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Conceptual organization

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Introduction

Questions about concepts bring into play all the cognitive science disciplines. For many centuries, concepts belonged to philosophy; but more recently, these original caretakers have shared responsibility for this domain with cognitive and developmental psychology, linguistics, artificial intelligence, anthropology, and neuroscience. Each of these fields has offered insights into these building blocks of thought, and each has contributed a unique perspective on fundamental questions about the nature of minds. However, the integrative approach of cognitive science holds the promise of providing new vantage points from a range of disciplines on this core issue.

Our goal here is to consider the nature of the interplay between culture, language, and thought in the development and modification of conceptual systems. Two questions serve as a unifying theme: How do peoples across the world and across development organize their knowledge about objects? How can we best capture the similarities and differences in these systems across cultures?

We have selected this topic because the past several years have witnessed a burgeoning appreciation of the influence of culture and its artifacts (especially language) in shaping human conceptual systems. Cognitive psychologists have developed a virtual army of experimental techniques to examine the acquisition of concepts and taxonomies and to probe the psychological consequences of these structures in reasoning. Developmental psychologists have introduced powerful, innovative techniques that enable us to tap into the early acquisition of conceptual and linguistic systems of organization and to trace their development over time. But as a rule, cognitive and developmental psychologists have carried out their research on limited cultural populations and with an unsystematic sampling of biological kinds. By contrast, anthropologists have devoted considerable attention to documenting taxonomies of the biological world from many distinct geographical and cultural regions; they have also provided detailed accounts of convergences between patterns of object classification and nomenclatural patterns (see Article 5, COGNITIVE ANTHROPOLOGY). But as a rule, these anthropological accounts have left issues concerning the perceptual and conceptual processing mechanisms that support these capacities largely unexplored. As these diverse contributions to the study of human conceptual organization are shared across disciplines, it becomes clear that the potential synergy among these interdisciplinary contributions makes the cognitive science enterprise especially promising.

We will describe two programs of research that are cross-cultural and cross-disciplinary in character. One program is focused on cross-cultural similarities and differences in systems of biological categorization. A central focus in this program is the notion of

a privileged level within a hierarchical system. Noting the considerable cross-cultural agreement in categorization, we go on to consider whether this agreement reflects a pattern in nature, where certain categories stand out as "beacons on the landscape of biological reality" (Berlin, 1992), a position advanced by anthropologist Brent Berlin at the University of California, Berkeley. Alternatively, cross-cultural agreement may reflect universal properties of the human mind, a position advanced by anthropologist Scott Atran at the University of Michigan and CNRS in Pris, France (Atran, 1990). The second research program traces the early establishment of conceptual systems and asks two interrelated questions: What initial cuts do infants and young children make in categorizing objects in the world? How do they go beyond these initial cuts to form the complex, flexible conceptual systems that characterize adult cognition? Central to this enterprise is the role of language in directing children's attention to object categories at various hierarchical levels.

It will become clear that these research programs have a great deal in common. Each is concerned with the acquisition and consequences of hierarchical systems of knowledge; each utilizes a multidisciplinary approach; each signals the importance of the interplay between processes inherent in the human mind and learning from the environment; and each points to the need for additional research from a cross-cultural, developmental perspective.

Privilege in taxonomic hierarchies: folk-biological classification and reasoning

One important aspect of categorization is that any individual may belong to multiple, hierarchically organized categories. For example, a furry creature may be categorized as a grey squirrel, a squirrel, a mammal, a vertebrate, an animal, a living thing, and so on. One of the major observations over the past two decades of research on concepts is that these levels are not equally salient psychologically. Instead a single level, called the "basic level" in psychology, appears to be privileged. What do we mean by *privileged?* Informally, the basic level constitutes the *best name* for something, the one that adults prefer to use in naming and, perhaps not coincidentally, the one that word-learners master first. Actually, there are a number of criteria which one could use for basicness, and the remarkable thing is that some pioneering observations by Eleanor Rosch at Berkeley, and her co-workers suggest that these various measures all mark the same level as privileged. Let us begin with her studies.

Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976) argued that the correlational structure of entities in the world creates natural clusters, and that concepts correspond to these clusters. For example, things with feathers are likely to have beaks, wings, and two legs and to fly. Creatures without feathers are less likely to have these other properties. This means not only that knowledge of some features can be used to predict other properties, but also that entities are distributed as clusters, or groups of similar things. Entities near the center of such clusters are said to be *better* or more typical examples of the category than more peripheral, atypical examples. One important theoretical idea is that the mental representation of these categories takes the form of a prototype which summarizes the central tendency of the category (cluster). The closer an example is to the prototype, the more typical it is. A contrasting view is that

the category representation is simply the disjunction of the representations of individual category examples (the so-called exemplar view). Data from experiments tend to favor the latter, exemplar-based view over the prototype view. For purposes of the present essay, this distinction is less important than the idea that categories reflect chunks or clusters of similar entities.

Rosch and her associates (1976) argued that there was one level of granularity at which these clusters stood out the most. They called this level the "basic level." Basic-level categories such as chair, hammer, and dog may be contrasted with more general superordinate categories (furniture, tool, animal) and more specific, subordinate categories (recliner, hammer, poodle). Rosch et al. evaluated a number of criteria for category use, and they all pointed to a single level as privileged. Basic-level categories are the most inclusive categories that (a) possess numerous common attributes, (b) have similar shapes and can be identified from averaged shapes of members of the class, and (c) involve the same movements when handled or interacted with. In addition, basic-level category labels are preferred in adult naming and are learned first by children. Moreover, adults can identify entities at the basic level more rapidly than at more subordinate and superordinate levels. Finally, across languages and cultures, these basic-level clusters are the ones that tend to be named. It is as if the structure of nature imposes itself on the human mind in the case of basic-level categories.

Observations from anthropology also point to one level that is psychologically privileged. Indeed, Berlin (1992) uses the same structure-in-the-world framework in arguing that one level in a taxonomic hierarchy is "crying out to be named."

Here is where it starts to get interesting, for what seems like a convergence between these two fields of research is actually a deep puzzle. The level that ethnobiological studies suggest is basic corresponds more or less to the genus level in scientific taxonomy. However, Rosch et al. found that the genus level was not basic: rather than *robin, trout,* and *maple* being privileged, Rosch et al. found that *bird, fish,* and *tree* met their criteria for basicness.

Why do anthropological and psychological measures of the basic level disagree? One possibility is related to expertise. Perhaps the Berkeley undergraduates in Rosch's studies knew little about biological categories, especially relative to people of the agricultural societies investigated in most ethnobiological studies. It seems plausible that people in cultures that are organized around technology may display less understanding of the natural world than people in traditional agrarian societies.

But this line of reasoning raises a developmental question: Would young children from technological and traditional societies show more agreement in the basic level than adults? If so, what factors might be responsible for this divergence with development? Does it stem from (a) expertise (in traditional societies) leading to the acceptance a more specific basic level or from (b) deterioration of knowledge in technologically oriented cultures leading to the acceptance of a more general basic level?

Answers to these questions will depend upon cross-cultural developmental programs of research. To the best of our knowledge, there have been no systematic examinations of this issue. However, Brian Stross's observations of children in Chiapas, Mexico (Stross, 1973), and Janet Dougherty's observations of children in Berkeley, California (Dougherty, 1979), suggest that there may be cultural differences in the privileged level, as indexed by children's preferred level of naming plants. Their results are preliminary, but they indicate a clear course for future research. What is required is

cross-cultural developmental research on language and conceptual organization from infancy, throughout acquisition, across cultures.

A second potential reason for the Rosch–Berlin disparity is that the distributional patterns of flora and fauna differ across traditional and technological cultures. Biodiversity is greater in Central American rain forests than in more temperate climates. Furthermore, technological advances, sadly, are coupled with pollution, acid rain, and destruction of habitat, which trigger a further loss of diversity. If there are fewer distinct natural kinds in technological cultures, then coarser conceptual cuts may suffice. In the limiting case of one kind of fish and one kind of bird, labels like *bird* versus *fish* serve us as well as *downy woodpecker* and *steelhead trout.* Of course we are not (yet) at the limiting case. However, distributional patterns need to be taken seriously. This is an area in which anthropologists' tools have been honed more sharply than those of psychologists. For example, ethnobiological research typically is based upon botanical and zoological surveys of local plants and animals. Psychologists are too often guilty (the authors are no exception) of compiling stimuli without sufficiently addressing their representativeness.

