Supporting Online Material for

Greater Disruption Due to Failure of Inhibitory Control on an Ambiguous Distractor

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Supporting Online Material

Materials and Methods

Subjects

Subjects ranged in age from 19 to 39 years. All subjects had normal or corrected-to normal vision and were naïve regarding the purpose of the experiments. All subjects gave informed written consent and the study was approved by Massachusetts General Hospital Human Research Committee and the Boston University Institutional Review Board.

Experiment 1 (RSVP task with translating dots)

Main experiment

A sequence of 8 items (2 digits and 6 letters [65.9cd/m^2]) were presented in a 1° diameter, dark-grey circle (28.8 cd/m^2) located within a 10° diameter, black circular background (0.2 cd/m^2). Each item (digit or letter) was presented for 75 msec and was followed by a 45 msec blank interval. The first and second targets were presented in one of the first four serial positions and in one of the second four serial positions, respectively. An entire stimulus interval lasted 915 msec.

In the background, a dynamic random-dot (DRD) display was presented which consisted of coherently moving dots (signal) and randomly moving dots (noise). The mean dot density was 1.27 dots/deg^2. Signal dots were randomly chosen in each frame. For example for the 5% coherent motion display, 5% of the dots carried the signal from one frame to the next and then a different set of dots carried signals in the next frame transition (*1*). The signal dot speed was 14.2deg/sec.

The direction of coherent motion in the background DRD display was one of 4 possible directions (70°, 160°, 250°, and 340°). The ratio of signal dots to the total number

of dots was varied from trial to trial between 0, 5, 10, 20, and 50%. In a complete experiment, each setting (direction and ratio) was repeated 20 times, so that a total experiment consisted of 4 directions X 5 coherence ratios X 20 repetitions = 400 trials. The order of presentation of these conditions was randomly determined for each subject. No accuracy feedback was given to the subjects.

Each trial began with the presentation of the aforementioned stimulus. After the disappearance of the stimulus, the subjects were instructed to report 2 digits (out of "1", "2", "3", or "4") that appeared within a sequence of alphabetical letters (RSVP task) presented at the center display, by pushing the corresponding digit keys on a computer keyboard. The number of trials with each of 7 possible time lags between the first and second targets was equated across all the coherence ratios so that task-difficulty is controlled across all the coherence ratios.

Threshold measurement

Threshold measurements were conducted after the main experiment. The stimulus was identical to that in the main experiment except that a white fixation point rather than a sequence of digits/letters was presented at the center. The method of constant stimuli was used. In each trial, a subject viewed a stimulus in which the coherent motion direction was 25°, 115°, 205°, or 295°, for 915 msec. The stimulus was then replaced with four arrows which pointed to 25°, 115°, 205°, and 295°. The subjects were instructed to click on the arrow that represented the perceived coherent motion direction. The ratio of signal dots to the total number of dots was varied in 7 steps (4, 11, 18, 25, 32, 39, and 46 %). As soon as the subject responded, a different motion stimulus was presented for a new trial. The order

of presentation of the coherence ratios was randomly determined for each subject. There were 36 trials for each coherence ratio, resulting in a total number of 252 trials for the threshold measurements. No accuracy feedback was given to the subjects.

Experiment 2

(RSVP task with low luminance contrast moving dots)

Main experiment

The method was identical to that of Experiment 1 except that the luminance contrast of the moving dots was now 2.2 cd/m^2 (65.9 cd/m^2 in Experiment1) and that the ratios of signal-to-noise dots in the background were now 10, 20, 30, and 40%.

Threshold measurement

The method is identical to that of Experiment 1 except that the ratios of the signal dots to the total number of dots were now 3, 11, 19, 27, 35, 43, and 51 %.

Experiment 3 (Eye-movement detection)

Main experiment

To test whether the performance dip is related to the presence of possible eye movements, eye movements were monitored with an eye-tracker with 0.5 deg spatial resolution and 30 Hz temporal resolution using View-point eye tracker® with 6 subjects, using otherwise the same methods as in Experiment 1 (see Fig. S1).

