AFFECT OF INTENSIVE ENVIRONMENTAL NOISE OF HUMAN POSTURAL CONTROL

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INTRODUCTION

Fall or inability to control posture in a working environment can potentially lead to hazardous conditions and lawsuits [1,2]. One possible factor for disruption of postural control, is environmental noise. Previous studies have shown that loud noise pertains to delayed reading and learning, reduced state of vigilance and task performance and can cause sleep disruption as well as interrupted cognitive processing. However, it is not yet clear how and to what extent environmental noise can affect human performance. The purpose of our study is to determine whether an intermittent white noise of 80 dB could affect the ability to control posture both in terms of the ability to hold the COM static and shifting the COM in a controlled manner.

METHODS

16 healthy young adults (6 Male, 10 female, age range 21-26) were recruited to participate in the study if a) they were healthy, b) right handed and c) had no previous experience of participating in balance studies. Individuals with impaired hearing or vision and those who had a condition that could potentially affect their balance were excluded from the study. Participants stood on the foot platform of Biodex balance system (SD 950 – 320 - Biodex Medical Systems, Shirley, NY, USA) throughout the trials. The display module of Biodex provided a visual picture where it showed a bull’s eye and three surrounding rings. A small moving dot at the middle of the screen represented a real-time (20 S/s). The intermittent white noise was played for 30 seconds at 80 dB intensity and was interrupted every second for a period of one second.

The participants were randomly assigned to two different conditions (with and without noise) and four different tests as follows: a) static postural stability tests with eyes open (SEO) participants were asked to stand on the stationary platform and keep their COG as static as possible; b) Static postural stability with eyes closed (SEC); c) dynamic postural stability tests (DYN) where the platform allowed a limited uncontrolled movement around AP and ML axes and d) Limits of Stability tests (LOS) in which participants were presented 9 balls on the display (one central and 8 in surrounding at 50% of BOS) and were challenged to transfer their COP to each of those 8 balls without change in the BOS (Figure 1 A and B).

Figure 1: (A) Visual interface during SEO, SEC and DYN tests, where COP is presented to the participant. (B) Visual interface for LOS trials, where subjects attempt to move COP to the eight predefined targets.

3. RESULTS AND DISCUSSION

The difference in the means of the outcome variables between noise and quiet trials for all three conditions of SEO, SEC and DYN were examined. The outcome variables that were considered in analysis where: overall stability index, antero-posterior stability index, medio-lateral stability index, time in zones A, B, C and D and time in quadrants 1, 2, 3 and 4 (please see figure 2). We also examined the difference in means of the noise and quiet trials for the LOS tests for the following outcome variables: overall performance, forward, backward, right, left, forward-right, forward-left, backward-right and backward-left performances.
The results of two way analysis of variance failed to reject the null hypothesis (with p<.05) and indicated that there are no significant differences between the noise and the quiet trials. Our results, however, showed significant differences between the conditions when SEO, SEC and DYN trials where being compared (p=0.0001).

Although literature consists of conflicting results on whether white noise can facilitate or deteriorate cognitive responses, in general, studies have shown that a background noise impacts attention [3] and cognitive processing [4]. Considering that control of posture is a cognitive demanding task [5], one could expect a change in the performance of individuals when they were exposed to white noise, particularly in LOS trials.

One major difference between our study and most of other studies that may pertain to discrepancies between our results and those of others is the timing of noise exposure. In our study, intermittent white noise was played simultaneous to the measurement, while others have measured cognitive response following exposure to the noise. Therefore, the possibility exists that if an individual worker is exposed to high level of noise, their balance performance will be affected after a period of time. The second most important difference between our study and those of others is the fact that we were measuring postural control as the outcome variable of our study, while others were focused on cognitive responses. Postural control is a multifactorial complex phenomenon that requires advanced coordination between central nervous system and musculoskeletal system. Previous studies of balance, who have defined a dual task paradigm have shown that if part of the attention are allocated toward additional tasks, lack of enough resources to perform postural control may augment the effect of stimulus [5]. One may speculate that difference in performance between noise and quiet trials could be observed if subjects were exposed to a dual task paradigm.

Our results also revealed that AP stability index was significantly higher than ML stability index, which supports the idea that our participants were having a better level of mediolateral stability (versus antero-posterior stability) during the test. One could speculate that if participants were standing in a less stable posture, the effect of noise on postural sway could be magnified and perhaps significant differences between noise and quiet trials could be observed. To address this issue, we recruited one more subject (Male, 26 years old) to further investigate noise effect in a less stable posture. The subject was instructed to stand in a tandem stance on the platform. SEO, SEC and DYN trials were performed similar to our original data collection. The result of this single subject test was in agreement with the original data, were we did not find any significant effect of noise on postural sway.

CONCLUSION

Our results confirmed that intermittent noise of 80 dB does not have an immediate effect on human postural control. However, our results cannot be generalized to conditions where individuals are exposed to either a higher intensity or longer duration of noise.

References: