Category-Based Similarity

Kenneth J. Kurtz
Department of Psychology
Jordan Hall, Bldg 420
Stanford University
Stanford, CA 94305-2130
kurtz@psych.stanford.edu

A basic component of human cognition is the ability to comprehend perceived stimuli in terms of stored knowledge. Recent proposals about categorization (eg. Murphy & Medin, 1985) have emphasized the role of theory–like knowledge while questioning the usefulness of similarity as an explanatory construct. It has been suggested that similarity may depend upon rather than determine conceptual structure.

The problem of *respects* for similarity (Medin, Gentner & Goldstone, 1993) is that the similarity of two items is not meaningful without specifying the nature of the comparison. One approach to this problem is to interpret the role of theories in categorization as providing constraints on similarity-based comparison (Medin, 1989). A principled mechanism (ie. a theory) might answer the question: if a concept representation is feature-based, then what features should be used and in what manner?

In order to keep similarity grounded, it is often computed over a feature space of object properties based only on surface perceptual appearance. But in order to account for the range of categorization ability, this notion of similarity must be expanded to include conceptual commonalities (see Goldstone, 1994). The extent to which any two stimuli are alike has a concrete component which is inherent in the perceived structure of the environment *and* an abstract component which is established according to the interaction between people and their environment.

By learning to categorize stimuli in terms of useful abstractions and consequences (such as labels or functions), concept representations develop which capture statistical regularities and which also reflect imposed or category-based similarities that arise from the roles objects take on for the learner in natural experience. Such representations serve as raw material for the appropriate generalization of prior knowledge to novel cases according to a sophisticated, yet constrained similarity mechanism.

Methods

The present research goal is twofold: 1) to assert claims about the flexibility and dependence of similarity, but 2) to explore through behavioral and computational approaches a mechanism of concept formation which produces rich representations and much-needed respects.

This study examines the hypothesis that concept representations are constructed as an integration of perceived structure and learned category-level information. It is predicted that similarity ratings collected from Ss who learn a categorization will systematically diverge from controls. Stimuli from the same learned class should be rated as more similar by those Ss with category knowledge since their learned representations grow closer to reflect the commonality.

Subjects were told they would learn about a set of microorganisms (realistic line drawings) and then apply their knowledge. In the control condition, the study phase consisted of viewing the stimuli and judging relatedness to the prior stimulus. In the categorization (Cat) condition, Ss also saw three labels and were asked to make a classification judgement. Ss learned with feedback until they could correctly classify the set. After the study phase, Ss in both conditions were shown all pairs and asked to rate similarity.

Results and Discussion

As predicted, Cat Ss rated pairs drawn from the same class as more similar than did the naive Ss. However, there was no evidence of lower similarity ratings by Cat Ss for pairs drawn from different classes. Additional analyses showed that the amount of between group difference was greater when the coherence of the class from which same-category pairs were drawn was lower. The evidence is suggestive of a shift in underlying representation as a function of category learning.

Such a mechanism is naturally instantiated in terms of connectionist models which form internal representations while learning complex input-target mappings. Such simulations were carried out and results suggest that a brain-style mechanism can account for the behavioral findings of category-based similarity.

References

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

Medin, D.L. (1989). Concepts and conceptual strcture. *American Psychologist*, 44, 1469–1481.

Medin, D.L., Goldstone, R.L. & Gentner, D. (1993). Respects for similarity. *Psychological Review*, 100, 254–278.

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