Seen it, heard it, felt it, got the t-shirt!

The effects of multisensory cues on the sense of presence and on the task performance in a virtual reality environment.

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Background

- **Presence** - subjective experience of being in one place or environment, even when one is physically situated in another (Witmer and Singer, 1998)

User experience

- **Multisensory feedback** - extra sensory cues increase sense of presence and task performance (Akamatsu et al, 1995)
- **Body posture** - sensory information, configuration of the environment, modulated by auditory, tactile and visual spatial references and **good measure of presence** (Meyer et al., 2013).

Tactile feedback in VR

- \+ positive effect on realism, increase task performance, work well in additional cues (Jacko et al, 2004, Akamatsu et al, 1995)
- \- decreased performance, distracting and annoying (Brewster, 2003, Vitense et al, 2003)

Aim of the study

- Investigate which sensory feedback contribute most to task performance and sense of presence in virtual reality environment.

Hypotheses

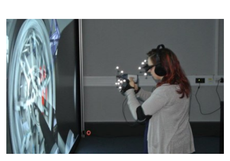
- Faster overall completion times and higher sense of presence when multimodal feedback is presented
- Slower overall completion time and increased reports of discomfort in sway condition

Methods - 16 participants, 3D power wall at Virtual Engineering Centre, drilling tool, gloves

Measures

- Objective –task performance,
- Subjective - SSQ, PQ questionnaire

Experimental set up :



Task:
Participants were required to change a wheel of a (virtual) racing car in the 3D environment as fast as they can.

Feedback cues:

Audio – screwing sound on bolts, 'snap' sound on the wheel
Visual – virtual hand, bolts, and wheel change color when in contact
Tactile– vibration when in contact, higher vibration at the end of screwing

Conditions - A, V, T, AV, AT, AVT, NONE
2 exp. blocks – normal vs. motion VR (2cm movement of

Sensory modalities in VR

Vision is most dominant in reality and virtual reality environments

Audio adds on naturalness of the environment and can facilitate performance when visual overload

Force-feedback (tools in VR) and Vibro-tactile (mobile devices) realistic tactile feedback is hard to achieve in VR – need of robot/phantom system to provide resistance.

Virtual engineering centre

•offers fantastic facilities for advances in modelling , simulation and 3D immersive visualization

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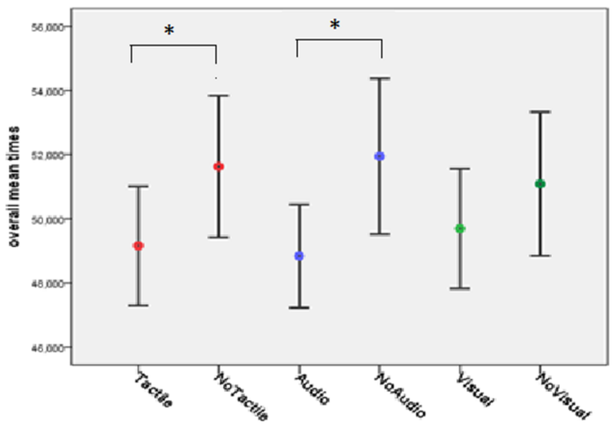
Main effect condition
(F(7,112) =1.977,p=0.06).
Tactile vs. no-tactile (p=0.05)
Audio vs. no-audio (p = 0.03)



