Sensitivity of Human Visual Areas MT and MST to Optic Flow Stimuli

Andrew T. Smith[1], Adrian L. Williams[2], Krishna D. Singh[3], and Matthew B. Wall[1]

[1]Dept of Psychology, Royal Holloway, University of London, UK; [2]Dept of Human Sciences, Brunel University, Uxbridge, UK; [3]Neurosciences Research Institute, Aston University, Birmingham, UK.

Background

The motion-sensitive MT/V5 complex in humans is widely assumed to comprise several sub-regions, but limited progress has been made in identifying them. In macaques, this complex includes at least 4 regions (MT, MSTd, MSTl, FST).

A recent study (Huk et al. 2002) has claimed a distinction between two adjacent areas (MT and MST) within the human MT complex. The sub-regions were defined in terms of having a discernible retinotopic organization (MT only) and measurable ipsilateral visual activation (MST only).

We have replicated their findings and examined these sub-regions in terms of specificity to optic flow stimuli, a key characteristic of primate MST.

Methods

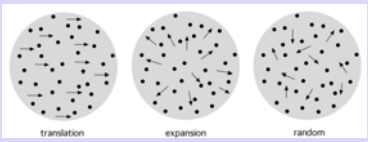
Healthy volunteers were scanned using either a 1.5T GE or a 3T Siemens scanner. EPI images of occipital cortex (voxel size 3x3x3mm, TR=3s) were repeatedly acquired during presentation of visual stimuli.

Stimuli were large (75 deg) fields of moving dots, arranged to form global flow patterns such as translation, expansion or rotation. Random dot motion was also used as a control.

Several block designs (15s epoch, 16 epochs) were employed, in each of which two motion stimuli were alternated. The difference in activation between the two stimuli was examined using SPM99.

The experiments of Huk et al (retinotopic mapping, unilateral stimulation) were also replicated.

T1-weighted scans were acquired with 1mm resolution. These were used to produce flattened representations of occipital grey matter with *StanfordTools*. Activation was then overlaid and visualised with *BrainTools*.



Random dot kinematograms.
Arrows indicate direction of motion.

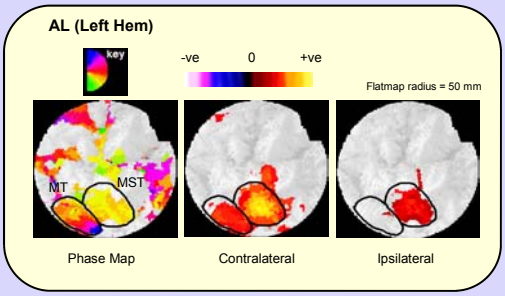
Results: Retinotopy and Ipsilateral Drive

Two distinct sub-regions were found within the human MT/V5 complex, in agreement with the results of Huk *et al.* (2000).

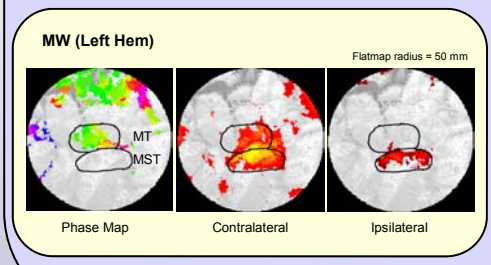
One sub-region (MT) shows strong signs of retinotopic organisation and is only weakly activated by stimuli confined to the ipsilateral visual hemifield.

The second sub-region (MST) is adjacent. It is located anterior to MT. It shows substantial ipsilateral activation and only weak signs of retinotopic organization.

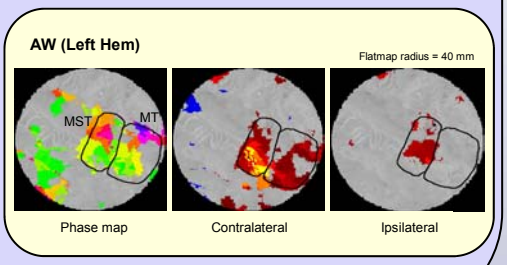
Our results differ from those of Huk *et al.* in the details. We were able to show retinotopic organization in MST, though only in some cases.



This case (AL) has signs of a retinotopic map in MST but it is less compelling than in MT.



