BOOK REVIEWS

BOLTON, Neil: **Concept Formation**. Oxford: Pergamon Press 1977. 163 p. ISBN 0-08-021493 £ 2.95

In scientific contexts the word "concept" refers to a unit of knowledge, but understandably in other contexts the word is also used for different, though related, senses. In psychology the term, "concept formation" is used for a subject field concerned with the way thinking begins, and in this context a "concept" normally means an elementary unit of thought or, as Howard and Tracy Kendler put it, within the language system of concept formation, a "concept" becomes a common response to a set of dissimilar stimuli." ("Concept Formation," in *International Encyclopedia of the Social Sciences,* p. 207)

To illustrate, when a child learns to say "dog" while designating different dogs, a concept has been formed. Neil Bolton, in the book under review, adopts this position when he writes, "I shall argue that we must define what a concept is in the most general terms in order to account for the existence of various modes of thinking." However, he quickly adds that, "the aim of thinking is knowing" and "a thought or concept is something for which the question of truth arises." (p. 4) Accordingly, the explanation of concept formation must, in Bolton's view, involve "a wider and more profound study of knowledge and must account for the logical nature of concepts and their reference to reality."

Readers of *International Classification* are, of course, concerned with concepts in the context of "the organization of knowledge and data," as the journal's sub-title indicates. The psychology of "concept formation," therefore, is admittedly tangential to their concerns, nor can this reviewer evaluate the contribution of the book to psychology. Nevertheless, it is interesting and relevant in this journal to assess the book's discussion of "concepts" in the expectation that it may point to some findings, grounded in psychology, that could be of interest to those concerned with classification, terminology, and concepts as they relate to the organization of knowledge. Moreover, although psychologists study the formation of concepts by children, as units of thinking, they also, as scientists, have to use concepts, defined as units of knowledge.

For example, Bolton speaks of the "*conceptual* and phenomenological analysis of *conceptual* behavior . . ." (p. 146, ital. added) My guess is that in the first context, "conceptual" designates a unit of knowledge, but in the second, it refers to a unit of thinking. This is the difference between concepts used by psychologists and the concepts of the children they study. Although different stages of "preconceptual" development are discussed by Bolton, and he uses words like "percept" and "conception," we still lack an adequate and accepted conceptualization of the different stages or types of "concept" – the word, in short, remains polysemantic. Within psychology itself, indeed, the subject field of "concept formation" itself, according to the Kendler's, "has not achieved the methodological or conceptual unity characteristic of such other fields in psychology as sensation, perception, learning and motivation" (p. 207). According to the Kendler's, the field originated in the introspective work of Wilhelm Wundt and the Würzburg school. Subsequently, in America, important contributions were made using experimental methods, following the lead of Watson's behavioralism. Clark Hull studied the capacity of students to learn the pronunciation of Chinese characters in which, by noting phonetic elements, characters representing homophones could be identified and clustered.

Behaviorism was much influenced by Pavlov's experiments, which proved that a dog could be trained to discriminate between white and gray circles – it was assumed that children could similarly learn concepts, e.g. to separate red from orange. Bruner, Goodnow & Austin (*A Study of Thinking,* 1956) asked their subjects to identify concepts based on various combinations of shapes, colors, and borders, as displayed on flash cards. This technique permitted the identification and evaluation of different learning strategies, relevant for educational psychology.

Quite a different tradition of research on "concept formation" comes from the studies of childhood development by Jean Piaget and his followers. Piaget discovered a natural learning sequence in small children, from their early perception that objects persist, to notions of conservation, followed by the capacity to class and interrelate objects, and eventually reasoning skills. Bolton's book builds on and criticizes this work, and also adds a complementary dimension drawn from phenomenology, especially the work of Husserl and Merleau-Ponty.

