Supplementary information

Hierarchical and Distinct Biological Motion Processing in Macaque Visual Cortical Areas MT and MST

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Anatomical and physiological localization of area MT and MST

We localized MT and MST via a combination of structural magnetic resonance imaging (MRI) scans, stereotaxic coordinates, and functional mapping of their physiological responses to optic flow and translational motion. Here in the Supplement, we provided further anatomical and neurophysiological evidence supporting it for interested readers, while keeping the presentations in the main text more concise and focused on the primary research questions.

We did two MRI scans for each monkey, one pre-surgery to guide chamber implantation and one post-surgery to guide the coordinates of electrode penetration in the grid. In the post-surgery scan we used a modified grid with dye markers (cod liver oil), and under Brainsight Navigator Software these markers extended into the sagittal plane in stereotaxic coordinates (Fig. S1a). We targeted mainly the dorsal subdivision of area MST which was located more posteriorly and medially in the upper bank of superior temporal sulcus, typically in a range of 11-17mm lateral from the midline and 3-7 mm posterior to the interaural plane. Area MT located beneath MST in the lower bank of superior temporal sulcus.

Furthermore, we did two functional mappings for each recorded MT and MST neuron before measuring their responses to BM stimuli. One was the RF mapping in a relatively coarse manner (see Methods). We mapped the visual field in a 9x7 space lattice with five repetitions at each spatial location, which was often insufficient to obtain a reasonably smooth RF map for most neurons. However, the center of RF was relatively less susceptible to neural noise, and this allowed us to quickly decide where to place the motion stimuli on the screen in subsequent experiments. The other was the more quantitative mapping of each neuron's responses to optic flow patterns (expansion/contraction/CW/CCW rotations) and eight translational motions. As in many previous studies[1-3], we also confirmed in our data that MST neurons were more responsive and more selective to optic flow patterns than MT neurons (Fig. S1b). These neurophysiological responses to optic flow provided additional criteria for distinguishing MT from MST.

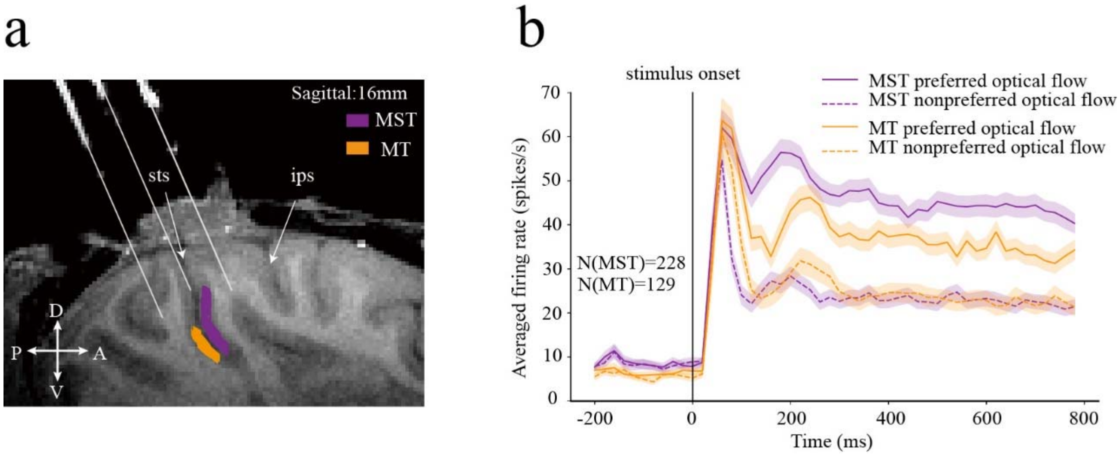

Figure S1: *(a) Chamber-aligned MRI image (scanned with markers) in the sagittal plane showing the regions of interest in one monkey, as implemented by Brainsight Navigator Software; (b): Neurophysiological responses of MST and MT neurons to optic flow patterns.*

Correlation between BM-specific processing and RF eccentricity

Psychophysical studies have shown that the ability to perceive biological motion was always poorer in the periphery than in the fovea[4,5]. This relative deficit persisted even when the peripheral stimulus was scaled up to account for spatial resolution differences. To shed neural insights on the eccentricity-dependent BM recognition performance, we examined the correlations between BM-specific encoding and stimulus eccentricity in area MST and MT.

