The Capacity for Face Perception is Independent of the Capacity for Face Memory

*chacker@usc.edu
http://geon.usc.edu

Catrina M. Hacker[1]* & Irving Biederman[1,2]

1. Program in Neuroscience 2. Department of Psychology, University of Southern California, Los Angeles, CA

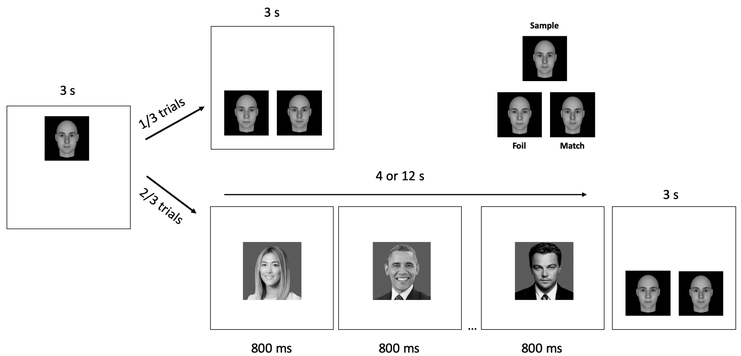
Image Understanding Lab

Are there independent components of face recognition?

Tests of face recognition proficiency implicitly assume it to be an undifferentiated ability. However, several possible independent components could comprise face recognition proficiency, such as those for the perceptual discrimination of faces, face memory and the ability to generalize across viewpoints.

Here we investigate two of these possible components—the proficiency for the perceptual discrimination of faces and the proficiency for face memory using a minimal match-to-sample task with computer generated faces.

Experimental Task



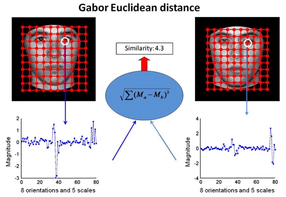
Subjects judged which of two computer-generated faces was an exact match to the first in a delayed-match-to-sample task with a delay of 0, 4, or 12 seconds. To suppress rehearsal during the delay period, subjects completed a celebrity recognition task in which they were instructed to indicate which in a series of headshots depicted a celebrity.

Specific Questions

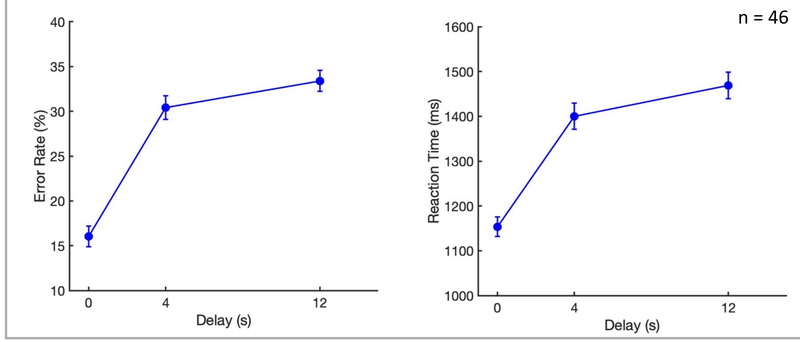
1. What is the cost on face discrimination performance of imposing a short delay between presentation of the sample and the two test faces when rehearsal is suppressed during the delay period?
2. On the group level, does the effect of differences in perceptual similarity between matching and foil faces vary with delay?
3. Over individual subjects, is the proficiency for face discrimination independent of the proficiency for face memory?

Assessing the similarity between the matching and foil faces

The similarity of the matching and foil stimuli was assessed using the Gabor Jet Model. This model based on V1 hypercolumn filtering predicts psychophysical discrimination of metrically varying faces almost perfectly (Yue et al., 2012; App and Didactic: Margalit et al., 2016).

