Does Between-Category Similarity Influence Categorization?

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Abstract

Humans can categorize objects at different levels of abstraction: basic (for example, cars and chairs) and superordinate (for example, vehicles and furniture). Usually, basic-level categorization is acquired faster than superordinate-level categorization, but the opposite results have been reported as well. One possible reason is that similarity between different basic-level categories influences speed of learning of these categories.

We investigated how between-category similarity affects speed of learning of basic-level discrimination and superordinate-level discrimination. In Experiment 1, we used four families of abstract shapes called Attneave's shapes to create four basic-level categories, each containing 8 exemplars of shapes. Participants were asked to rate similarities between the shape families shown on a computer monitor. We then analyzed the ratings using multidimensional scaling to evaluate similarities between four categories.

For Experiment 2, we combined two similar basic-level categories in one superordinate-level category. Two dissimilar basic-level categories formed the second superordinate-level category. Participants then had to learn to make a correct response to a member of each category shown on computer monitor. We expected participants to learn basic-level discrimination faster when two categories are similar. When two categories are dissimilar, we expected them to learn superordinate-level discrimination faster.

Experiment 1: Method

- Created 4 categories of abstract Attneave shapes
  - 4 basic-level categories, 8 exemplars each
- 13 participants rated similarities across the categories from 1 (least similar) to 5 (most similar)
- Analyzed similarity ratings using multidimensional scaling analysis
  - Derived two-dimensional similarity maps using Euclidean distance and Sstress badness function

Figure 1. Example of 8 category members and prototype. Participants were never shown the prototype.

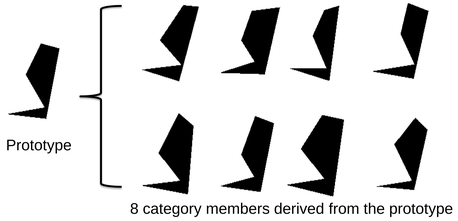
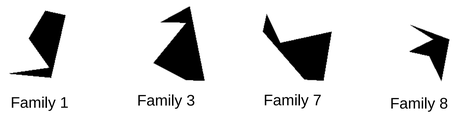


Figure 2. Prototypes for 4 basic-level categories used in Experiments 1 and 2.



Experiment 1: Results

- Participants rated categories 1 and 3 as being similar to each other, and categories 7 and 8 as being dissimilar from each other
- Muldimensional scaling showed that category 1 and 3 were significantly closer to each other than category 7 and 8
  - Paired t-test, $t\,(12) = 4.62$, $p = 0.0006$

Figure 3. Two-dimensional map of similarity space obtained from 13 participants.

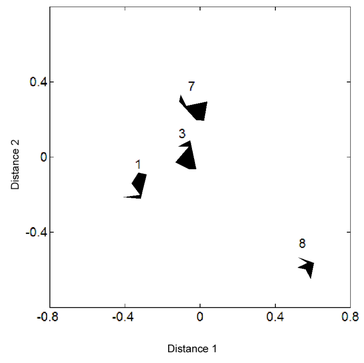
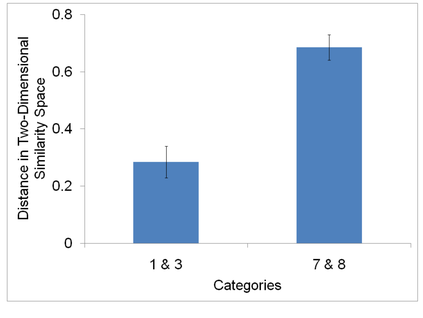


Figure 4. Mean distance between categories 1 and 3, plus 7 and 8 in two-dimensional similarity space. The distances were obtained using individual two-dimensional maps.



