The Influence of Height and Edge Proximity on Balance and Reaction Time

Wendi Weimar, John Garner, Brian Campbell & Paul St. Onge
Auburn University, Auburn, AL.
weimawh@auburn.edu

INTRODUCTION

Previous research has indicated that standing on incline surfaces at heights can attenuate flat surface balance (Wade, Weimar and Davis, 2004). However, research indicating changes in static balance as a result of being on a platform above the ground has received little attention. It is the documentation of the prevalence of falls and the lack of understanding regarding the influence of height on balance that has led to the current study. The purpose of this study is to assess the static balance and information processing demands of standing on an elevated platform. The results of this study will aid in the understanding of the mechanisms that bring about these decrements in balance.

METHODS

This study utilized the Modified Clinical Test of Sensory Interaction on Balance (mCTSIB) of the NeuroCom® Basic Balance Master System™. The mCTSIB protocol quantifies dual support sway velocity. This study employed the eyes open condition only, for thirty seconds, at each of the three height conditions. The three height testing conditions consisted of (1) flat, level ground, (2) the middle of the 5 meter diving platform and (3) the edge of the 5 meter diving platform. Two spotters were present during all balance testing sessions. In addition, a Dekon Human Performance Analyzer was used to collect reaction time data following an auditory stimulus. The auditory stimulus, was a 1000 Hz tone, presented at 60 dB through an external speaker on the front of the data collection unit, located at eye level one meter behind the subject. The participants were asked to report to the Aquatics Center on three separate testing days. Each person was randomly assigned to a height condition order. Once at the Aquatics Center the participant's balance was measured at the predetermined height condition for thirty seconds. Next balance and reaction time measures were taken over the same interval. This balance and reaction time trial took approximately 4 minutes and included sixty reaction time trials. Sway velocity in degrees/seconds were averaged over the thirty seconds to provide a single balance score for balance alone and balance during reaction time trials for each height condition. In addition, the sixty reaction time trials were averaged and provided a single reaction time score for each height condition.

RESULTS

Balance conditions were measured alone and in conjunction with the reaction time task. A significant main effect was noted across all height conditions for the balance alone scores ($F(2,24) = 8.977$, $p = 0.000$, $\eta^2=0.418$). Follow up tests indicate that significant differences exists between the ground and the 5 meter edge conditions ($F(1,25) =17.495$, $p = 0.000$, $\eta^2=0.412$) as well as between the 5 meter mid and the 5 meter edge conditions ($F(1,25) = 15.949$, $p = 0.001$, $\eta^2=0.389$). A significant main effect was also noted across all height conditions measured during the reaction

time trials ($F(2,24)$ = 7.05, p = 0.002, η^2=0.185). Follow up tests indicate that significant differences exists between the ground and the 5 meter mid conditions ($F(1,25)$ = 7.017, p = 0.013, η^2=0.185) and a significant difference exists between the 5 meter mid and the 5 meter edge conditions ($F(1,25)$ = 7.836, p = 0.009, η^2=0.202). A significant main effect was also noted for balance measured across all height conditions measured alone and during the reaction time task ($F(5,125)$ = 16.843, p = 0.000, η^2=0.403). Follow up tests indicate that significant differences exists between the ground and the ground with reaction time balance measures ($F(1,25)$ = 29.409, p = 0.000, η^2=0.541) and a significant difference between the 5 meter mid and the 5 meter mid with reaction time balance measures ($F(1,25)$ = 21.661, p = 0.000, η^2=0.464) and a significant difference between the 5 meter edge and the 5 meter edge with reaction time balance measures ($F(1,25)$ = 20.261, p = 0.000, η^2=0.448). No significant difference was noted across any of the height conditions for reaction time.

Balance Condition	Ground	5M Mid	5M Edge
Balance Alone (deg/sec)	0.313 (0.12)	0.402 (0.33)	0.563 (0.32)
Balance w/RT (deg/sec)	0.258 (0.11)	0.311 (0.16)	0.486 (0.28)

Table 1: Mean and standard deviations of the balance scores alone and taken during the reaction time measures.

DISCUSSION

These results indicate that height and proximity to the edge contributes to the decrement in one's balance, or at least the increase sway velocity. Interestingly, balance under these height conditions improved when the participant was asked to perform the reaction time task. It was originally thought that a decrement would be noted in the task, while balance would remain relatively constant. However, it appears that the height condition is great enough to cause the participant to devote attention to losing one's balance, but that a task is distracting enough to this concern regarding losing balance to actually decrease the sway velocity. To explain this more simply, being at height caused the participants to focus only on remaining balanced and it appears that this focus caused them to sway more (perhaps in an attempt to elicit more information from their proprioceptors). However, the introduction of a task, allowed the performer to not focus so much on remaining balanced, to devote attention away from balance to the reaction time task. This is supported by the results that balance improved during the reaction time task vs the balance alone scores and that reaction time did not degrade at the various height conditions.

These results suggest that care be taken to ensure that safety precautions are in place when people are going to be close to the edge of a platform at some height above the ground. Particularly in situations when the uninitiated are going to have cause to be near the edge as is the case in amusement parks, zoos and other sightseeing or recreational settings. Perhaps attention diverting devices could be implemented to distract the individuals at height from focusing only on the fact that they are high above the ground.

REFERENCES

Wade, LR, et. al., 2004, *Ergonmics*, 15: 1614-1623.