Semantic and visual similarity guide visual search for words and numbers

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- **DOES SEMANTIC-RELATEDNESS IMPACT VISUAL SEARCH?**

  - When people look for things in their environment, they guide their attention using mental representations of the to-be-located item(s), stored in visual working memory (Wolfe et al., 2004).
  - Templates are used to guide attention to regions of a scene that share features with the target and to compare incoming visual input to a representation of the target in memory (Hout & Goldberg, 2014).
  - Is it possible that related (perhaps non-visual) information may be activated by template use (e.g., through spreading activation), drawing our attention to items that share semantic similarity with the target, or making it harder to reject such things as distractors?

- **SEARCH FOR NUMBERS**

  - With complex stimuli, teasing apart visual and semantic similarity is quite difficult.
  - Numbers provide a domain in which semantic similarity is inherently controlled, and can therefore be quantified (i.e., via numerical distance; Schwarz & Eiselt, 2012).
  - We measured the visual similarity of numbers 0-9 using multidimensional scaling (MDS), which is a statistical tool by which researchers can obtain quantitative estimates of similarity among a group of items (Hout, Papesh, & Goldberg, 2012). Participants rated the similarity of the numbers using the spatial arrangement method (SpAM; Hout, Goldberg, & Ferguson, 2013) of MDS.
  - Other participants searched for a target digit amongst other digits (e.g., 0 amongst 1-9), making target-absent vs. target-present responses. N = 30.
  - Eye movements were recorded using an Eyelink 1000. Linear mixed effects models were used to analyze viewing behavior as a function of visual similarity (indexed via distance in MDS space) and semantic similarity (indexed by numerical distance).

![Two-dimensional MDS solution for digit stimuli. The pattern closely mirrors data from Shepard et al. (1975).](image)

- **RESULTS**

  - Fixation of distractors was guided by both visual and semantic similarity.
  - Visual similarity played a larger role than semantic similarity in guiding search.
  - Effects of visual similarity were stronger on target-absent than target-present trials.
  - See Godwin, Hout, & Menneer, PB&R 2014 for full report.

![Proportion of distractor objects fixated as a function of the visual similarity (left panel) and semantic similarity (right panel) to the target object, for both target-present (blue) and target-absent (red) trials.](image)

- **WORD SEARCH**

  - Using simple stimuli, we've shown that attention can be drawn to items that share visual and semantic similarity to the target.
  - New questions: 1) do the findings scale up to more complex stimuli that require foveation for identification? And 2) if so, are object identification processes affected by semantic similarity?
  - E.g., when searching a website for information (see Fitzsimmons poster #4177 and Driegeh talk Saturday PM), does semantic information play a role in information processing?

- **CONCLUSIONS**

  - Search for numbers and words is influenced by both visual and semantic similarity.
  - We found evidence that visual and semantic factors not only affect attentional guidance, but also word identification, using measures such as time-based processes and the number of fixations. This contributes to the growing literature on semantic influences in visual search.
  - The conjunction of MDS and eye-tracking provide a useful tool for teasing apart vision and semantics, and offer a useful alternative to existing methods (e.g., Levenstein distance).