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ARE THERE KINDS OF CONCEPTS?

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■ **Abstract** Past research on concepts has focused almost exclusively on noun-object concepts. This paper discusses recent research demonstrating that useful distinctions may be made among kinds of concepts, including both object and nonobject concepts. We discuss three types of criteria, based on structure, process, and content, that may be used to distinguish among kinds of concepts. The paper then reviews a number of possible candidates for kinds based on the discussed criteria.

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INTRODUCTION

Many years ago, the cryptic but pointed comment of a collegue on a book by one of the present authors (Smith & Medin 1981) said, ‘‘This is an excellent overview but you two seem to think that concept is spelled, n o u n.’’ The commentator may have been generous at that, because natural object concepts were the focus (with attempts made to justify the reasons). In this paper, we do not distinguish questions about kinds of categories from questions about kinds of concepts. Although the distinction between concepts and categories is important (see Solomon et al 1999), where there are distinct kinds of categories, the associated concepts will also be distinct. Although the reviewer’s barbed comment is still relevant today, since that time there has been a continuous and substantial volume of research on categories and concepts. This has served to greatly broaden the topic’s empirical and theoretical base, so that today there is a lot more to say about different kinds of concepts than there was in 1981. Accordingly, this review is organized around the question of whether there are distinct kinds of concepts.

On the surface it seems transparently true that there are kinds of concepts—notions like democracy seem different from things like party or from concepts such as ‘‘black-capped chickadee.’’ But a little reflection suggests that the notion of kinds of concepts must be evaluated relative to the theoretical work a kind or domain is going to be asked to do. For example, if one is interested in concept learning, the relevant issue might be whether different kinds of concepts are acquired in the same way. Note that this shifts but does not remove the explanatory burden: For the question to be meaningful, criteria are needed for deciding whether concepts are ‘‘acquired in the same way.’’ In brief, questions about kinds of concepts should be answered by theories rather than intuitions. In this paper, we attempt to bring together candidates for kinds of concepts that have emerged across the different theoretical perspectives of current research on concepts.

One motivation for the interest in kinds is that a number of scientists, especially researchers in the area of cognitive development, have argued that cognition is organized in terms of distinct domains, each characterized by (usually) innate constraints or skeletal developmental principles (e.g. Hirschfeld & Gelman 1994a). That is, cognition is said to be domain specific. Some researchers object to the claims about innateness as well as the claims about domain specificity (e.g. Jones & Smith 1993). To evaluate this debate, one needs criteria for domains (or kinds).

A less-contentious reason to worry about kinds concerns trade-offs between different levels of explanation and specificity or preciseness of generalizations. To use an analogy with biological kinds, there are interesting properties that all living things share, but there are further interesting generalizations that may hold only for mammals or only for primates or only for human beings. Treating all concepts as being of the same type may be useful for some purposes but we may be missing important principles that apply robustly only for subsets of concepts.

Another reason to care about kinds of concepts is that even universal aspects of concepts may be more salient and easier to study in some concepts than in others. Neurologists study the squid axon not because squids are the only things that have axons but because the squid axon is large. Finally, the most obvious reason to worry about kinds is that exploring different kinds allows us to test the generality of our theories and models.

The rest of this review is organized as follows. First, a variety of criteria for establishing distinct kinds of concepts is presented. Then some candidates for kinds are discussed and the corresponding literature is evaluated with respect to our criteria. Finally, a descriptive summary and prescriptive advice are presented.

In evaluating the literature from a specific perspective, we take advantage of a number of other recent review papers and edited volumes (e.g. Nakamura et al 1993, Van Mechelen et al 1993, Lamberts & Shanks 1997, Ward et al 1997a, Medin & Heit 1999). Komatsu (1992) analyzes research on the role of intuitive theories and other forms of knowledge versus the role of similarity in categorization (for related analyses, see also Goldstone 1994a; Hahn & Chater 1997; Hampton 1997, 1998; Heit 1997; Malt 1995; Murphy 1993; Sloman & Rips 1998). Solomon et al (1999) focus on the role and implications of multiple conceptual functions for concept theories. A review by Medin & Coley (1998) traces relationships between laboratory studies using artificially created categories and research using natural (lexical) concepts (see also Estes 1994).

CRITERIA FOR KINDS OF CONCEPTS

We consider three types of interrelated criteria for distinguishing concept types: (*a*) structural differences, (*b*) processing differences, and (*c*) content-laden principles.

Structural Differences

A great deal of research on the psychology of concepts has been directed at their componential structure, especially as it relates to categorization. Virtually everyone believes that concepts should be analyzed in terms of constituent attributes or features. For example, the concept of stallion may be understood in terms of features such as animate, four-legged, male, adult, and so on. Thus, criteria for kinds of concepts based on structural differences would be based primarily on differences in the kinds of features in a concept and the relations among these features. The 1970s were characterized by a shift from the position that categories are organized in terms of defining (singly necessary and jointly sufficient) features (the so-called classical view) to the view that category membership is more graded and structured in terms of features that are only typical or characteristic of categories—the so-called probabilistic or prototype view (for seminal papers, see Rosch & Mervis 1975, Smith et al 1974; for an early general review, see Smith & Medin 1981).

