Visual similarity is stronger than semantic similarity in guiding visual search for numbers

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BACKGROUND

- *What influence does semantic information have on visual search?*
- *The influence of semantics on search is an increasingly important consideration (e.g., scene contexts: Oliva & Torralba, 2007; search models: Wolfe, Võ, Evans & Greene, 2011).*
- *Numbers provide a domain in which semantic similarity is inherently controlled.*

Search for 5: *Schwarz & Eiselt (2012)*

faster, more accurate, more efficient than

equivalent to
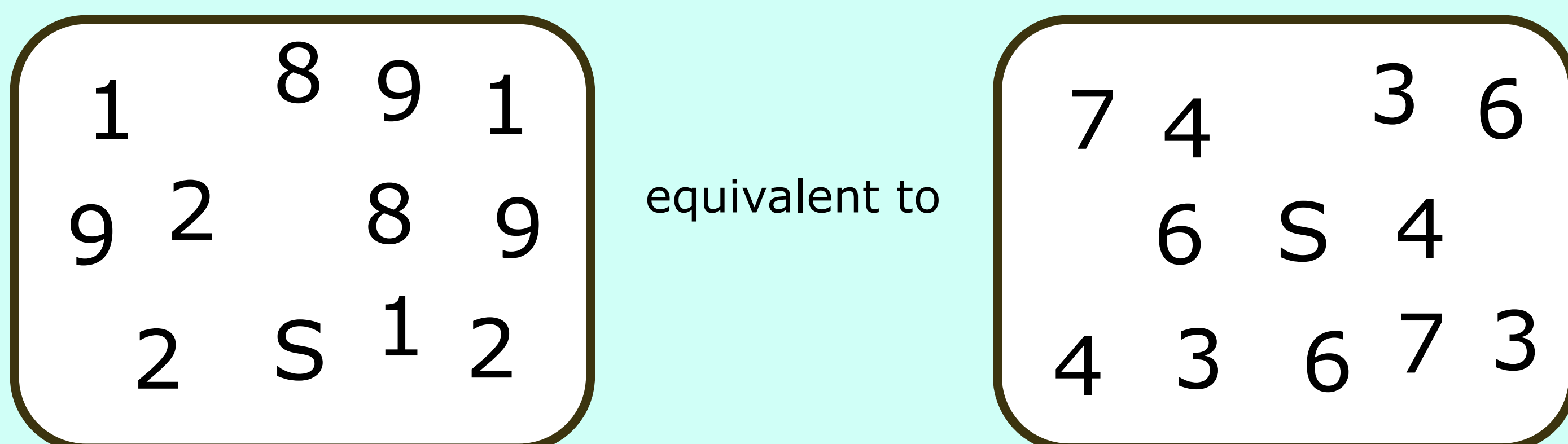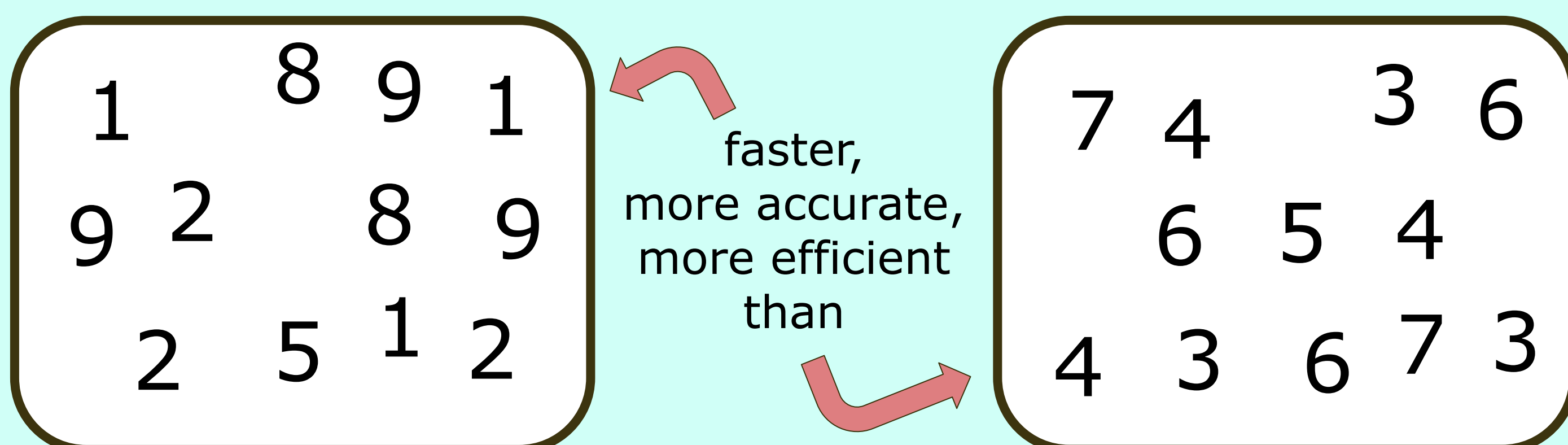
➔ *Increasing numerical target–distractor distance allows distractors to be rejected and targets found more effectively.*
➔ *Findings of numerical similarity are not simply due to visual similarity.*

