Comparing the Effectiveness of Stereo Projection versus 3D TV in Inducing Self-Motion Illusions (Vection)

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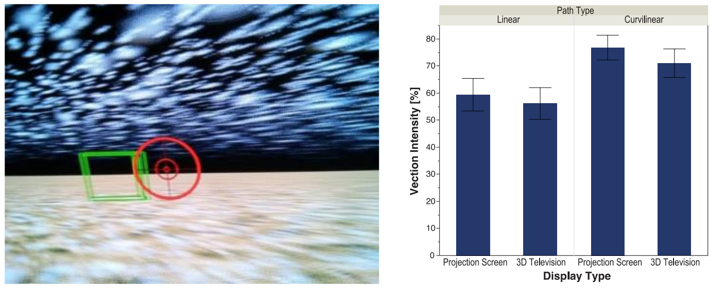

Figure 1: *Left: A picture of the virtual environment in which the tasks were performed, showing the green follow-me object and red cross-hair. Right: Vection intensity for projection screen and 3D television by path type. Error bars represent 95% confidence intervals.*

1. Introduction

A necessary part of developing effective and realistic Virtual Reality (VR) simulations is emulating perceptual sensations that occur to humans in corresponding natural environments. VR users are often seated and unable to freely move through the virtual world, therefore necessitating other means to simulate and perceive self-movement. One approach to tackle this challenge is to induce embodied *illusions* of self-motion ("vection") in stationary observers, typically by providing moving visual stimuli on a wide field-of-view display. While numerous stimulus parameters have been shown to affect vection [see Riecke, 2011 for a review], there is little research investigating how the type of display itself might contribute. Here, we compared the vection-inducing potential as well as user experience and usability of two common displays for large-field stimulation: A passive stereoscopic projection setup and a 3D television with shutter glasses. Uncovering differences in vection between these displays would contribute to the theoretical understanding of vection and the potential relevance of different display properties, and guide the development of more immersive and effective VR setups. From a practical standpoint, this study helps to determine whether the more expensive projection system provides a benefit over the more accessible and affordable 3D television.

2. Methods

Twenty-three participants reported the intensity of visually-induced linear forward vection ("vection in depth") and curvilinear vection (same forward velocity of 5m/s, but with an additional constant curvature of 24°/s). Using a 2×2 counter-balanced within-subjects design, the independent variables were display type (3D television vs. projection screen) and path type (linear vs. curvilinear). The virtual environment used was comprised of a simple ground texture and snowflake-like white spots intended to provide strong optic flow but no landmarks (see Figure 1, left). The stereoscopic projection system consisted of two InFocus IN5500 projectors (1920×1200 pixel each), passive polarization glasses, and a flat polarisation-preserving screen of 2.45m × 1.55m. The 3D TV setup was a 1920×1080 pixel 50 inch Panasonic TC-P50UT50 3D Television with active shutter glasses. For both displays, participants' viewing distance was adjusted to yield the same horizontal field of view of 72°. Seated participants were asked to use a joystick to follow a green cube through the virtual environment to mimic the typically used active locomotion control in VR. Following the experiment, participants were interviewed to gauge their attitudes towards the displays in regards to vection intensity, motion sickness, immersion, and overall preference.

3. Results and Discussion

A 2×2 repeated-measures ANOVA revealed no significant main effect of display type (3D TV vs. projection screen) on vection intensity, $F(1, 22) = 1.45$, $p = .241$. However, curvilinear paths induced overall more intense vection than linear paths as illustrated in Figure 1 (right), $F(1, 22) = 23.01$, $p < .001$. There was no significant interaction between display type and path type, $F(1, 22) = .521$, $p = .478$. Although there were no significant differences in overall display preference, motion sickness, or immersion ratings, participants who felt that the 3D TV was more immersive referenced the clarity of the display. Participants rating the projection system as more immersive commonly attributed this to the larger size of the projection screen and the smoothness of the graphics. In conclusion, this study suggests that overall user experience and reported vection seems relatively tolerant towards changes in display type as long as the field of view is kept constant. Carefully planned research that systematically varies only one factor at a time to reduce potential confounds is needed to more systematically investigate potential influences of specific display factors like contrast, overall luminance, display size, viewing distance, or perceived image sharpness.

References

RIECKE, B. E. (2011). Compelling self-motion through virtual environments without actual self-motion – Using self-motion illusions ("vection") to improve user experience in VR. In J. Kim (Ed.). *Virtual Reality*. InTech. 149–176.

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