Images that produce more consistent fixation maps are more memorable

Kyoung whan Choe[1], Omid Kardan[1], Hiroki P. Kotabe[1], John M. Henderson[2] & Marc G. Berman[1]

[1]Department of Psychology, University of Chicago, [2]Center for Mind and Brain & Department of Psychology, University of California, Davis

Environmental Neuroscience Lab

Visual Cognition Laboratory

Introduction

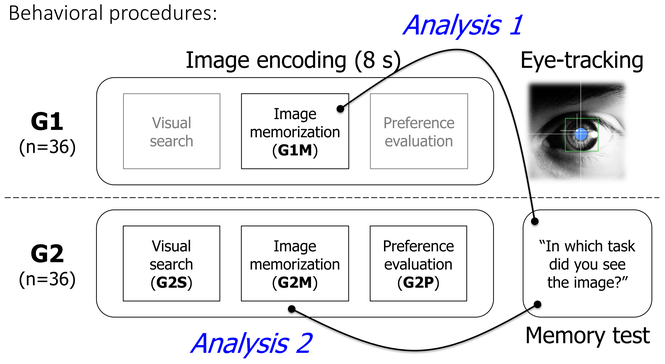
- What makes an image memorable? Understanding the factors affecting image memorability could lead to many interesting applications in psychology, education, and marketing research
- Using eye-tracking, we studied how performing different tasks on images (e.g. searching for an object, trying to memorize an image, evaluating how much one likes an image) can influence image memorability

Research questions

- Can eye-tracking predict which image will be better remembered?
- Can performing a task on an image lead to better memory for that image than intentionally trying to remember it?

Experimental methods

- Participants: Two groups of 36 undergraduate students (G1 and G2)
- Stimuli: 132 full-color scenes on a 20-inch CRT monitor (25.8 x 19.4˚ VA)
- Eye-tracking: EyeLink 1000 (SR Research), 1000 Hz, the right eye only
- Behavioral procedures:



- Eye movement analysis: Raw data were preprocessed with EyeLink Data Viewer. A fixation map of a participant viewing a scene was constructed by convolving a Gaussian kernel over its duration-weighted fixation locations [1]. The size of the Gaussian kernel was set to σ=0.34˚ to take into account the measurement errors of video-based eye trackers [2]
- Fixation map analyses were performed using custom MATLAB scripts

References

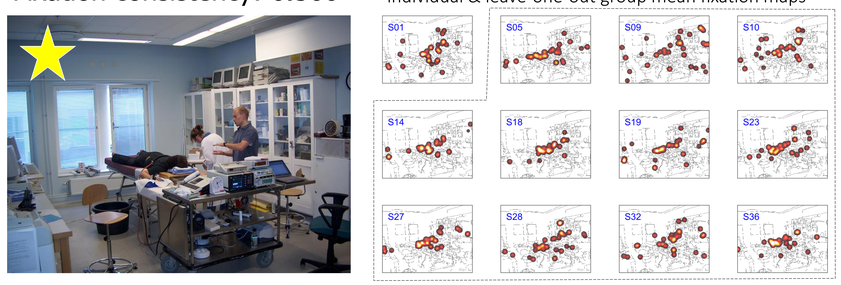
[1] Henderson (2003). Human gaze control during real-world scene perception. *Trends in Cognitive Sciences*
[2] Choe, Blake, & Lee (2016). Pupil size dynamics during fixation impact the accuracy and precision of video-based gaze estimation. *Vision Research*
[3] Bylinskii, Isola, Bainbridge, Torralba, & Oliva (2015). Intrinsic and extrinsic effects on image memorability. *Vision Research*
[4] Xu, Jiang, Wang, Kankanhalli, & Zhao (2014). Predicting human gaze beyond pixels. *Journal of Vision*
[5] Draschkow, Wolfe, & Vo (2014). Seek and you shall remember: scene semantics interact with visual search to build better memories. *Journal of Vision*

Acknowledgements: Supported by a grant from the TFK Foundation to Marc G. Berman, and National Science Foundation Grant BCS-1151358 to John M. Henderson.

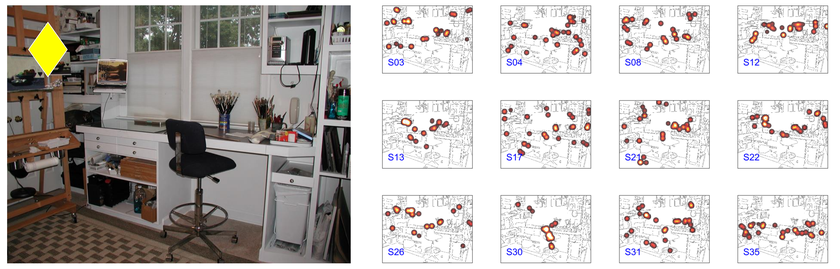
Contact: Kyoung whan Choe (kywch@uchicago.edu) for more information

