Activity patterns in human motion sensitive areas depend on the interpretation of global motion

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Introduction

It is often difficult to disambiguate whether motion signals coming from overlapping contours arise from single or multiple surfaces. It is not clear which areas of the human visual brain are directly involved in this kind of perceptual decision. This question can be examined using stimuli formed by superimposed moving gratings (plaids). These are perceived either as sliding in different directions (component motion, (CM)) or as a single coherent pattern moving in the intermediate direction (pattern motion, (PM)).

Primate area MT was suggested to process pattern motion, as some of its neurons respond to global motion, which could relate to coherent single-surface perception. In the present study we asked two critical questions: First, whether MT is a substrate for perceptual decision between alternate discordant interpretations. Second, whether it represents motion in a manner consistent with the existence of a winner-take-all model, or, in contrast, it would also allow for activity patterns consistent with the simultaneous representation of multiple surfaces.

Methods

In the present fMRI experiments (Philips ACS-NT, 1.5 T, matrix: 64x64, 22 slices, voxel size: 3.5x3.5x5mm³, TE/TR=40/2083ms) we presented unambiguous plaid stimuli, that biased subjects' perception toward PM or CM, and ambiguous plaid stimuli, that induced spontaneous switches between the PM and CM perceptions. During the functional measurements, subjects (n = 7) reported their percepts by means of button presses (see figure). Data analysis was performed using BrainVoyager 2OfKl (Brain Innovation, Maastricht, The Netherlands) and included pre-processing and both hypothesis- (multiple regression) and data-driven (cortex-based independent component analysis, cbICA (1)) analysis of fMRI time-series. In cbICA, regions of interest that were defined in individual subjects on the basis of mapping experiments (retinotopic, flowfield mapping, moving vs static plaids) served as criterion for the automatic selection of the most interesting components.

Results

Plaid motion was highly effective in specifically activating hMT+. A general linear model, based on subjects' reports, showed that, for both unambiguous and ambiguous stimuli, the activity in this area was highly correlated with the perceptual reports of the subjects. This effect was observed also in dorsal areas to which hMT+ projects, but not in primary visual cortex. CM (two-surface perception) evoked higher activation than PM (one-surface perception). One cortical component, that included hMT+, a network of dorsal areas and the sensorimotor cortex contralateral to the hand of button-press could be reliably obtained with cbICA. In the figure this surface map, with the corresponding time-course, is shown for one of the subjects.

Conclusions

The increased activation level during component motion over pattern motion is consistent with the assumption that hMT+ represents segregated assemblies for multiple surfaces moving in different directions (2). Since stimulus features were kept constant during the ambiguous plaid condition, these results uncover a functional correlate of perceptual interpretation within hMT+ and higher areas of the dorsal stream. Our study suggests that human MT+ can support not only one global representation but also multiple motion representations.

References