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THE MYTH OF CATEGORIZATION

Summary. The concept of categorization has changed for psychologists over the last few decades. In the 1940s, categorization was treated as the meeting of two bounded, describable entities: A psychological or behavioral invariant, such as a name, was assumed to attach itself to an invariant class of objects or events in the environment. Recent developments have called attention to the complexities of the categorization process and specifically to the fluid, fuzzy nature of the environment. A still more complete development of the concept would acknowledge the fluidity and variance in behavior. Categorization must involve a correspondence between two continua.

A concern with categorization is a concern with how people divide up the world. Roughly defined, a category is a group of non-identical objects or events which an individual treats as equivalent. "Dog," for example, is the name of a category that consists of a variety of (usually) four-legged animals. Psychologists have been concerned with the composition of categories and with the principles that govern their formation. Such concern has been expressed using many different investigative procedures and under many labels—classification, concept formation, identification, and so on—but until recently the various approaches to the experimental study of categorization were all alike in at least two major respects.

First, they assumed that categories have well-defined boundaries and that the elements in a category all share certain exhaustively specifiable properties. Second, categorization experiments used artificial, simple stimuli that, conveniently, formed bounded classes in which all members shared certain properties. Vygotsky (1962) and colleagues, for example, showed subjects wooden blocks that varied in color, shape, size, and height. A nonsense syllable on the bottom of each block indicated its category. In one scenario, an experimenter selected one block—say a tall, large one labeled *lag*—and asked the subject to select other objects in the same category. The experimenter overturned objects that had been selected incorrectly until the subject could correctly sort all of the objects into the proper groups—tall and large, flat and large, tall and small, and flat and small. Classic investigations by Hull (1920), the Kendlers (1962), Bruner, Goodnow, and Austin (1956), Heidbreder (1946, 1948, 1949), and many others used similarly contrived stimuli.

ENVIRONMENTAL VARIATION

Recently psychologists have abandoned the notion that categories are bounded and well-defined, and, appropriately, abandoned in categorization experiments simple artificial stimuli like Vygotsky's blocks. The trend has been spearheaded by Rosch and her colleagues, who have emphasized that many categories have at best very "fuzzy" boundaries and that a more important characteristic of categories occurring in the natural environment may be their "internal structure" (Mervis & Rosch, 1981; Rosch, 1977; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976).¹ They have examined many natural categories whose members do not share a set of easily specifiable features. Mechanisms such as Wittgenstein's notion of family resemblance have been invoked to account for the linkage between category members (e.g., Rosch & Mervis, 1975).

There is now widespread interest in the fuzziness of category boundaries, evident, for example, in linguistics in a paper by Labov (1973), in psychology in various applications of fuzzy set theory (e.g., Hersh & Caramazza, 1976; Oden, 1977; also see Zadeh, 1965), and in philosophy in one form or another (consider Goodman, 1965; Quine, 1969b; cf. Russell, 1923). Rosch's work has dealt primarily with natural categories, both perceptual and semantic (e.g., Rosch, 1973)—the whole spectrum of colors, as opposed to a choice between green and red, or types of trees, as opposed to a choice between squares and triangles. A concern with natural categories has been felt even in the animal laboratory in studies, for example, in which pigeons identified trees and people (Herrnstein, Loveland, & Cable, 1976), or in a recent study in which pigeons proved able to distinguish oak leaves from other types of leaves (Cerella, 1979). Brown (1976) has noted the importance of this trend (cf. Brown, 1977; Schönbach, 1977).

Our conceptualization of categorization has moved from the contrived to the natural, from rigid hypotheses about categorization to a greater sensitivity to the full range of phenomena which the process might encompass. In our concern with fuzziness, we have come to deal more and more with the fluidity of the environment. Categorization is no longer seen as a matter of attaching a name to a distinct object or event or even to a distinct class of objects or events but rather to classes with intentions (defining properties) that are difficult to specify, to spatial and temporal segments of a continuity.

Seen in this light, the trend is harmonious with the stress on continuity evident in the works of James (1890), Dewey (1896), Bergson (1946), Skinner (1935), and others.² Variance is the rule in the events or objects we categorize, a fact that is easy to observe. The range of different objects which we call "fruit," for example, varies considerably, and, at extremes, many objects, such as coconuts or tomatoes, will not be categorized reliably. No two dimes are ever identical, and although they may certainly differ along fewer dimensions than two possible members of the "fruit" category, even "dime" is a name for a fuzzy set. Even the "same" object, seen at different times, varies in several ways from occasion to occasion: Our contact with the object is, for one thing, temporally distinct—as James (1890) noted, we don't call two ticks of a clock the "same" tick—and the object likely varies in spatial orientation and other ways which affect our perception of it from one occasion to

the next. Variance, again, is the rule, and the current conceptualization of categorization takes it into account.