But... Is this a 5? *Cohen (2009)*

no faster than
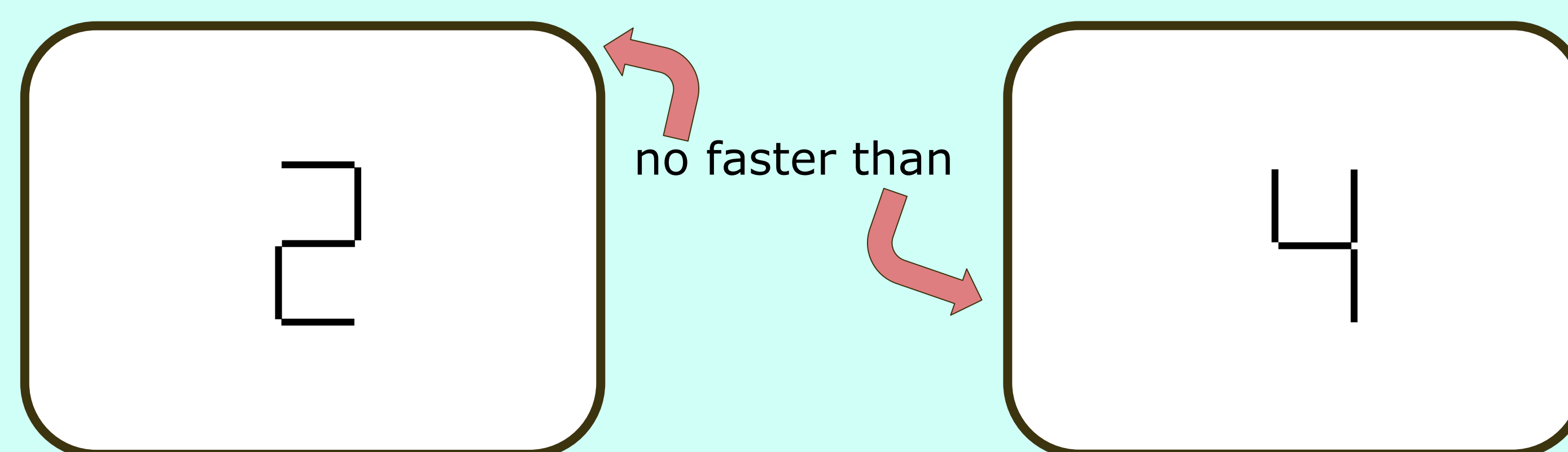
➔ *Quantity information does not affect the speed of the decision.*
➔ *However, visual similarity accounts for response time.*
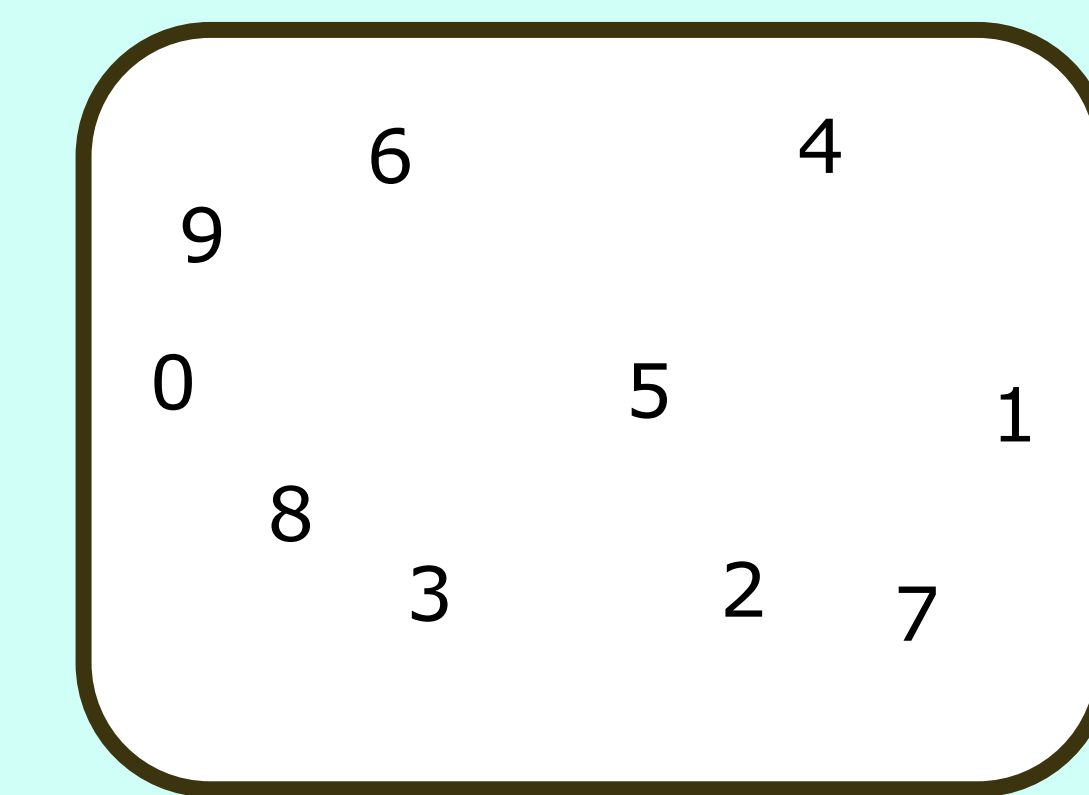
RESEARCH PURPOSE

