Unsupervised Category Learning with Integral-Dimension Stimuli

SE367 : Cognitive Science

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What !

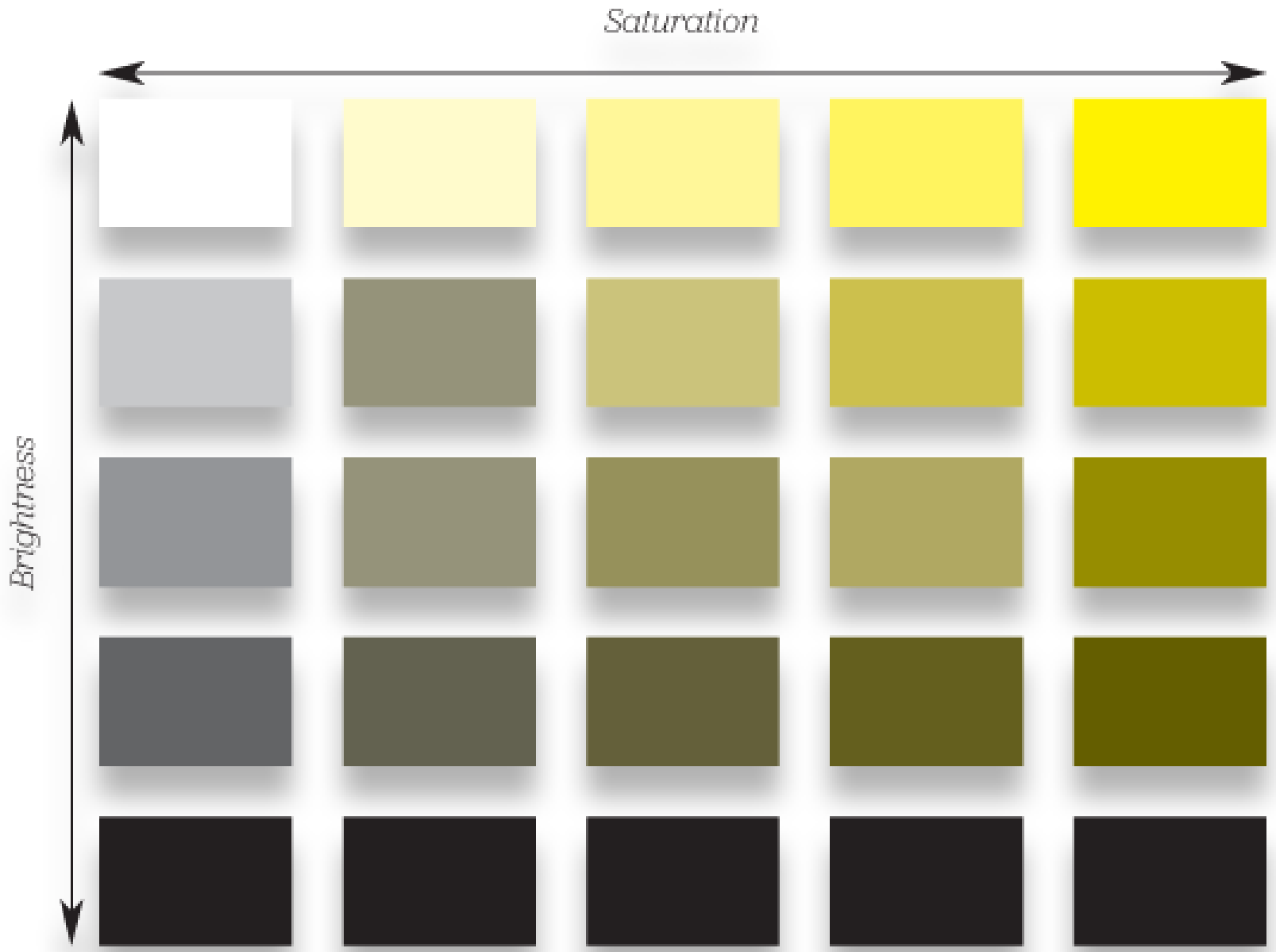
- Category Learning
- Unsupervised
  - absence of feedback
- Constrained Tasks
  - underlying optimal categorisation of stimuli
  - focus on the decision strategy of the person
  - IF the person is capable of learning the optimal structure

Integral Dimensions

- Two dimensions are said to be integral if it is impossible to attend to one and ignore irrelevant variations in the other *(Garner & Felfoldy, 1970)*

- Extracting a dimensional structure is a more derived and secondary cognitive process *(Garner 1974)*

