain unnamed (Berlin, 1992). This finding has raised interesting questions regarding whether to credit people with knowledge of a concept, particularly when the concept is unnamed (or covert). On one side of the debate are those who insist that only concepts that are named by native speakers can be said to have conceptual status within that culture (Brown, 1977; Burling, 1964; Hunn, 1977). Others maintain that the absence of an explicit name does not necessarily imply the absence of an underlying concept (Berlin, 1992; Lucy & Gaskins, 2001); these researchers point out that speakers can recruit other linguistic devices, including phrasal descriptions, dedicated verbs, and dedicated numeral classifier terms (for more thorough descriptions of classifier systems, see Allan, 1977, and Craig, 1986).

For the purposes of this chapter, the primary question is whether the concepts *living thing, plant,* and *animal* are named in various languages. If the concepts are named, then it is possible that these names could facilitate the discovery of these core biological concepts.[2] If the concepts remain covert, then we can consider the linguistic devices that are recruited to mark these concepts and ask whether these devices have the same conceptual power as names.

The Case for Animal

Many languages have a unique, dedicated name that spans the entire animal kingdom and that could therefore serve as an invitation to form the concept. Yet this is not a universal phenomenon. Many languages have no such overt name, leaving *animal* as a covert category. Speakers of these languages recruit other linguistic devices to refer to the concept *animal.*

One linguistic device, characteristic of several languages, is to mark the concept phrasally. For example, in Yukatek Maya, where there is no overt name for animal, speakers use the compound noun *"ba'alche'"*, which incorporates the terms for the phrase "things (che') of the forest (ba'al)." (It is interesting to note that this phrase is not meant to include plants, although they are also undeniably "things of the forest.")

Another linguistic device, available exclusively to speakers of classifier languages, is the use of a dedicated classifier term for all and only instances of the covert category. For example, in Yukatek Maya, all (and only) animals take the same classifier term (*"tu'ul"*). Speakers of Tzeltal Maya (who have no overt name for the concept *animal*) and Korean (who do) also recruit this linguistic

[2]Although it is beyond the scope of this chapter, it would be very interesting to ask whether and how language differences affect conceptual development by comparing the developmental trajectory of a concept that is named in one language but remains covert in another. For example, do children from communities speaking Spanish master the concept *plant* more readily than those from communities speaking Yukatek Maya, where *plant* remains covert?

device, using the classifier terms *koht* and *mari,* respectively, in conjunction with all and only animal names. See Berlin (1992) or Lucy and Gaskins (2001) for a discussion of still other grammatical devices, including certain verbs, that are reserved for animals.

Before we move on, two issues bear mention. These will be relevant also in considering names for *plant* and *living thing.*

DO ALL LINGUISTIC DEVICES CONFER THE SAME CONCEPTUAL POWER AS OVERT NAMES? Clearly, even in the absence of a unique dedicated noun, speakers recruit other linguistic devices to single out the concept *animal.* But whether these alternatives confer the same conceptual power as names remains very much an open question. Do these alternatives to naming also serve as invitations to form categories? My intuition is that they do not (Waxman, 1999). Consider the case of the classifier terms. Unlike overt names for things (count nouns, in English), these are unstressed grammatical elements acquired relatively late in development. As a result, they are less likely to be available to guide early conceptual acquisition. Moreover, although there are cases in which a classifier is dedicated to (or reserved exclusively for) a particular concept (c.f., *koht* and *mari*), this is the exception rather than the rule. Most classifier terms are used with a wide range of objects from diverse ontological domains. For example, in Japanese, there is a classifier that is used in conjunction with the nouns for small animals. But this term is also used in conjunction with nouns referring to artifacts, and it cannot be used with the nouns for large animals. Clearly, then, this classifier cannot serve as an invitation to form the concept *animal.* An even more colorful example comes from Dyirbal, an Australian aboriginal language, in which the classifier *"balan"* is used with the nouns referring to women, fire, scorpions, and other dangerous things (Lakoff, 1988). The kinds of commonality linking this diverse set of objects are quite different than those linking all animals together. In sum, there is no compelling reason to assume that a group of objects that take the same classifier term will have the same conceptual status as those that take the same name.