As noted earlier, much of the discussion and research on conceptual structure has employed object concepts (e.g. chair, bird, tool, etc). The possibility remains that other categories conform to a classical view structure or exhibit entirely novel structure.

Processing Differences

One might also distinguish among kinds of concepts based on the types of processing that are done to develop and maintain them. For example, categories formed through data-driven, bottom-up processes may be different from categories formed through top-down categorical processes. It is an obvious but important point that claims about either structure or processing cannot be evaluated in isolation, that structure-process pairs must be considered (e.g. Anderson 1978). For example, a hypothesis-testing mechanism for learning classical view categories would likely fail to acquire probabilistic categories. Researchers interested in processing principles have generally assumed that differences in structure are associated with processing differences. Of course, process may drive structure. For example, categories created in the service of goals may be fundamentally different from natural object categories. An alternative idea is that there may be multiple processes that operate on the same structure.

It is fair to say that theories about conceptual structure and processing are based primarily on research with object categories, though the conclusions from this work are thought to apply to a wide range of concepts. Are object categories analogous to the squid axon mentioned above? That is, are object concepts just easy-to-study representatives of all concepts? One may also wonder whether object concepts are themselves uniform in kind. Below we discuss recent research that suggests that there are principles of conceptual structure and processing that cannot be generalized across all concepts. We then turn to the question of whether important variations exist among object categories.

Content-Laden Principles

In contrast to the view that there are general, abstract principles of conceptual structure and processing, advocates of domain specificity focus on principles that apply uniquely to concepts with specific contents. For example, in this view, kinds of concepts may be divided into domains of concepts, such as naïve biology, naïve psychology, and naïve physics. Given that the contents of concepts in different domains are almost surely going to be different, it is tempting to conclude that these advocates have created kinds (or domains) simply by defining them into existence. As we shall see, the domain specificity view does have empirical content. First, however, we consider candidates for kinds based on structure and those based on processing.

CANDIDATES FOR KINDS OF CONCEPTS BASED ON STRUCTURE

Nouns Versus Verbs

It appears that the distinction between nouns and verbs is universal (Sapir 1944). Gentner and colleagues (Gentner 1981, 1982; Gentner & France 1988; Gentner & Boroditsky 1999) have marshaled theoretical and empirical arguments for the view that nouns and verbs map onto ontologically distinct aspects of the environment (see also MacNamara 1972). Although the contrast is not without exception, the general idea is that nouns refer to clusters of correlated properties that create chunks of perceptual experience. Languages honor these perceptual discontinuities, as evidenced by good cross-cultural consistency in the presence of lexical entries corresponding to these chunks. In contrast, predicative concepts in general and verbs in particular focus on relations among these entities involving such things as causal relations, activity, or change of state. Given that relations presuppose arguments or objects, it would seem that nouns are conceptually simpler than verbs and, Gentner (1981) argues, more constrained by perceptual experience. If so, one might expect that (*a*) (concrete) nouns should be learned before verbs (see Bloom et al 1993, Choi & Gopnik 1995, Au et al 1994, Tardif et al 1999, Tomasello 1992, Waxman 1998, Waxman & Markow 1995, Woodward & Markman 1997; for review, see Gentner & Boroditsky 1999), (*b*) there should be more cross-linguistic variability in verbs than in nouns (see Bowerman 1996; Levinson 1994, 1999; Waxman et al 1997), and (*c*) linguistic (syntactic) structure should play a greater role in verb learning than in noun learning (see Naigles 1990, Choi & Bowerman 1991, Pinker 1994). Although there is not universal agreement on any of these claims, the weight of evidence appears to agree with each of them.

The distinction between nouns and verbs no doubt needs to be somewhat nuanced. For example, motion is associated with both nouns and verbs (e.g. Kersten & Billman 1995), but there is a bias for nouns to be associated with motion intrinsic to an object and for verbs to be associated with motions involving relations between objects (Kersten 1998a,b).

Count Nouns Versus Mass Nouns

Another lexical distinction that reveals differences in conceptual structure is the mass/count distinction. For example, although you can say ‘‘a dog’’ (count noun), you cannot say ‘‘a rice’’ or ‘‘a sand.’’ Wisniewski et al (1996) note that the mass/count distinction applies to superordinate categories as well: Some superordinate concepts are mass nouns (e.g. ‘‘some’’ furniture), and others are count nouns (e.g.

"an" animal). In a series of studies, Wisniewski et al demonstrate that the linguistic distinction between mass and count superordinates reflects conceptual differences as well. They found that members of mass superordinates tend to co-occur and people tend to interact with many members of a mass superordinate at one time, but they tend to only interact with single members of count-noun superordinates. Furthermore, they found that properties that characterize individuals are a more salient aspect of count superordinates. Wisniewski et al conclude that mass superordinates refer to unindividuated groups of objects, rather than to single objects, and that, unlike count superordinates, mass superordinates are not true taxonomic categories. Markman (1985) also noted conceptual differences between mass and count superordinates. Specifically, she found that across languages, terms for categories at more abstract levels of a hierarchy are more likely to be mass nouns than are terms for categories at low levels of a hierarchy. She also found that children learned concepts with the same extension faster when they were referred to by a mass noun than by a count noun (Markman et al 1980).

