Supplemental Material

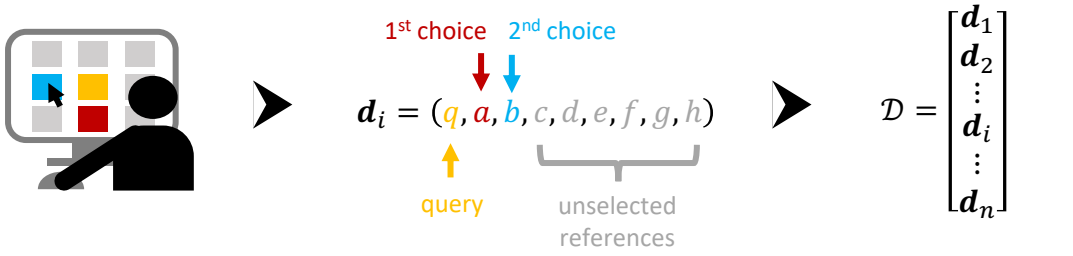
Interleaved Training Improves Category Learning by Increasing Perceptual Similarity of Within-Category Exemplars

Sharon M. Noh[1*], Brett D. Roads[2*], Bradley C. Love[2], & Alison R. Preston[1]
[1]The University of Texas at Austin, [2]University College London

Psychological Embedding Procedure

Data Collection

Trial Behavior → Observation Format → All Observations



Cognitive Model

The model's free parameters can be divided into two groups for conceptual clarity.

$\boldsymbol{Z} \in \mathbb{R}^{m \times d}$ — Free parameters that specify the coordinates of the m stimuli in the d-dimensional embedding space.

$\boldsymbol{\theta} = (\rho, \tau, \beta, \gamma, \boldsymbol{w})$ — Free parameters that govern the computation of distance and similarity.

Probability of 1st choice / Probability of 2nd choice

Probability of One Observation:
$$p(\boldsymbol{d}_i|\boldsymbol{Z}, \boldsymbol{\theta}) = P(a|\boldsymbol{Z}, \boldsymbol{\theta})P(b|a, \boldsymbol{Z}, \boldsymbol{\theta}) = \frac{s(\boldsymbol{z}_q, \boldsymbol{z}_a)}{\sum_r s(\boldsymbol{z}_q, \boldsymbol{z}_r)} \frac{s(\boldsymbol{z}_q, \boldsymbol{z}_b)}{\sum_{r \neg a} s(\boldsymbol{z}_q, \boldsymbol{z}_r)}$$

Probability of All Observations:
$$p(\mathcal{D}|\boldsymbol{Z}, \boldsymbol{\theta}) = \prod_{\boldsymbol{i}} p(\boldsymbol{d}_i|\boldsymbol{Z}, \boldsymbol{\theta})$$

Similarity Kernel:
$$s(\boldsymbol{x}, \boldsymbol{y}) = \exp\left(-\beta \|\boldsymbol{x} - \boldsymbol{y}\|_{\rho, \boldsymbol{w}}^{\tau}\right) + \gamma$$

Inference Objective:
$$\max_{\boldsymbol{Z}, \boldsymbol{\theta}} \sum_i k_i \log p(\boldsymbol{d}_i|\boldsymbol{Z}, \boldsymbol{\theta})$$

Where k_i denotes the importance of the observation.

Predicted Ease

The psychological embedding can be used to predict the difficulty of each item.

(z_i, y_i) — Tuple representing the embedding point and corresponding class label of the ith stimulus.

$\mathcal{I}$ — The set of indices representing all the stimuli in the domain of interest.

$\mathcal{S}_i = \{j \in \mathcal{I} | y_j = y_i \wedge j \neq i\}$ — The set of indices that have the same class as the ith stimulus.

$$ease_i = \frac{\sum_{j \in \mathcal{S}_i} s(\boldsymbol{z}_i, \boldsymbol{z}_j)}{\sum_{k \in \mathcal{I}_{\neg i}} s(\boldsymbol{z}_i, \boldsymbol{z}_k)}$$

The probability that the ith item will be categorized correctly assuming an agent has knowledge of all stimuli except the ith stimulus.