A third difference between the work of psychologists and anthropologists is that different measures are used in the two types of investigations. For example, Berlin's observations relied heavily on linguistic measures like naming, whereas Rosch et al. focused more on perceptual tasks. Perhaps if the same measures were used, the differences in the apparent basic level would disappear. Clearly needed is a systematic comparison with a common set of measures.

Having raised these questions, it would be nice if we could answer them. But at best, we have only a piece or two of what promises to be a large (and fascinating) puzzle. Our first pass at comparability actually involves a measure used by neither Rosch nor Berlin – category-based induction. In this task, participants are told that some property is true of some category and are then asked to evaluate how likely that property is to be true of some other category. For example, if downy woodpeckers have sesamoid bones, how likely is it that ringneck pheasants also have sesamoid bones? Alternatively, one might ask questions involving different taxonomic levels: for example, if downy woodpeckers have sesamoid bones, how likely is it that all woodpeckers (all birds, all animals) have sesamoid bones?

Our experiments were designed and conducted by John Coley, Douglas Medin, and Elizabeth Lynch from Northwestern University in collaboration with Scott Atran (Coley et al., 1997). We used a range of plants and animals and abstract properties (e.g., has enzyme *x*) projected to different taxonomic levels (e.g., woodpecker, bird, animal). The participants in our first few studies were Northwestern University undergraduates whose knowledge of the natural world was, to say the least, limited. If the levels that Rosch found to be basic are privileged in induction, then anytime we ask our participants to project a property above that level, the rating or confidence should show a sharp drop. For example, from the statement "Downy woodpeckers have enzyme *x*," they should be fairly sure that all woodpeckers have the enzyme, somewhat less sure that all birds have it, and not at all sure that all animals have it. Berlin's observations would lead to the expectation that the biggest drop would come earlier, in this case in going from woodpeckers to all birds. In each of our studies (they involved ruling out alternative explanations and other methodological issues that we won't bore you with) we found that, consistent with Berlin's ideas about basicness, the folk-generic level

(corresponding closely with the genus level in scientific taxonomy) acted as privileged in induction. We then ran more or less the same study with Itzaj Maya men and women from a community in Guatemala. The Itzaj have managed to live in the rain forest without destroying it, and both men and women are highly knowledgeable about the biological world. You will not be surprised to learn that we had to make a few adjustments in our procedure (e.g., different plants and animals, a verbal measure of confidence rather than a numerical rating scale). Nonetheless, our results were virtually identical – the genus or folk-generic level was clearly privileged relative to higher levels.

But how likely is it that our students and the Itzaj have the same privileged level on other measures of basicness, such as speeded categorization or names first learned by children? This, of course, is an empirical question, and we are far from sure that these parallels will continue. In fact, we have evidence from the same sort of reasoning tasks that points to some differences. Typically, undergraduates show strong similarity effects in category-based reasoning. For example, if told that sparrows have some disease, they are more sure that robins (which are similar birds) can also get this disease than that, for example, pheasants can get the disease. Although the Itzaj Maya sometimes give the same answers, they provide very different justifications for them. In particular, the judgments of the Itzaj are heavily based on specific ecological knowledge rather than similarity. To give a hypothetical example, they might explain that sparrows and robins both eat some insect that could give them the disease. Undergraduates cannot do this sort of reasoning very well, because typically they do not have the ecological knowledge to support it.

These investigations of categorization and reasoning among peoples from diverse cultures, language groups, and natural environments have identified points of universality and of difference. But it is also important to go further in this interdisciplinary endeavor, to pinpoint the mechanisms responsible for the similarities and differences we have observed across cultures. For example, to ascertain whether these cultural differences are related primarily to differences in expertise, we are currently studying the categorization and reasoning of selected subpopulations of North Americans (e.g., bird-watchers, tree experts, etc.) to see how novices and experts differ. Another approach is to chart the emergence and modification of these systems over time. This is where the developmental component of this multidisciplinary endeavor becomes essential. In the next program of research it will become clear that developmental work can reveal the *initial cuts* that infants make in categorizing the objects they encounter; it can also illustrate the powerful role of language in shaping the acquisition of hierarchical systems.

