Motion-based Equilibrium Reprocessing Therapy

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9. Summary

In the introductory chapter the importance of congruent sensory function is emphasized and especially how this relates to vestibular functioning in health and disease. The focus is laid on motion sickness and chronic peripheral vestibular disease. In these areas we see that people habituate to the new situation, which is also called equilibrium reprocessing. Focus in this thesis was laid on the potential respiratory impact on motion sickness and the possible consequences for the design of military motion sickness desensitization programs. Furthermore, it is hypothesized that these principles of military motion sickness desensitization might be transferred to the treatment of vestibular disease. In fact, this approach for motion sickness desensitization and vertigo treatment could be summarized as Motion-based Equilibrium Reprocessing Therapy.

In chapter 2 cardiorespiratory parameters on a rotating chair are investigated as the fore-aft torso movements are part of the motion sickness desensitization programs and respiratory relaxation techniques are applied successfully in these courses. It is hypothesized whether these repetitive trunk movements by themselves may induce hyperventilation and consequently add to the motion sickness. The hyperventilation provocation test, performed prior to the actual experiment, did not result in nausea. During the rotation of the chair none of the cardiorespiratory parameters was significantly different from baseline measures. On an individual level, however, sustained hyperventilation was seen. The findings show that hyperventilation is not the main cause of nausea during Coriolis effects on a rotating chair. It is concluded that measuring cardiorespiratory parameters is not necessary during motion sickness desensitization programs, but as hyperventilation does occur on an individual basis it is advised to pay attention to respiratory parameters.

In chapter 3 the effect of alignment to the gravito-Intertial Force (GIF) on the development of motion sickness during low-frequency horizontal motion was investigated. Subjects were seated on the ESA-sled while a sinusoidal movement (0.176 Hz) across the 6 m long track was performed. There were three experimental conditions in which the ESA-sled cabin was either not, partially or fully compensated for the GIF. There were no significant differences between the conditions, although a survival series pointed towards a possible temporary protection for the development of motion sickness in the condition that partially compensated for the GIF. An analysis of predictive values revealed that initial symptoms (but no nausea) or absence of these initial symptoms early in the runs predicted the occurrence or absence of nausea during the experiment. It was concluded that there seems to be a rationale to partially compensate for the GIF while trying to prevent motion sickness. Lastly, a significant drop in relative end-tidal CO_2 levels is seen. It is hypothesized that this might be a sign for pulmonary compensation for the nauseating stimulus.

In chapter 4 the 6DoF DESDEMONA motion platform was used to investigate the role of the frequency of oscillatory linear motion on the development of motion sickness, the impact on respiratory variables and the occurrence of enforced breathing due to

the motion stimulus. A special interest went out to the relative high motion sickness incidence found in the literature at 0.167 Hz as normal breathing frequency is close to this frequency. The results show that with increasing stimulus frequency (0.05 Hz- 0.8 Hz) an increased likelihood for synchronization of the breathing frequency with the stimulus frequency seems to be present. With increasing stimulus frequency a steady increasing drop in end-tidal CO_2 levels is seen. Also there seems to be a maximum incidence of motion sickness around the 0.2 Hz range and this is in accordance with the available literature. It is concluded that the high motion sickness incidence at 0.167 Hz is not due to enforced breathing, since enforced breathing increases with higher stimulus frequencies. At an individual level it was seen that an induced hyperventilatory response through the motion stimulus can result in 'sickness during motion' and it is stressed out that this should not be confused with motion sickness.

In chapter 5 the 6DoF CAREN motion platform was used to investigate the possibilities to extrapolate principles of military aviation vestibular desensitization programs to chronic peripheral vestibular disease. Preliminary results of the Motion-based Equilibrium Reprocessing Therapy are presented. Patients were exposed to sinusoidal vertical passive whole body motion in increasing intensity for a maximum of 10 sessions. The therapy was well tolerated and a dramatic symptom change occurred. Subjects experienced less handicap and an increase in level of functioning.

In chapter 6 the extended possibilities of the CAREN motion platform were used to qualitatively and quantitatively investigate the influence of optokinetic roll stimuli on walking stability. In front of the subjects a virtual roll dome was projected on a 6 m 180° field-of-view screen. Subjects walked at a constant speed. Subjects experienced severe gait disturbances, tilt and an impossibility to compensate for the roll stimulus. It is concluded that optokinetic roll stimuli decrease walking stability and most probably increase the risk of falling. This study also demonstrates the importance of well-calibrated visual stimuli while using simulation techniques within the field of rehabilitation.

In Chapter 7 the results of the thesis are put in perspective and future prospects are given. It is concluded that the peak motion sickness incidence seen at 0.2 Hz is not due to enforced breathing. The financial and practical reasons why a follow-up study at larger g-levels is not possible in the near future are discussed. Furthermore it is advised to substantiate the results of Motion-based Equilibrium Reprocessing Therapy in a larger study, preferably a randomized clinical trial. As the use of virtual reality in rehabilitation practice becomes more common important aspects of successful use of virtual reality are highlighted. Lastly, the reasons why a combined transdisciplinary approach in vestibular research should be strived for is stressed out.