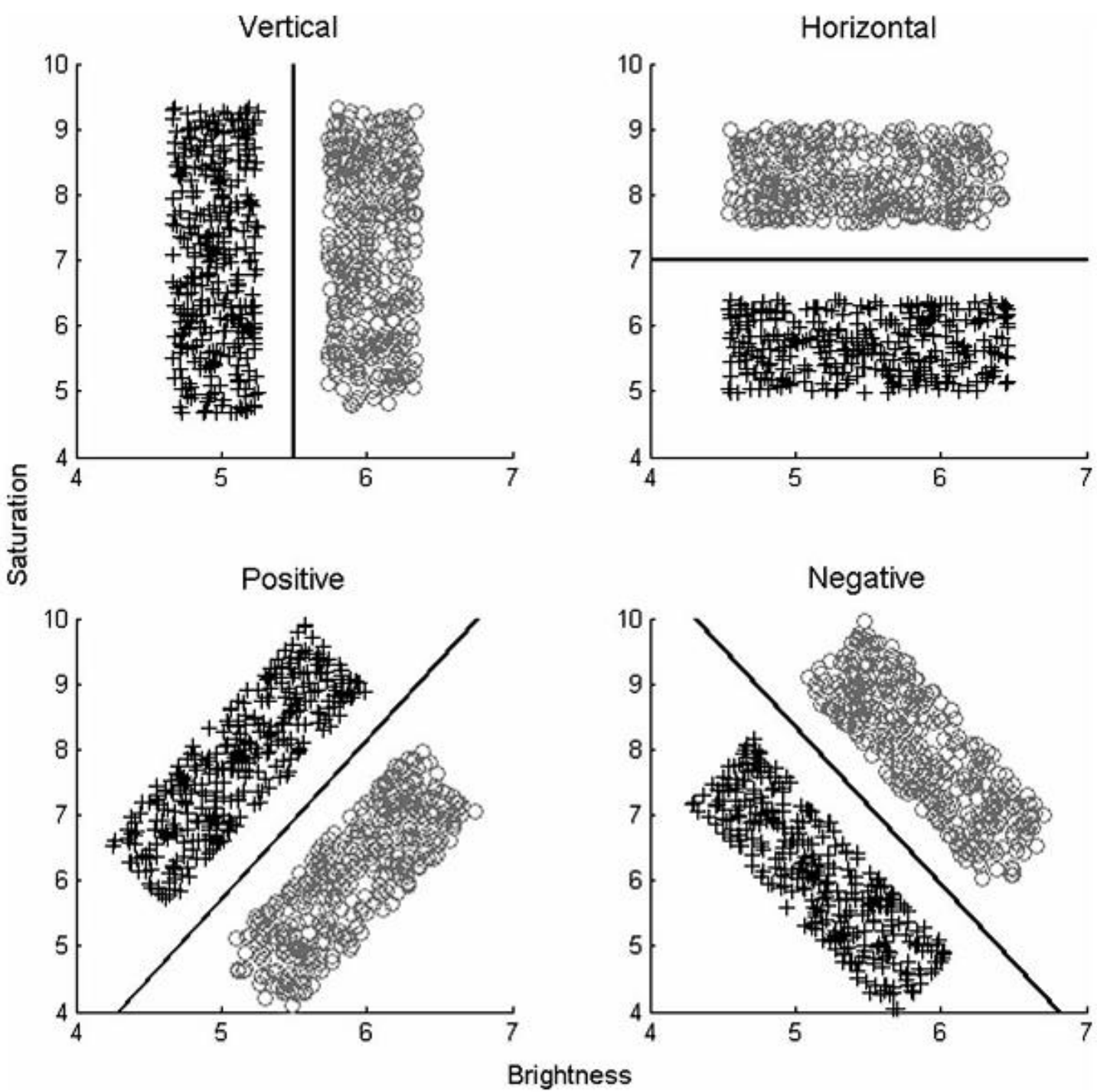
  - Brightness and Saturation
  - Pitch and Loudness


Saturation
Brightness

Experiment

- Stimuli
  - constructed from the integral dimensions of brightness and saturation defined in the Munsell colour system *(Munsell, 1915)*

- Four conditions


Vertical
Horizontal
Positive
Negative
Saturation
Brightness
10
9
8
7
6
5
4
4
5
6
7

Experiment

- Participants were told that rectangular colour patches varying in brightness and saturation would be presented one at a time on a monitor, and their task was to learn to categorize the stimuli into two categories.

- Five response blocks alternated with four observation-only blocks

Results

- Accuracy improved across the two days of training only in the vertical and positive conditions, and accuracy was highest in the VERTICAL condition.

- Individual participant data suggest that while it was certainly more difficult for participants to improve with training in the horizontal, positive, and negative conditions in general, it was not altogether impossible.

Model-based analysis

- Unidimensional Classifiers
  - Attention to selectively one dimension
- Conjunctive Classifier
  - Independent decisions about the stimulus on both dimensions
- Linear Classifier
  - integrate the stimulus information from both dimensions

Model Fitting

- Vertical condition
  - 73% were using decision strategies consistent with selective attention to brightness.

- Horizontal condition
  - Only 8% were using decision strategies consistent with selective attention to saturation.
  - Instead, participants were either attending selectively to brightness or integrating brightness and saturation information to some extent.
  - However, even linear classifier was not much better

Model Fitting

- Diagonal Conditions
  - relatively small percentage of data sets accounted for by uni-dimensional models (34% and 22% of the data in the positive and negative conditions)
  - participants were integrating brightness and saturation information, albeit not optimally

Experiment -2

- Supervised Conditions
- The percentage of blocks in which the optimal classifier was the best fitting model greatly increased in all conditions with the addition of feedback.
- One-d class 91% (vertical) and 69% (horizontal)
- Diagonal - the use of one-dimensional decision strategies was far less frequent

Experiment -3

- Unsupervised version of the horizontal condition with increased inter-category distance

- Although participants were more accurate, the increased accuracy was not driven by an increased ability to attend selectively to saturation. Instead, consistent with Experiment 1, participants tended to integrate brightness and saturation in a manner that suggested greater weighting of brightness.

Conclusions

- Individuals are capable of learning categories constructed from the integral dimensions of brightness and saturation in the absence of feed-back.

- Consistent with the claim that integral dimensions are initially processed holistically *(Kemler Nelson, 1993)*, participants had some success in conditions that required the integration of brightness and saturation.

Conclusions

- Consistent with the claim that integral dimensions can subsequently be processed in terms of the individual dimensions given the appropriate task demands *(Garner, 1974)*, participants were able to learn when a one-dimensional strategy on brightness was highly accurate.
- Participants demonstrated a general tendency to weight brightness more heavily than saturation across all three experiments, suggesting that brightness may have privileged status relative to saturation

Thank You