DOES THE BREADTH OF AN OVERT NAME AND ITS POLYSEMY AFFECT ACQUISITION? Another issue—the breadth and polysemy of the term *animal*—also warrants serious attention. Consider first the variations in the breadth of this term. In some languages, including Indonesian (F. Anggoro, personal communication, June 2003), Vezo (Astuti, 2000; Astuti, 2001) and Merina (R. Astuti, personal communication, June 2003), the term that translates most closely to *"animal"* frankly excludes humans. In fact, in these languages (unlike English, for example) there is no unique term spanning both human and nonhuman animals. Speakers of these languages explicitly deny that humans are animals. In Indonesia, children are taught that there are *three* (rather than two) classes of living things: *plants, animals,* and *humans.* Similarly, in Vezo culture, the concepts *animal* and *human* are virtually mutually exclusive. Astuti (2001) documents a fascinating case study suggesting that members of the Vezo culture share the strong, explicit belief that infants must be transformed if they are to leave behind the animal world and "become human."

Issues regarding the breadth of the term *"animal"* are not restricted to distant languages and exotic cultures. On the contrary, a close examination reveals that the name *animal*, whenever it does exist in a language, is deeply polysemous (i.e., it takes many different senses). Consider the case of English, wherein *"animal"* can take (at least) three different senses. *"Animal"*$_{sense\ 1}$ refers to the entire animal kingdom. *"Animal"*$_{sense\ 2}$ includes nonhuman animals only. This is the primary sense conveyed by the term *animal* in Vezo and Indonesian, but it is also evident in English, when we admonish children, for example, "Don't eat like an animal." *Animal*$_{sense\ 3}$ includes mammals only. This sense was conveyed recently in a spontaneous comment I recently overheard at the Lincoln Park Zoo. A group of elementary-school children who were visiting the Insect House repeatedly asked their teacher, "When can we go see the animals?"

If words are invitations to form categories, then the polysemy of this term should have conceptual and developmental consequences. Even in languages in which the concept *animal* is uniquely and overtly named, the name may not serve as a particularly good invitation because its deep polysemy ensures that the guest list (or, the extensional set) is unstable and ambiguous. Although the nonhuman mammals always seem to be included in the invitation, this is not the case for the humans and the nonmammals of the animal kingdom. How do children sort out this polysemy? I will return to this question later, when I consider the consequences of this polysemy on acquisition of the underlying concepts *animal* and *living thing*.

The Case for Plant

Across languages, the incidence of covert categories for the concept *plant* is even greater than for *animal*. Although many languages, such as English, have a unique dedicated overt noun, it is not uncommon for this concept to remain unnamed. In such cases, the covert category is indicated with other linguistic devices.

For example, in Tzeltal and Yukatek Maya, a dedicated classifier (*tehk* and *ku'ul*, respectively) is reserved for all and only members of the plant kingdom. Other languages employ a different strategy, marking the concept with a predicate phrase. For example, Tzeltal speakers consistently describe the plant domain phrasally as ". . . those things that don't move, don't walk, possess roots, and are planted in the earth." Vezo speakers use the phrase "things that sprout." Another linguistic device is compounding. In American Sign Language, for example, a new, morphologically complex noun is created by compounding a set of lower-level (basic level) names (e.g., tree, rose, orchid) to indicate the inclusive concept *plant*. The names that are included in the compound term are not a stable set but instead can vary considerably depending on the context (A. Senghas, personal communication, June 2003; see Stavy & Wax, 1989, for other problems in naming *plant*, taken from Hebrew).

Although speakers of diverse languages can refer to the concept *plant* even in the absence of an overt noun, whether the linguistic devices recruited in these languages have the same conceptual power as names remains

unclear. I have argued that it is unlikely that dedicated classifiers, predicate phrases, and compounds (especially those composed of unstable sets of elements) offer the same conceptual advantage as overt dedicated nouns when it comes to forming categories. This is, however, an empirical question.

The Case for Living Thing

To the best of my knowledge, no human language has a simple, dedicated noun to mark the concept *living thing*. Moreover, no language marks members of this concept with a dedicated classifier term (e.g., a classifier term reserved for all and only living things). For example, in Japanese, the Kanji character that represents the concept *alive* can be applied to plants and animals but also to a host of other perishable items, including cakes, wines, and sauces (Inagaki & Hatano, 2003). Virtually all languages employ phrasal descriptions (e.g., *"living thing"*; *"owner of life"*), in which the predicate form (e.g., *living*) is used in conjunction with the most general object terms available in the language (e.g., *thing*).