BEHAVIORAL VARIATION

Our general concern is with the “principles by which humans divide up the world” (Rosch et al., 1976, p. 382). A “category” or “concept” indicates that some division has occurred. According to Rosch, a category is “a number of objects which are considered equivalent” (Rosch et al., 1976, p. 381). Posner (1973), following Bourne (1966), gives a closely related and more specific definition: “A concept has been formed when a human subject shows the ability to respond to a series of different events with the same label or action” (p. 46). In each rendering, a subject must somehow demonstrate that he or she considers differing objects or events equivalent. An individual demonstrates this by behaving “equivalently” with respect to them, or as Posner notes, by giving us the *same* response. This is the essence of the concept of categorization as explicitly defined in psychological research. Some name or other identifying response gets attached to an apparently diverse set of objects or events. Or, in other words, an invariant element in behavior gets attached to variant elements in the environment.

But no such invariant exists. Behavior is as fluid as the environment, and the same is true of neurological or cognitive events which might be said to correspond to categories.³ Consider some early instances of a child starting to call things “dog.” The label is applied imperfectly at first—perhaps, at some point, to all four-legged creatures. Eventually, the child’s “dog” category approximates our own. At each step in the acquisition of the category, the name “dog” indicates the nature of the category. When the child applies the word “dog” to a Dalmatian on one occasion and a Beagle on another, we know that the child considers them “equivalent” or “the same.” But how did the child know that its two “dog” responses were the same? They were not identical; they were physically and temporally unique, just as the dogs were. We have long noted that there are different words for the same thing (e.g., Brown, 1958), but we also know that word instances vary in pitch, volume, and duration, that the “same” word may be spoken either with or without the vocal cords, and that there are still other easily discriminable variations in response form. Rosch et al. (1976) note that “categorization occurs to reduce the infinite differences between stimuli” (p. 428). Apparently we should add that categorization occurs to reduce the infinite differences between responses.

The segmentation of one’s own behavior may be pre-programmed to some extent, determined by some underlying neurological event, but learning can contribute to the process. Consider a boy learning to swim the side stroke. He practices according to instructions and at first is insensitive to the great variation that occurs; his “side stroke” category is broad and will be sharpened with practice. Experience plays a role in segmentation when one learns a new language, certainly whenever phonetic categories of the new language impinge upon the integrity of the old. In learning Zulu, for example, one must master two [b] sounds, and in learning Hindi, four consonant sounds in roughly the [d] to [t] range. The relative contributions of

innate, learning, and maturational factors in the recognition of invariants in one's own behavior have not been established.

Behavioral variation is overlooked or underemphasized in most studies of categorization. Rosch and her colleagues place primary emphasis on environmental variance (e.g., Rosch, 1973; Rosch et al., 1976; Rosch, 1977; cf. Heider, 1972). In a typical task, the objects to be categorized—e.g., colors or geometrical forms—are constructed so as to vary in systematic ways and displayed to subjects on cards. The subjects learn to name certain subsets of these stimuli, and the manner in which they do so sheds light on the structure of the acquired category. Environmental variance is also emphasized in applications of fuzzy set theory (Brownell & Caramazza, 1978; Hersh & Caramazza, 1976) and other recent work on concepts or categories (e.g., Bolton, 1977; Garner, 1976; Goldman & Homa, 1977; Oden, 1977; Zadeh, Fu, Tanaka, & Shimura, 1975).

What would at first seem to be an exception to this rule is work on speech perception. But here we typically look at variation in speech sounds only when presented as stimuli, not when they occur as responses. Yet this is, once again, a case in which the categorizing responses vary just as the stimuli do—in fact, in this instance, *precisely* as the stimuli do. In a paper that applies fuzzy set theory to a model of speech perception (Oden & Massaro, 1978), subjects pressed buttons to categorize speech sounds; the button pushes, although undoubtedly varying in topography, latency, magnitude, and duration, were implicitly considered invariant.

Such work, in overlooking response variation, is not necessarily deficient, and neither, for that matter, were the Heider or Vygotsky studies. But the Heider approach was abandoned in an effort to tackle some of the intricacies of categorization as it occurs in the natural environment. Looking more closely at response variables like force, latency, and duration—or, in a naming task, even at spectrographic fluctuations—might reveal new and interesting dynamics of the categorization process, just as Rosch's work has done. We know that variation occurs on both sides of the environment/behavior interface. How do they covary?

In some instances, variables such as duration, reaction time, rate (Herrnstein et al., 1976; Cerella, 1979), or “confidence” (Medin & Schaffer, 1978) of naming or identification responding have been measured, but the rationale for such measurement has usually been restricted to particular theories about the cognitive processes involved in categorization and does not stem from the more general concerns that have been addressed here.⁴ Results of such investigations do show, however, the sorts of variation in behavior that have been discussed. In a study reported in 1972, for example, Rosch noted that focal colors—viz., more central category members—were given shorter names and had shorter latencies than non-focal colors (Heider, 1972).

Categorization is sometimes studied without relying on a naming response or any other obvious identification response—for example, in the “oddity” task or in tasks requiring only a “same” or “different” response. We could, by such means, sidestep theoretical vagaries and still investigate the categorization process, but doing so would reduce the concept to psychological triviality. The concept would survive, but at the expense of our understanding of the subject matter that spurred the concept in the first place.⁵

A MYTHOLOGICAL CONCEPT

One thing that all recent concepts of categorization have in common is the notion that people divide up the world. Rosch was looking for the “principles” by which the division occurs. Humans are often seen as compulsive classifiers (cf. Bergson, 1946), and classification, discussed in almost any context, is understood to mean such a process (consider Stevens, 1939, p. 233). But the environment divides up behavior just as behavior divides up the environment. There is variation and continuity in each, and the “segmentation” that occurs, occurs in each.

