Translational Vestibulo-Ocular Reflex and Motion Perception During Interaural Linear Acceleration: Comparison of Different Motion Paradigms

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The neural mechanisms to resolve ambiguous tilt-translation motion have been hypothesized to be different for motion perception and eye movements. Previous studies have demonstrated differences in ocular and perceptual responses using a variety of motion paradigms, including Off-Vertical Axis Rotation (OVAR), Variable Radius Centrifugation (VRC), translation along a linear track, and tilt about an Earth-horizontal axis. While the linear acceleration across these motion paradigms is presumably equivalent, there are important differences in semicircular canal cues. The purpose of this study was to compare translation motion perception and horizontal slow phase velocity to quantify consistencies, or lack thereof, across four different motion paradigms. Twelve healthy subjects were exposed to sinusoidal interaural linear acceleration between 0.01 and 0.6 Hz at 1.7 m/s/s (equivalent to 10° tilt) using OVAR, VRC, roll tilt, and lateral translation. During each trial, subjects verbally reported the amount of perceived peak-to-peak lateral translation and indicated the direction of motion with a joystick. Binocular eye movements were recorded using video-oculography. In general, the gain of translation perception (ratio of reported linear displacement to equivalent linear stimulus displacement) increased with stimulus frequency, while the phase did not significantly vary. However, translation perception was more pronounced during both VRC and lateral translation involving actual translation, whereas perceptions were less consistent and more variable during OVAR and roll tilt which did not involve actual translation. For each motion paradigm, horizontal eye movements were negligible at low frequencies and showed phase lead relative to the linear stimulus. At higher frequencies, the gain of the eye movements increased and became more in-phase with the acceleration stimulus. While these results are consistent with the hypothesis that the neural computational strategies for motion perception and eye movements differ, they also indicate that the specific motion platform employed can have a significant effect on both the amplitude and phase of each.

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