A USEFUL TEST IN SELECTING MOTION-SICK-PRONE INDIVIDUALS***

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Abstract. This test is a result of the past decade of studies investigating the vestibular sensitivity of individuals to Coriolis accelerations. A significant differentiation shown between the 'nonsick' (NS) and the 'sick' (S) subjects within each peer group (navigators, pilots, and nonflying personnel) indicates its value in testing the level of resistance an individual has to Coriolis accelerations; this supports its usefulness in determining an individual's resistance to motion sickness. The studies - conducted on experienced pilots (NS-299, S-51), navigators (NS-60, S-34), airman trainees (NS-91, S-19), and pentathlon athletes (NS-14, S-0) - demonstrate the usefulness of this test in the overall selection of personnel in preflight, postflight, and training programs.

1. Introduction

Motion sickness can be defined as a functional disability which may occur when an individual is furnished with nonintegratable information concerning his position or motion. Recently, Money (1970) and Miller and Graybiel (1972) have presented excellent reviews on the etiology, symptomatology, and various theories of the essential nature of motion sickness.

In normal flight conditions, pilots frequently experience disturbing motions, depending on their flight patterns or on their own head movements within the aircraft. Motion sickness displays symptoms of dizziness, illusions, vertigo, pallor, cyanosis, salivation, perspiration, chills, cold extremities, epigastric awareness, nausea, emesis, neural depression, changes in perception, heart rate, and blood pressure. Nausea is a cerebral interpretation of a sensory input from some unusual and discomforting stimulus, such as a Coriolis acceleration as reported by Moore and Cramer (1965). Emesis may result from nausea as a result of efferent impulses from the cerebral cortex to the brain stem nuclei of the vagal and phrenic nerves.

Of specific interest to us are the disturbing effects caused by Coriolis stimulation. When one moves his head to another angular relationship to the axis of rotation, severe and disturbing sensations occur. Besides head movement, a second rotation imposed on a vehicle will cause such discomforts. Stimulating the vertical semicircular canals in both sagittal and frontal planes by tilting the head during rotation on a...
vertical axis or by being tilted 60° on the USAFSAM biaxial stimulator while being rotated, was reported by Dowd (1965) to cause unpleasantness which may lead to motion sickness. This combination of rotation and movements of the body and head resulting in a Coriolis stimulation was found by Moore et al. (1965) and Dowd et al. (1966) to disturb advanced flying personnel.

The Coriolis effect was termed by Stewart and Clark (1965) as a "perception of apparent bodily rotation in planes other than the plane of cockpit motion during the rotation of the stimulator." Fernandez and Lindsay (1964) described vestibular responses to Coriolis stimulation in that when one tilts his head while being rotated, the endolymphatic fluid moves within asynergic pairs of semicircular canals. Thus, one pair of canals enters into the rotating plane. Guedry and Montague (1961) emphasized that the semicircular canals are stimulated by the Coriolis forces acting on the endolymphatic fluids. Many investigators indicate that the degree of motion-sickness susceptibility varies with experience and with the training of the individual. Angular acceleration has been named as the primary stimulus for motion sickness by Johnson (1953) and Johnson and Stubbs (1951), while Steele (1963) emphasized the individual's previous sensory experience. It appears from the author's research that both angular accelerations and the individual's previous sensory experience are contributing factors in motion sickness.

Incidences of air sickness in flight training have been reported by Tucker et al. (1965): between 10% and 17% of all flying trainees experienced motion sickness at least once, repeated motion sickness occurred only in 5%, and 0.7% of the students were usually dropped annually from the program. Alexander et al. (1945) emphasized that acceleration is a significant factor in rating sickness. Kellogg et al. (1965) showed that subjects with bilateral vestibular defects not only failed to show or report symptoms of motion sickness in parabolic flights, but actually enjoyed such an experience. DeWit (1953) found steeper sensation cupulograms at lower perception thresholds for motion-sick susceptible subjects in comparison to subjects who seldom or never become motion sick. Van Egmond et al. (1954) noted that the vestibular apparatus is of primary importance in the pathogenesis of motion sickness, emphasizing that 80% of all persons susceptible to sea sickness possessed an abnormally steep cupulogram. Bruner (1955) found that 12.7% of 699 seamen were almost always sea sick, and he termed it 'habitually sea sick'. He states that the 'sine qua non of motion sickness is acceleration', and this is the prime factor in altering an individual's susceptibility. Powell et al. (1962), in a study reporting on motion sickness in the Royal Canadian Air Force, estimated that 11% of the trainees had one or more incidents of motion sickness in the year 1960-1961 and that 6.7% failed to complete flight training. The loss of rated personnel who have progressed to operational assignments is even more discouraging. The disqualification of such trained personnel from flying duties is obviously wasteful and expensive. The United States Air Force has a continuous problem with motion-sickness losses (secondary to illness) during training of navigators and pilots, and this has remained relatively constant. This loss rate is expected under current screening procedures. It has been shown by How-