Isolated and Interrelated Concepts

The structural difference between noun and verb concepts in terms of clusters of features versus relational properties may also usefully distinguish among kinds of nouns. Some noun concepts are intrinsically defined, whereas others appear to be more relational in character (Barr & Caplan 1987, Caplan & Barr 1991). For example, the concept of grandmother seems to centrally involve the relational notion of being a female parent of a parent. Barr & Caplan (1987) found that relational concepts show more graded membership and smaller differences between gradients of typicality and membership judgments than do intrinsically defined concepts. Given that the literature has tended to focus on intrinsic concepts, perhaps other phenomena associated with categorization and other uses of concepts may not generalize to relational concepts. There is not sufficient evidence to hazard a guess with respect to this possibility.

Goldstone (1996) has marshaled evidence for the distinction between isolated and interrelated concepts where a concept is interrelated to the extent that it is influenced by other concepts. He further showed that current models of categorization (e.g. exemplar models) can account for some but not all of the phenomena associated with interrelated concepts. However, he offers a recurrent network model that successfully describes varying amounts of intercategory influence. The fact that a unitary computational model accounts for both isolated and interrelated concepts undermines the view that these are distinct kinds of categories.

Objects Versus Mental Events

Although some researchers have focused on parallels between object and event concepts (e.g. Rifkin 1985; for social events, see Morris & Murphy 1990), Rips and his associates have demonstrated important differences between objects and mental events (e.g. Rips & Conrad 1989, Rips & Estin 1998). For example, part-whole relations seem to behave differently for objects and mental events. The steering wheel of a car is not a kind of vehicle but a part of planning, such as evaluating competing plans is a type of thinking (Rips & Estin 1998). Evidence from other experiments suggests that parts of mental events (and, to an intermediate degree, scripts) are less bounded (discriminable) and more homogeneous than parts of objects (Rips & Estin 1998). Finally, if the categories that describe mental events are less bounded, then they may be more difficult to learn than object categories (see Keil 1983).

Artifacts Versus Natural Kinds

Numerous studies have shown that different kinds of features are important to natural kind verses artifact categories (Barton & Komatsu 1989, Gelman 1988, Keil 1989, Rips 1989). These studies indicate that functional features are more important for artifacts, and features referring to internal structure are more important for natural kinds. For example, Barton & Komatsu (1989) presented participants with natural kind and artifact categories that had changes either in molecular structure (e.g. a goat with altered chromosomes or a tire not made of rubber) or in function (e.g. a female goat not giving milk or a tire that cannot roll). Changes in molecular structure were more likely to affect natural kind categories than artifact categories (e.g. a goat with altered chromosomes is less likely to be a goat), whereas changes in function were more likely to affect artifact categories (e.g. a tire that cannot roll is less likely to be a tire). Later research does suggest some ambiguity with regard to the criterial features of artifact categories. Malt & Johnson (1992) found that artifact category membership decisions were more influenced by physical than by functional features. (For another view on the nature of artifact categories see Bloom 1996, 1998; Malt & Johnson 1998.) Overall, these studies suggest that natural kind and artifact categories may differ on the basis of the kinds of features that are criterial for membership in the category.

Research by Ahn (1998) may explain why different kinds of features are criterial for natural kind and artifact categories. Ahn claims that the centrality of a feature to a category depends on the causal status of that feature relative to the other features in the category (see also Ahn 1999, Sloman & Ahn 1999, Sloman et al 1998). Specifically, if a feature is thought to give rise to other features in the category, removing that causal feature affects category identity more than the removal of a noncausal feature does. Ahn showed that the causal status hypothesis accounted for the results of Barton & Komatsu (1989) and Malt & Johnson (1992). That is, the features in these studies that had been judged as criterial to their categories were also rated as the most causal. In artificial category studies, Ahn (1998) showed that regardless of whether the category was a natural kind or an artifact, when functional features caused compositional features, functional features were considered more essential to category membership, whereas when compositional features caused functional features, compositional features were considered more essential to category membership. This suggests that the differences between artifact and natural kind categories may result from the fact that different kinds of features are causal in natural kind and artifact categories (for further discussion, see Keil 1995). The original problem of determining whether artifacts and natural kinds constitute distinct kinds of categories thus becomes the problem of determining whether the causal status of the features of a category can be determined independently of its status as a natural kind or an artifact.