Threshold measurement

The method was identical to that of the threshold measurement of Experiment 1.

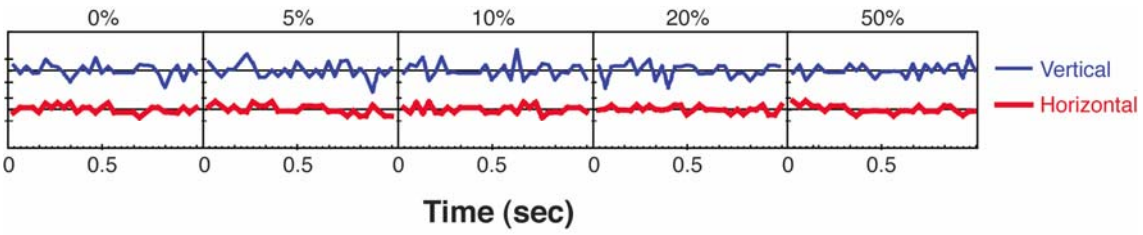

Fig. S1. Example of sampled vertical and horizontal movements of the right eye of a representative subject for 5 translating coherent motion ratios (at the top of each panel) in Experiment 3. Each small tick on the y-axis represents 15 min/arc. There was no significant difference among different coherent ratio conditions.

Experiment 4 (RSVP task with contracting dots)

Main experiment

The method was identical to that of Experiment 1 except that the coherent motion moved toward the center of the display (contraction). Fig. S2 shows the results.

Threshold measurement

The method was identical to that of the threshold measurement of Experiment 1 except for the following aspects. While in half trials all the dots moved randomly, in the other half, 3, 4, 5, 7, 9, 10 or 12% of the dots contracted. Subjects were instructed to report whether or not a display included contracting dot motion.

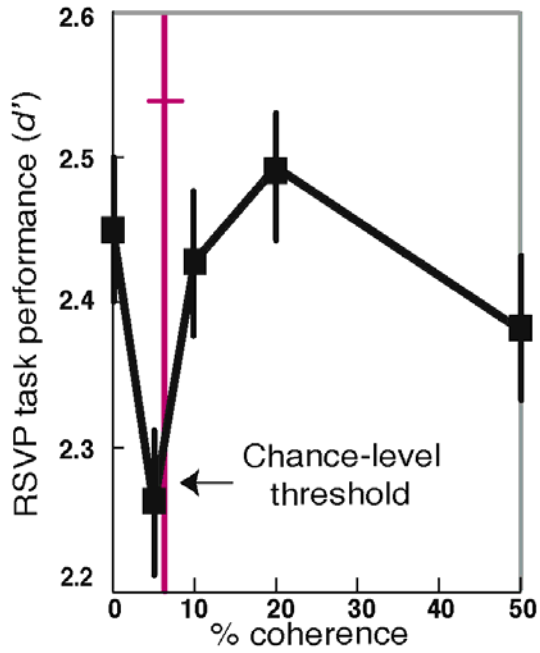

Fig. S2. Results of Experiment 4. Mean RSVP task performance (*d'*) as a function of the contracting coherence ratio of background dynamic random-dot (DRD) displays. *d'* at 5% coherence ratio was significantly lower than at 0% coherence ratio ($p < 0.01$), the 10% coherence ($p < 0.05$), and the 20% coherence ($p < 0.001$), indicating a performance dip at 5% coherence ratio. Vertical error bars, ±1 SEM. A vertical pink bar represents the mean chance-level threshold with a horizontal bar, ±1SEM, indicating that 5% coherent motion is under the chance-level threshold.

Experiment 5 (fMRI experiment)

Stimulus

The same stimulus was used as in Experiment 4.

