Gravito-inertial force resolution in perception of synchronized tilt and translation
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Natural movements in the sagittal plane involve pitch tilt relative to gravity combined with translation motion. The Gravito-Inertial Force (GIF) resolution hypothesis states that the resultant force on the body is perceptually resolved into tilt and translation consistently with the laws of physics. The purpose of this study was to test this hypothesis for human perception during combined tilt and translation motion. EXPERIMENTAL METHODS: Twelve subjects provided verbal reports during 0.3 Hz motion in the dark with 4 types of tilt and/or translation motion: 1) pitch tilt about an interaural axis at ±10° or ±20°, 2) fore-aft translation with acceleration equivalent to ±10° or ±20°, 3) combined "in phase" tilt and translation motion resulting in acceleration equivalent to ±20°, and 4) "out of phase" tilt and translation motion that maintained the resultant gravitoinertial force aligned with the longitudinal body axis. The amplitude of perceived pitch tilt and translation at the head were obtained during separate trials. MODELING METHODS: Three-dimensional mathematical modeling was performed to test the GIF-resolution hypothesis using a dynamical model. The model encoded GIF-resolution using the standard vector equation, and used an internal model of motion parameters, including gravity. Differential equations conveyed time-varying predictions. The six motion profiles were tested, resulting in predicted perceived amplitude of tilt and translation for each. RESULTS: The modeling results exhibited the same pattern as the experimental results. Most importantly, both modeling and experimental results showed greater perceived tilt during the "in phase" profile than the "out of phase" profile, and greater perceived tilt during combined "in phase" motion than during pure tilt of the same amplitude. However, the model did not predict as much perceived translation as reported by subjects during pure tilt. CONCLUSION: Human perception is consistent with the GIF-resolution hypothesis even when the gravito-inertial force vector remains aligned with the body during periodic motion. Perception is also consistent with GIF-resolution in the opposite condition, when the gravito-inertial force vector angle is enhanced by synchronized tilt and translation.

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