mise. His contextualization of scientific theory and moral-technological interpretation of science's purpose brings him close in spirit to American pragmatism and neo-pragmatism. Finally, his opposition to "psychology," long dismissed as crudely fixated on introspection and phrenology, is today better linked with radical behaviorism's critique of traditional ideas of consciousness and will.

Bibliography

Charlton, D. G. (1959). *Positivist thought in France during the Second Empire, 1852–1870*. Oxford: Oxford University Press. A standard reference work, tracing the immediate influence of Comte in France.

Comte, A. (1830–42). *Cours de philosophie positive* [in 60 "leçons"] (Vols. 1–6). Paris: Bachelier. Reprint in 2 vols. *Philosophie prémier: Cours de philosophie positive, leçons 1 à 45* (M. Serres, F. Dagonet, & A. Sinaceur, Eds.), and *Physique sociale: Cours de philosophie positive, leçons 46–60* (J.-P. Enthoven, Ed.). Paris: Hermann, 1975. There is no complete English translation of all 60 "Lessons." Partial translations: Frederick Ferré, *Introduction to Positive Philosophy* (Indianapolis, 1988); Gertrud Lenzer, *Auguste Comte and Positivism: The Essential Writings* (New Brunswick, 1998). Ferré's translation of the two introductory lessons provides a brief overview of Comte's work as a whole. Lenzer's selections from the *Cours*, themselves sharply abridged, are from Harriet Martineau's 1853 "authorized" but very "freely translated and condensed," *The Positive Philosophy of Auguste Comte* (Vols. 1–2). (London, 1853).

Comte, Auguste. (1844). *Discours sur l'esprit positif*. Paris: Carilian-Goeury and Victor Dalmont. There is a 1903 translation, *A Discourse on the Positive Spirit* (E. S. Beesly, Trans.). London: William Reeves. Hard to obtain and not always reliable, Beesly's translation of the *Discours* nevertheless provides the most accessible account of Comte's philosophy for the general reader.

Gouhier, H. (1933–1941). *La jeunesse d'Auguste Comte et la formation du positivisme* (Vols 1–3; Vol. 3, 2nd ed., 1970). [The youth of Auguste Comte and the development of positivism]. Paris: J. Vrin. Still the most thorough and detailed study of Comte's early work, though now to be read together with Pickering (1993). Very extensive bibliography.

Haac, O. (Ed. and Trans.). (1995). *The correspondence of John Stuart Mill and Auguste Comte*. New Brunswick, NJ: Transaction. Lively, revealing exchange between two major 19th-century thinkers from 1841 to 1847, at first enthusiastic about their shared commitment to positivism and its social promise, gradually discovering deep disagreements about the desirability of formalizing the logic of science, the status of women, and the possibility of a scientific psychology.

Kremer-Marietti, A. (Ed.). (1998). Special issue bicentenary commemorating Comte's birth. *Revue internationale de philosophie, 52*, (203). Collection of new essays by Comte specialists (English and French) from various disciplines, reconsidering Comte's legacy in light of recent revisionary scholarship and contemporary social and political issues.

Laudan, L. (1981). Towards a reassessment of Comte's *Méthode Positive*. In L. Laudan, *Science and hypothesis: Historical essays on scientific methodology* (pp. 141–162). Dordrecht: D. Reidel. One of the very few recent studies of Comte's epistemology of science, set against the background of issues and arguments in mainstream Anglo-American philosophy of science.

Mill, J. S. (1969). Auguste Comte and positivism. In J. M. Robson (Ed.), *The collected works of John Stuart Mill* (Vol. 10, pp. 261–368). Toronto: University of Toronto Press. (Original work published 1865.) There is also a separate reprint of the 1885 edition (Bristol, 1995). This is the most influential study of Comte's philosophy, written after Mill's early enthusiasm had cooled, generally favorable toward Comte's defense of science, but strongly critical of his failure to provide an "organon of proof," his attitude toward psychology, and his later social theories.

Pickering, M. (1993). *Auguste Comte: An intellectual biography* (Vol. 1). Cambridge, UK: Cambridge University Press. Definitive resource on Comte's life and thought from the early years through publication of the last volume of his *Cours* (1842). Extensive bibliography. Second volume in preparation.