Abstract Concepts

Abstract concepts, such as truth and justice, seem different from object concepts, such as dogs and boats. Yet little work has addressed how we understand abstract concepts. One suggestion has been that abstract concepts are understood through conceptual metaphors (Gibbs 1997, Lakoff & Johnson 1980). During this process, representations of concrete concepts are mapped onto the abstract concepts to facilitate understanding. For example, justice might be understood through a conceptual representation of a scale, and anger might be understood through a conceptual representation of boiling water. If abstract concepts are understood via a metaphorical representation of an object concept, we might not expect to find structural differences between these two types of concepts. Clearly more work needs to be done on how abstract categories are formed and understood.

Basic Level Versus Subordinate and Superordinate Concepts

The observation by Markman (1985) that mass categories are likely to be superordinate categories suggests that differences in taxonomic level may correspond to differences in conceptual structure. Although most objects can be described or named at a number of different levels of abstractness (e.g. rocking chair, chair, furniture item, human artifact), the ‘‘best name’’ for objects (Brown 1958) is at one particular level. In a classic paper, Rosch et al (1976) argued that bundles of correlated properties associated with objects form natural discontinuities or chunks that create a privileged level of categorization. They showed that the basic level is the most inclusive level, at which many common features or properties are listed, the most abstract level at which category members have a similar shape (for a more detailed analysis of comparability and levels, see Markman & Wisniewski 1997), and the level above which much information was lost. Furthermore, the basic level is preferred in adult naming, first learned by children, and the level at which categorization is fastest. In short, these and other measures all converged on a single level as privileged. The findings by Rosch el al (1976) presented a powerful picture of a single taxonomic level as privileged across a wide range of conceptual measures. The authors suggested that the basic level is the level that provides the most cognitively accessible information about the correlational structure of the environment. Are basic-level categories different in kind from categories at other levels? Surprisingly, a number of lines of research suggest that this may not be the case.

First of all, recent evidence suggests that, at least on some tasks, the basic level may change as a function of expertise (e.g. Tanaka & Taylor 1991; Palmer et al 1989; Johnson & Mervis 1997, 1998). For example, experts may prefer to name at subordinate levels, and they verify category labels equally fast at subordinate and basic levels. Although Rosch et al (1976) had contemplated this possibility, this evidence compromises their explanation of the basic level by suggesting that the cognitive accessibility of feature correlations is expertise dependent, rather than universal and absolute. An interesting possibility is that learning may modify the constituent features or attributes of a concept. A number of recent findings and models provide support for this possibility (e.g. Gauthier & Tarr 1997, Goldstone 1994b, Livingston et al 1998, Norman et al 1992, Schyns & Rodet 1997, Schyns 1998; for an overview and commentary, see Schyns et al 1998; for an edited volume, see Goldstone et al 1997). In short, the salience of feature clusters may not be absolute and invariant but rather variable as a function of learning.

Another complication is that although ethnobiologists (Berlin 1992) and psychologists both find evidence for a privileged taxonomic level, they disagree about where in the taxonomy this level is located. Berlin (1992) pinpoints privilege at the level that would typically correspond to genus (e.g. blue jay, bass, beech), whereas Rosch et al (1976) found the privileged level to be a more abstract level, corresponding more nearly with class (e.g. bird, fish, tree). One explanation is that this represents an expertise effect. The people in traditional societies studied by ethnobiologists may be biological experts relative to undergraduates in a technologically oriented society—the population of choice for psychologists. Another possibility is that ethnobiologists and psychologists use different measures of basicness and that these measures do not converge (see also Barsalou 1991).

Coley et al (1997; see also Atran et al 1997, Medin et al 1997) did direct cross-cultural comparisons of these two types of populations using a single measure, inductive confidence. They assumed that if the basic level is the most abstract level at which category members share many properties, then inductive confidence (reasoning from one member having some novel property to all members having that property) should drop abruptly for reference categories above the basic level. Surprisingly, both the Itzaj of Guatemala (members of a traditional society) and US undergraduates consistently showed the same level as privileged, and this level corresponded to genus, consistent with expectations derived from anthropology. This finding raises the possibility that different levels within an object hierarchy are useful for different kinds of tasks (different types of processing). At least for novices, there is a disparity between the level privileged for induction and that favored in naming and speeded category verification tests (though experts may show a convergence across these three tasks). Despite the admirable thoroughness of the original studies of Rosch et al (1976), evidence is increasingly challenging their claim that a single taxonomic level is privileged across the divergent processing demands of particular tasks.

Although Rosch et al have claimed that informativeness determines the basic level, Barsalou (1991) has suggested that perceptual factors may be more central. Barsalou argues that entities are categorized first by shape, because the visual system extracts the low-spatial-frequency information that is used to recognize shape faster than it extracts the high-spatial-frequency information that is necessary to recognize more detailed information (e.g. texture). For example, shape has fairly low variance across birds, making shape a strongly predictive feature for the category bird. This argument is strengthened by the fact that entities that do not share the same shape as their fellow basic-level category members (defined by informativeness) are usually not categorized initially at the basic level but instead are categorized initially at the subordinate level (Jolicoeur et al 1984). For example, a chicken is first categorized as a chicken rather than a bird, presumably because it has an atypical shape for a bird. Barsalou (1991) suggests that there may be a perceptual basic level, based primarily on shape and used largely during perception, and a more informational basic level, carrying more conceptual information and used for secondary categorizations during reasoning and communication. This idea may help explain the discrepancy between the privileged level discovered by Rosch et al 1976) on perceptual tasks and that discovered by Coley et al (1997) on the induction task.

