Recurrent Neural Pathways in Motion and Shape Visual Perception: a TMS Study

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Introduction

Various areas of the visual cortex are connected with feedback neuronal paths. The purpose of this study was to prove the need for a recurrent processing of visual information for successful performance of visual tasks.

Using TMS, Silvanto et al. (2005) inhibited the primary visual (V1) and middle temporal (MT) areas at different time intervals and showed that for successful motion detection, a stimulus should be processed first in V1, then in MT, then again in V1.

Wokke et al. (2013) used the same method and showed that for successful shape detection, stimulus should be processed first in the lateral occipital area (LO) and then in V1.

These and other similar studies lead to an assumption that recurrent neural pathways (between V1 and a stimulus-specific extrastriate area) are critical for visual perception.

Hypothesis

Using TMS inhibition it is possible to dissociate the two recurrent pathways:

- V1->MT->V1 for motion perception
- V1->LO->V1 for shape perception

Conclusion

We observed the following two recurrent pathways:

- V1->MT&V1 for motion perception
- V1->extrastriate cortex->V1 for shape perception

Both motion and shapes perception require reprocessing in V1.

References

Silvanto, J., Lavie, N., & Walsh, V. (2005). Double dissociation of V1 and V5/MT activity in visual awareness. *Cereb Cortex*, *15*(11), 1736-1741. doi: 10.1093/cercor/bhi050

Wokke, M. E., Vandenbroucke, A. R., Scholte, H. S., & Lamme, V. A. (2013). Confuse your illusion: feedback to early visual cortex contributes to perceptual completion. *Psychol Sci*, *24*(1), 63-71. doi: 10.1177/0956797612449175

Methods

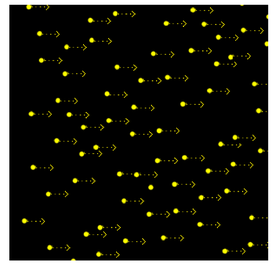
- **Conditions**
- 2 discrimination tasks were used as controls to each other:
  - Motion detection task (10 subjects)
  - Shape detection task (19 subjects)

  All stimuli had 48 ms duration
- 3 visual areas were inhibited:
  - V1 (localized with the phosphenes method)
  - MT (moving phosphenes method & coordinates taken from previous fMRI studies)
  - LO (coordinates taken from previous fMRI studies)

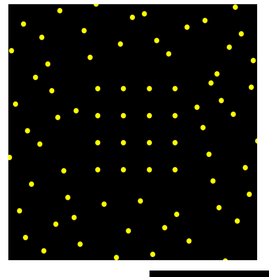
  No-TMS condition was used as a baseline
- TMS time intervals varied from 20-40 to 140-160 ms after stimulus offset

Statistical method: LME models controlling individual variability

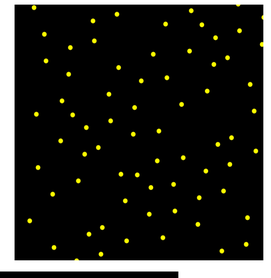
Motion target

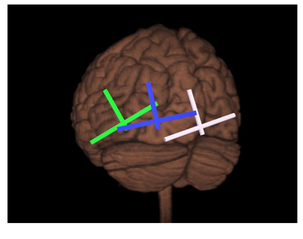


Shape target



Distractor for both tasks





Results

- **V1**

For moth tasks, 2 critical periods were observed. Both motion and shape should be processed in V1 2 times

- **Stimulus-specific extrastriate area**

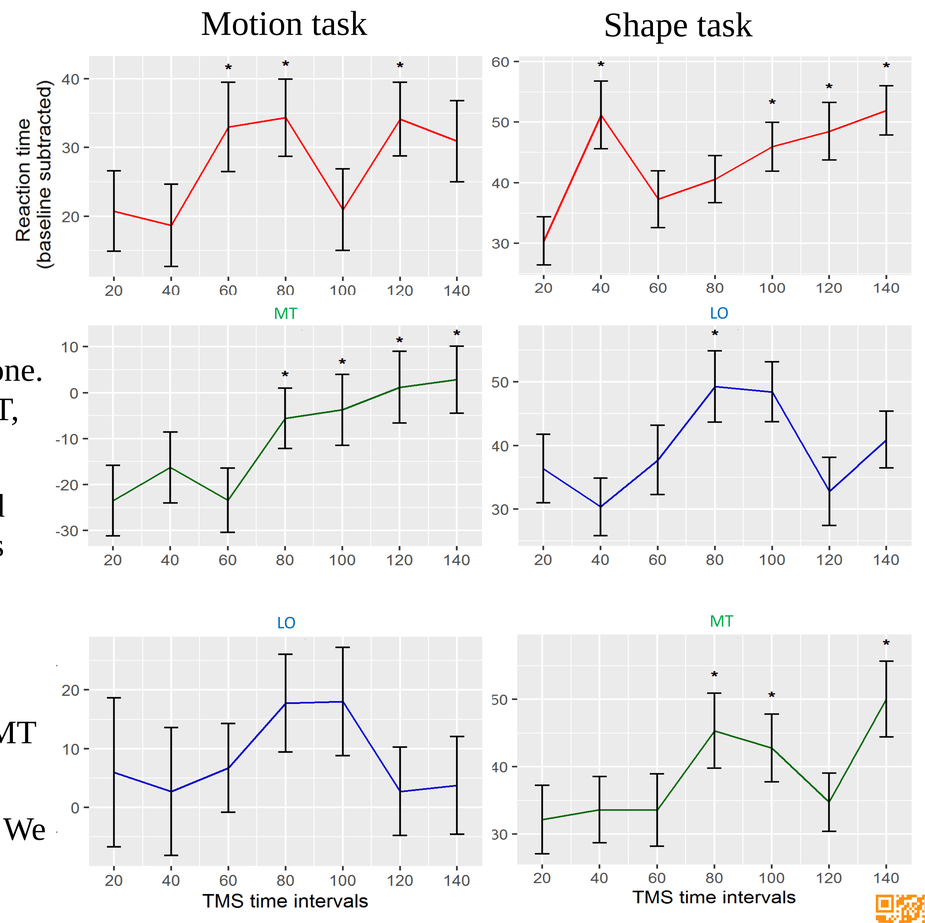
For motion detection, MT critical interval starts after the 1st V1 critical interval and continues with the 2nd one. Motion stimulus was processed first in V1, then in MT, then in V1&MT.

For shape detection, LO critical interval was observed between two V1 critical intervals. Shape stimulus was processed first in V1, then in LO, then again in V1.

- **Control area**

For motion detection, the control LO area was not critical. We managed to dissociate a motion-specific MT area.

For shape detection, the control MT area was critical. We did not manage to dissociate a shape-specific area.



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