Procedures

Image Acquisition. Subjects were scanned in a 3T scanner. A head coil was used throughout the experiment for anatomical and functional scans (see below). Three high-resolution 3D anatomical MR images (MP-RAGE) were acquired (TR = 2.531 sec, TE = 3.28 msec, flip angle = 7º, TI = 1100 msec, 256 slices, voxel size = 1.3 x 1.3 x 1.0 mm^3, resliced during analysis to 1 mm^3), for use in subsequent reconstruction of cortex in flattened format (*2*). Functional MR images were acquired using gradient echo EPI

sequences (TR = 2 sec, TE = 30 ms, Flip Angle = 90º) to measure BOLD contrast. Thirty-five contiguous slices (3.5 x 3.5 x 3 mm^3) oriented parallel to the intercommissural plane were obtained for the main tasks (see below), and twenty-five contiguous slices (3 x 3 x 3 mm^3) orthogonal to the calcarine sulcus were obtained for the MT+ localization (see below).

Main tasks. There were two conditions in which subjects participated on different days; a task-relevant condition and a task-irrelevant condition. The reasons why they were conducted on different days were that sufficient numbers of trial repetition were necessary in both conditions to obtain high S/N ratios. Half subjects performed the task-relevant condition first and the other half the task-irrelevant condition first to counterbalance the temporal orders of the conditions. Each condition consisted of 12 fMRI scans, each of which consisted of around 76 trials and lasted for 6 minutes. An event-related design was used. Eye movements were not monitored.

a. Task-relevant condition. In each trial, a DRD motion display was presented with a fixation point appearing at the center of the screen for 915msec. In half of the trials, the display consisted of 5, 10 or 20% coherent contracting motion, and in the other half it consisted of 0% coherent motion. After the disappearance of the DRD display, subjects were instructed to press the leftmost of 4 buttons on a handheld box if they perceived any coherent motion in the display and to press the rightmost button if coherent motion was not perceived. The response interval lasted at least for 2000 msec and then a new DRD display

was presented for a new trial. Subject responses were recorded by a computer that controlled the experiment so that mean performance could be subsequently calculated.

b. Task-irrelevant condition. The procedure trial was identical to that of Exp. 4, except that for the digits “1”, “2”, “3”, and “4” subjects were asked to press the leftmost, second left, third left and rightmost buttons on the box held by subjects, respectively. The scanning procedure is the same as in the task-relevant condition.

Region of interests (ROI).

a. MT+ localization. In a separate session, low-contrast, moving and stationary, concentric rings were presented to localize area MT+ (*3-9*). A block-design was used in the MT+ localization. One scan took 256 sec. Two scans were repeated for each subject. The resultant activation map (see data analysis) was used to define an area MT+ individually.

b. LPFC localization. We employed an automated surface-based parcellation system (*10*) to identify the middle frontal gyrus individually and then the anterior half of the gyrus was defined as LPFC.

c. Other areas. The posterior occipito-temporal sulcus (pOTS) was defined as being in the depth of the OTS, at its posterior part where OTS meets the inferior temporal sulcus (*11*). Sulci and gyri including the angular gyrus were localized by the brain parcellation method (*10*).

FMRI data analysis. Data were analyzed by using FS-FAST and FreeSurfer (http://surfer.nmr.mgh.harvard.edu). All the functional images were motion corrected(*12*), spatially smoothed with a Gaussian kernel of 5.0 mm (FWHM), and normalized across

scans individually. For MT+ localization, the average signal intensity was calculated for each condition (moving vs stationary), for each subject. Voxel-by-voxel statistical tests were conducted by computing the contrast based on a univariate general linear model. Significance levels were projected onto the flattened cortex individually. Region of MT+ was demarcated based on this functional map ($p < 0.01$).

To calculate activation in the ROIs for each coherence ratio in the main fMRI tasks, we estimated the average signal intensity from voxels in the ROIs at each of 24 time points with an interval of 1 sec, ranging from 4 sec prior to trial onset to 20 sec post-trial onset individually. Subsequently, their peak hemodynamic responses (peak ± 1sec) were averaged across subjects, for each coherence ratio, for each of the task-relevant and task-irrelevant conditions.

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