

Objects, Parts, and Categories

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SUMMARY

Concepts may be organized into taxonomies varying in inclusiveness or abstraction, such as *furniture, table, card table or animal, bird, robin*. For taxonomies of common objects and organisms, the basic level, the level of *table and bird*, has been determined to be most informative (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). Psychology, linguistics, and anthropology have produced a variety of measures of perception, behavior, and communication that converge on the basic level. Here, we present data showing that the basic level differs qualitatively from other levels in taxonomies of objects and of living things and present an explanation for why so many measures converge at that level.

We have found that part terms proliferate in subjects' listings of attributes characterizing category members at the basic level, but are rarely listed at a general level. At a more specific level, fewer parts are listed, though more are judged to be true. Basic level objects are distinguished from one another by parts, but members of subordinate categories share parts and differ from one another on other attributes. Informants agree on the parts of objects, and also on relative "goodness" of the various parts. Perceptual salience and functional significance both appear to contribute to perceived part goodness. Names of parts frequently enjoy a duality not evident in names of other attributes; they refer at once to a particular appearance and to a particular function.

We propose that part configuration underlies the various empirical operations of perception, behavior, and communication that converge at the basic level. Part configuration underlies the perceptual measures because it determines the shapes of objects to a large degree. Parts underlie the behavioral tasks because most of our behavior is directed toward parts of objects. Labeling appears to follow the natural breaks of perception and behavior; consequently, part configuration also underlies communication measures. Because elements of more abstract taxonomies, such as scenes and events, can also be decomposed into parts, this analysis provides a bridge to organization in other domains of knowledge.

Knowledge organization by parts (partonomy) is contrasted to organization by kinds (taxonomy). Taxonomies serve to organize numerous classes of entities and to allow inference from larger sets to sets included in them. Partonomies serve to separate entities into their structural components and to organize knowledge of function by components of structure. The informativeness of the basic level may originate from the availability of inference from structure to function at that level.

Gallia est omnis divisa in partes tres. Gaul as a whole is divided into three parts. How many essays, since Caesar's account of his European campaign, have begun by decomposing the subject matter into parts? Knowing the parts of a topic and their interrelationship seems to be fundamental to comprehending the topic, whether the topic is a country under siege, a scientific discipline, or an automobile in need of repair. In this article, we examine the special role of parts in determining the basic or preferred level of abstraction in a taxonomy.

The world is filled with an overwhelming variety of objects and living things. One of the most fundamental aspects of human thought is the ability to perceive similarities and differences in objects and organisms, and to thereby group or classify them. Grouping individuals into categories gives us a basis for treating different objects and organisms as equivalent and enables us to reduce the numbers of entities in the world to manageable proportions. Classification also allows us to infer properties of individuals from knowledge of the category and to communicate information economically by category labels. The utility of categories can be further increased by organizing them into taxonomies of inclusiveness or abstraction. The animal taxonomy is a classic example. Robins, for example, are included in the class of birds, and birds are included in the class of vertebrates. The more inclusive classes are more abstract in that the features characterizing the class are more general and less concrete. Such structures allow succinct representation of knowledge and provide powerful potential for inference.

A preferred level of reference, or basic level of categorization, is a second characteristic of natural categories that has been linked to structure in the perceived world (Berlin, 1972; Berlin et al., 1973; Rosch et al., 1976). In essence, the basic level phenomenon is that categories at one level of specificity in a taxonomy are psychologically and linguistically more primary than more general and more specific categories. Relative informativeness has been used by Rosch et al. (1976) to identify the basic level. This has been operationalized as a relatively steep rise in the number of attributes listed by subjects for objects described at several levels of abstraction. For instance, subjects list very few attributes for *vehicles*, *furniture*, and *tools*, but list a far greater number of attributes for *car*, *table*, and *hammer*. Only a few additional attributes are listed for *two-door car*, *card table*, and *ball-peen hammer*. It has been suggested (Rosch, 1978) that basic level categories are most informative because, given our perceptual apparatus and the

structure in the world, this is the level at which the natural correlations and discontinuities among features are most salient. Presumably, where informativeness is greatest, so is the inferential power of categorization.

Many empirical operations converge at the basic level in common taxonomies of objects and organisms. Basic level categories are the most general categories having members with similar and recognizable shapes; they are also the most abstract categories for which a single image can be formed for the category (Rosch et al., 1976). Basic level categories are the most general categories having members that are interacted with in the same ways (Rosch et al., 1976). In labeling an object, basic level terms are preferred (R. Brown, 1958; Cruse, 1977; Rosch et al., 1976), and in verification, basic level labels are verified most rapidly (Murphy & Smith, 1982; Rosch et al., 1976). Basic level terms tend to be the first categories named and understood by children (Mervis & Rosch, 1981), the first terms to enter a lexicon, shorter and less derived terms (Berlin, 1972; Rosch et al., 1976), and contextually neutral (Cruse, 1977). The first two measures reflect our perception of objects, the next measure reflects our behavior toward objects, and the final measures reflect our communication about them. It remains to be explained why so many different and significant operations converge at the same level.

Although the basic level of reference has been defined quantitatively, there seem to be qualitative differences among the levels of abstraction in common taxonomies (Rosch et al., 1976; Smith, Balzano, & Walker, 1978). Specifically, superordinate categories seem to primarily share functional features—vehicles are for transporting, and tools are for fixing. They do not seem to share perceptual features, in sharp contrast to objects belonging to the same basic level category, which appear to share both perceptual and functional features. On closer examination of the attributes listed by subjects, it appeared to us that one kind of feature especially predominates at the basic level of reference, namely, parts. Attributes listed for *screwdriver* include *handle* and *blade*, and attributes listed for *chair* include *seat*, *back*, and *legs*. Although object parts are portions of wholes, and therefore perceptual features, many names of parts seem to have a

special status in that they are at once perceptual and functional. They refer to both a perceptually identifiable segment of an object and to a specialized function of the object. A *handle*, for instance, is typically long, thin, and of a size compatible with the human hand; a handle is used for grasping. Likewise, a *blade* is also elongated, with one of its long edges thinner and sharper than the other; it is used for cutting. Similarly, a *seat* is a squarish, horizontal surface, of a size and height to be compatible with humans; it is used for sitting. The other sorts of attributes generated by subjects, for instance, *red*, *found in water*, *heavy*, *used for fixing*, do not have this dual character. Thus part names, in contrast to names of other attributes describing objects and organisms, have two faces: one toward appearance, the other toward function.

In these studies, we garner evidence supporting the proposal that it is the psychological prevalence of parts that grants special status to the basic level; that parts underlie the distinctiveness of objects from one another at the basic level, and that parts underlie each of the types of converging operations, and thereby account for their convergence. These claims entail three predictions, to be examined empirically. First, knowledge about parts is expected to underlie the superior informativeness of the basic level. Second, because part structure is expected to underlie the natural breaks or discontinuities at the basic level, different objects at the basic level should differ on parts and share other attributes. Third, different subordinate objects belonging to the same basic level category should share parts and differ on other attributes. Following Rosch (1978), we refer to issues concerning inclusion and abstraction relations between categories as the *vertical* dimension of categorization, and to issues concerning the relations among subcategories at the same level of analysis as the *horizontal* dimension of categorization. The first prediction, then, is a prediction about representation of vertical relations among categories, and the next two predictions are about representation of the horizontal relations.

These predictions were explored for categories of plants and animals as well as for categories of common objects. Although it is difficult to identify defining characteristics of members of object categories, functional