Timing and causal role of OPA in scene-based object recognition (#25406)

Created: 07/02/2019 06:28 AM (PT)
Public: 02/28/2021 10:21 AM (PT)

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1) Have any data been collected for this study already?
No, no data have been collected for this study yet.

2) What's the main question being asked or hypothesis being tested in this study?
We have the ability to recognize objects within a split-second, regardless of the location, visual angle, or whether an object is partially occluded. Even in a blurred image, contextual cues from the surrounding scene help us to identify an object (Oliva & Torralba, 2007).

Brandman & Peelen (2017), in a combined fMRI-MEG study, revealed significantly better decoding accuracy for degraded objects in scenes compared to degraded objects alone and scenes alone. This effect started from around 300 ms and was localized in object-selective cortex. It was proposed that this effect reflects scene-related predictions, encoded in scene-selective regions (including the occipital place area; OPA), arriving at the object-selective visual cortex, disambiguating the degraded object from 300 ms after stimulus onset. This implies that the scene-selective cortex was involved before this point in time. Here we test the causal contribution of OPA at different time points by applying disruptive double-pulse transcranial magnetic stimulation (TMS) over the right OPA at an early (after 60-100 ms), middle (after 160-200 ms), and late time point (after 260-300 ms). While TMS is applied, participants have to indicate the correct category for degraded objects within scenes and isolated intact objects. The scenes will also be presented without the object in order to observe how predictive the scene itself is to the object category.

We will test the following two hypotheses: 1) TMS over OPA will impair the recognition of degraded objects within scenes, but not of intact isolated objects. 2) TMS over OPA will impair object associations in the scene alone condition. 3) These effects are specific to the middle time point, since during early stimulation activity has not yet arrived in OPA and for late stimulation the processing of scenes has already occurred (as scene-based predictions have already been fed back to object-selective cortex; Brandman & Peelen, 2017).

To test these hypotheses, an adapted version of the visual recognition task by Brandman & Peelen (2017) will be used. Previous studies have indicated that the efficacy of TMS is subject to inter-individual variation and is limited by depth of this area within the brain, skull thickness and orientation of axons within an area. Additionally, TMS parameters, such as intensity, coil shape, coil orientation and pulse waveform, can determine whether TMS will be effective or not. Therefore, we will perform an initial study, a replication of Dilks et al. (2013) which will be used to select participants that are sensitive to TMS over OPA. These subjects will be included in the main study, which will be conducted in a separate experimental session.

3) Describe the key dependent variable(s) specifying how they will be measured.
Participants will be asked to indicate which out of eight objects was represented in the picture (object in scene or object alone). If a scene alone was shown, participants have to indicate which object was removed from the picture. The aim is to answer with the correct object category. The main dependent variable is the percentage of correct trials in object alone, scene alone, and object in scene conditions. A secondary variable is reaction time.

4) How many and which conditions will participants be assigned to?
The experiment adopts a 3x3 repeated-measures design. The first factor, TMS timing, has 3 conditions: early, middle and late. The second factor, stimulus type, has 3 conditions: (intact) object alone, scene alone, and (degraded) object in scene. All conditions have an equal number of trials and are presented in random order.

5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
Repeated-measures ANOVAs will be performed with TMS timing (3 levels) and stimulus type (3 levels) as within-subject factors. Accuracy and reaction time will act as dependent variables in separate ANOVAs. A significant interaction effect is expected, reflecting the hypothesized finding that TMS timing affects performance on the degraded objects in scene condition and in the scene-alone condition, but not in the intact object alone condition. In addition, for both the degraded objects in scene condition and the scene-alone condition we plan to perform the following pairwise contrasts (paired t-tests) related to the hypotheses outlined above: 1) TMS middle vs TMS early, 2) TMS middle vs TMS late.

6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.
Participants will be excluded who do not complete the experimental procedure. Furthermore, participants whose accuracy falls below 2.5 SDs of the overall mean across conditions will be excluded.

7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.
A sample size of n = 24 will be collected. This number is based on a medium effect size and behavioral data from Brandman & Peelen (2017).

8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)
As mentioned before, susceptibility to TMS effects vary inter-individually. Therefore, in an exploratory analysis the main analysis will be repeated with the addition of some covariates: First, the phosphene threshold. Second, the effect size of scene recognition reduction in the initial experiment, that is, the replication study of Dilks et al. (2013).