An Interim Summary

Thus far we have considered whether there are (a) core principles, inherent in the mind of the learner and whether there are (b) features of naming to support the acquisition of three essentially biological concepts: *animal*, *plant,* and *living thing*. With regard to *animal*, there do indeed seem to be core principles to guide acquisition, and this bodes well for the early acquisition of this concept. However, the role for naming is less clear cut. Although across languages this concept is more likely to be named than *plant* or *living thing*, it nonetheless can remain unnamed (covert). Moreover, even when this concept is named, the name is plagued with a deep and pernicious polysemy. This polysemy, which encompasses (at least) three different *animal senses,* likely reflects the conceptual complexities and ambiguities in our representations of this concept. This polysemy could have consequences on acquisition, and these are discussed in subsequent sections. With regard to *plant*, there are apparently no conceptual or perceptual principles to distinguish plants (as a coherent concept) from other inanimate objects. Although this biological concept is sometimes graced with a unique, inclusive name, it often remains unnamed. With regard to *living thing*, there appears to be a resounding absence of support for acquisition from either core principles or naming practices. This absence is especially striking because *living thing*, the parent concept that spans the entire plant and animal kingdoms, is arguably the holy grail of any coherent theory of biology.

Where does this state of affairs leave the child in his or her efforts to establish the concept *alive*? This brief review of conceptual and linguistic affairs yields two developmental predictions. First, in the apparent absence of the advantages conferred by core principles or naming, this overarching biological concept should be relatively late to develop. This is consistent with positions advanced by Piaget (1929) and Carey (1985), but at odds with

Hatano and Inagaki's (1999) claim for an early appreciation of this inclusive concept. Second, on the path to its acquisition, the concept *alive* should be aligned (too) closely with its conceptually stronger and linguistically more polysemous daughter concept, *animal*.

In the next section, I present some preliminary evidence from our collaborative research that bears on these predictions. The evidence suggests that young children do indeed appreciate an inclusive biological concept *living thing* but that this concept is fragile—it is hard for researchers to uncover and difficult for children to retain. In the concluding section, I speculate that this difficulty occurs because the concept *living thing* is eclipsed by its conceptually stronger and linguistically more polysemous daughter, the concept *animal*.

Acquisition of the Concept *Living Thing*

In this section, I present preliminary evidence from three different populations of elementary-school–aged children being raised in the American Midwest. The urban and suburban children come from large public schools in Chicago and Evanston, Illinois, respectively. The rural children are members of the Menominee Nation in Wisconsin. They live on the tribal reservation and attend the Menominee Tribal Schools. Children in all populations were tested individually in their schools on a series of tasks. Here, I present evidence from a name generation task and a sorting task.

Name Generation

In this task, children were simply asked, "Tell me everything you can think of that is alive."[3] Children were permitted to name as many, or as few, items as they wished. We have found that despite its simplicity, this task provides useful information regarding an individual's spontaneous conceptual organization of the domain of living things. The analyses presented here are based on a subset of the names generated. We selected the first 10 items named by each child in each age group and each population.

The results, summarized in Table 4.1, illustrate a rather drawn-out developmental trajectory for *living thing*. The 4- and 5-year-old children generated a restricted set of items, including predominantly people and mammals (note that the youngest urban children also included birds) but no plants. By 6 and 7 years of age, children generated a more inclusive set of animals, adding fish and birds to their lists, but plants were still absent from these lists. Finally, by age 9 or 10 years, children in all populations included plants as well as animals in their spontaneous lists of names. Gradually, then, over the elementary-school years, plants join in more slowly.

[3]We subsequently asked children to generate the names of all the animals and all the plants that they could think of. These data are not reported here.

Table 4.1. Naming Task: Alive

Population	Age 4–5	Age 6–7	Age 9–10
URBAN	people	people	people
Chicago, IL	mammals	mammals	mammals
	birds	birds	birds
		***fish**	fish
			***plants**
SUBURBAN	people	people	people
Evanston, IL	mammals	mammals	mammals
		***birds**	birds
		***fish**	fish
			***plants**
RURAL MENOMINEE	people	people	people
Menominee Nation, WI	mammals	mammals	mammals
		***birds**	birds
			***fish**
			***plants**

Note. Categories mentioned in the first 10 names listed by children at each age in each population.