Then why is the notion that we divide up the world so pervasive? Why do our concepts of categorization, naming, classification, and identification all make this assumption? Perhaps our tendency to see people as dividing up the world is compelling for the same reason that we so easily recognize occurrences of some word as being “the same” from one occasion to the next in our own behavior—because we are irresistibly sensitive to certain commonalities in our behavior. Variation, relatively speaking, is all but invisible to us. How understandable, in that case, that we devise a concept of categorization in which invariant, pre-segmented behaviors or psychological entities get attached to an amorphous world.

The fact that we so inexorably and automatically attend to commonalities in our behavior suggests that the ability to do so is somehow fundamental to our functioning and implies a sort of Gödel's Theorem of psychological study: Characteristics of our functioning impede the extent to which we can study that functioning effectively. The concept of categorization may be one instance in which characteristics of the psychologist were restrictive. Concepts such as categorization would never take the form that they do in psychological research if psychologists began with observations of continuity and variation in behavior and the environment. Other concepts in psychology may now be historical relics because they were inconsistent with such observations. We know, for example, that a concept of memory based on response repetition has come into disrepute as an experimental heuristic; was this inevitable solely given that such a concept, like the concept of categorization, overlooks behavioral variance?

That there is variance in both behavior and environment is not a new idea, but somehow our relative insensitivity to the behavioral variance has kept us from a full exploration of the categorization process. Categorization is not a myth—at least not to the extent that people behave as if non-identical objects were equivalent.⁶ But various experimental and theoretical formulations of the concept in psychology have not adequately acknowledged the complexities of the process.⁷ It is not enough to say that we divide up our world into categories, for our behavior is itself divided up by the world. The process of division is a mutual one.

NOTES

1. The concern with internal structure is also evident in work by Bransford and Franks (1971) and in some of Posner's work (e.g., 1969, 1973), although these studies restricted themselves to relatively simple stimuli.

2. Consider James's (1890) classic portrayal of the stream of consciousness: "*no state once gone can recur and be identical with what is was before.... For an identical sensation to recur it would have to occur the second time in an unmodified brain. But as this, strictly speaking, is a physiological impossibility, so is an unmodified feeling an impossibility.... A permanently existing 'Idea'...which makes its appearance before the footlights of consciousness at periodic intervals is as mythological an entity as the Jack of Spades*" (Vol. I, pp. 230–236; italics original).

3. Postulating the existence of a cognitive or neurological event that washes away the differences in certain behavioral events is no solution to the problem. For one thing, there is no reason to believe that internal events are any simpler than the external ones they underlie; it seems reasonable to suppose that they are every bit as complicated. Furthermore, we know that experience can play a role in concept acquisition, as is noted, for example, in Rosch's discussion of expertise (Rosch et al., 1976, pp. 431–432; also see Goldman & Homa, 1977). It seems unlikely, then, that all concepts are simply "preset" in neural matter. Finally, postulating the existing of some underlying invariant will only divert us from examining dynamic relationships that may exist between behavioral and environmental events. Neurological abstraction processes must exist (consider the missing fundamental in pitch perception), but they are not, to my knowledge, well understood. At this point, trying to bolster a mythical concept of categorization with a mythical neurological or cognitive process that handles behavioral variance would not be a great step forward.

4. An exception is an experiment reported by Brown (1956, pp. 291–294), in which a subject's ability to discriminate category names was shown to be a determinant of the categories he or she formed.

5. A comparison response, in particular, would be inadequate for many reasons. Whereas categorization seems an inevitable process for infrahumans, comparison is not. Nature does not arrange circumstances under which, say, a rat must examine two objects and then respond "same" or "different." A comparison response is probably strictly a verbal phenomenon and hence a special product of humans. In unpublished research done in Harvard's operant laboratory, pigeons had trouble learning comparison responses, although limited success with chimpanzees has been reported (e.g., Premack, Woodruff, & Kennel, 1978). The comparison response probably differs from the categorization response in complexity; perhaps comparing two objects first requires two separate categorization responses. Given marked differences in generality and probable differences in complexity, studying one process would seem to be no substitute for studying the other.

6. In spite of this partial disclaimer, I believe that the paper's title is appropriate. It is based on James's characterization of the fixed idea as an entity as "mythological...as the Jack of Spades." See Note 2 this chapter for a more complete quotation.

7. There are exceptions. According to Brown (1956), for example, "Where the subject is human and the responses are verbal it is...clear that the experimenter makes a judgment of response equivalence—an array of entities is called by the 'same' name. The bounds of verbal categories are set by human beings.... Not [everyone] will agree as to which utterances are the 'same.' The varying utterances categorized as one word have a kind of functional equivalence in that they will produce the same social effect.... *The categorical response must appear in correlation with entities of a particular class and must be extended to entities of that class*" (p. 277, italics added).