VESTIBULAR AND POSTURAL ASSESSMENT DEVICE AND METHODS

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ABSTRACT

Changes in otolith function as a result of prolonged exposure to weightlessness may result in the loss of sensorimotor control, which could increase the risk of impaired control of spacecraft and related systems. NASA currently addresses this risk through several post-flight sensorimotor assessments, which can guide future preventive measures. We propose an alternative simple, fast and cost-efficient way to carry out this monitoring using an augmented binocular alignment test called VANTAN (Assessment of Otolith Function and Asymmetry as a Corollary to Critical Sensorimotor Performance in Missions of Various Durations – 17-BPBA_2-0060 (PI: Shelhamer)). The new device will be able to perform measurements on ocular alignment and postural control, both of which are functional manifestations of the otolith. Previous studies have demonstrated a relationship between ocular misalignment and changes in postural sway[1,3] implying that alignment changes could be used to indirectly infer postural control and therefore locomotion changes[2] through the mechanisms of otolith function. With this device, we desire to gain a better understanding of the relationship between postural control and ocular alignment, and potentially reduce the need for more involved posture testing during spaceflight. Additionally, it may enable assessment of postural and ocular alignment changes *during* spaceflight, such as when astronauts are strapped to a treadmill, and predict levels of postural instability post-flight. This would be a completely new capability.

EXPERIMENT AND ANALYSIS

The device will be tested on participants exposed to vestibular perturbations that mimic disruption of the otoliths as seen in spaceflight. Baseline measurements and perturbation measurements will be carried out using the following assessment. VANTAN will be administered first, done with the participant seated. Next, participants will perform the posture measurement, staying seated with their eyes closed. The tablet will be held against their sacral spine area, which most accurately approximates the center of mass[4], for 20 seconds. VANTAN and posture measurements will be repeated for a standing condition, where the participant has both feet on the floor and eyes closed. Sitting and standing measurements are necessary to determine if postural demand may affect ocular alignment and vice versa.

To analyze the results, mean values for VANTAN will be calculated for each trial, and 2D sway parameters will be calculated from the postural assessment data. Trends in each sway parameter will be compared to trends in VANTAN data, and will be done within each phase and across phases to measure changes due to adaptation and overall change, respectively. The most direct measure of interdependence will be the Pearson correlation coefficient, which we will assess between postural sway and binocular alignment. With a desired power of 0.8 and a significance level of 0.05, pairs of measures that are correlated with a coefficient of at least 0.8 can be identified with a population size of N=10, which we can accommodate within a one-year study.

PREDICTED OUTCOMES

If trends in VANTAN and postural sway data are correlated, it would show that changes in ocular alignment might predict changes in postural sway and vice versa, and also imply that postural control can be assessed through this method. Additionally, if trends exhibit correlation specifically between the standing and sitting conditions, it would mean that changes in postural demand might impact vestibular function as measured by changes in binocular alignment, shedding light on one efferent vestibular mechanism that is not well understood and implying a possible use of this device to measure postural control during spaceflight.

REFERENCES

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