Scharff, R. C. (1995). *Comte after positivism*. Cambridge, UK: Çambridge University Press. The only recent book-length study of Comte's philosophy in English. Part I includes detailed, critical comparison of Comte and Mill. Part II urges Comte's contemporary relevance, arguing that his concern for the relation between philosophy and its past makes him an ally of postpositivists like Richard Rorty, Charles Taylor, and Hilary Putnam (after 1980). Extensive bibliography.

Simon, W. M. (1963). *European positivism in the nineteenth century: An essay in intellectual history*. Ithaca, NY: Cornell University Press.

Wright, T. R. (1986). *The religion of humanity: The impact of Comtean positivism on Victorian Britain*. Cambridge, UK: Cambridge University Press.

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CONCEPTION. *See* Human Origins.

CONCEPTS. [*To treat the term and the process of conceptual thinking, this entry comprises four articles*: An Overview; Structure; Learning; *and* Combinations.]

An Overview

Concepts are the building blocks of mental life. By *concept* we mean a mental representation of a category. Categories are the sets of entities "picked out" by con-

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cepts. For example, the concept "dog" entails any and all knowledge associated with dogs, such as the information that they generally have four paws, can make good pets, and like to chase cats. In contrast, the category "dog" consists of the set of qualified members, which in this case would include Lassie, all golden retrievers, all dobermans, and so on.

Much of the research on concepts has focused on categorization, the basic cognitive function whereby we determine whether a given item belongs to a particular category. In addition to categorization, concepts play important roles in reasoning, in learning, in the generation of new ideas through conceptual combination, and in communication and understanding. Because any complete theory of concepts must account for the full range of functions they serve, it will be helpful to start by taking a closer look at each of these functions before we go on to discuss the various models of concepts that have been proposed.

Functions

Perhaps the most fundamental purpose of concepts and categorization is *to guide inferences*, allowing us to relate new experiences to what we already know. Knowledge about a category enables us to make inferences or predictions about new instances. For example, having categorized a small, ceramic object as a mug, it is reasonable to infer that it can be lifted by its handle, may contain hot liquids, could break if dropped, and so on. Not only are new entities understood in terms of familiar concepts, but experience can also provide feedback, facilitating learning by modifying or updating previously held knowledge. For example, when expectations fail (e.g., when one encounters a handleless mug) one may need to revise the concept in question and perhaps set up subcategories (e.g., well-insulated mugs that can be grasped directly versus those that require a handle). An important issue is the question of how far an inference may be extended. A mug can be categorized at many levels of specificity: as a cup, a drinking vessel, a kind of dishware, a container, or an artifact. Should the handleless mug modify one's expectations about cups, drinking vessels, or containers in general?

The ability *to combine concepts* means that a small set of concepts can be used to generate a virtually unlimited number of novel ones. This creativity is paralleled by an impressive flexibility in our ability to understand or interpret novel combinations. How do we know that "car mug" refers to where a mug is used, while "plastic mug" refers to its material, and "coffee mug" to its contents? Another important theoretical challenge is to develop models that can explain how the combination of concepts affects or modifies our understanding of the components. For example, our concepts of "soup mug" and "coffee mug" are likely to differ not only in terms of their typical contents, but also in terms of their probable shapes and materials.

The interrelated processes of *communication* and *understanding* affect virtually every other conceptual function. Through communication, we are able to share knowledge about a concept with others and invoke shared understanding. Since most (though not all) of our concepts have corresponding lexical terms, communication and language are closely linked; however, their precise relationship is still unclear. The interrelationship between language acquisition and conceptual development continues to fascinate not only cognitive and developmental psychologists, but linguists and philosophers as well.

With these multiple functions as background, we now turn to a brief review of the central ideas and principles behind our current understanding of concepts.

The Basic Level

How are our categories organized? Many categories exhibit a hierarchical structure, whereby a given object can be categorized at different levels of specificity (as illustrated by the mug example above). However, not all of those levels are created equal. In the 1970s, anthropologist Brent Berlin observed that across cultures, intermediate categories appeared to play a special role. Building on his work, psychologist Eleanor Rosch and her colleagues used a variety of converging measures to demonstrate the privileged status of what they termed "basic level" categories (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, *Cognitive Psychology*, 1976, *8*, 382–439). These categories tend to have simple, one-word labels such as "mug," "dog," and "chair." They are the first names adults give to describe objects and tend to be the first words learned by children. Distinctive features seem to cluster at the basic level—few features are associated with more abstract categories and more specific categories do not offer much useful additional information. Treating an intermediate category level as privileged generally allows us to make a satisfactory trade-off between informativeness and efficiency. For example, in most situations, knowledge that an object is a "dog" provides us with much more useful information than knowing that it is an "animal." However, knowing that the dog is a "schnauzer" requires more cognitive processing, and the additional information provided may not be useful enough to warrant the additional effort it requires (unless, perhaps, one is a veterinarian or a schnauzer owner).

