Cognitive control and object recognition in highlighting

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Highlighting is a phenomenon thought to demonstrate the influence of attention on associative learning (Kruschke, 2009):

Learn	Test	Observed
AB>X	A	A>X
AC>Y	BC	BC>Y

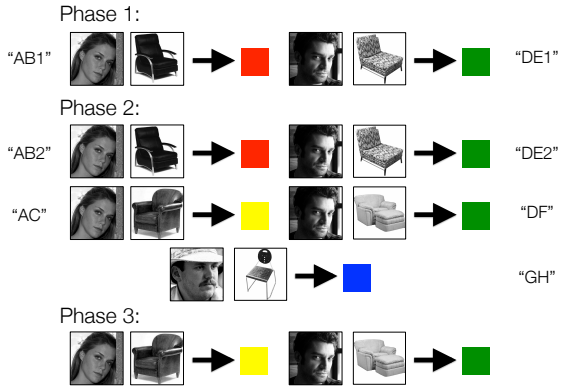
Evidence from behavior, computational modeling, and eye movement support an attentional account of highlighting. We aimed to test two key neural predictions of the attentional account:

1. Frontoparietal brain networks involved in attentional selection should be engaged when processing a highlighted compound (AC) versus a non-highlighted compound
2. If the shared (A) and unique cues (B/C) differ in category, attention to the unique cues should bias activation in object-selective cortex during learning.

Localizer: Are the photos different?

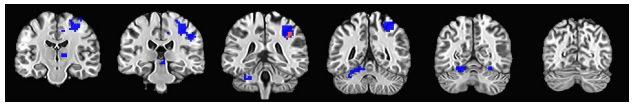
Block design; TR=3000 ms, paired photos presented for 1500 ms each, nonmatches ~15%. Two blocks per category (plus null white noise category) per run (~2:40); 5 runs/experiment.

Train (w/feedback):



Fast event-related design; TR=3000 ms; one trial every four seconds, sequenced by de Bruijn cycle (Mattar et al., 2011). Two runs ~12:00; every category either shared or unique in every subject.

Parietal activation for highlighted vs. non-highlighted compounds.



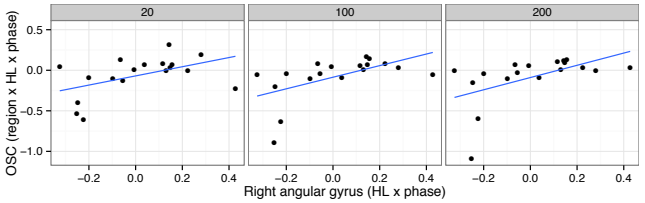
Maps thresholded at t(17)=3.95, minimum cluster size 12, p=0.05 (corrected).

AC>DF; (AC–AB1) > (DF–DE1)

AC–DF engages right PPC, thalamus, fusiform; left cerebellum. Interaction engages right angular gyrus.

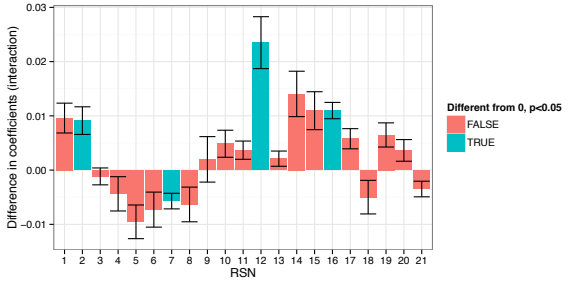
Relationship between activation in posterior parietal and object-selective cortices.

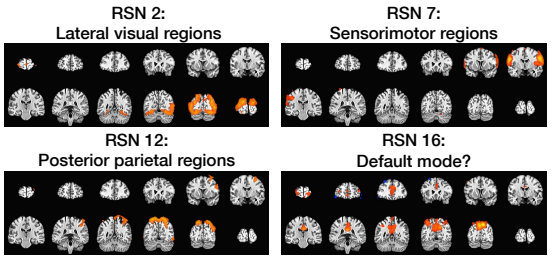
In each subject, we created ROIs for face-, place-, body-, and chair-selective cortices at 20, 100, and 200 voxels each. In each such ROI, we calculated the same interaction contrast documented above, adding a regional factor (region corresponding to shared vs. unique cue), and correlated that three-way contrast with the interaction contrast in the right angular gyrus.



Recruitment of resting-state networks for processing highlighted compounds.

In each subject, we regressed the activation maps for AB1, AC, DE1, and DF on the 21 resting-state networks (RSNs) from Smith et al. (2009), then computed the interaction contrast on the regression coefficients. Four RSNs showed differential loading over the compounds:





Discussion.

Preconditioning a compound-response association (AC>Y) with a partially overlapping compound inviting a different response (AB>X) engages right parietal cortex relative to preconditioning with a partially overlapping compound inviting the same response (DE>Z, DF>Z).

The magnitude of this engagement tracks the strength of category-related activity in object-selective cortex, consistent with greater attention to the unique category than the shared category. Functional networks comprising higher-level visual regions and posterior parietal regions show increased representation in the brain maps corresponding to the highlighted compound-response pair.

These results lend biological support to an attentional account of highlighting.

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