A preliminary investigation into the effect of nauseogenic vection and whole-body heating on motion sickness severity: a combined and individual stressors approach

[Abstract]

This item was submitted to Loughborough University’s Institutional Repository by the/an author.

Citation: ARNOLD, J.T. ., et al., 2018. A preliminary investigation into the effect of nauseogenic vection and whole-body heating on motion sickness severity: a combined and individual stressors approach. FASEB Journal, 32(1 supplement), Abstract no. 590.24.

Additional Information:

- This paper is in closed access. This abstract is from the Experimental Biology 2018 Meeting.

Metadata Record: https://dspace.lboro.ac.uk/2134/33180

Version: Submitted version

Publisher: © Federation of American Society of Experimental Biology

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THE EFFECT OF NAUSEOGENIC VECTION AND WHOLE-BODY HEATING ON MOTION SICKNESS SEVERITY: A COMBINED AND INDIVIDUAL STRESSORS APPROACH.

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Introduction: The use of virtual reality for training, medical and recreational applications is limited by the side effects of prolonged exposure to vection. Secondary factors such as ambient temperature may be crucial in modulating the onset and severity of these side effects. To understand the role of environmental temperature in modulating nausea in virtual reality, this preliminary investigation explored the differential impacts a hot ambient temperature and vection on motion sickness severity using an individual and combined stressors approach.

Methods: Thirteen healthy individuals (eight female, five male, 25 ± 3 yrs) watched a 22 min pre-recorded driving simulator clip sequence across four experimental conditions; N_C: 22°C ambient temperature with computer screen, N_VR: 22°C ambient temperature with VR headset, H_C: 35°C ambient temperature with computer screen, H_VR: 35°C ambient temperature with VR headset. Subjective measures for visually induced motion sickness were explored using the fast motion sickness scale (FMS; 0-20 visual analogue scale) and the simulator sickness questionnaire (SSQ) both during and following exposure to each condition. To explore the effect of vection and whole-body heating on physiological indices of motion sickness, local sweat rate (via ventilated sweat capsules), rectal temperature, skin blood flow (via laser Doppler flowmetry), skin temperature, blood pressure and heart rate were examined.

Results: FMS and SSQ ratings indicate a significant main effect for vection, increasing sickness severity (Δ in FMS, 3.7 ± 2.6 and SSQ, 8.7 ± 7.3; p<0.001). A Significant main effect for ambient temperature on SSQ, increasing sickness severity, (Δ SSQ, 2.8 ± 5.1; p=0.04), but not FMS (Δ FMS 0.7 ± 1.7; p=0.07). No interaction (vection*temperature) for FMS (p=0.2) or SSQ scores (p=0.07), indicating an additive response, however a noticeable difference in the magnitude of mean change between H_C and H_VR, compared to N_C and N_VR, indicating signs of a synergistic interaction. No interaction was observed across physiological parameters (p>0.1). However, a visual inspection of sweat rate data again revealed a noticeable difference in the magnitude of mean change between H_C and H_VR, compared that for N_C and N_VR, indicating signs of an interaction. A similar trend found for cutaneous vascular conductance.

Conclusion: The principal finding provides no significant evidence for interaction between a temperature and vection on perceived VIMS ratings, yet a trend for synergism observed in the SSQ scores immediately following exposure. Physiological assessment of sweat rate and cutaneous vascular conductance, variables known to change in the presence of motion sickness, also show initial trends towards synergistic interaction (vection*temperature). Close inspection of the data shows partial evidence for responders and non-responders, thus potentially masking the presence of any possible interaction which may be otherwise seen in those who respond. Investigation into the combined stress of heat and true motion, for direct comparison to the current study, provides an intriguing area for future investigation.