These data suggest three points. First, this analysis of children's spontaneous name generation is consistent with the idea that an overarching biological concept, *living thing*, that includes both plants and animals is a relatively late acquisition (Carey, 1985; Piaget, 1929), but the data presented in the next section will offer a different perspective. Second, although *plant* is more sparsely represented in this concept than its sister *animal*, children do appear to distinguish *plant* from the other inanimate objects; notice that artifacts and other inanimate objects are not represented in the first 10 items in any child's list. Third, the results suggest that initially, the concept *living thing* is aligned quite closely with its daughter *animal*, and with *mammal* in particular.

Sorting Task

The data from this task reveal a rather different view of the child's developing notion of *living thing*. In this task, children are presented with a set of 17 cards, each depicting a different object (Table 4.2). To begin, the experimenter

Table 4.2. Sorting Task

person	worm	water
bear	maple tree	rock
squirrel	cranberry bush	bicycle
blue jay	dandelion	scissors
trout	sun	pencil
bee	clouds	

Note. Complete list of stimuli.

presented each card, one at a time in random order, and identified the pictures on each. She then engaged the child in a series of sorting tasks with this set of cards, each time focusing on a different biological predicate. First, she elicited a sorting on the basis of the predicate *"alive,"* saying, "Let's put all the things that are *alive* over here and all the things that are *not alive* over there." In subsequent sortings, she asked each child to sort the pictures on the basis of the following biological predicates (presented in random order): *"die"*; *"need food"; "grow or get bigger."* We coded children's responses to reflect the range of objects that they included in each of the various sorts. For example, if a child included only the mammals (e.g., person, bear, squirrel), (s)he was credited with adopting a "mammal" pattern. If a child included the other animals as well (e.g., blue jay, trout, bee, worm), (s)he was credited with adopting an "animal" pattern. If a child included all the living things (including all plants and animals), (s)he was credited with adopting a "living thing" pattern. If a child included the other nonliving natural kinds (e.g., sun, clouds, water, rock) along with the living things, (s)he was credited with adopting a "living and natural" pattern. If a child revealed no consistent pattern in sorting, this was coded as "no pattern."

"ALIVE." The results from children's sorting patterns for the predicate *"alive"* are presented in Figure 4.2. At 6 and 7 years of age, children were unlikely to sort out all and only the living things when asked about the predicate "alive." (Suburban children were somewhat precocious, relative to their age-mates in the remaining populations. We suspect that this is not a stable difference; replications of this effect are warranted.) By 9 or 10 years of age, the predominant response from the suburban and Menominee children was to include all living things. Children from our urban sample lagged behind the others at this age: They were just as likely to include plants in their *"alive"* sorts as to exclude them. In general, the evidence from the *"alive"* sorting task is consistent with the notion that an inclusive biological concept, *living thing,* emerges gradually over the elementary school years and that initially animals

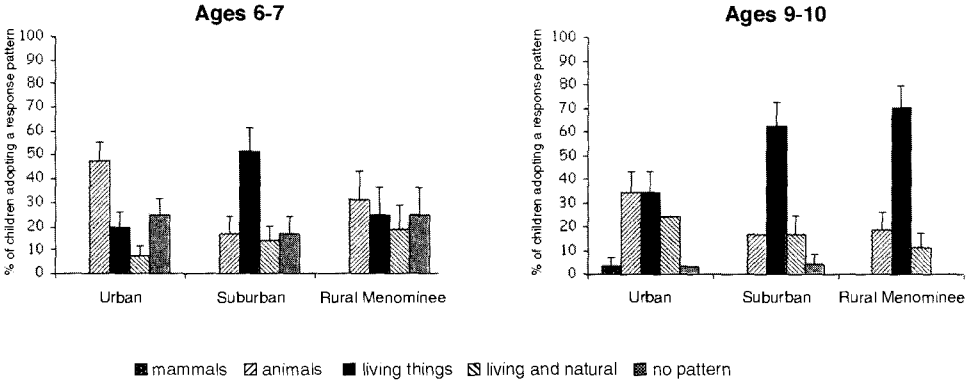

Figure 4.2. Sorting task: Alive. Percentage of children adopting each pattern of response, depicted as a function of age and population.

are more richly represented in this concept than are plants. However, when children were asked to sort on the basis of other biological predicates, a very different picture emerged.

