

# The vestibular frame for visual perception of head rotation

Albert V. van den Berg; David Arnoldussen; Jeroen Goossens

Author Affiliations

- Albert V. van den Berg

Functional Neurobiology, Helmholtz Institute, Utrecht University, The Netherlands  
Dept. Biophysics, Donders Institute for Brain Cognition and Behaviour, Centre for Neuroscience, Radboud University Nijmegen Medical Centre

- David Arnoldussen

Dept. Biophysics, Donders Institute for Brain Cognition and Behaviour, Centre for Neuroscience, Radboud University Nijmegen Medical Centre

- Jeroen Goossens

Dept. Biophysics, Donders Institute for Brain Cognition and Behaviour, Centre for Neuroscience, Radboud University Nijmegen Medical Centre

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## Abstract

The visual flow provides the brain with important information about the changing orientation of eye, head, and body and the direction of movement. The visual flow related to *translation* and *rotation* of the eye is processed in extra-striate areas in combination with an extra-retinal signal like eye-in-head movement. Previously we have shown that the putative human homologue of monkey area MST includes a subregion with BOLD signals that represent the (simulated) rotation of the subject's head. Here we investigate the 3D organisation of this capacity. We simulated forward motion through a 3D cloud of dots along a sinusoidal trajectory. Thus, the gaze line rotated relative to the environment about an axis perpendicular to the plane of the trajectory. As in our previous study we decoupled the retinal rotation (as determined by the gaze rotation) from the simulated head rotation *about the same axis*, by combining identical gaze rotation with different eye pursuit conditions. We varied the axis of rotation between vertical and various axes in the horizontal plane of the head. Using wide-field (120 deg diameter) presentation of such stimuli to 6 subjects and, recording BOLD signals at 1.0 mm resolution (Siemens 3T), we observed distinct locations within human pMST for the vertical axis and for two horizontal axes aligned with the posterior and anterior canals of the vestibular system. These subregions were characterised by BOLD signals that varied in proportion to the simulated speed of rotation of the *head* and no modulation by the gaze rotation. The same two areas related to the horizontal vestibular axes were activated by simulated head pitch. These data indicate that the processing of visual flow and eye-in-head movement signals to represent head rotation is arranged in a vestibular frame of reference. We present perceptual evidence to probe this notion further.

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