The effect of attention on contextual integration of objects and scenes

Olga Leticevscaia[1], Talia Brandman[2], Marius V. Peelen[3]

1.University of Reading, United Kingdom, 2.Weizmann Institute of Science, Israel, 3. Donders Institute for Brain, Cognition and Behaviour, Netherlands

Introduction

The surrounding context of objects has the power to facilitate their recognition in everyday life[1].

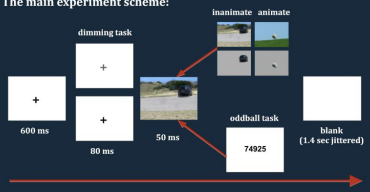
Scene-based contextual facilitation of objects was found in a recent study[2], showing that decoding of degraded objects in scenes from multivariate brain responses was better than the sum decoding of degraded objects alone and scenes alone.

Selective attention towards the objects relevant to the current goal biases the neural representation of an object in the human brain[3].

Is contextual facilitation of objects modulated by selective attention?

Procedure

The main experiment scheme:



- MEG Elekta Neuromag, 306 channels.
- Two interleaved tasks: Attended condition (oddball task) and Unattended condition (fixation dimming task).
- To manipulate participants' attention, we showed the same visual display but asked participants to perform different tasks on each run.
  Participants attended objects in order to respond to a random number appearing instead of objects.
  Asking participants to respond when a fixation cross changes its luminance aimed to drive participants' attention away from stimuli.

Data analysis

cross-decoding

The multivariate response across MEG sensors in each time-point is used to train the pattern classifier for animacy categorization in intact objects.

Then, we test the classifier's predictions on animacy decoding in each time-point, for degraded objects and degraded objects in scenes.

Response pattern across multiple sensors at a single time-point

Testing classifier predictions on objects alone

Testing classifier predictions on objects in scenes

References

(1) Oliva, A. & Torralba, A. (2007) The role of context in object recognition. *Trends Cogn Sci* ,11, 520-527.

(2) Brandman, T. and Peelen, M. (2017). Interaction between scene and object processing revealed by human fMRI and MEG decoding. *Journal of Neuroscience*, 37(32):7700–7710.

(3) Chen, A. J. et al., (2012). Goal-directed attention alters the tuning of object-based representations in extrastriate cortex. *Frontiers in human neuroscience*, 6.

Contact author

Author - Olga Leticevscaia

by email: olga.leticevscaia@pgr.reading.ac.uk

by Twitter: @leticevscaia

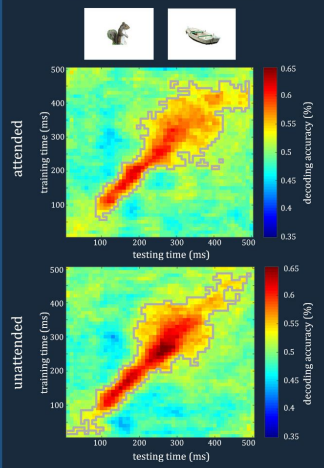
University of Reading · Weizmann Institute of Science · Donders Institute

Results

Gray outline - above-chance classification of object category (TFCE p<0.05)

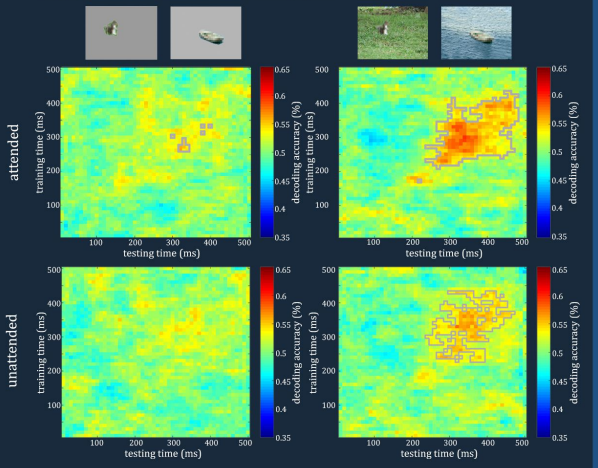
Decoding accuracy across a time * time space from stimulus onset to 500 ms, averaged across subjects.