The central issue posed by Bolton is a dialectic between the "traditional" assumption that concepts are formed inductively, i.e. through observation of environmental regularities, and the phenomenological premise that they are "formed deductively, through the application of already-formed cognitive-structures to events and objects" (p. 5). Instead, Bolton argues, cognitive structures and environmental events reciprocally interact, permitting the learner to form concepts and test them against reality. (The influence of language as a third interactive dimension seems to be neglected by psychology – or at least by Bolton).

Bruner et al, according to Bolton, proposed a parallel distinction between concept "formation" and "attainment," the former referring to "the process of establishing a new category," and the latter to that "of discovering which elements belong to the category and which do not" (p. 99). A parallel distinction, familiar to classification researchers, separates "classifying" from "classing": defining a new class is different from identifying objects that belong to it. Nevertheless, Bolton questions the "psychological reality" of this distinction because, he says, in both processes "the subject's task is to determine the attributes that serve to identify stimuli as instances of a type." This opinion becomes intelligible when we distinguish between the psychological processes of learning, and the skills that can be learned.

To illustrate this point, let us suppose that *to classify* is, in Bruner's language, to "form" (or create) a concept, and *to class* is to "attain" (or apply) a concept. Let us then imagine the viewpoint of a library user rather than

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that of a librarian. A user enters the stacks and sees there many books shelved by class numbers. Without benefit of a classification schedule he wonders what a class number, e.g. "473", could mean. After looking at some of the books bearing this number, he gains an imperfect understanding of the concept signified by "473." Alternatively, starting with several references found by looking up a subject heading in the card catalog, our user discovers that most of the books bear the class number, "473." From this experience he deduces or induces the signification of this concept.

Note that in this illustration, our user has neither *created* nor *applied* a concept – he has neither classified nor classed – but he has *learned* (or "formed") one. If we think of the notation system used in classification as a "code," then the process of classifying is a type of "coding," and the process of classing is "encoding." The user-learner, then, is "decoding." But decoding can occur by complementary methods: working from the sign to examples, or from examples to the sign, i.e. deductively or inductively. This is the distinction whose importance Bolton questions, since decoding can be accomplished by either approach, or by both, interactively.

In his concluding chapter Bolton explicity rejects the supposed opposition between inductive and deductive modes of concept formation, and argues that they are complementary, as examined by Husserl in his notions of 'intention" and "attention" (see below) and between "physical" and "logico-mathematical" experience (again, below) (Bolton, 145). The issues of coding (creating, classifying) and of encoding (applying, classing) simply lie outside the interest of Bolton – and of psychology. Reciprocally, of course, classification science has no real interest in the learning processes experienced by library users – perhaps they should! – but for this reason the language system of psychology seems strangely obscure to those who are primarily concerned with classification, i.e. with concepts as units of knowledge.

Nevertheless, readers may find some interest in Bolton's definitions of "concept" and his typology of concepts. "A concept may be defined," Bolton says, "as a stable organization in the experience of reality which is achieved through the utilization of rules of relation and to which can be given a name" (p. 23). His definition, clearly, moves significantly from the simpler learning theory notion of the Kendler's quoted above, but it still anchors the notion to a subjective "experience," even though it is "reality" that is experienced. The definition is interesting in another respect also, for it implies three essential elements of a concept as identified in concept theory: first, there is an extension or referent, i.e. the "reality" experienced; second there is the intension or sense, given by the "rules of relation," and third, there is the term, or "name." To this extent, although in different language, concept theory and psychology appear to converge.

Bolton's classification of concepts is also interesting. His first division is between concepts that can be "classified" into mutually exclusive categories and those that cannot. In the latter class are "philosophical" concepts, such as personal qualities or values, like "pleasant," "expedient," and "right." Such concepts, according to Bolton, can be compared by means of a "scale of forms," but they overlap each other and therefore cannot be classed into mutually exclusive categories.

