Dual-Task Balance in Healthy Adults

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Postural control is the ability to regulate balance and stability and is affected by increases in cognitive load (i.e., a dual-task situation) [1]. In a dual-task paradigm, participants perform a cognitive and motor task simultaneously. Also, dual-task balance is associated with specific brain wave functions [2]. This study aims to determine whether we can replicate and extend prior work using a new, affordable, and portable mobile electroencephalography (mEEG) device, the Muse headband.

The purpose of this study was to determine the relationship between postural control and changes in cognitive load: surface, vision, and task. The feasibility of the mEEG device, Muse Headband, was tested. The Muse mEEG device has not been reported in a standing balance study.

 Twenty-five young adults (19-25 years, 13 women) who were able to walk and stand without assistance completed this study. Before data collection, participants completed written informed consent. Participants completed a demographic questionnaire and the Patient Health Questionaire-9 (PHQ-9) to assess the degree of depression severity over the past two weeks. Participants completed eight conditions on the Biodex Balance System: surface (firm/foam), vision (full vision/ no vision), and task (single-task/dual-task). Two 30-second trials were completed for each condition. Postural sway and mEEG data were recorded for the 30-second trials. The order of the conditions was pseudorandomized to prevent any bias.

For all trials, participants were instructed to rest their arms by their sides and look straight ahead. For each dual-task trial, participants were given a 3-digit starting number between 200-999. Participants were instructed to subtract by three from the given three-digit number. Verbal responses in the dual-task trials were recorded. During no-vision trials, participants were instructed to close their eyes at the beginning of the trial and instructed when to open their eyes.

Postural control was measured by the Stability Index (SI) on the Biodex Balance System. SI is the angular movement of the center of gravity [3]. A larger SI is associated with more movement off the center of gravity. For all conditions, participants’ feet were positioned at the same place on the Biodex Balance System by lab assistants across both the firm and foam surfaces. The Muse mEEG device was placed around the participant’s head at the beginning of the study. The mEEG device enabled real-time recordings of electrical activity in the brain.

There was no observed correlation between SI and age, body mass index, or depression. Therefore, none of these variables were used as a covariate in the analysis. We conducted a 2 (surface: firm/foam) by 2 (vision: full vision/ no vision) by 2 (task: single-task/dual-task) repeated measures analysis of variance. We observed the main effects of vision, surface, and task (ps < .05) for the SI. As expected, the SI increased as a function of cognitive load. The largest SI occurred during no vision and foam surface trials independently of the task [Figure 1].

There was an interaction between vision and surface (ps < .001). SI was greater when standing on the foam surface compared to the firm surface; however, as shown in Figure 2, the magnitude of the difference was greater in the no vision condition. There was an interaction between vision and task (ps < .001), such that SI was greater in the dual-task compared to the single-task
condition, but only in the full vision condition [Figure 3].

Fig. 1 Stability Index for all Trials

Fig. 2 Vision by Surface

Fig. 3 Vision by Task

The SI results are consistent with previous literature in that increased cognitive load and increased difficulty in motor tasks influence the SI.

Currently, we are using spectral analysis to determine if changes in cognitive load are associated with changes in EEG activity and power. Alpha waves are associated with relaxed and/or meditative states, while beta waves are associated with alertness and increased concentration. Based on previous studies, it is predicted that the absolute power of brain waves will be correlated with task performance and cognitive load. Specifically, it is predicted that the absolute power of alpha waves will decrease in dual-task conditions due to increased concentration and stimulation [4]. The absolute power of beta waves is predicted to increase during dual-task trials since beta waves are associated with alertness.

Statement of Research Advisor

Connor’s research represents an important step in determining the feasibility of using a mobile electroencephalography (mEEG) device during whole-body postural control. He replicated previous work demonstrating that cognitive load impacts sensorimotor control and indeed demonstrated that mEEG is a viable option for data collection. Ultimately, his work has a pivotal role in shaping the future work in our lab. Connor assisted in the design of the research, planned and executed data collection, and assisted with the signal processing and statistical analysis. He presented his project locally at the AU student symposium and will present nationally at the annual meeting of the North American Society for the Psychology of Sport and Physical Activity in June.

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References


**Authors Biography**

Connor Cantrell is a third-year student pursuing a B.S. in Biomedical Sciences with a minor in Business at Auburn University. He has been a research assistant for the past 2 years and is currently a research fellow in the Brain and Behavior Lab leading the Dual-Task Balance in Healthy Adults study.

Dr. Danielle Lang is a recent Auburn graduate currently working as a post-doctoral researcher at Walter Reed Army Institute of Research. Her research focuses on the use of wearables in analyzing physiological parameters of health across various populations.

Kristina A. Neely, Ph.D. is an Associate Professor in the School of Kinesiology and director of the Brain and Behavior Lab. Her research focuses on the influence of movement on cognitive functions, such as inhibitory control and working memory.