This case (MW) has no sign of a retinotopic map in MST



This case (AW) has a clear retinotopic map in MST as well as MT.

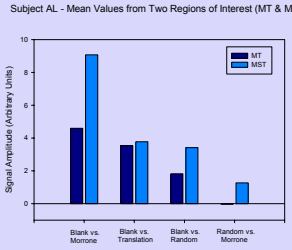
Results: Sensitivity to Optic Flow

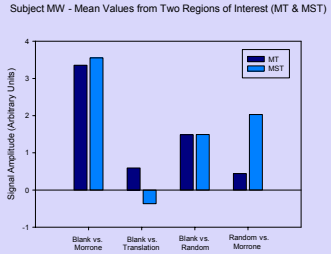
MT

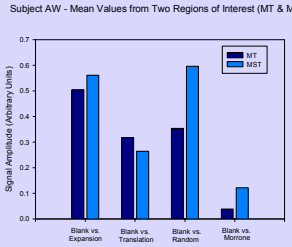
In this area, activity is seen whenever any motion pattern is contrasted with a blank field. But when optic flow is contrasted with random motion, there is no difference, suggesting that MT *is not* sensitive to global motion structure.

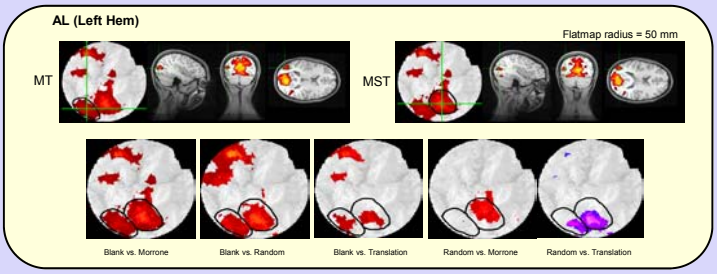
MST

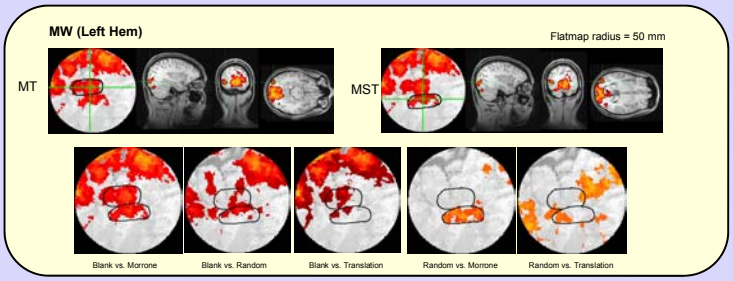
In this area, activation varies markedly with the global flow structure of the pattern. A temporally varying flow stimulus containing a mixture of rotation and expansion (as used by Morrone *et al*, 2000) gives the strongest BOLD response. Pure expansion and translation give weaker responses and random dot motion, less still. The results suggest that human MST *is* sensitive to global motion structure.

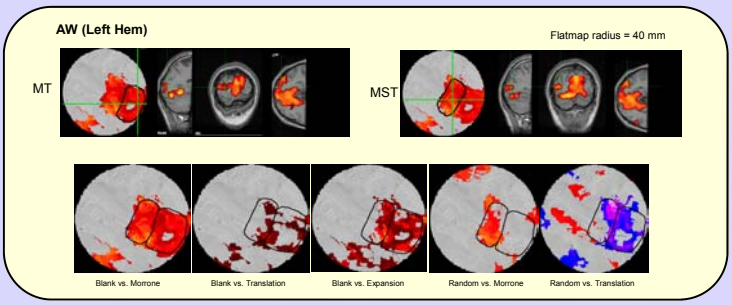












Conclusion

Human MST is sensitive to the global structure of motion stimuli (optic flow). Human MT has no measurable sensitivity to global flow properties

This is in line with neurophysiological findings with non-human primates.

References

Huk AC et al. J. Neurosci. 2002, 22, 7195-7205.

Morrone MC et al. Nat. Neurosci. 2000, 3, 1322-1328

Contact Information

Andy Smith
Royal Holloway, University of London
E-mail: a.t.smith@rhul.ac.uk
Web: http://www.pc.rhul.ac.uk/vision/

This work generously supported by:

The Wellcome Trust