ENHANCING FUNCTIONAL PERFORMANCE USING SENSORIMOTOR ADAPTABILITY TRAINING PROGRAMS

J.J. Bloomberg[1], A.P. Mulavara[2], B.T. Peters[3], R. Brady[3], C. Audas[3], T.M. Ruttley[1], H.S. Cohen[4]
[1]Neuroscience Laboratories, NASA-Johnson Space Center, Houston, TX, [2]Universities Space Research Association Division of Space Life Sciences, Houston, TX, [3]Wyle Life Sciences, Houston, TX, [4]Bobby R. Alford Department of Otorhinolaryngology and Communicative Sciences, Baylor College of Medicine, Houston, TX

INTRODUCTION

During the acute phase of adaptation to novel gravitational environments, sensorimotor disturbances have the potential to disrupt the ability of astronauts to perform functional tasks. The goal of this project is to develop a sensorimotor adaptability (SA) training program designed to facilitate recovery of functional capabilities when astronauts transition to different gravitational environments. The project conducted a series of studies that investigated the efficacy of treadmill training combined with a variety of sensory challenges designed to increase adaptability including alterations in visual flow, body loading, and support surface stability.

MAIN RESULTS

SA training using a treadmill (an analogue to overground locomotion) was effective in producing increased adaptability in a more complex over-ground ambulatory task on an obstacle course. This confirms that for a complex task like walking, treadmill training contains enough of the critical features of overground walking to be an effective training modality. Balance board training alone did not increase training efficacy demonstrating the limitations of training by showing that the training tasks must have certain critical features to allow full generalization.

Training that used constantly varying and challenging sensory input during each training session gave subjects a greater ability to rapidly reorganize appropriate response strategies when encountering a novel sensory environment and did not produce interference to motor learning. This indicates that training modes can be designed to maximally promote the rapid adaptability that would be required to deal with an emergency scenario requiring immediate responses soon after landing on a planetary surface.

To investigate the utility of body unloading as a training modality we demonstrated that walking on a treadmill for 30 minutes while supported at 40% of body weight via a pneumatic harness produced adaptive alteration in head movement control, lower limb kinematics, and gait cycle timing. These results indicate that alteration in body load can serve as an effective adaptability training modality.

Using a treadmill mounted on top of a six degree-of-freedom motion base platform we investigated locomotor training responses produced by subjects introduced to a dynamic walking surface. This study examined the strategies employed by subjects exposed to continuous, sinusoidal lateral motion of the support surface while walking on a treadmill. The results indicate that in order to optimize gait stability, some subjects depending more heavily on vision and others on proprioception. These results allow us to better design training modalities specifically targeted to an individual crewmember’s sensorimotor biases.

CONCLUSIONS

The data obtained in this project will provide information for the design of exercise systems that integrate sensory challenges during regular exercise allowing crewmembers to maximize their motor response adaptability facilitating the adaptive transitions to different gravitational environments. Current research is focused on investigating the long-term retention capabilities (months) of SA training and its impact on a variety of operationally oriented functional tasks including manual control. This will allow the training to be conducted preflight and therefore reducing the requirement for an inflight training component saving inflight crew time and upmass hardware requirements.

ACKNOWLEDGEMENT

This work was supported by the National Space Biomedical Research Institute through NASA NCC 9-58