- *To simultaneously assess the influence of visual similarity and semantic similarity in visual search for numbers 0 to 9.*

PAPER AVAILABLE ONLINE

The in press version of a paper based upon this work is available at the following address:
http://bit.ly/1fl0x53

## METHOD: Measuring visual similarity

- *To quantify visual similarity of digits 0 to 9.*

- *N = 21*
- *Numbers initially arranged in rows with random placement.*
- *Participants were asked to*
  - *drag and drop the images*
  - *to organize the space,*
  - *such that images that were closer in space denoted greater similarity.*
- *(Goldstone, 1994; Hout, Goldinger, & Ferguson, 2013)*

RESULTS: Measuring visual similarity

- *MDS PROXSCAL scaling algorithm*
- *two dimensions gave an appropriate fit to the data (as measured by stress)*
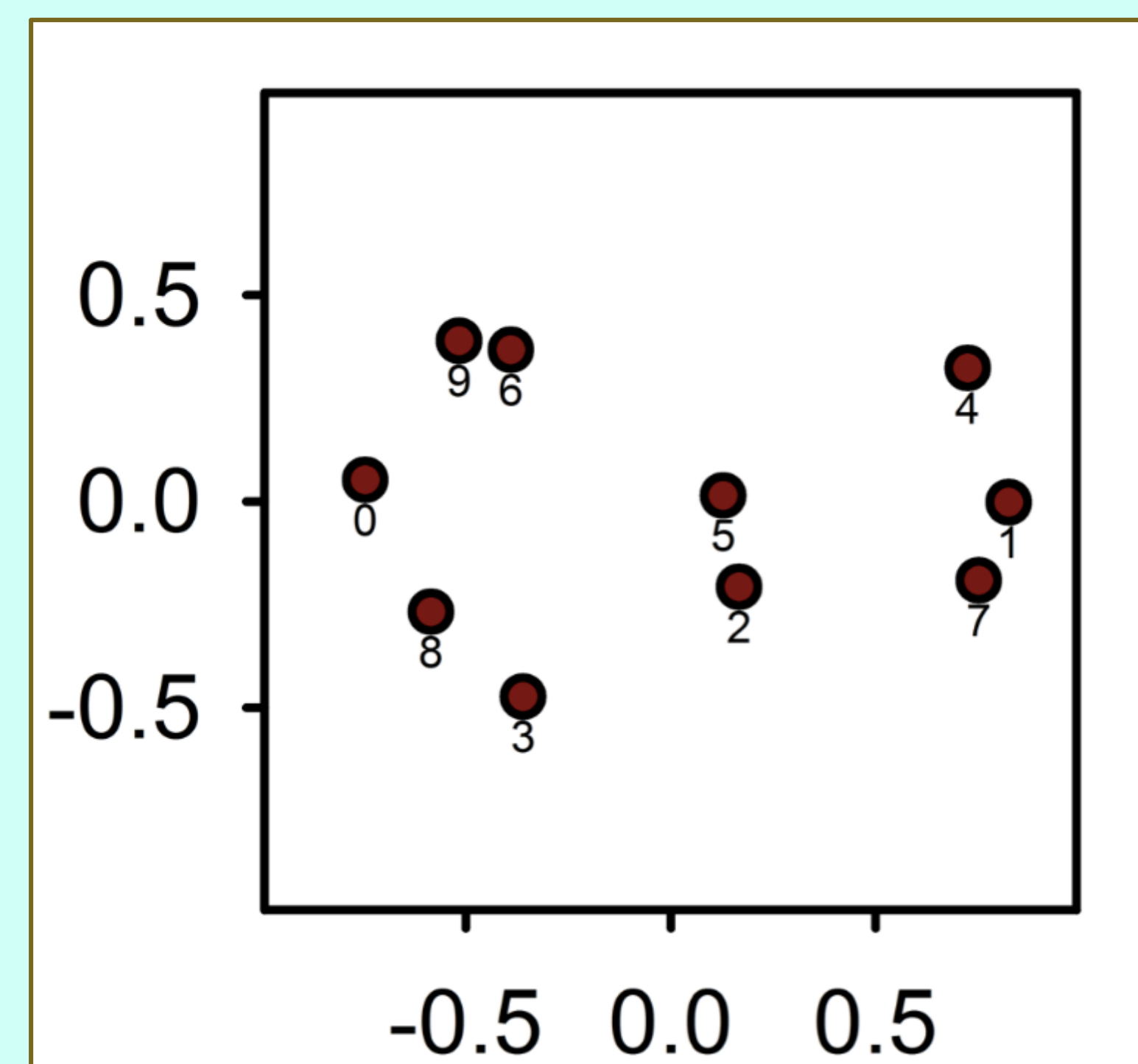
Two-dimensional MDS solution for the digit stimuli. The X- and Y-axes represent the primary and secondary dimensions, respectively

This pattern mirrors that in the similarity plot of Shepard et al. (1975), in which visual similarity was rated via pairs of numbers.

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Shepard, R. N., Kilpatric, D. W., & Cunningham, J. P. (1975). The internal representation of numbers. Cognitive Psychology, 7, 82–138. doi:10.1016/0010-0285(75)90006-7

Wolfe, J. M., Võ, M. L.-H., Evans, K. K., & Greene, M. R. (2011). Visual search in scenes involves selective and nonselective pathways. Trends in Cognitive Sciences, 15(2), 77–84. doi:10.1016/j.tics.2010.12.001

METHOD: Visual search

- *Eye movements were recorded during search for a target digit amongst other digits (e.g., 0 amongst 1-9).*
- *N = 30*
- *20 practice trials + 288 experimental trials*

RESULTS: Visual search

Fixed Effect Estimates and results of statistical tests for the Mixed Linear Model, including the Slope, the Standard Error of the Slope and the z-value.