Analysis 1: Fixation consistency and memorability

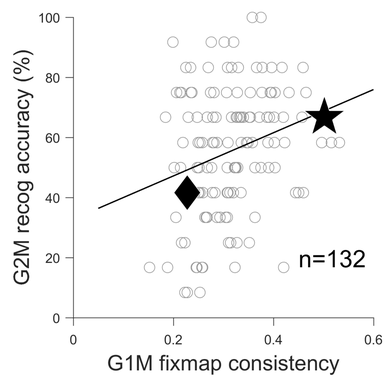
Fixation consistency: 0.566 = average of the Pearson correlation values between the individual & leave-one-out group mean fixation maps

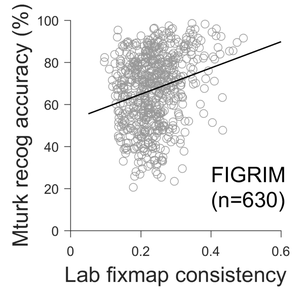


Fixation consistency: 0.275



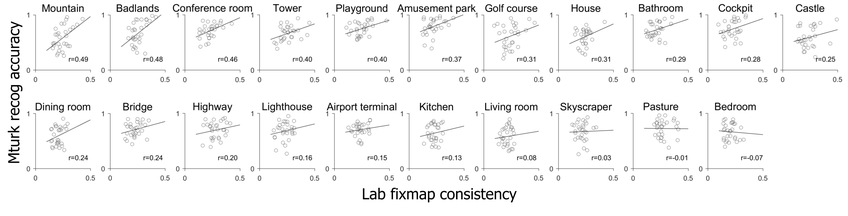
- The images with higher fixation consistency in G1M viewers were better recognized by G2M viewers, who saw the images during memorization (r = .26 [.09, .41], p = .003)
- The relationship between fixation consistency and image memorability was replicated in an open-access, larger dataset at http://figrim.mit.edu [3] (r = .24 [.16, .31], p<.001)



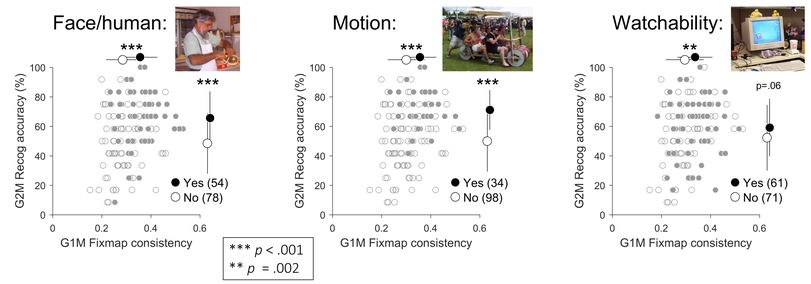


For each 630 FIGRIM image,
- Fixation data from the 2 sec viewing
- Fixation consistency: ~ 16 eye-tracking sbjs
- Image memorability: ~ 74 Mturk workers

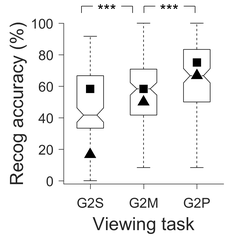
- The relationship was positive in 19 out of 21 FIGRIM categories



- The images with semantic-level information [4] showed both higher fixation consistency and higher memorability, *suggesting image semantics aids memory formation* [5]

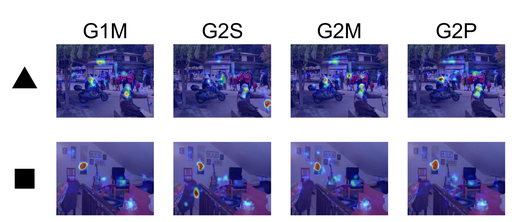


Analysis 2: Task effects on image memorability

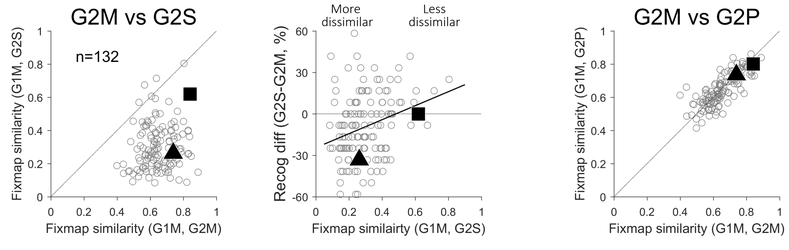


- Image memorability decreased after visual search and, *paradoxically, increased after preference evaluation* compared to intentional memorization
- Fixation maps illustrate how overt visual attention was deployed during image encoding
- The similarity of fixation maps across tasks was analyzed to investigate possible mechanisms for the task effects

Fixation similarity
the Pearson correlation between the averaged individual fixation maps within each task



- During search, the viewers allocated visual attention differently from memorization (p < .001). Moreover, the degree of dissimilarity between the G1M and G2S fixation maps was correlated with the decrease in memorability (r = .29 [.13, .44], p = .001)
- However, the memorization and preference evaluation tasks did not produce significantly different fixation maps (p > .250)



- Overt visual attention is necessary but not sufficient for image encoding
- We speculate that the very act of deciding how much one likes an image can enhance image encoding and later recognition, independent of the actual liking of that image

Please assess how much you like this poster! *(so you may remember)*