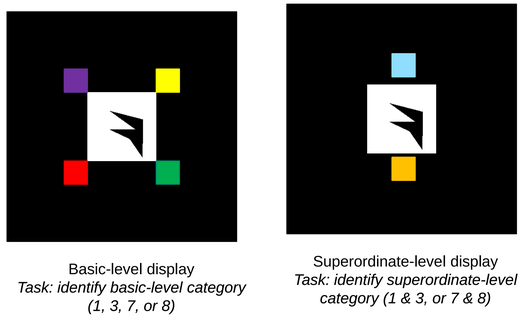
Experiment 1: Conclusions

- Category 7 and category 8 are highly dissimilar
  - We expect them to be difficult to group at superordinate level, but easy to discriminate at basic level
- Category 1 and category 3 are more similar
  - We expect them to be easy to group at superordinate level, but difficult to discriminate at basic level

Experiment 2: Method

- Created 2 superordinate categories
  - Similar basic-level categories: 1 & 3
  - Dissimilar basic-level categories: 7 & 8
- Trained 25 participants to perform concurrent basic-level and superordinate-level discrimination
  - 4 participants did not learn the task, and were excluded from the study
- Training lasted for 320 trials (5 blocks of 64 trials)
  - Written feedback (correct/incorrect)
  - Correction trials
  - No time limit
  - Choice keys counterbalanced across participants
- Conducted *d'* transformation to correct for different level of chance performance across 2 tasks
  - Chance level in percent correct: basic-level – 25%, superordinate-level – 50%
  - Chance level in *d'*: 0.0 for both tasks

Figure 5. Example of basic-level trial and superordinate-level trial.



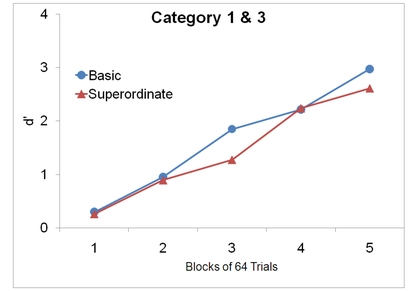
Basic-level display
Task: identify basic-level category (1, 3, 7, or 8)

Superordinate-level display
Task: identify superordinate-level category (1 & 3, or 7 & 8)

Experiment 2: Results

- For both categories, basic-level task was learned faster than superordinate-level task, but the difference was more pronounced for category 7 & 8
- Across 320 trials, category 7 & 8 was significantly more accurate than category 1 & 3 at both basic and superordinate levels
  - Main effect of category, $F\,(1, 20) = 13.67$, $p = 0.0001$
- On average, basic-level discrimination for category 7 & 8 was significantly more accurate than superordinate-level discrimination
  - Planned least square contrast, F (1, 20) = 5.05, p = 0.04
- For category 1 & 3, there was no significant difference between basic-level discrimination and superordinate-level discrimination

Figure 6. Acquisition of basic-level and superordinate-level discrimination.



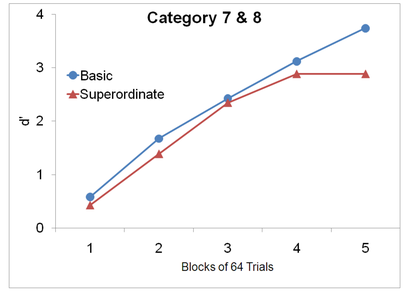
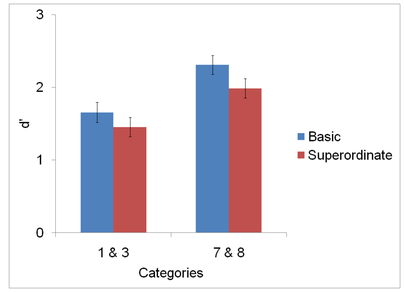


Figure 7. Average accuracy in basic-level and superordinate-level tasks across 320 trials.



Experiment 2: Conclusions

- Two most dissimilar categories (7 & 8) produced the expected pattern of responses
  - Higher accuracy in basic-level task than in superordinate-level task
- Two similar categories (1 & 3) did not produce the opposite pattern
  - Accuracy in basic-level task did not differ significantly from superordinate-level task
- Perhaps, if the categories were even more similar to each other, then we would observe the opposite pattern
  - Higher accuracy in superordinate-level task than in basic-level task
- Future research will explore this possibility