Language and the acquisition of hierarchical systems of knowledge: developmental and cross-linguistic considerations

One of the most robust findings in the developmental literature is that infants and young children first succeed in labeling and categorizing objects at a mid-level position within a hierarchical system, well before they do so at other hierarchical levels. We note that developmentalists face the same puzzles that we identified earlier concerning this preferred level. For example, there has been some debate as to the precise scope of children's first categories (e.g., duck versus bird); it has also been difficult to

provide a formal account of this privileged level. These uncertainties notwithstanding, the notion that mid-level basic object categories are privileged in development is well established.

But how do children progress beyond these initial, privileged mid-level categories to build hierarchical systems of organization? Developmental research has revealed that language serves as a catalyst for the acquisition of concepts, particularly those at *nonprivileged* levels. To ascertain whether children direct their ATTENTION differently in the context of word learning than in nonlinguistic contexts, researchers have introduced children to novel words and have observed the effects of these labels in object classification at various hierarchical levels. Several different laboratories have revealed that children direct their attention differently in the context of learning a novel word than in neutral situations that include no novel words (see Waxman, 1994, for a review). Sandra Waxman at Northwestern University and her colleagues have shown that by two or three years of age, children interpret novel count nouns as referring to object categories and interpret novel modifiers (e.g., adjectives) as referring to properties of objects and subordinate-level categories. Thus, when children hear an object labeled, the linguistic form of the label directs their attention to particular aspects of the object.

These correlations, or linkages, between linguistic form (e.g., noun, adjective) and hierarchical level reveal one way in which language influences conceptual organization. These linkages have been invoked to help explain how toddlers so rapidly map words to their meanings and so successfully establish hierarchical systems of categories. Notice that these linkages, which have also been noted in the ethnobiological literature (Berlin, 1992), insure that the labeling practices of the adult community will shape the lexical and conceptual systems of the young.

But how do these linkages unfold? To answer this question, Waxman and her students pursued two complementary lines of research, examining the influence of language on categorization in two distinct populations: 12- to 14-month-old infants from English-speaking families, who have just begun to produce their first words, and preschool-aged children acquiring either English, French, or Spanish as their native language.

In the infancy studies, Waxman employed a novelty-preference task to examine the influence of novel words on 12-month-olds' object categorization. In the familiarization phase, an experimenter offered an infant four different toys from a given category (e.g., four animals), one at a time. In the test phase, the experimenter presented both (a) a new member of the given category (e.g., another animal) and (b) an object from a novel contrasting category (e.g., a tool). Infants were tested on both basic (e.g., cats versus horses) and superordinate (e.g., animals versus vehicles) level categories. The logic of this paradigm for examining infant categorization is as follows. If the infant notices the commonalities among the familiarization stimuli, then the infant's attention during familiarization should decrease; at test, the infant should show a preference for the novel, over the familiar, test object. Further, if novel words direct infants' attention toward object categories, then infants who hear novel words in conjunction with the objects presented during familiarization should be more likely to categorize in this task than should control subjects who hear no category labels. The data revealed a consistent effect of novel words in these infants on the brink of producing language.

Infants who heard novel words were more likely to form object categories than were those in a no word control condition.

Three points are especially germane here. First, infants in all conditions formed basic-level categories (e.g., cats versus horses) successfully; novel words did not influence infants' successful performance at this level. This accords well with assertions regarding the developmental primacy of these mid-level categories. Second, at nonbasic levels (e.g., animals versus vehicles), words exerted a clear influence. Only infants hearing novel words successfully formed object categories; those in the no word control condition exhibited no such pattern. This indicates that labels serve as a catalyst in conceptual development, particularly when the perceptual support for a category is not as compelling as it is at the privileged basic level. Third, the linkage between language and conceptual organization is relatively general during infancy: both nouns and adjectives highlight object categories, particularly at superordinate levels. This general linkage becomes more specific over development: by at least three years of age, children distinguish between nouns and adjectives, assigning to each particular types of meaning. Therefore, between infancy and the preschool years, there is a growing sensitivity to using linguistic form as a cue to meaning.