Murphy & Wisniewski (1989) present further evidence that different taxonomic levels serve different functions. Specifically, superordinates may be used to conceptualize scenes or other types of schemas where interconceptual relations are important, whereas basic-level concepts may be used to conceptualize entities in isolation. (For a recent review of research on hierarchical category structure, see Murphy & Lassaline 1997.)

Another claim by Rosch et al (1976) that is under examination is the idea that the basic level is the level at which categories are first learned by children. Specifically, recent studies have raised the possibility that superordinate categories may be learned as early as, or earlier than, basic-level categories. For example, Mandler et al (1991) found that children 18 months old were able to distinguish between members of the superordinate categories of animals and vehicles, but they were not able to distinguish between members within each of these categories (such as dogs and rabbits, and cars and boats). Mandler et al argued from this finding that children acquire certain kinds of superordinate categories, which they call global categories, prior to basic-level categories.

Other evidence suggests that the categories that a child first acquires are not determined by their position within a taxonomic hierarchy but rather depend on the particular objects to which the child has been previously exposed. For example, infants 3–4 months old trained on domestic cats in a habituation paradigm dishabituate to members of contrasting basic-level categories (e.g. dogs, birds, tigers) but not to novel domestic cats. This suggests that during training, the infants formed a representation of the basic-level category ‘‘domestic cats’’ (Eimas & Quinn 1994, Eimas et al 1994). However, infants also appear to be facile at learning categories at superordinate levels. When infants 3–4 months old are trained on different members of the superordinate category ‘‘mammal’’ (e.g. dogs, cats, tigers, zebras), they dishabituate to nonmammal category members (birds, fish) but not to novel mammals (e.g. deer, beavers) (Behl-Chadha 1996). Apparently, the infants were able to form a representation of the superordinate category ‘‘mammal.’’

These studies suggest that children can form both basic-level and global concepts depending on the stimuli presented (see also Quinn & Johnson 1997.) Although these findings appear to be robust, there may be less unanimity with respect to their interpretation. A critical question concerns the criteria for the claim that a child has learned a concept. For example, is sensitivity to perceptual discontinuities that correspond to concepts equivalent to having a concept? (For one point of view on this issue, see Mandler 1997, Mandler & McDonough 1998.)

Overall, recent research tends to weaken the claim for a qualitative distinction between the different levels of a taxonomic hierarchy. The blurring of the distinction between levels undermines the notion that basic-level concepts are special kinds of concepts that reflect the structure of the world, independent of knowledge, expectations, goals, and experience.

Hierarchies Versus Paradigms

The previous discussion of levels is premised on categories being hierarchically organized. But social categories based on factors such as race, age, gender, and occupation (e.g. female teenager, Asian mail carrier) represent more of a cross-classification or paradigm than a taxonomy. Is there a notion of privilege for social categories, as there is for hierarchical categories? It appears that a key factor in social information processing is accessibility of categories (e.g. Smith & Zarate 1992, ER Smith et al 1996) and that some social categories may be accessed automatically (e.g. Bargh 1994, Devine 1989, Banaji et al 1993, Greenwald & Banaji 1995, Zarate & Smith 1990). Some intriguing evidence even suggests that the activation of one social category leads to the inhibition of competing social categories (Macrae et al 1995). Although the structural difference between paradigms and taxonomies is important, it is too early to tell if processing principles also differ between social categories and taxonomic categories, mainly because direct comparisons have not been done.

Ross & Murphy (1999) studied categories associated with foods and their consumption, a context that is interesting because it allows one to study relations between taxonomic categories (e.g. breads, meats, fruits) and script categories that cut across taxonomic categories (e.g. snack foods, dinner foods, junk foods). They report evidence that script categories are less accessible than are common taxonomic categories. Both types of categories were used in inductive reasoning, but their use varied with the type of inference involved. This work points to the fact that even hierarchically organized object categories may admit to other organizations.

Category Structure and the Brain

Studies of patients with selective cognitive impairments have often provided important clues to normal functioning. One intriguing observation concerns category-specific deficits, where patients may lose their ability to recognize and name category members in a particular domain of concepts. Perhaps the most studied domain difference has been living versus nonliving kinds. For example, Nelson (1946) reported a patient who was unable to recognize a telephone, a hat, or a car but could identify people and other living things (the opposite pattern is also observed and is more common).

These deficits raise the possibility that living and nonliving things are represented in anatomically and functionally distinct systems (Sartori & Job 1988). An alternative view (e.g. Warrington & Shallice 1984) is that these patterns of deficits can be accounted for by the fact that different kinds of information are needed to categorize different kinds of objects. For example, sensory information may be relatively more important for recognizing living kinds, and functional information more important for recognizing artifacts (for computational implementations of these ideas, see Farah & McClelland 1991, Devlin et al 1998). Although the weight of evidence appears to favor the kinds-of-information view (see Damasio et al 1996, Forde 1999, Forde & Humphreys 1999), the issue continues to be debated (for a strong defense of the domain-specificity view, see Caramazza & Shelton 1998).