"DIE." Like *"alive,"* the predicate *"die"* is a biological notion. Only individuals that have the capacity for life have the capacity to die. In fact, from a biological perspective, these two predicates represent two sides of the same coin. Following this logic, children's understanding of *"die,"* and therefore their sorting with this predicate, should mirror their performance in the *"alive"* sorting task. However, this was not the case. Across all populations, even the youngest children showed a strong tendency to include all living things when sorting on the basis of *"die"* (Figure 4.3).

DEAD OR ALIVE? OTHER BIOLOGICAL PREDICATES. How can we best interpret these discrepant findings? One possibility is that this discrepancy arises because one task is a better measure of children's underlying biological knowledge. If this is the case, then how do we adjudicate between them? To ascertain which sorting task—dead or alive—provides the more accurate reflection, we gathered converging evidence from two additional biological predicates, *"grow"* (Figure 4.4) and *"need food"* (Figure 4.5). As is evident in these figures, children's performance on both of these tasks mirrors the rather precocious patterns that they produced with the predicate *"die."*

Taken together, the sorting data suggest that an inclusive concept of *living thing* is available to children as young as 6 years of age (and perhaps earlier) and that it is organized around truly biological notions, including death, growth, and nutrition (for related views, see Inagaki & Hatano, 1996, 2003; and Slaughter, Jaakkola, & Carey, 1999). Paradoxically, though, it seems that the structure of children's biological concept *living thing* is reflected more clearly with the predicate *"die"* than *"alive."*

Why might this be case? How can we accept the evidence for a precocious grasp of the concept *living thing* in the face of conflicting evidence suggesting that this concept is a later developmental achievement? Why is this precocity

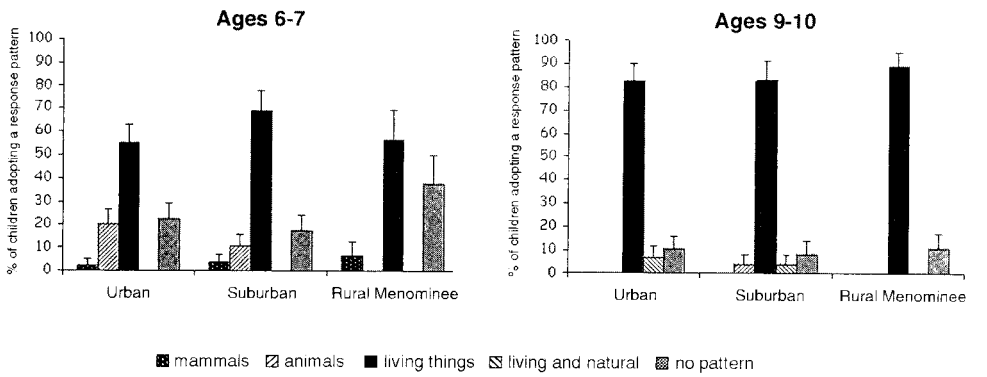

Figure 4.3. Sorting task: Die. Percentage of children adopting each pattern of response, depicted as a function of age and population.

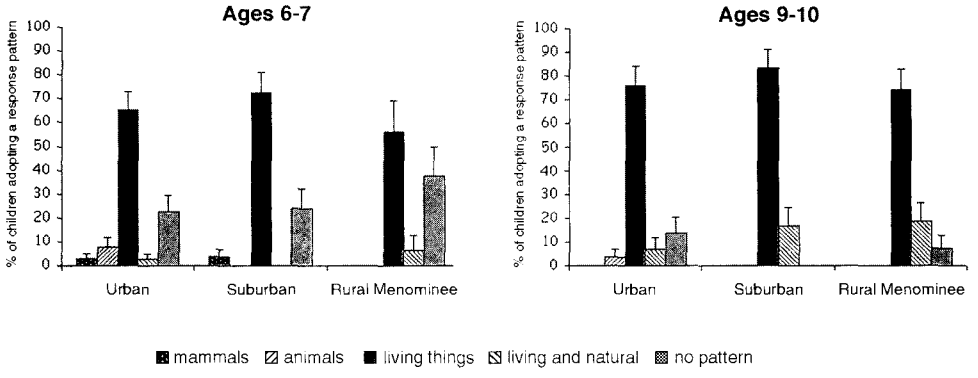

Figure 4.4. Sorting task: Grow. Percentage of children adopting each pattern of response, depicted as a function of age and population.

