Vibrational cues enhance the perception of illusory self-motion (vection)

Jörg Schulte-Pelkum, Bernhard E. Riecke, & Heinrich H. Bülthoff
Max-Planck-Institut für biologische Kybernetik, Tübingen, Germany

Poster presented at IMRF 2004, Barcelona

Max-Planck-Gesellschaft

MPI FOR BIOLOGICAL CYBERNETICS

www.poems-project.info
Support: EU project POEMS-IST-2001-39223 and Max-Planck Gesellschaft

• Introduction

Can vibrational cues enhance the visually induced illusion of self-motion (vection)?

Multi-modal aspects in ego-motion perception have hardly been studied so far.

If one is stationary and sees a large visual stimulus moving at a constant velocity into one direction, one experiences after some time a compelling illusion of self-motion to the direction opposite to the visual motion. This self-motion illusion (vection) can be induced by visual, auditory, or tactile stimulation (see Dichgans & Brandt, 1978; Lackner, 1977).

The present study investigated whether visually inducedvection can be enhanced by adding vibratory cues. Up to now, potential multi-modal effects on the perception of vection have hardly been studied. The overall goal of this research program ("POEMS") is to enhance ego-motion simulation by providing consistent multi-sensory information about self-motion.

• Method

Hypotheses: A) Adding vibrations to visual motion should enhance vection, B) If subjects know that they can be really moved physically, this should increase vection.

Procedure: Participants pressed a button, upon which the scene started to rotate. The task was to report when they started to see egomotion. They were asked to stand in front of a mirror and report the movement of their images.

Independent variables: 1) Vibrations (on/off), 2) Acceleration profile of visual stimulus (3 or 12 sec to reach 30°/s), 3) Platform on/off

Dependent variables: 1) Vection onset time, 2) Vection velocity, 3) Vection confidence rating

• Results

Vection onset times yielded shorter vection onset time vs. baseline. The condition with vibrations induced a sensation of self-motion. The main results from 24 participants are plotted in Fig. 6 and Fig. 7. Repeated-measures ANOVAs showed the following effects: Vibrations reduced vection onset times (F(1,21)=8.34, p<.009), and increased the convincingness of the illusion (F(1,21)=3.82, p<.011). There was absolutely no effect of the platform on/off conditions on the vection data. Interestingly enough, though, 67% of the participants believed that they had really moved (see Fig. 8). Vection intensities as measured by % joystick deflection were not affected by any of the factors varied (vibrations, platform on/off, acceleration time - plots are not shown here). Acceleration time had a significant effect on vection velocities: With short accelerations, onset times were reduced (F(1,21)=26.74, p<.001).

The main hypothesis was corroborated: Vibrations enhanced vection.

The condition with vibrations is more convincing than the baseline condition. The main hypothesis was corroborated: Vibrations enhanced vection.

In summary, the hypothesis that vibrations enhance the vection illusion was corroborated. Vibrations reduced the vection onset latencies and increased the convincingness ratings of illusory self-motion. Even though the “platform on” condition did not influence the vection data, 67% of the participants believed that they had actually moved. In most of these cases, the vibrations had been on. Interestingly, 3 participants had noticed a conflict between vibrations and visual motion, since the vibration amplitudes were not matched to the visual velocity profiles. In these cases, they reported that the illusion became unrealistic. Most of the participants reported that they had imagined themselves being on a moving vehicle on the market place, and that the vibrations supported that imagination and made it “more real”.

From these results, we conclude that the facilitating effect of vibrations on vection are moderated by cognitive factors. It seems that vibrations, if applied properly, can enhance the sensation of vection if they are attributed to some locomotion device. On the other hand, if conflicts between visual and vibrational cues are noticed, the vibrations impaired vection. These results show that there are multi-sensory interactions in the perception of ego-motion, which has important implications for motion simulator design.

• Discussion & Conclusion

The study investigated whether visually induced vection can be enhanced by adding vibratory cues. The main result was that vibrations reduced vection onset times and increased the convincingness ratings of vection. Additionally, 67% of the participants believed that they had really moved. These results suggest that multi-sensory interactions in the perception of ego-motion, which has important implications for motion simulator design.