Waxman next asked whether and how these linkages are influenced by the language being acquired. In collaboration with Anne Senghas, an MIT-trained linguist, Luis and Susana Benveniste, from Buenos Aires, and Danielle Ross, a native of Montreal, she conducted a series of cross-linguistic, developmental experiments with young monolingual children in the process of acquiring either English, French, or Spanish.

A comprehensive review of the cross-linguistic literature highlighted the cross-linguistic stability of the grammatical category *noun*, as compared to *adjective*. We therefore predicted that the linkage between count nouns and object categories, which emerges early in development, would be evident across human languages. We also predicted that there would be cross-linguistic variation in the interpretation of adjectives (see Waxman et al., 1997, for a more complete account).

Despite the similarities among English, French, and Spanish, there is an important difference in the grammatical use and referential status of adjectives in these three languages. In Spanish (but not English or French), adjectives commonly appear in many of the same syntactic contexts as nouns and (like nouns) often refer to object categories. To examine the consequence of this syntactic and semantic overlap in children's expectations concerning word meanings, we adopted a forced-choice procedure. Children were introduced to a target object (e.g., a dog) and four alternatives: two members of the same superordinate-level category as the target (e.g., bear, fox) and two thematically related alternatives (e.g., dog bone, dog's bowl). In each language, children were assigned to one of three conditions, depending upon how the target objects were introduced: either with a *novel noun* (e.g., "Look at the *dax*"), a *novel adjective* (e.g., "Look at the *dak-ish* one"), or *no word* ("Look at this").

Children's interpretations of novel nouns were uniform across the languages examined. The expectation that a novel noun can be extended to include the target object and other members of its superordinate-level kind was evident in French- and Spanish-speaking children, just as it has been in English-speaking children and in infants in an English-speaking environment. This is consistent with the prediction that the noun-category linkage would be stable across development and across languages.

Children's interpretations of novel adjectives varied across the languages, clearly implying an important role for language-specific learning. In English and French, children revealed no preference for the taxonomic (or thematic) alternatives in the *novel adjective* conditions in our categorization task. By contrast, in Spanish, children exhibited a strong tendency to extend novel adjectives, like novel nouns, to the taxonomic alternatives. In Spanish, then, where adjectives are habitually permitted to adopt some of the syntactic and semantic features associated with count nouns, children have learned that adjectives, like nouns, may be used in a categorical sense. Thus, children acquiring different languages revealed different tacit expectations regarding the range of meanings associated with the grammatical category *adjective*.

In sum, children acquiring English, French, or Spanish share an expectation that a count noun applied to an individual will refer to that individual and can be extended to include other members of the superordinate-level kind. However, experience with these different native languages leads to different outcomes in children's expectations concerning the range of meaning associated with novel adjectives. This is consistent with the hypothesis that the linkage between nouns and object categories emerges early and is a candidate for universality, and that the meanings associated with adjectives may be more language-specific.

These cross-linguistic findings dovetail with those from infants. Basic-level categories appear to be salient to infants and young children. Categorization at this level is successful under a variety of circumstances. Yet, at nonbasic levels, labels play a powerful role, guiding the formation of categories beyond the privileged mid-level. Infants share with preschool-aged English-, French-, and Spanish-speaking children an expectation that count nouns can be extended to categories of objects. This expectation facilitates the formation of superordinate-level categories. By contrast, the mappings between adjectives and their meanings appear to emerge later in development, and to vary systematically according to the particular language under acquisition. Thus, early in acquisition, infants share a common set of expectations concerning the linkages between word meaning and conceptual organization, and these initial expectations become more entrained with age and language experience.

Implications for cognitive science

There are several unifying themes in the research described in this essay. Both the adult and the developmental programs draw upon multidisciplinary findings to address fundamental questions in the acquisition and modification of conceptual systems of organization. Both underscore the importance of the interplay between processes inherent in the human mind and learning based upon the input from the environment. Both expose the power and complexity of language as a force in the establishment of hierarchical systems of knowledge. A number of other common concerns and themes have been implicitly interwoven: conceptual acquisition and change; ranks and levels in hierarchically organized categories; and the complex and powerful role of language in shaping both. But perhaps most important, these programs illustrate vividly the possibilities that arise in cognitive science once interdisciplinary borders become permeable. We are optimistic about further integrating cross-cultural, cross-disciplinary, and developmental programs of research to address fundamental issues in cognitive science.

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