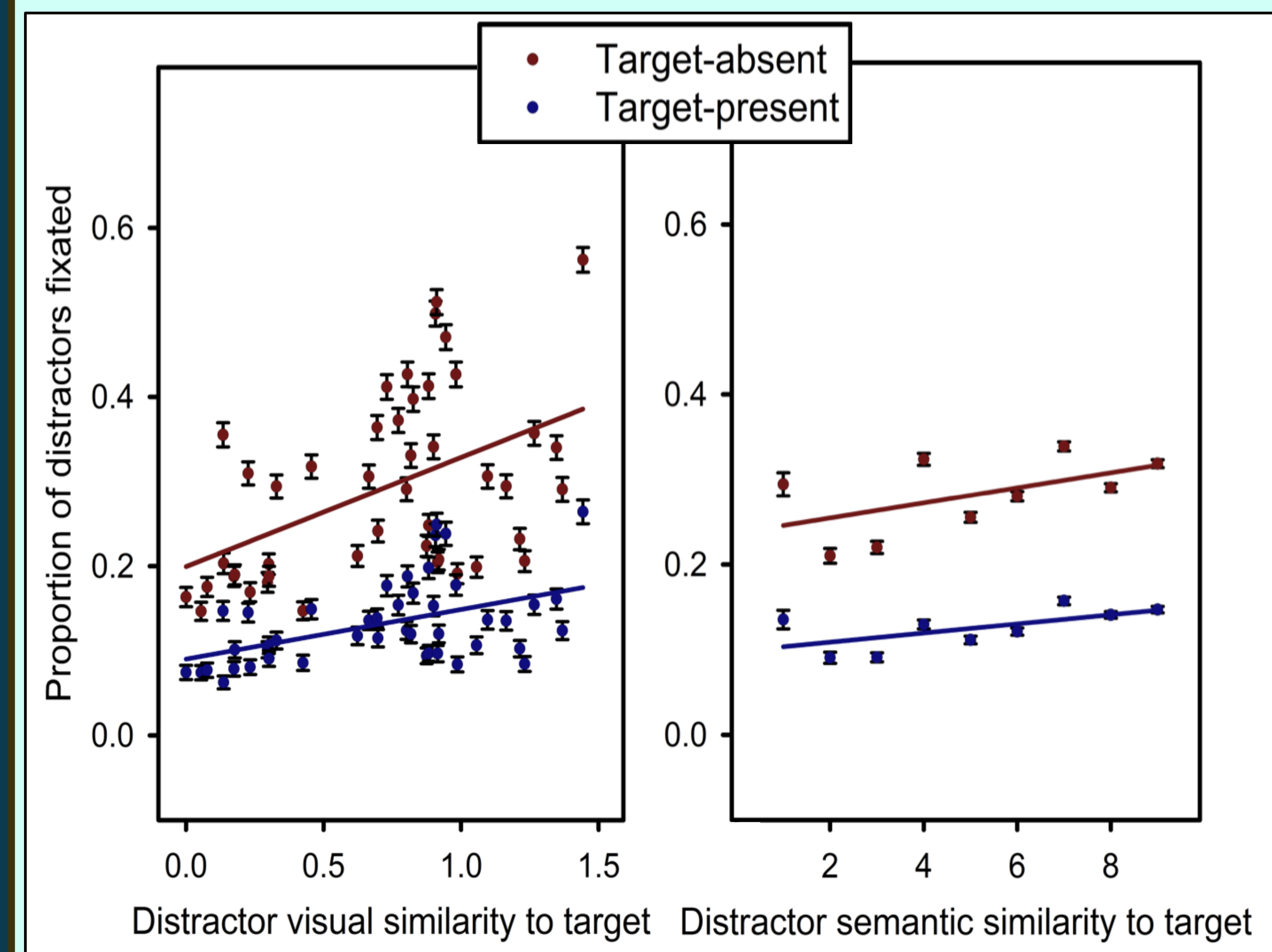| Effect	Model Coefficients	SEM	z
Intercept	-1.62	0.14	-11.52**
Target Presence	-0.93	0.04	-23.38**
Visual Similarity to Target	0.48	0.03	16.79**
Semantic Similarity to Target	0.05	0.01	11.00**
Target Presence x Visual Similarity to Target	-0.14	0.05	-3.05*

*Figure XX: 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. Note that there are (10*9)/2=45 separate visual similarity values, while semantic similarity is collapsed over equal values (e.g., 9 pairs had similarity of 9).*

- *Fixation of distractors was guided by both visual and the semantic similarity.*
- *Visual similarity played a larger role than semantic similarity in guiding search.*
- *Effect of visual similarity was stronger on target-absent than target-present trials.*

SUMMARY AND CONCLUSION

Search for numbers is guided by visual and semantic similarity, but with stronger guidance by visual similarity.

These findings contribute to the growing literature of the relative importance of semantic and visual information in visual search, as well as providing a proof of concept for the usefulness of MDS as a tool for such studies.