Beyond common features: The role of roles in determining similarity

Matt Jones (mattj@psy.utexas.edu) and Bradley C. Love (love@psy.utexas.edu)
Department of Psychology, The University of Texas at Austin. 1 University Station A8000; Austin, TX 78712 USA

A common assumption underlying most category learning research has been that category information is represented in terms of intrinsic properties or features (cf., Nosofsky, 1986; Shepard, Hovland, & Jenkins, 1961). However, recently there has been a growing awareness that many concepts are determined not by features but by the relationships between category members and members of other categories (Gentner & Kurtz, in press; Markman & Stilwell, 2001). For example, while a *game* cannot be defined in terms of features (Wittgenstein, 1968), it has a simple definition as something that can be *played* (Markman & Stilwell, 2001).

One intriguing implication of this idea is that relational information may be a central component of object representations (in addition to feature information), with objects playing the same roles in predicates or events being perceived as similar. For example, the concepts *hammer* and *baseball bat* might be similar because they both regularly hit other objects. A further question is whether similarity is affected by roles per se, or whether involvement in the same relationship is all that matters. For example, are hammers and baseballs similar because they both participate in the relation *hit*(*x*, *y*)? This is the prediction made by models of word learning such as LSA (Landauer & Dumais, 1997) that derive meaning from co-occurrence statistics. Because these corpus approaches are insensitive to the role an object plays in an utterance, they predict that similarity will be thematically determined, in that objects that participate in common relations will be similar regardless of the correspondence between their roles.

Method

The present experiment tests the potential contributions to similarity of roles and relations independently. In the first phase of the experiment, each subject read 16 atomic sentences and rated them according to how realistic and interesting they were. Certain nouns varied between subjects in the relations they participated in and the roles they played within their relations. The second phase consisted of a series of forced-choice similarity comparisons among these nouns, in which subjects selected which of two base words was most similar to a target word.

Results

The effect of common role was assessed using similarity comparisons in which one base word played the same role as the target and the other base played the opposite role in the same relation. For example, among subjects who read “The polar bear chases the seal” and “The collie chases the cat,” 65% later selected *cat* over *collie* when asked which was more similar to *seal*. Among subjects who instead read “The seal chases the fish,” only 29% chose *cat*. An analysis combining eight contrasts of this type showed a significant effect of common role ($\chi^2[1] = 64.8$, $p < 10^{-15}$) with 73% of subjects choosing the base that matched the target’s role.

Tests for the effect of common relation involved comparisons in which one base word matched the target in relation but not in role, and the other base was involved in a different relation. The analysis showed a significant effect of common relation ($\chi^2[1] = 7.43$, $p < .01$) with 61% of subjects selecting the base that had appeared in the same relation as the target.

Discussion

The present results demonstrate that similarity is affected by relational information in at least two ways. First, participation in the same relation increases the similarity between objects, even if they play different (or opposite) roles. Second, people are sensitive to structure within relations, such that playing the same role further increases similarity. This structure-sensitivity implies that word learning models like LSA need to be modified to discriminate among sentential contexts, according to the role (e.g., agent vs. patient) played by the word in question.

These results also support the claim that the processes by which humans learn similarity and categories extend beyond the purely feature-based approaches currently assumed. Incorporating relational information into experiments and models will lead to a more encompassing theory that may shed light on many current unsolved problems.

References

Gentner, D. & Kurtz, K. J. (in press). Learning and Using Relational Categories. In W. Ahn, R. L. Goldstone, B. C. Love, A. B. Markman, & P. Wolff (Eds.), *Categorization inside and outside of the lab: Festschrift in Honor of Douglas L. Medin*. Washington, DC: American Psychological Association.

Landauer, T. K. & Dumais, S. T. (1997). A solution to Plato's problem: The latent semantic analysis theory of acquisition, induction, and representation of knowledge. *Psychological Review, 104*(2), 211-240.

Markman, A. B., & Stilwell, C. H. (2001). Role-governed categories. *Journal of Experimental and Theoretical Artificial Intelligence, 13*(4), 329-358.

Nosofsky, R. M. (1986). Attention, similarity and the identification-categorization relationship. *Journal of Experimental Psychology: General, 115*(1), 39-57.

Shepard, R. N., Hovland, C. L., & Jenkins, H. M. (1961). Learning and memorization of classifications. *Psychological Monographs, 75*.

Wittgenstein, L., (1968). *Philosophical investigations*, trans. G.E.M. Anscombe. New York: MacMillan.