Summary

Researchers are beginning to systematically explore a variety of structural principles according to which conceptual representations vary. There is fairly good support for the idea that nouns and verbs are different kinds of concepts, or at least that the distinction serves to organize an interesting body of research on linguistic and conceptual development. The lexical distinction between nouns and verbs appears to be mirrored in conceptual structure. Another factor that emerges across a number of candidates for kinds of concepts is the difference between those that are composed of clusters of features and those composed of relations. In the next section, we focus on processing-related differences, but given that processing affects structure, this can be seen as an addition to our list of structural distinctions.

CANDIDATES FOR KINDS OF CONCEPTS BASED ON PROCESSING

Common Taxonomic Versus Goal-Derived Categories

Barsalou (1983, 1985) pointed out that many categories are created in the service of goals and that these goal-derived categories may differ in important ways from object categories. Examples of goal-derived categories include ‘‘things to take out of your house in case of a fire'' or ''foods to eat when on a diet.'' Goal-derived categories may activate context-dependent properties of category members. For example, the fact that a basketball is round is a stable property that should be accessed independent of context, but the fact that basketballs float may only be accessed in contexts where a goal relies on its buoyancy. Barsalou's research also shows that members of goal-derived categories are not especially similar to one another and, thus, that they violate the correlational structure of the environment that basic-level categories are said to exploit. In addition, Barsalou has determined that the basis for typicality effects differs for goal-derived versus common taxonomic categories. Typicality or goodness of example is generally assumed to be based on similarity relationships—a good example of a category (e.g. robin for the category ''bird'') is similar to other category members and not similar to nonmembers, whereas an atypical example (e.g. penguin as a bird) shares few properties with category members and may be similar to nonmembers. Barsalou (1985) found that typicality for goal-derived categories was based on proximity to ideals rather than on central tendency. For instance, the best example of diet foods is not one that has the average number of categories for a diet food but one that meets the ideal of zero categories. In short, it appears that goals can create categories and that these categories are organized in terms of ideals.

Is this distinction between taxonomic and goal-derived categories fundamental? It is difficult to say. Barsalou notes that the repeated use of goal-derived categories (e.g. things to take on a camping trip for an experienced camper) may lead to them being well established in memory. Perhaps more surprising are recent observations that suggest that ideals play more of a role in organizing common taxonomic categories than previously had been suspected. Atran (1998) reports that for the Itzaj Maya of Guatemala, the best example of the category ''bird'' is the wild turkey, a distinctive bird that is culturally significant and prized for both its beauty and its meat. Lynch et al (1999) found that tree experts based judgments of tree typicality on the positive ideal of height and on the absence of undesirable characteristics or negative ideals—central tendency played at most a minor role. It may be that typicality is organized in terms of central tendency only for relative novices. Actually, Barsalou's original investigation (1985) found that although common taxonomic categories were most strongly based on central tendency, proximity to ideals made a reliable and independent contribution to goodness of example judgements. In short, common taxonomic and goal-derived categories may be more similar than is suggested by first appearance.

Social Information Processing and Individuation

One could make a case for the view that processing associated with social categories is different from the processing of object categories. For example, there is the intriguing observation by Wattenmaker (1995) that linear separability (separating categories by a weighted additive function of features) is important for social categories but not for object categories. More generally, people appear to be flexible in social information processing. Fiske et al (1987) proposed a continuum model whereby people may form impressions either by top-down, category-based processes or by bottom-up, data-driven processes. (For a parallel constraint satisfaction model of impression formation in which stereotypical and individuating information are processed simultaneously, see Kunda & Thagard 1996.) Factors such as the typicality of examples and the goals of the learner influence the relative prominence of these two processes. This general framework has held up well and serves to organize a great deal of research on social information processing (for a review, see Fiske et al 1999). It is not clear, however, whether there are corresponding processes that operate for nonsocial categories because this question has been relatively neglected. The only relevant study we know of (Barsalou et al 1998) did identify at least some conditions under which individuation of examples took place. The dearth of comparisons derives in part from the relative neglect of different kinds of processing associated with object categories.

Stereotypes, Subtypes, and Subgroups

Although people clearly rely on stereotypes based on categories such as race, gender, and age, increasing evidence suggests that people may be more likely to use more specific social categories in their daily interactions. For example, people appear to have and use several different subcategories for the elderly, such as grandmother-type and elder statesman (Brewer et al 1981).

Do these subcategories share properties with subordinate object categories? Some kinds of subcategories may operate similarly to subordinate object categories, but others may operate differently. Fiske (1998) argues that social subcategories can be divided into two different kinds based on the goals of a perceiver. When a perceiver is trying to understand why a few individuals differ from her stereotype of a group, she might form a subtype to explain their aberrant behavior (Hewstone et al 1994, Johnston et al 1994). For example, a person may form a subtype for black lawyers to explain why several black individuals she knows speak differently and live in a different part of town than her stereotype of blacks. Notably, forming a subtype allows one to maintain his or her current stereotypes.

