Hierarchical Categorization and the Effects of Contrast Inconsistency in an Unsupervised Learning Task

Jim Davies and **Dorrit Billman**
School of Psychology, Georgia Institute of Technology
Atlanta, GA
psg95jd@prism.gatech.edu and dorrit.billman@cc.gatech.edu

Introduction

Two factors may guide concept learning: catpuring predictive structure in input, and forming groupings which can be categorized by a simple criteria. Experiments from unsupervised learning suggest that there is a strong bias to sort things based on their similarity, similarity being property covariation. These sorts provide maximum predictive utility (Billman & Knutson, 1996; Anderson, 1991). Work on free sorting of examples has found that people frequently sort based on the values of a single dimension (Ahn & Medin, 1992). We find evidence that people will use both biases under different conditions.

Method

The stimuli consisted of drawings of creatures laser printed on cards. There were nine attributes or dimensions (bodyshape, mouth, tail, etc.), each of which had six possible values (long, lion-like, snake-like, etc.). Each participant viewed 18 cards. Each deck had two strongly marked *superordinate* categories based on covariation of attributes A, B, and C (since there are only two supers, there were only two values for these attributes). Each of the supers had three *subordinate* categories with three instances each. Subordinate structure was marked by covariation of the values of the remaining six attributes.

Table 1. Stimulus design (Columns are attributes, numbers specify a particular value, x's represent randomly assigned values)

Consistent Condition	**Inconsistent Condition**
ABC DE FG HI	ABC DE FG HI
111 11 xx xx	111 11 xx xx
111 22 xx xx	111 xx 11 xx
111 33 xx xx	111 xx xx 11
222 xx 11 xx	222 22 xx xx
222 xx 22 xx	222 xx 22 xx
222 xx 33 xx	222 xx xx 22

Each row in each condition represents a category with three members. There were two conditions (each with 12 participants): Consistent and inconsistent contrast. Consistent contrast means that within a given superordinate category, the same attributes are predictive of subordinate category membership. If people sort based on predictive utility alone, then there should be no difference in the ability of the two groups to retrieve the intended sort. However, if people sort based on the values of a single dimension, then they will not be able to retreive the intended sort, as there is no global consistency (consistency *across* supers) in either condition. Participants viewed all the cards and then sorted them freely into groups.

Results

Sixty-six percent of participants sorted hierarchically, which is, in general, not predicted by categorization models. In the consistent condition, Forty-one percent of participants in the consistent condition produced the correct (correlation-based) sort, but no one in the inconsistent condition did. Thus people are sensitive to predictive structure when it is organized consistently. The inconsistent condition was very difficult; many pilot participants could not reproduce the correct sort even after seeing it and trying again. Sixty-six percent in the inconsistent condition sorted by a single attribute, compared to the consistent condition, in which only 25% did.

Conclusion

We conclude that participants will sort by correlational structure if it is easy to notice. If stimulus structure or task make it difficult to learn about the structure, subjects will choose the very simple strategy of sorting by a single dimension.. Models which are sensitive to pressures for coherent, compact descriptions and for informative groupings are needed to account for these data.

References

Ahn, W. & Medin, D. L. (1992). A two stage model of category construction. *Cognitive Science*. 16, 81-121.

Anderson, J. R. (1991). The adaptive nature of human categorization. *Psychological Review*, 98, 409-429.

Billman, D. & Knutson, J. (1996). Unsupervised concept learning and value systematicity: a complex whole aids learning the parts. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 22(2), 458-475.