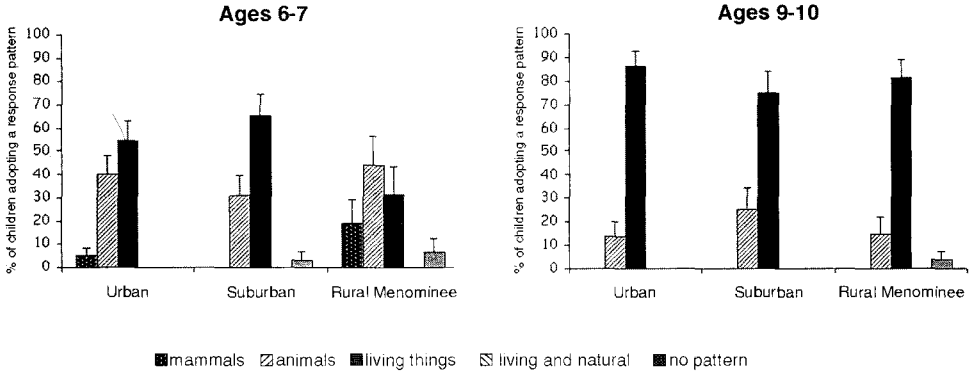

Figure 4.5. Sorting task: Food. Percentage of children adopting each pattern of response, depicted as a function of age and population.

evident with some predicates (notably *die, grow, need food*) but not others (paradoxically, *alive*)? This brings us full circle to the question posed at the outset of this chapter: Why is the concept *living thing* so difficult to grasp?

Why Is the Concept *Living Thing* So Difficult to Grasp?

If a biological concept of *living thing* is indeed conceptually available to young children, then why is it so elusive? I suspect that this is related to (a) the apparent absence of core principles, inherent in the mind of the learner, to support its acquisition; (b) the dramatic absence of overt, simple, dedicated names to serve as invitations to form this concept and as guideposts to support reasoning; and (c) the pervasive influence of its daughter, *animal*.

Although this is pure speculation, I propose that *animal*, that strongly principled and perniciously polysemous daughter concept, is the culprit. As I

have suggested, *animal* enjoys a privileged developmental status, certainly compared with its parent *living thing* or its sister *plant*. The acquisition of the concept *animal* is guided by a set of core principles that are available to young infants and by naming practices (recall that across languages, the concept *animal* is more likely than the other biological concepts to be named). In view of these facts, I suggest that (a) the overarching biological concept *alive* is available early in development but that (b) lacking the advantage of names and core principles to support its acquisition, it is fragile and (c) that it therefore is susceptible to being co-opted by its strong daughter, *animal*, whereby its meaning is appropriated to one of the polysemous "animal senses."

This speculation is consistent with the evidence. We have shown that young children do indeed appreciate an inclusive biological concept *living thing* but that this concept is fragile. It is hard for researchers to uncover and difficult for children to retain. I speculate that this is because the concept *living thing* is eclipsed by its conceptually stronger and linguistically more polysemous daughter, the concept *animal*.

Conclusion

Questions concerning children's acquisition and construal of the biological world are fascinating ones that bear on the nature of the human mind and on the acquisition of knowledge. Answers to these questions depend on systematic, insightful, and integrative research programs that cut across traditional disciplines, to include (at the very least) psychology, anthropology, and linguistics. By adopting an integrative approach and by gathering the intuitions of individuals from a broad range of cultures, we hope to ascertain how the core biological concepts *animal*, *plant,* and *alive* are acquired and how these are shaped by the principles of the human mind, the structure of human language, and the richness of the environment.

In keeping with the spirit of this chapter, let me close where I began—with an appreciation of the gift of curiosity. It is probably fair to say that at this early juncture, our collaborative venture has served up few hard and fast answers. But it has already inspired new questions and elevated our curiosity. Why is the overarching biological concept *living thing* unnamed across languages? Why does there appear to be an absence of core principles, or conceptual–perceptual architecture, to support the acquisition of this quintisentially biological concept? What does this tell us about the acquisition of folkbiological knowledge?

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