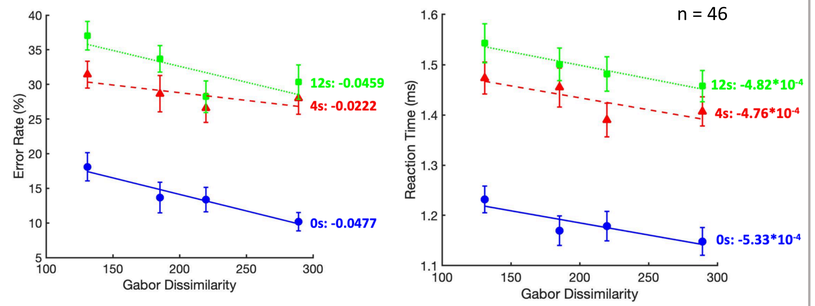


There is a strong cost of delay on reaction times and error rates



On a group level, the effects of face discrimination difficulty are independent of the duration of face memory

Slope = ΔER or ΔRT per unit dissimilarity



Increased Gabor Dissimilarity between the two test faces had a moderate but measurable effect on the error rates and reaction times in discriminating the match and foil faces.

There was no significant difference between the slope over Gabor Dissimilarity for error rates, $F(2,135) = 1.69$, *ns*, or reaction times, $F(2,135) = 0.59$, *ns* indicating that cost of increased perceptual similarity is independent of delay.

References

Yue, X., Biederman, I., Mangini, M. C., von der Malsburg, C., & Amir, O. (2012). Predicting the Psychophysical Similarity of Faces and Non-Face Complex Shapes by Image-Based Measures. *Vision Research. 55*,41-46. doi: 10.1016/j.visres.2011.12.012

Margalit, E., Biederman, I., Herald, S. B., Yue, X., & von der Malsburg, C. (2016). An applet for the Gabor scaling of the differences between complex stimuli. Attention, Perception, & Psychophysics. 78(8), 2298-2306. doi:10.3758/s13414-016-1191-7.

Acknowledgements

Supported by the Dornsife Research Fund and the USC Provost Undergraduate Research Fellowship.

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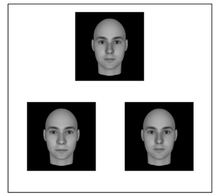
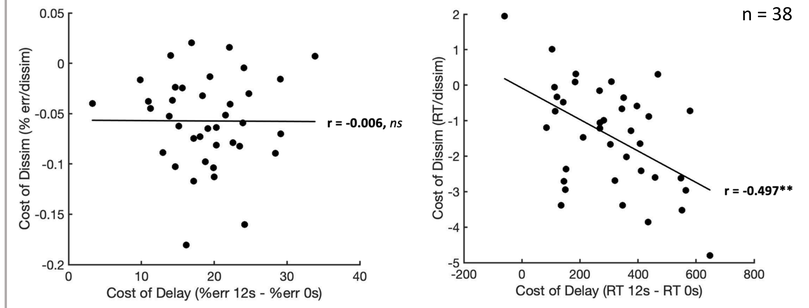
Calculating a Measure of Proficiency for Face Memory and Perception

To assess whether proficiency for the perceptual discrimination of faces is independent of proficiency for face memory across individuals, a subset of subjects completed a match-to-sample task in which all three faces were presented simultaneously. A measure of proficiency for face perception was calculated as the slope of error rates or reaction times over Gabor Dissimilarity on the match-to-sample task, so that a more negative slope corresponded to a higher cost of perceptual similarity between match and foil faces. Similarly, proficiency for face memory was calculated as the difference in performance with a 12 s delay versus a 0 s delay on the delayed-match-to-sample task.



Are individual subjects' proficiencies for face memory and face perception correlated or independent?



Proficiency for face memory and proficiency for face perception are independent with respect to error rates and moderately correlated with respect to reaction times. We do not currently have an explanation for this discrepancy.

Odd/even reliability over trials was 0.716^{***} (acc) and 0.933^{***} (RT) for the delayed-match-to-sample task and 0.832^{***} (acc) and 0.964^{***} (RT) for the match-to-sample task.

Conclusions

1. There is a strong cost of retention interval on the ability to recognize a memorized face when rehearsal over the interval is suppressed.
2. On a group level, the effect of variation in perceptual similarity between matching and foil faces is independent of delay.
3. Across individuals, the capacity for face perception is independent of the capacity for face memory with respect to error rates and moderately correlated with respect to reaction times.

These results suggest that proficiency for face memory and proficiency for face discrimination are largely independent; a view that challenges the assumption that face recognition proficiency is an undifferentiated ability. Future studies will need to: 1) assess the robustness of these results across a broader population, 2) explore other possible independent components of face recognition, 3) address the possible genetic basis of these independent components, and 4) address the possible existence of different subtypes of prosopagnosia in which subjects may be impaired on only a subset of these components.