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Investigations in Neuroscience: A Summary of Completed Studies

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ABSTRACT

U.S. Researcher measured eye movements, postural and locomotor responses during spaceflight as part of the Extended Duration Orbiter Medical Project (EDOMP) neuroscience studies. Higher levels of processing in the central nervous system are involved in compensating for improperly perceived spatial orientation. The research was carried out in conjunction with U.S SpaceShuttle flights to assess potential changes in an astronaut's ability to land or evacuate following microgravity adaptation.

KEYWORDS: Long-term spaceflight, neuroscience, spatial orientation, sensory motor changes.

INTRODUCTION

Second and third order responses are largely used to study the brain mechanisms behind human spatial orientation and the adaptive adjustments made in response to the sensory rearrangements experienced during orbital flight. The following Researchers measured as part of the Extended Duration Orbiter Medical Project (EDOMP) neuroscience studies: (1) eye movements during acquisition of either static or moving visual targets, (2) postural and locomotor responses prompted by unexpected movement of the support surface, (3) changes in the interaction of visual, proprioceptive, and vestibular information, (4) changes in the major postural muscles via descending pathways, or (5) changes in locomotor pathways. Spatial orientation in spaceflight operations involves situational awareness, or the ability of a crew member to perceive the attitude, location, or velocity of the spacecraft or other objects in three dimensions, including orientation of one's own body. Integrating data from many sensory modalities results in the perception of spatial orientation. Higher levels of processing in the central nervous system, which manage eye movements, movement, and stable posture, are involved in this. When compensating reactions to the improperly perceived spatial orientation occur, operational issues with spaceflight arise. In order to assess potential changes in an astronaut's ability to successfully land the SpaceShuttle or perform an emergency post-landing egress following microgravity adaptation during space flights of varying lengths, neuroscience investigations Researcher carried out in conjunction with U.S. SpaceShuttle flights.

LONG TERM SPACEFLIGHT & SPATIAL ORIENTATION:

Future space flights may be impacted by the results of various sensory motor and spatial orientation tests, but Researchers currently know little about how the human body adapts to spaceflight. Therefore, the development of effective countermeasures will largely depend on the findings from relevant neuroscience studies. In order to identify spaceflight-related adaptation alterations within a specifically specified fraction of the sensorimotor systems that potentially have a detrimental impact on mission performance, neuroscience studies Researchers conducted. As part of the EDOMP, the Neuroscience Laboratory at the Johnson Space Center (JSC) established three integrated Detailed Supplementary Objectives (DSO) to study spatial orientation and the corresponding compensatory reactions. The four main objectives Researcher to: (1) create a normative database of vestibular and related sensory changes in response to spaceflight; (2) ascertain the underlying aetiology of neurovestibular and sensory motor changes associated with exposure to microgravity and the subsequent return to Earth; (3) immediately inform spaceflight crews about potential countermeasures that could enhance performance and safety during and after flight; and (4) ascertain the underlying aetiology of vestibular and related sensory changes in response to space

OPERATIONAL ENQUIRIES

Analysis of Motion Perception (DSO 604 OI-1) Using a standardised Sensory Perception Questionnaire [1-2] and Motion Sickness Symptom Checklist, crew members provided preflight, in-flight, and postflight reports on their own and surrounding motion perception as Researcher as their experiences with motion sickness. These reports included quantitative assessments of perceived self motion and surrounding motion related to (1) voluntary head/body movements during flight, during takeoff, and immediately after takeoff, and (2) exposure to motion profiles in a tilt translation device (TTD) and a device for orientation and movement environments (DOME) located in the Preflight Adaptation Trainers (PAT) Laboratory at JSC [3]. Using a microcassette voice recorder, verbal descriptions of felt self motion and surround motion Researcher recorded throughout flight, during entrance, and at wheels-stop. In this inquiry, four experiment prototypes Researcher used. Before flight for training and data collection, and once more after flight for data collection, two protocols employing the TTD-PAT and DOME-PAT devices Researcher carried out. A third technique that involved voluntary head and torso motions was carried out both during flight and just after the landing's wheels stopped. During the mission's Shut- tle entrance phase, a fourth protocol, consisting of head movements alone, was carried out. Using a standardised Sensory Perception Questionnaire [1-2] and Motion Sickness Symptom Checklist, crew members Researcher asked about their experiences with self- and surround-motion perception as well as motion sickness before, during, and after the flight.

VISUAL-VESTIBULAR INTEGRATION:

The head was unrestrained and free to move in all planes during all phases of the investigation in a variety of experiment paradigms known as voluntary head movements (VHMs). Target acquisition, gaze stabilisation, pursuit tracking, and sinusoidal head oscillations Researcher among the tasks that Researcher investigated. Whenever feasible, all individuals Researcher subjected to each of these four treatments during the whole voyage. Targets Researcher placed permanently at predictable angular distances in both the horizontal and vertical planes according to target acquisition standards, which utilised a cruciform translator system. Each target was colour labelled (20° green, 30° red, etc.) according to the degree of angular deviation from centre to make discrimination easier. In order to complete all target acquisition tasks, the subject had to look as quickly and precisely as they could from the central fixation point to a predetermined target indicated by the operator (right red, left green, up blue, etc.). This required using both their head and their eyes to acquire the target. A cruciform target display that was installed to the Shuttle middeck lockers was used to measure targets while they Researcher in flight. In every instance, the face was suitably covered with surface electrodes, and both horizontal and vertical electrooculography Researcher used to record eye movements (EOG). A triaxial rate sensor system fitted on goggles that Researcher securely fastened to the head was used to track head motions. The calibrated laactqinugisition targets Researcher used to measure both head motions (using a head-mounted laser) and eye movements. The gaze stabilisation technique involved a brief rotation of the head after obstruction of vision while the participant made a deliberate attempt to fixate their eyes on a recently visible wall-fixed target. With this straightforward paradigm, verbal instruction was used to manage the subject's conscious purpose, and the brief stimulus encouraged mental set consistency throughout the testing procedure. The further benefit of this protocol's brief transitory stimuli was that they mimicked normal head movement patterns while limiting long-term adaptation effects. Two distinct methods Researcher employed for pursuit tracking during preflight and postflight trials: smooth pursuit and pursuit tracking using both the head and the eye. Additionally, both predictable sinusoidal stimuli and unexpected stimuli with randomly directed velocity steps Researcher used in these protocols. These procedures Researcher chosen to examine the interactions between the vestibulo-ocular reflex and the smooth pursuit eye movement system (VOR). To examine changes in the approach utilised to determine the relative contributions of eye and head movement in sustaining head-free gaze, sinusoidal chase tracking tasks Researcher conducted at moderate (0.333 Hz) and high (1.4 Hz) frequencies. Position ramps that changed in direction, maximum displacement, and velocity Researcher employed for the erratic pursuit tracking. With vision intact, in which the subject maintained a fixation point in the primary frontal plane, and with vision occluded, in which the subject imagined the fixation point available with vision, sinusoidal head oscillations (head shakes) Researcher made at 0.2, 0.8, and 2.0 Hz in both the horizontal and vertical planes. Unless otherwise stated, all 604-OI3 protocols Researcher carried out a minimum of three times before takeoff, twice while in flight, and up to five times after landing. Usually, 10 days or less before takeoff, the last preflight test was conducted. Within 24 hours after orbital insertion and again within 24 hours of landing, in-flight measurements Researcher carried out. The first measurement after takeoff occurred roughly two hours after wheels halt. Following the landing, measurements Researcher taken 3, 5, 8, and 12 days later. Only when the participants' preflight baseline readings had not returned Researcher the 5, 8, and 12-day postflight tests completed.

RESTORATION OF POSTURAL BALANCE CONTROL

Before, during, and after Shuttle flights of varied lengths, 40 crew members carried out two experiment procedures to complete EXPERIMENT in its entirety. The first of these procedures measured the reflex (open loop) response to abrupt, stability-threatening base of support changes with a primary focus on reactionary responses. The second protocol measured the postural sway while in an upright, calm stance with normal, decreased, and changed sensory feedback in order to examine sensory integration. Before flight, the two procedures Researcher carried out by each participant on a minimum of three occasions in order to provide a reliable set of 1-g control data that could be used to assess postflight alterations. To record the whole sensory-motor readaptation time course following flying, each subject also conducted the two paradigms up to five times. Postflight testing Researcher planned on a roughly logarithmic time scale over the following eight days, starting on landing day, as soon as the Orbiter wheels halt. Of the 40 astronauts who participated in the study, 11 had been on short (4–7 day) missions, 18 had been on medium (8–10 day) missions, and 11 had been on long (11–16 day) missions. three of the individuals Researcher seasoned (veterans), whereas seventeen Researcher novices. Differences between preflight and postflight performance in all participants Researcher used to estimate the impact of spaceflight on neural regulation of posture. From a statistical comparison of the performance of the short, medium, and long length mission participants, the impact of mission duration was deduced. By comparing the performance of rookie and veteran pilots statistically, it was possible to deduce the impact of prior spaceflight experience.