Fiske (1998) points out that the amount of experience one has with a group also plays a role in whether a subtype is formed. When people have little experience with a group, they tend to perceive less variability among individuals, requiring subtypes to explain any aberrant behavior. With more knowledge about a group, however, people tend to perceive more variability among individuals, which in turn may lead them to form category subgroups. Subgroups consist of category members who are more similar to one another than category members of another subgroup. The key distinction between subgroups and subtypes is that subtypes are made up of a group of people who disconfirm the stereotype in some way, whereas subgroups are usually made up of people who are consistent with the stereotype but in a different way from another subgroup. For example, as Fiske (1998) notes, housewives and secretaries might both be consistent with the stereotype of female, but in different ways.

The most common examples of subordinate object categories (e.g. rocking chair, kitchen chair; song birds, birds of prey) seem to be more analogous to subgroups than subtypes, although there may be some examples of subtype-like object categories as well (e.g. birds that do not fly). A question that needs to be addressed is why subtypes appear more common for social categories than for object categories. (For an analysis of motivational processes aimed at preserving stereotypes, see Kunda 1990.)

Category Processing and the Brain

Process dissociations have often been used as markers of distinct systems, and recently this logic has been applied to categorization. Specifically, Knowlton & Squire (1993; see also Squire & Knowlton 1995) have reported dissociations between categorization and recognition in amnesic and normal individuals, which they interpreted as indicating that multiple memory systems underlie these two tasks. These findings pose challenges for categorization models that assume that categorization and recognition are mediated by a common system. This challenge has not gone unanswered. Nosofsky & Zaki (1998) showed that an exemplar model of categorization can account for the Knowlton & Squire (1993) dissociations, and a strong methodological critique has been made of the Squire & Knowlton (1995) study (Palmeri & Flanery 1999). No doubt the debate will continue.

Ashby et al (1998) offered a neuropsychological theory that assumes that category learning involves both an explicit verbal system and an implicit decision-bound learning system (see also Erickson & Kruschke 1998; for multi-strategy category learning models, see Nosofsky et al 1994). The Ashby et al model is promising in that it integrates neuropsychological and computational modeling, but it is premature to evaluate either its success or the illumination it might provide on kinds of categories.

Other Distinctions

We are necessarily limited in the scope and depth of our coverage; other reviewers would no doubt highlight other differences. One intriguing idea that should at least be mentioned is the proposition that categories are grounded by emotional responses and that stimuli that trigger the same emotion category are seen as similar and are categorized together (Niedenthal et al 1999). Another idea is that different kinds of categories may be represented in memory through different kinds of representational formats. For example, although object categories may be organized in memory in a spatial format, events may be organized in more of a temporal format (Barsalou 1999).

Summary

Our reading of the evidence is that the case for kinds of concepts based on processing is somewhat weaker than the case for kinds based on structure. In addition, the work on goal-derived categories serves to reinforce structural distinctions. It could also be said that we have imposed something of an artificial bound between structure and processing—the strongest case for distinct kinds will require computational models that make concrete assumptions about both structure and processing. We turn now to the third candidate for kinds of concepts, those based on content.

CANDIDATES FOR KINDS OF CONCEPTS BASED ON CONTENT: DOMAIN SPECIFICITY

A general trend in the cognitive sciences has been a shift from viewing human beings as general-purpose computational systems to seeing them as adaptive and adapted organisms whose computational mechanisms are specialized and contextualized to our particular environment (Tooby & Cosmides 1992). In this view, learning may be guided by certain skeletal principles, constraints, and (possibly innate) assumptions about the world (e.g. see Keil 1981, Kellman & Spelke 1983, Spelke 1990, Gelman 1990). In an important book, Carey (1985) developed a view of knowledge acquisition as built on framework theories that entail ontological commitments in the service of a causal understanding of real-world phenomena. Two domains can be distinguished from one another if they represent ontologically distinct entities and sets of phenomena. A criterion used to determine whether two concepts refer to ontologically distinct entities is that these concepts are embedded within different causal explanatory frameworks (Solomon et al 1996, Inagaki & Hatano 1993). These ontological commitments serve to organize knowledge into domains such as naïve physics (or mechanics), naïve psychology, or naïve biology (see Wellman & Gelman 1992; Spelke et al 1995; Keil 1992, 1994; Au 1994; Carey 1995; Hatano & Inagaki 1994; Johnson & Solomon 1997; Gopnik & Wellman 1994).