Recently, research has been conducted to determine whether the basic level may shift with expertise (e.g., Tanaka & Taylor, *Cognitive Psychology*, 1991, *23*, 457–482). In other words, perhaps (as suggested in the example above) the privileged level for a person who trains dogs is not at the level "dog," but at a more

specific level, such as "schnauzer." An important question is what determines privileged status. Is it inherent to the objects that make up the category? Or is it dependent on the relationship between the category and user?

Models of Conceptual Structure

Following Smith and Medin (*Categories and Concepts*, Cambridge, MA, 1981), one can distinguish three models of conceptual structure. *The classical view* maintains that all instances of a category share defining properties, i.e., features that are singly necessary and jointly sufficient conditions for belonging to the category. For example, a triangle is a closed geometric form with three sides and interior angles that equal 180 degrees.

Although the classical view appears to handle geometric figures fairly well, a number of challenges to this view have been raised. If our use of concepts depends on defining characteristics, then specifying these characteristics should be straightforward. Yet people have difficulty doing so, even for frequently used concepts. For example, although "can fly" might seem to be a defining property of the category "bird," ostriches and penguins do not fly, while bats do. Furthermore, most people agree that the classical view is not able to explain the *typicality* findings that have been consistently obtained across studies. Typicality refers to the idea that categories are not discrete; people are able to judge different instances of categories as better or worse (more or less typical) examples of these categories. For example, robins are usually considered typical birds while penguins are not.

The probabilistic or prototype view argues that there need not be defining properties and that concepts are instead organized in terms of properties that are characteristic of category members. To continue with the example given above, birds generally fly, sing, and build nests, but there are exceptions for each of these properties. Research by Rosch and others (e.g., Rosch & Mervis, *Cognitive Psychology*, 1975, *7*, 573–605) has suggested that membership in a category can therefore be graded rather than all-or-none, where the better members of the category (e.g., for birds, robins) have more characteristic properties than the poorer members of the category (e.g., penguins). Prototype theory maintains that characteristic properties are used to generate a "prototype" for each category. Potential instances of a category are compared to this representation of the average or ideal category member in order to determine category membership. Hence, probabilistic theories are able to explain typicality effects.

The exemplar view agrees with the claim that concepts need not have necessary and sufficient features but further asserts that (1) categories are represented in terms of individual exemplars and (2) potential instances are compared to known category exemplars to determine their status. For example, children seeing a pheasant for the first time might categorize it as a bird, not because it possesses birdlike characteristics, but rather because it resembles a turkey, which they know to be a bird. These comparisons may be made to a single exemplar or to a set of exemplars.

Each of the preceding three models accounts for some but not all findings and therefore each view has its proponents. There is currently no consensus about which model has the greatest capability to explain conceptual structure. Indeed, dissatisfaction with these views has led to alternative approaches to structure, outlined below.

Conceptual Models

Different as they are, the three views we have been discussing can all be described as *similarity-based models* of categorization. Consider a general model of similarity such as that proposed by Tversky (*Psychological Review*, 1977, *84*, 327–352) where the similarity of two representations is some weighted function of their shared and distinctive features. The classical view corresponds to the special case where the concept and all category members share defining features and these defining features receive all the weight. The probabilistic view conforms to a model where characteristic features are also weighted, while the exemplar view is a pure similarity model, relying on the comparison of instances to stored examples.

Similarity-based models have recently come under criticism. One concern is that the notion of similarity is not adequately constrained. Similarity can shift dramatically depending upon the weights given to particular features. For example, a zebra and a barber pole could be more similar than a zebra and a horse if the feature "striped" were weighted sufficiently. Another "constraint issue" is the problem of determining which features to use when comparing two objects. Any two objects share an unlimited number of features as well as differences. For example, both curtains and pens are man-made, can be destroyed in fire, weigh less than 200 pounds, weigh less than 201 pounds, and so on. How do we decide which attributes matter? In general, the flexibility of similarity reduces its explanatory power.