Classifiable concepts start with a basic division between "physical" and "logico-mathematical" concepts. Bolton argues that the distinction has an analytic value, but in practice the two types always combine, the former designating empirical facts or realities, the latter subjective modes of relating to them, e.g. by comparing, counting, and operating. Bruner et al distinguish between different ways of combining physical and logico-mathematical concepts, thereby forming "conjunctive," "disjunctive," and "relational" concepts. In each, a concept is formed by combinations, e.g. a red circle, red or green, and fewer circles than squares. This typology, originating in an experimental context, may also have broader implications.

Another typology formulated by Bruner and his associates grew out of the way children of different ages sort objects. A "perceptible" mode is based on immediate perceptions, as of color or size; a "functional" mode on the uses made of objects; and a "nominal" mode, when the objects share a common name, e.g. all "fruits" or "toys." A similar categorization made by Kagan led to identification of "analytic concepts," (like Bruner's "perceptible"); "relational concepts" (like Bruner's "functional"); and "inferential concepts" (like Bruner's "nominal").

My guess is that these terms apply not so much to types of concepts, as to "classes," which is to say they suggest different ways of classing sets of concepts. The perceptible (analytic) mode involves classing by shared properties of designated objects, the functional (relational) mode suggests part/whole relationships, and the relational (nominal) mode points to a genus/species relation. Obviously the typology is incomplete, but it is interesting to see the parallel between a scheme based on the psychology of childhood learning and the more sophisticated models formulated in classification theory.

A point that Bolton mentions but never develops is the influence of language, which clearly underlies Bruner's "nominal" classification. When discussing the formation of logico-mathematical concepts. Bolton points to a distinction between "primary" and "secondary" experience, the latter being based on a knowledge of the former, and coming at a later stage. To illustrate, Bolton says the concept of "dog" is primary, but "animal" is secondary, since the child can form the latter only after learning to identify dogs, cats, horses, etc. However, if one supposes that a child had only seen spaniels and poodles, his "primary" experience would have been of two different kinds of dog, and the concept of "dog" would be a secondary construct. What makes the concept of "dog" primary may not be so much induction from the observation of physical objects as a reflection of the formative influence of established language usages. As another illustration, suppose that our hypothetical library user had asked a librarian to explain the meaning of class number "473." he could have found a short-cut to learning, i.e. by "definition," rather than by induction or deduction. I would be surprised if children made complicated inferences to establish concepts all by themselves. Are they not also powerfully assisted by language which channels their concept learning (decoding) processes by frequent definitions.

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In this connection it is surprising that Bolton does not mention the Pavlovian concept of a "second signaling system," based on words, which builds on the "first signaling system," namely that of direct observation in the physical world. The Russian psychologist, A. A. Lublianskaya, in this tradition, notes that "a word becomes a signal of the second signaling system only when it becomes a concept." (Kendler) But surely also a subject learns a concept by becoming acquainted with a word.

Here we confront the problem of synonymy, since different words are used for similar if not identical concepts, as noted above with respect to the different modes of classing concepts. The convergence of different methodologies and paradigms in the psychology of "concept formation" provides instructive examples, for the distinction between "classing" and "classifying" has a number of analogues. Piaget, for example, distinguishes between "assimilation" and "accomodation." According to Bolton, "assimilation" (classing) occurs when the child relates "an object or event to an existing cognitive structure or *scheme*," and, by contrast, "accomodation" (classifying) involves "the adjustment of schemes to the demands of objects and events." This distinction also appears to match the division made by the experimentalist, Bruner, between concept "formation" (classifying) and "attainment" (classing).

Comparable distinctions also arose among the phenomenologists, according to Bolton, running from William James and G. F. Stout to Husserl and Merleau-Ponty. Although their focus is on modes of perception, we find a kind of parallel between Stout's "awareness/apprehension" and Husserl's "intention/attention." Cognitive structures, resting on intention (or awareness) provide a conceptual framework, as when classing, for the superficial handling of events and objects. By contrast attention (or apprehension) directed to objects and their "fringes" or relations or implications may lead to the creation (classifying) of new concepts.