Researchers advocating domain specificity have suggested that concepts from different domains are qualitatively different. Although it is difficult to give a precise definition of domain (for a review, see Hirschfeld & Gelman 1994a), the notion of domain specificity has served to organize a great deal of research, especially in the area of conceptual development. For example, studies of infant perception and causal understanding suggest that many of the same principles underlie both adults' and children's concepts of objects (e.g. Baillargeon 1994, 1998; Spelke et al 1992). For example, common motion appears to be a key determinant of 4-month-old infants' notion of an object. The Gestalt principle of good continuation, however, plays no detectable role in the concepts of object for infants at that age.

One of the most contested domain distinctions, and one that has generated much research, is that between psychology and biology (e.g. Carey 1991; Johnson & Carey 1998; Coley 1995; Hatano & Inagaki 1994, 1996, 1999; Inagaki 1997; Inagaki & Hatano 1993, 1996; Kalish 1996, 1997; Gelman & Wellman 1991; Rosengren et al 1991; Gelman & Gottfried 1996; Springer 1992, 1995; Springer & Keil 1989,1991; Simons & Keil 1995; Keil 1995; Keil et al 1999; Au & Romo 1996, 1999). Carey (1985) argues that biological concepts like animal are initially understood in terms of folk psychology. Others (Keil 1989, Springer & Ruckel 1992) argue that young children do have biologically specific theories, albeit more impoverished than those of adults. Ultimately, the question breaks down to whether one accepts the criterion used to define ‘‘ontologically distinct entities.’’ For example, Springer & Keil (1989) show that preschoolers think biological properties are more likely to be passed from parent to child than are social or psychological properties. They argue that this implies that the children have a biology-like inheritance theory. Solomon et al (1996) claim that preschoolers do not have a biological concept of inheritance because they do not have an adult-like understanding of the biological causal mechanism involved. But is there really a single adult understanding of biology? To address this question, one would need to examine adult understandings from a variety of samples both within and across cultures (Keil et al 1999).

What criteria should be used to define a particular domain? Domain-specificity theorists claim that domain-defining framework theories are qualitatively different from other theories in that ‘‘they allow and inspire the development of more specific theories but do so by defining the domain of inquiry in the first place’’ (Wellman & Gelman 1992:342). Do domains yield distinct kinds of concepts? Of necessity, our concepts refer to different kinds of things in the world. A fear is that domain-specificity theorists simply define kinds into existence by stating a priori that certain kinds of content (e.g. physics, biology, psychology) are important. In response, we point to the fact that claims about constraints or contents are always subject to skepticism and counter-attack in the form of both research and theory (e.g. for infant perception, see Cohen 1998, Cohen & Amsel 1999, Needham 1998, Needham & Baillargeon 1997, Xu & Carey 1996, Wilcox & Baillargeon 1998; for the role of conceptual knowledge in naming and linguistic development, see Jones & Smith 1993; Soja et al 1991, 1992; LB Smith et al 1996; Landau et al 1998; Landau 1996; Diesendruck et al 1999; Gelman & Eberling 1998). In short, claims about domains are anything but taken for granted.

It is one thing to stake out a domain and quite another to work out the details of how the associated competencies develop, how they are manifest in adults, and how cross-domain interactions emerge. Addressing these questions sets a research agenda that promises to increase our understanding of concept formation and use. For example, Gelman and her associates have been studying the linguistic cues in parental speech that are correlated with distinct ontological kinds (Gelman et al 1999, Gelman & Tardif 1998). In addition, adult folkbiological models and associated reasoning strategies may differ substantially both within and across cultures (Lopez et al 1997, Coley et al 1999) in a way that sharpens discussions of universal principles of biological understanding (see Atran 1998).

To briefly mention cross-domain interactions, one key idea and candidate for a universal principle in folkbiology has been psychological essentialism, the theory that people act as if biological kinds have a (hidden) essence that provides conceptual stability over changes in more superficial properties (e.g. Atran 1990, Hall 1998, Medin & Ortony 1989; see also Margolis 1998). But people also appear to essentialize social as well as biological categories (Rothbart & Taylor 1992, Miller & Prentice 1999, Hirschfeld 1996), which raises a number of further interesting questions. Does this essentialism bias arise independently in these two domains, does it start in one and transfer to the other, or is it possibly a bias that initially is highly general and only later on is restricted to biological and social kinds (see Atran 1995; Gelman et al 1994; Hirschfeld 1995; Gelman & Hirschfeld 1999; Kalish 1995; Gottfried et al 1999; Gelman 1999; Keil 1994; Braisby et al 1996; Malt 1994; Malt & Johnson 1992, 1998; Bloom 1998; Ghisilen 1999; Gelman & Diesendruck 1999; for a related discussion and debate, see Rips 1994)?

Summary

Although we remain agnostic or even skeptical about some of the claims arising from the domain-specificity framework, we believe that it is undeniable that this framework has been enormously helpful in organizing a large body of intriguing findings and observations, coupled with progress on the theoretical front.

CONCLUSIONS

One should not expect a definitive answer to the question of whether there are distinct kinds of concepts. As suggested earlier, this question has to be addressed relative to theories. What does seem clear, however, is that sensitivity to kinds of concepts is quite an effective research strategy. Far from creating insularity, questions about kinds are fostering richer theories of conceptual behavior.

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