SPACEFLIGHT'S EFFECTS ON LOCOMOTOR CONTROL

The objectives Researcher achieved by using five main procedures. The purpose of the first protocol was to ascertain if being exposed to the microgravity environment of spaceflight caused changes in eye-head-trunk coordination while moving about. In this procedure, subjects Researcher instructed to walk on a motorised treadmill at 6.4 km/h for 20 seconds while maintaining visual fixation on a centrally situated, earth-fixed target that was either placed 2.0 m or 0.30 m from the eyes. A few trials Researcher also carried out with periodic visual blockage, too. A video-based motion analysis system was used to assess the head and trunk kinematics during locomotion. By looking at the lower limb joint kinematics recorded during preflight and postflight testing and the contribution of the lower limb movement on the head-eye-trunk coordination obtained in the first protocol, the second protocol—which also used a treadmill—sought to investigate strategies used for maintaining gaze stability during postflight locomotion. The third protocol was created to offer a systematic examination of possible modifications in the neuro-muscular activity patterns related to postflight locomotion. The participant was required to walk on the treadmill at 6.4 km/h while focusing on a target that was 30 cm away from their eyes both before and after flight. Selected leg muscles' surface electromyography was recorded and then normalised based on the mean amplitude and temporal relationship to heel striking. Protocol 4 looked on how walking and spatial orienting abilities changed after spaceflight. Before and after flight, the individual was instructed to complete a goal-directed locomotion paradigm that involved walking a triangle-shaped course with and without vision. This paradigm allow Researchers for the measurement of numerous important factors while performing a realistic walking task and incorporated inputs from various sensory systems. These included walking speeds, postural stability, and orientation skills. The sixth proto-col tested a subject's capacity to leap from an 18 cm height with either their eyes open or closed. Each visual condition under three trials. Using a video-based motion analysis system, body segment measurements Researcher taken. The Neuroscience Laboratory at JSC developed the aforementioned procedures with the help of the Discipline Implementation Team (DIT) for international neuroscience. The DIT took part in the biannual evaluations of the scientific findings from the continuing neuroscience EDOMP projects. The investigations Researcher changed as necessary to follow the advice and ideas of DIT members. Each neuroscience DSO on a flight had a very small number of participants, restricting comparability amongst studies (Appendix B). The comparatively large number of participants who participated in each experiment helped to somewhat overcome this constraint.

SUMMARY

Overall, the findings from neuroscience studies indicate that spaceflight has a significant impact on sensory-motor function. During target acquisition and movement, the gaze is disturbed. Dynamic postural responses clearly demonstrate a relationship between the length of the flight and past spaceflight experience, as well as the severity and persistence of postural ataxia. The EDOMP has provided us with important information that has improved our understanding of the neural substrate driving sensory-motor function and how spaceflight affects that neural substrate. Importantly, the outcomes of the neurosensory research have contributed to the definition of our requirement for sensory-motor restraints.

References

1. Harm DL, Parker DE. Perceived self-orientation and self-motion in microgravity, after landing and during preflight adaptation training. J Vestib Res, Equil & Orient 1993; 3:297-305.
2. Reschke MF, Bloomberg JJ, Paloski WH, Harm DL, Parker DE. Physiologic adaptation to space flight:neurophysiologic aspects: sensory and sensory-motor function. In: Nicogossian AE, Leach CL, Pool SL, editors. Space Physiology and Medicine. Philadel- phia: Lea & Febiger; 1994. p 261-85.
3. Harm DL, Parker DE. Preflight adaptation training for spatial orientation and space motion sickness. J Clinical Pharmacology 1994; 34:618-27.