When the term, "concept formation" is used in the philosophy of science, it means a self-conscious activity designed to provide useful elements of knowledge, i.e. *new* concepts. The criteria emphasized in this literature typically concern problems of operationalization and theoretical relevance. Similar problems arise in classification theory. The psychological approach to "concept formation," by contrast, is concerned with the way *established* concepts are learned. The extent of overlap between the two fields, and the two senses of "concept," is perhaps not great, but there is indeed some overlap and Bolton's monograph, with a good bibliography of the field and a balanced effort to synthesize diverse approaches and methods, provides a good introduction for anyone interested.

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STEINHAUSEN, D., LANGER, K.: **Clusteranalyse.** Einführung in Methoden und Verfahren der automatischen Klassifikation. (Introduction into methods and procedures of numerical classification). Berlin–New York: W. de Gruyter 1977. 206 p., ISBN 3-11-007054-5

In applied sciences and in empirical studies it is common usage to investigate a great number of objects (like persons, documents) and to measure, for each object, a series of interesting variables (e.g. psychological, sociological or medical data or bibliographic descriptors). This data collection has to be searched for hidden structures and relations. One way to do this task proceeds by classification: The (great) set of objects is partitioned into a (small) number of classes ('types', 'clusters') such that members of each class are as similar as possible (homogeneity of classes) and that members of different classes are very dissimilar (separation of classes); thereby 'similarity' and 'dissimilarity' are measured by the given values of the variables. It is evident that the composition of the classes and their representatives may give insight into the structure of the data set and that the classes may serve as a basis for the solution of organisational problems.

There exist many mathematical or statistical methods for formulating and solving the problem of constructing a 'good' or 'best' system of classes (= classification) on the basis of the given data set. These methods are known under the name 'cluster analysis' (or 'numerical' or 'automatic' classification). The book of D. Steinhausen and K. Langer gives an introduction into this subject and intends to fill a gap between theoretical and applied work on cluster analysis. It contains some twenty FORTRAN programs with corresponding numerical examples with real data and is written for students from applied fields which have some knowledge of statistics and algebra. Its contents may be summarized as follows:

1. Introduction (General problem, overview, examples, the steps of a cluster analysis procedure; 7 p.). *2. Principles of multivariate procedures* (Regression, variance and covariance analysis, canonical analysis, discrimination, factor and principal component analysis, multidimensional scaling; 25 p.). *3. Similarity and distance functions* (Formal properties; nominal and ordinal variables; Euclidean, MAHALANOBIS- and L_r-distances, correlation; distance of clusters; 16 p.). *4. Cluster analysis algorithms* (Hierarchical methods; clustering criteria, amelioration of an initial partition, sift-and-shift procedures, other procedures, 81 p.). *5. Special problems* (Analysis of variables, validation and comparison of clusterings, practical problems; 15 p.). *6. Summarizing overview* (6 p.). *7. Appendix* (Set theory and algebra; 12 p.). Bibliography.

The book describes only some most usual and standard methods and gives no information about more recent work on the field (only 11 of 74 bibliographic data concern papers on cluster analysis after 1971). Partially it relies heavily on existing books on cluster analysis. At first sight the text seems to be well written and illustrative; the applied scientist will be pleased by practical guidelines, numerical examples and evaluation criteria. A second look, however, reveals a lot of fuzzy statements, inconsistencies and mathematical errors from which I cite the following examples:

'Groups' (generally overlapping, see p. 12) define a 'grouping' with *disjoint* classes (p. 16); this is usually named a 'partition' in mathematics; here a partition may embrace overlapping classes (see p. 186). – *Each* object set is called a 'cluster' (p. 186). – No statistical model is introduced; nevertheless terms like 'independent components' (p. 32, 34), uncorrelated variables (p. 58) are used. – Metric similarities are defined (p. 51), but not motivated; the corresponding exercise 10 (p. 67) is false. – The formulation with 'cosinus theorem' (p. 63) cannot

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