Igarashi, Black (eds.), Vestibular and Visual Control on Posture and Locomotor Equilibrium. 7th Int. Symp. Int. Soc. Posturography, Houston, Tex., 1983, pp. 164–169 (Karger, Basel 1985)

Motion Sickness Elicited by Passive Rotation in Squirrel Monkeys

Modification by Consistent and Inconsistent Visual Stimulation[1]

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Introduction

Current theory and recent evidence suggest that motion sickness occurs under conditions of sensory input in which the normal motor programs for producing eye, head, and body movements are not functionally effective, i.e. under conditions in which there are difficulties in maintaining posture and controlling eye movements [6]. Conditions involving conflicting or inconsistent visual-vestibular (VV) stimulation should thus result in greater sickness rates since the existing motor programs do not produce effective control of eye-head-body movements under such conditions.

We feel that the relationship of postural control to motion sickness is an important one and one often overlooked. We reported the results of a study which showed that when postural requirements were minimized by fully restraining squirrel monkeys during hypogravity parabolic flight, no animals became motion sick, but over 80% of the same 11 animals became sick if they were unrestrained and maintained control of their posture [3].

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On the basis of these results it appears that postural requirements may modulate the effects of visual and vestibular inputs on the production of motion sickness. For this reason it would seem appropriate to investigate motion sickness under experimental conditions similar to those used in studies of postural control so that the contributions of visual, vestibular, and proprioceptive inputs to the development of motion sickness, as well as to reflex responses, can be determined in an orderly manner. As the first step in our research using this approach, we have investigated the effects of visual stimulation on motion sickness susceptibility of the freely moving squirrel monkey.

Methods

Squirrel monkeys were exposed to each of four different conditions of visual and vestibular stimulation while free to move in a clear Plexiglass cage (52 × 23 × 30 cm). Each session lasted until 5 min after the time of vomiting or for a maximum of 30 min if vomiting did not occur. An interval of at least 30 days without testing was maintained between experimental sessions.

An optokinetic drum and turntable provided the visual and vestibular stimulation. The optokinetic drum was covered with alternating white and dark green stripes, each of which subtended a visual angle of approximately 6.5°. The turntable (Goerz Model 611) and drum could be rotated separately or together.

The four visual and vestibular conditions of stimulation used in this experiment are shown schematically in figure 1. Two baseline conditions were used to determine the separate effects of vestibular stimulation and visual stimulation on motion sickness responses. In the vestibular dark condition the turntable holding the animal was rotated in the dark, and the animal received no visual stimulation. In the visual only condition, the turntable remained stationary, while the optokinetic drum rotated around the animal, providing optokinetic stimulation.

The two conditions of greatest interest in this study involved combined VV stimulation. In the concordant VV condition the turntable was rotated within the drum which was stationary with respect to the room (i.e. the normal condition that occurs whenever an organism moves within an earth-fixed environment). Consistent visual and vestibular cues were provided in this condition. In the fixed VV condition, the optokinetic drum was coupled or fixed to the turntable and rotated with the animal, so that no optokinetic stimulation was produced by the rotation. This arrangement results in inconsistent or conflicting VV stimulation.

Under each of the conditions of visual and vestibular stimulation, two different angular velocities were tested, 60°/s ($n = 22$) and 150°/s ($n = 20$). In all conditions postural requirements, and indirectly, vestibular stimulation, were dependent upon the characteristics of free movement produced by each animal within the testing cage. Motion sickness was assessed by determining latencies to retching and/or vomiting by audio monitoring.