Objective and Subjective data— Modulation of the environment

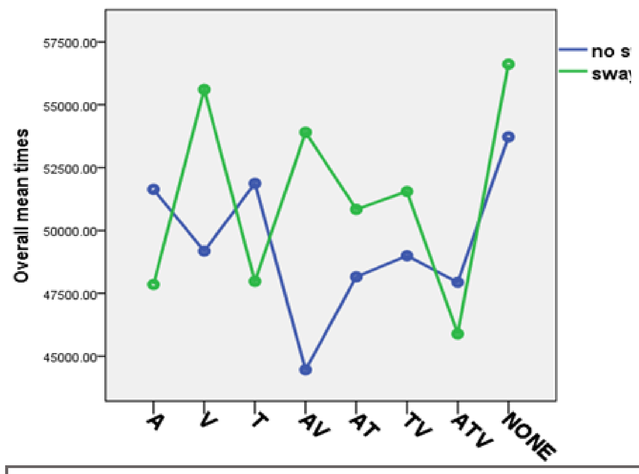
SSQ – participants reported higher levels of discomfort when they performed task in sway condition as compared to non-sway condition.

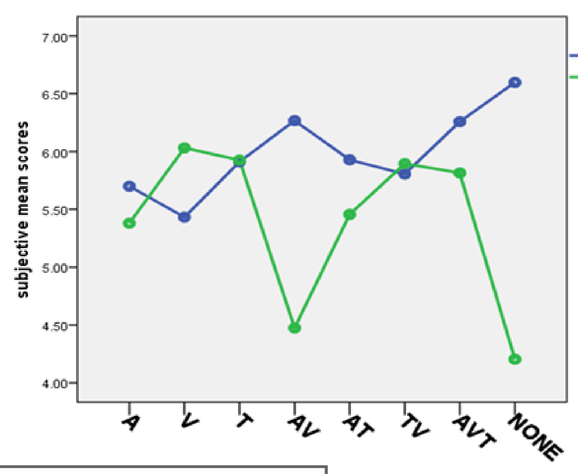
2 experimental blocks - normal and moving (2cm movement of depth plane at 0.5 Hz)

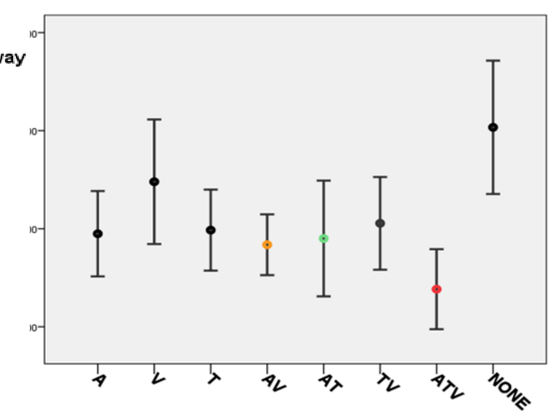
Objective and Subjective data - Overall times

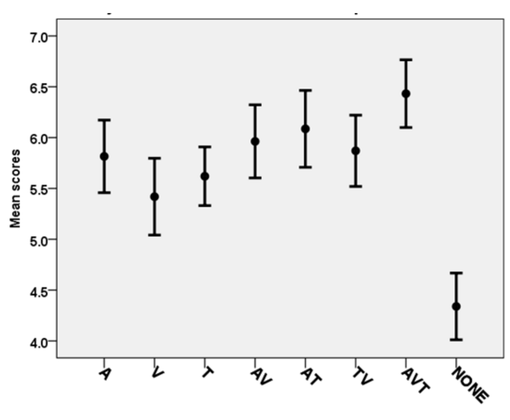
None vs ATV = p = 0.02 none vs all rest –p<0.001

None vs – Tactile – p= 0.03









Correlation between perceived discomfort and perceived sense of presence:
SSQ and PQ (no sway) r = -0.6934, p=0.0029
SSQ and PQ (sway) r= -0.5136., p=0.04

Conclusion

- We need to include user experiences when investigating usability of feedback signals.
- Audio, tactile and visual cues are important additional cues that add to objective performance and subjective evaluation.

Future Implications:

- Tactile and visual cues are not realistic - they provide relevant information in an unrealistic fashion – still enhanced sense of presence – sensory substitution is worthwhile.
- Learning in VR – how well do these cue translate into real environments? – new experiments
- Our findings are relevant to future design of virtual reality systems with multimodal feedback.

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