In our neurophysiological experiments, we placed the BM stimuli at the center of the receptive field (RF) for each recorded neuron (see Methods). This means that stimulus eccentricity in our study was equivalent to neuron’s RF eccentricity. Fig S2 depicted the Pearson correlation between RF eccentricity and form/inversion DI in MST (purple) and MT (orange), respectively. We can see that there were weak but significant negative correlations between RF eccentricity and BM-specific encoding (Form & inversion DI), and this pattern emerged only in area MST but not in MT. These results suggested that

BM-specific processing in the brain was stronger in the fovea than in the periphery, compatible with the psychophysical studies showing the worsened BM detection in the peripheral visual field relative to the central visual field. In a nutshell, our findings provided the neural correlate of eccentricity-dependent BM perception, indicating that the neural resources for BM perception are primarily confined to the central region of the visual field.

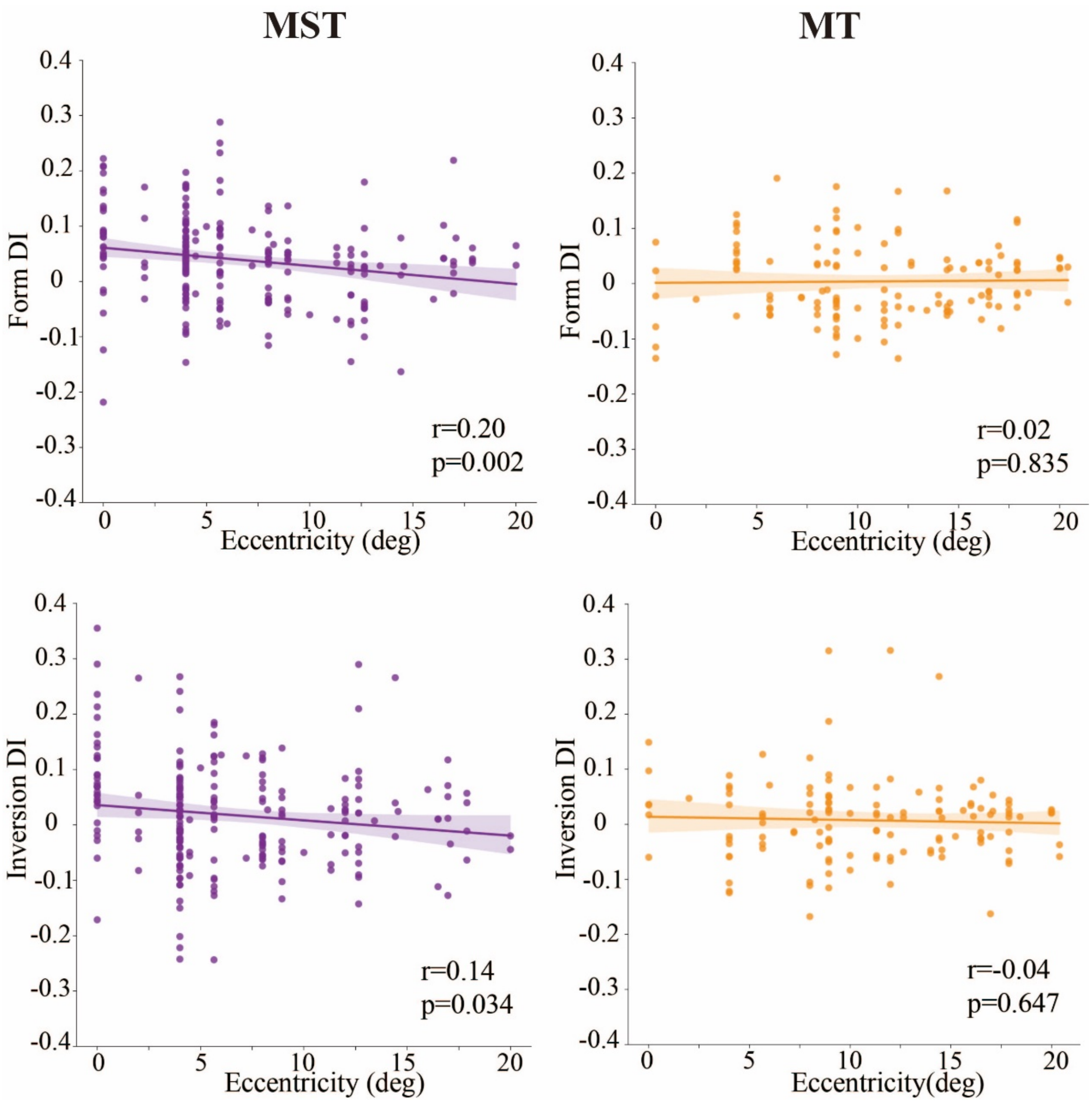

Figure S2: *The Pearson correlation between RF eccentricity and form/inversion DI in area MST (purple) and MT (orange). The results indicated that RF eccentricity was negatively correlated with both form and inversion selectivity in MST but not in MT.*

References

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