Theory-based models offer an alternative to the view that categorization depends solely on the similarity between a concept and an instance. Rather, theory-based models assert that category membership requires that an instance have the appropriate "explanatory relationship" to a concept's organizing theory. These models may address the question of why we have the categories we have, since theories can explain the coherence of a concept or category even when there is no obvious perceptual similarity among category members. For example, the category "role models" may include mem-

bers as diverse as Michael Jordan, William Shakespeare, Mother Theresa, E. T., and the family pet. Despite the differences within the group, the category is still coherent because each member possesses some admirable quality (even though that quality may be quite different for each member of the category).

Theory-based models suggest solutions to some problems, but they face their own set of challenges. For example, what exactly counts as a theory and where do theories come from? For the time being, there is no convincing answer to the question of what roles theories and similarity play in categorization. Work continues to be done to try to understand their relationship.

Summary and Challenges

We have described some of the key functions, phenomena, and theories about concepts. Although research continues to be done on the categorization function of concepts, much current work focuses on other functions of concepts. For example, some work suggests that the basic level may be different for reasoning (e.g., Coley et al., *Cognition*, 1997). Other research makes the important point that the way we use concepts affects their very structure and organization (Ross, *Journal of Experimental Psychology*; 1997, *Learning, Memory and Cognition*, 1997). We believe that the pursuit of questions such as these—and the next generation of questions their answers will raise—will open an interesting chapter in the study of concepts.

Bibliography

Barsalou, L. (1985). Ideas, central tendency, and frequency of instantiation as determinants of graded structure in categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11*, 629–649.

Berlin, B. (1992). *Ethnobiological classification: Principles of categorization of plants and animals in traditional societies.* Princeton, NJ: Princeton University Press.

Carey, S. (1985). *Conceptual change in childhood.* Cambridge, MA: MIT Press.

Goldstone, R. L. (1994). The role of similarity in categorization: Providing a groundwork. *Cognition, 52*, 125–157.

Komatsu, L. K. (1992). Recent views of conceptual structure. *Psychological Bulletin, 112* (3), 500–526.

Murphy, G. L., & Medin, D. L. (1985). The role of theories in conceptual coherence. *Psychological Review, 92*, 289–316.

Osherson, D. N., Smith, E. E., Wilkie, O., Lopez, A. & Shafir, E. (1990). Category-based induction. *Psychological Review, 97* (2), 185–200.

Rips, L. J. (1975). Inductive judgments about natural categories. *Journal of Verbal Learning and Verbal Behavior, 14* (6), 665–681.

Waxman, S. R. (1991). Convergences between semantic and conceptual organization in the preschool years. In S. A. Gelman & J. P. Byrnes (Eds.), *Perspectives on language and though: Interrelations in development.* New York: Cambridge University Press.

Wisniewski, E. (1997). When concepts combine. *Psychonomic Bulletin and Review, 4* (2), 167–183.

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Structure

A concept is the accumulated knowledge about a type of thing in the world. Thus, the concept of "car" contains someone's accumulated knowledge about cars. Such accumulations occur for many types of things in the world that are important to us. The parts of speech provide one very rough guideline for the types of concepts that people develop; for example, concepts are developed for nouns (entities), verbs (actions), adjectives (properties), and prepositions (relations). Ontological types provide another rough guideline; for example concepts are developed for living things, artifacts, events, mental states, locations, and times. Within each of these broad types, many specific concepts are developed, such as concepts for various living things (e.g., bird, rose).

Preliminary Issues

The central issue here concerns the structure of the knowledge that accumulates for a concept. As we will see, the structure of these accumulations is extremely complicated, residing at many interacting levels. Before addressing this structure, however, it is necessary to address two preliminary issues.

Active Nature of Concepts. A concept is not a passive database about a type of thing. Instead, it plays a variety of active roles in guiding cognition and action. Most generally, a concept provides inferences that go beyond perceived entities. On perceiving a car, our brains do not passively store a recording of it, as do video and audio recorders. If all that our brains did was to passively make a copy, then all we would know about a perceived car is what we sensed about it. In contrast to recorders, our brains activate a concept of "car," which becomes integrated with the perceived car. Because our concept of car contains accumulated knowledge about previous cars, it provides a rich source of inference about the perceived entity. Although we may not see an engine, we infer that the car has one. Although we may not see the car move, we infer that it can be driven away. In this manner, concepts provide expertise about the world that goes considerably beyond what we sense. For all the different types of things for which concepts accumulate, we become able to anticipate their properties and behaviors. This basic inferential capacity enters into all cognitive processes, ranging across perception, memory, language, and thought.