Supplemental Data

The Representation of Egomotion in the Human Brain

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Supplemental Experimental Procedures

Definition of Regions of Interest

Scanning runs to define regions of interest (ROIs) were usually performed in a session separate from the main experiments. MT and MST were defined by the use of an ipsilateral stimulus, based on [S1] and [S2] and previously used in our lab [S3]. A circular patch of dots (8° in diameter) was presented, with its center placed 10° to the left or right of fixation. Blocks of 15 s in which the dots were static were alternated with blocks of 15 s in which the dots moved alternately inward and outward along the radial axes (thus creating alternating contraction and expansion). Sixteen blocks (eight static and eight moving) were presented in each scanning run; one scanning run was completed with the stimulus on the left and another with it on the right. With this procedure, MT and MST can be differentiated in terms of the absence or presence, respectively, of ipsilateral drive.

Retinotopic areas V1–V4 were identified by a standard retinotopic mapping procedure [S4], with a counterphasing checkerboard "wedge" stimulus (a 24° sector) of radius 12°. The counterphase frequency was 8 Hz. Check size was scaled by eccentricity in approximate accordance with the cortical magnification factor. The wedge rotated clockwise at a rate of 64 s/cycle, and eight cycles were presented. This stimulus was presented twice to each participant, and the data from the two scanning runs were averaged to give the final retinotopic maps.

In order to identify any areas outside the occipital lobe that may also be important, a third localizer stimulus was used. This consisted of a dot field moving in a coherent optic-flow pattern, identical to the single-patch stimulus used in the main experiment and described above, which alternated with a blank (except for a fixation point) screen in blocks of 15 s. This 30 s stimulus sequence was repeated ten times to give a run length of 310 s (including a 10 s buffer period at the beginning), and participants completed two such scanning runs.

Data Acquisition and Analysis

Images were acquired with a 3T MR scanner (Magnetom Trio, Siemens, Erlangen, Germany) equipped with an eight-channel array headcoil. Functional images were acquired with a standard gradient-echo, echoplanar sequence (repetition time [TR] = 2000 ms, echo time [TE] = 31 ms, flip angle = 80°, voxel size = 3 × 3 × 3 mm, 28 axial slices, bandwidth = 752 Hz/pixel). In addition, high-resolution T1-weighted images (anatomical scans) were also acquired for each participant (modified driven-equilibrium Fourier transform [MDEFT] [S5], 176 axial slices, in-plane resolution 256 × 256, 1 mm isotropic voxels, TR = 7.92 ms, TE = 2.45 ms, flip angle = 16°, bandwidth = 195 Hz/pixel). MDEFT was chosen in place of standard sequences because of its improved contrast between gray matter and white matter. This is beneficial for segmentation and flattening.

All data were preprocessed and analyzed with BrainVoyager QX (version 1.8; Brain Innovation, The Netherlands). Functional data were corrected for head motion and slice timing, and were filtered with a temporal high-pass filter of 0.014 Hz. No spatial smoothing was applied to the functional data. The anatomical image from the first session for each participant was used as a reference to which all the functional images from both the first and any subsequent sessions were coregistered. This anatomical image was also inflated and flattened to allow visualization of the retinotopic mapping data on the flattened cortical surface.

All data (except the retinotopic mapping data, see below) were analyzed with standard methods, including the application of the General Linear Model (GLM) as implemented in BrainVoyager QX for analysis of fMRI time series. Regressors were defined on the basis of the presentation of the conditions, and these functions were convolved with a canonical, synthetic haemodynamic response function (HRF) in order to produce the model. Additional regressors derived from the participant's head motion during each scan were also included in the model in order to reduce the occurrence of artifactual head-motion-related activity. Appropriate contrasts were defined individually for each participant.

Regarding the ROIs, MST was defined as all contiguous voxels that were significantly active during ipsilateral-motion stimulation. MT was defined as all contiguous voxels that were active during contralateral but not ipsilateral stimulation, with one proviso: Because previous research [S1–S3] has shown that the center of MST is located anteriorly with respect to the center of MT, any MT voxels situated farther anterior than the median value of the MST ROI on the horizontal (axial) plane were removed from the MT ROI.

Retinotopic data were analyzed by the fitting of a model to the timecourse obtained with the rotating wedge stimulus. This consisted of a rectangular wave, convolved with the HRF, of appropriate duty cycle reflecting when the stimulus entered a particular portion of the visual field. The phase of the fitted response was taken as an index of visual-field location, in terms of polar angle. Reversals of the direction of phase change across the cortical surface were taken as boundaries of visual areas [S4]. ROIs (visual areas V1–V4) were drawn by eye, on the basis of these boundaries viewed on a flattened version of each participant's reference anatomy.

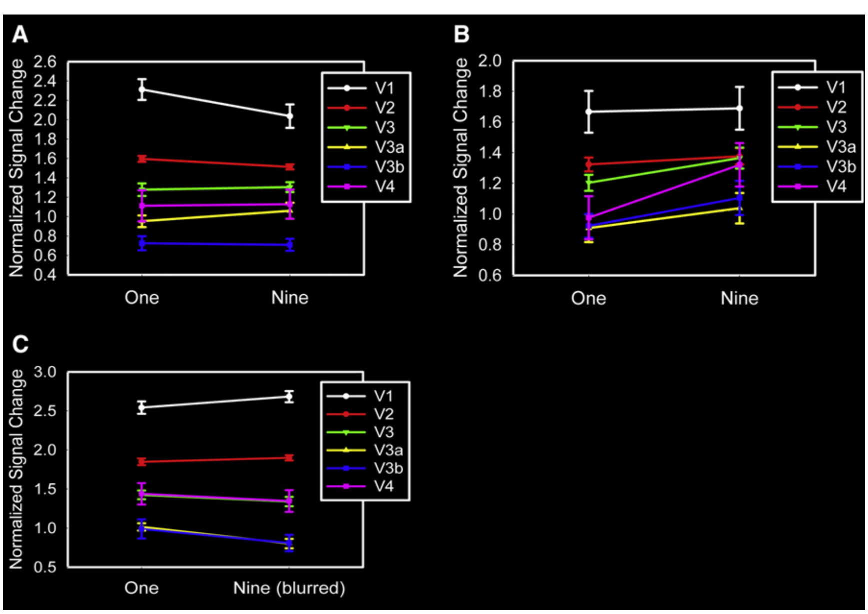

Figure S1. Additional Results

Mean response amplitudes (normalized signal change) from visual areas V1–V4 for (A) control experiment 1, (B) control experiment 2, and (C) control experiment 3.

Supplemental References

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