Animacy decoding of intact objects



Object animacy was successfully decoded from intact objects within the animacy pattern localizer: High decoding accuracy starting at 100 ms after stimulus onset.

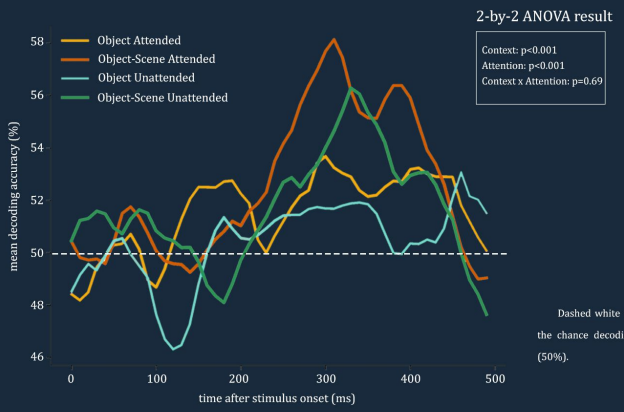
Cross-decoding object animacy from degraded objects



The decoding of degraded objects presented alone was not significantly above chance in unattended condition and only several time points in attended condition showed significant above chance decoding accuracy.

Decoding accuracy between 230 ms and 480 ms reached significance (TFCE, p<0.05) in the presence and absence of selective attention to objects in scenes.

Decoding accuracy across the smoothed time diagonal (matched testing and training time)



2-by-2 ANOVA result

Context: p<0.001
Attention: p<0.001
Context x Attention: p=0.69

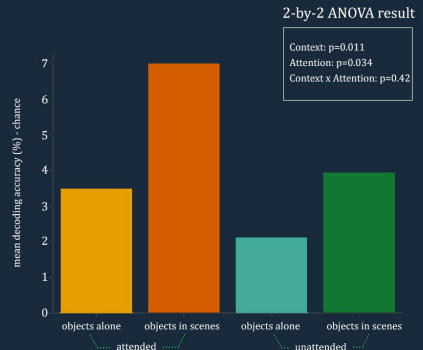
The decoding accuracy across the time diagonal was averaged across subjects and analysed with the ANOVA. Scene context and selective attention boosted object decoding along the time diagonal independently.

The Object-Scene Attended condition replicated the decoding dynamics of objects in scenes found in [2] peaking at 320 ms after stimulus onset (see the adapted graph [2, Figure 7C, p.7708] on the right-hand side panel for comparison).

Dashed white line denotes the chance decoding accuracy (50%).

Results

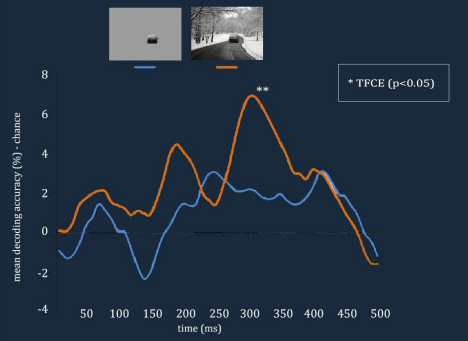
Averaged cross-decoding accuracies



To test contextual facilitation effect found in previous work [2] at 320 ms after stimulus onset and its interaction with attention, we averaged the decoding accuracy around this time point in each of four cross-decoding conditions.

The adapted graph below [2, Figure 7C, p.7708] demonstrates the dynamics of the facilitatory effect of scene context significantly boosting the decoding of objects in scenes at 320 -340 ms after stimulus onset in comparison to the decoding of objects alone.

Cross decoding along the diagonal



Conclusions

1. The attended condition of the present study replicates the dynamics of the contextual facilitation effect published in Brandman and Peelen, 2017.
2. Scene context and selective attention boost object representations independently.