On the neural basis of spontaneous reversals in the perception of apparent motion

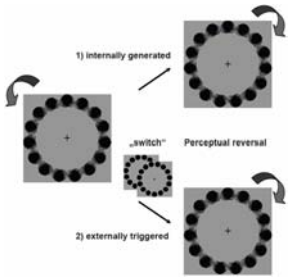
Rüdiger Ilg, Stefan Burazanis, Afra M. Wohlschläger, Andreas Wöller, Mark Mühlau
Neurologische Klinik, Klinikum Rechts der Isar
Technical University Munich

Introduction

Reversible figures have been used to study the percept generation and temporal integration of visual information. In static ambiguous figures it is difficult to distinguish the underlying perceptual reversal mechanism from effects secondary to the changing perceptual content. In how far the observed perceptual reversal emerges from early processes at lower levels of the visual system, or results from influences of higher cognitive processes, remains unclear. Both, top-down and bottom-up models of perceptual reversals, have been discussed. Using the apparent motion of ambiguously rotating circles we could show that the reversal of the perceived rotation direction can be triggered by a short irregularity in the stimulus sequence which is not consciously perceived. This paradigm allows us to directly compare perceptual reversals that are either internally generated or externally triggered and thus to focus on the underlying neural process of perceptual reversals.

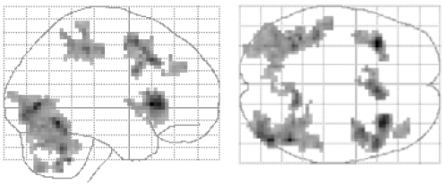
Methods

Two circles of black dots were alternately displayed with an offset-angle of 12° (5 frames per second), thus inducing the impression of an ambiguously rotating circle. In half of the trials reversals were externally triggered by so-called “switch”-events (frames with doubled duration) that were randomly inserted before the mean perceptual reversal. Reversals of the rotation direction were indicated by button-press. Two conditions were studied: 1) internally generated reversals, and 2) externally triggered reversals. fMRI scanning was performed on 20 healthy volunteer subjects using a Siemens Symphony Scanner (1,5 T). The stimuli were presented in an event-related design. The statistical analysis was performed with SPM 2.

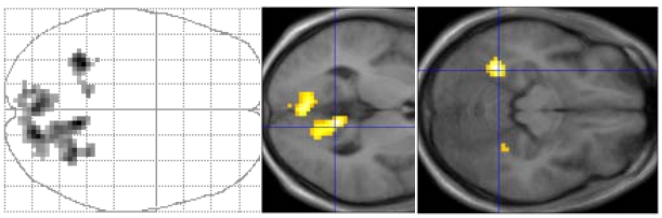


Results

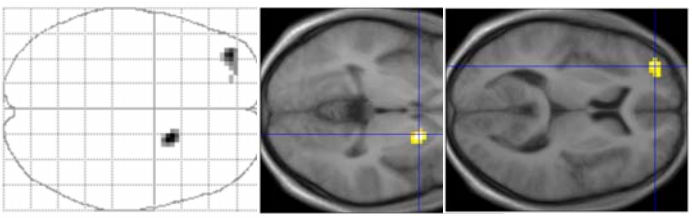
Perception of ambiguous apparent motion (all vs. baseline):
The overall contrast resulted in a broad bilateral activation of the extrastriate visual cortex, predominantly at the occipitotemporal junction (hMT+/V5), the fusiform gyrus, inferior frontal cortex, insula, somatosensory cortex, motor cortex, parietal cortex, pre-SMA and cerebellum (30 voxel, p < .05 corrected, miniblock).



Internal vs. external perceptual reversals:
Differential activation of the primary visual cortex (BA 18/17, r>l), fusiform gyrus, and superior parietal cortex (30 voxel, p <. 001 uncorrected, response locked).



External vs. internal perceptual reversals:
Differential activation of the left inferior frontal cortex and ríght putamen (30 voxel, p < .001 uncorrected, response locked).



Conclusion

The activation of the human motion complex, frontal and parietal areas during the perception of ambiguously rotating circles is in line with previous studies on the perception of apparent motion and spontaneous direction reversals[1,2]. The direct comparison of internally generated and externally triggered perceptual reversals reveals an activation of the primary visual cortex (V1/V2) and left fusiform gyrus for internally generated reversals, whereas externally triggered reversals resulted in an activation of the left prefrontal cortex and right putamen. The differential activation of primary visual areas in internally generated perceptual reversals is interpreted as evidence for a bottom-up mechanism of perceptual reversals originating at early visual processing levels. This process can be modulated by top-down influences of higher cortical areas as shown by the frontal activation in external triggered reversals.

References

1) Sterzer, P., Russ, M. O., Preibisch, C., & Kleinschmidt, A. (2002). Neural correlates of spontaneous direction reversals in ambiguous apparent visual motion. Neuroimage 15 (4)
2) Muckli, L., Kriegeskorte, N., Lanfermann, H., Zanella, F. E., Singer, W., & Goebel, R. (2002). Apparent motion: event-related functional magnetic resonance imaging of perceptual switches and States. J Neurosci 22 (9)

HBM 2006, June 11 – 15, Florence