

The Effect of Cognitive Performance on Static Balance Index

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Abstract

Introduction: In simultaneous assignments, "attention" must be divided between assignments. Due to the competition in processor resources, the result of this action is the reduction of the performance efficiency, at least in one of the tasks. Research on the effect of cognitive task on balance is not conclusive, and the effect of cognitive task and types of tasks at the same time on balance is unknown. The aim of the study is to investigate the intervention effect of two cognitive and visual tasks on balance. **Materials and Methods:** In this semi-experimental study, 20 young girls performed the test in 4 modes, balance without intervention, balance with cognitive intervention, balance with visual intervention, and balance with both interventions, on the Biodex machine at instability level 4. Overall stability index was recorded as dependent variable. **Results:** The results of variance analysis of repeated measurements at the level of $P < 0.05$ did not show a significant difference between static balances in different situations. Therefore, all research hypotheses were rejected. **Conclusion:** It seems that the lack of significant difference between the different positions is related to the lack of control of the participants' cognitive capacity and the created cognitive load and its effect on the posture control mechanisms.

Keywords: Primary task; Secondary task; Visual task, Balance index; Stroop task

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Introduction

Some researchers believe that the failure in the efficiency of simultaneous activities is a result of the competition of two tasks to use the same and common resources; Because both tasks have the same processing requirements (1). In studies related to performing two tasks at the same time, the individual's performance when performing each of the two tasks alone should be compared with their simultaneous performance. Any change, regardless of the baseline level of performance, may be considered as the effect of doing two tasks at the same time.

According to the inter-domain competition model, the competition between situational control and cognitive activity to achieve attentional resources causes a change in situational performance in dual-task conditions, and since attentional resources are divided, balance performance is less efficient in dual-task conditions (2). Although postural balance is considered an automatic activity, performing balance tasks at the same time causes a decrease in the efficiency of balance activities.

Three factors are known to be effective in imbalance and falls. These factors include: internal factors (related to the individual), external factors (related to the environment) and behavioral factors (related to the activity). Although there is a complex relationship between these three factors, frequent falls are more related to internal factors. In other words, benefiting from a proper state balance requires a balanced connection of these systems with each other. Therefore, it can be stated that creating a disturbance in any of these sensory afferent systems may lead to balance disorders and increase the probability of a person falling and, as a result, increasing the risk of injury.

Many experts consider the central stability zone as a key component in improving sports performance (3). It is believed that strong core stability allows the athlete to transfer the forces generated by the lower limb through the trunk to the upper limb or sports equipment; And on the other hand, a weak central stability region disrupts energy transfer and thus reduces sports performance (3) and increases the risk of injury to weak muscles (4).

Previous studies have examined the effect of central stability exercises on balance control and performance in athletes and special groups such as the elderly, and some studies have pointed out the positive effect of such exercises on posture control in non-athletes of different ages, with However, the degree of balance disruption during multiple cognitive tasks has not been measured. The current research was designed to find an answer to the question of what effect doing various cognitive tasks has on the static balance index and how the changes in balance are explained by the existing theories.

Material and Methods

Twenty healthy girls students of Shahid Beheshti Rehabilitation School voluntarily participated in the study through advertisement, their age range was between 20 and 30 years. Obtaining the quorum score in the general health test and not having acute or major orthopedic problems, especially "in the pelvis, lower limbs and spine" were the conditions for entering this study. People who did not want to continue the study were excluded. In this study, the consent form was read and signed by all individuals.

Research tools

Biodex balance device

This device focuses on the proprioceptive neuromuscular mechanism and affects unilateral postural stability as well as joint dynamics. In past studies, very good validity and reliability for body posture control and balance evaluations have been reported by this device (5). The validity of its measurement has been reported as 0.93 for the lateral balance index, 0.94 for the overall balance index, and 0.95 for the posterior balance index.

Health questionnaire

The General Health Questionnaire (GHQ) was prepared by a person named Goldberg in 1972. This questionnaire is used to measure people's general and mental health. At first, this questionnaire had a large number of questions, but its final version was limited to 28 questions (6).

Stroop test software

The Stroop test requires participants to view a list of words printed in a different color than the meaning of the word. The Stroop test was first developed by Ridley Stroop in 1935 to measure selective attention and cognitive flexibility through visual processing (7).

Implementation method

After completing the consent form and GHQ and height and weight measurement by the examiner, the participants were

placed on the Biodex device in four modes, in the order of the test conditions, so that we can control the effect of the order of the test conditions.

Exam situations that include 4 stages:

1. Balance only (control)
2. Balance with secondary cognitive tasks
3. Balance along with the secondary task of vision
4. Balance with doing both tasks (cognitive and visual) at the same time

The duration of each trial was 40 seconds and the rest time between each test mode was 5 minutes. In the first condition, the person was asked to stand on the sliding surface of the device and just try to keep his/her balance. After 5 minutes of rest in the second situation, the person had to start counting down loudly from the number 200 with the maximum speed and accuracy with an interval of 3, and at the end of the test time, the final number was recorded.

The third condition with which the participants were tested was the Stroop vision task, which included 20 questions; In such a way that the person had to announce the correct option based on the color and text appearing on the monitor facing him/her with maximum speed and accuracy; And finally, in the fourth state of the test, the participant had to perform all the above three states simultaneously. The time spent and the participants' answers were important, and the amount of time spent and incorrect answers were calculated; that the examiner had warned the subjects about this at first.

It should be noted that by using the average scores obtained by 20 participants, the level of attention of each person according to the correct and incorrect answers they gave to each task was checked and ranked into excellent, good, average and poor levels.

Statistical methods

To check the normality of the distribution of the dependent variable from the Shapiro-Wilk test, and to compare the average stability indices in the four conditions of the test, Friedman's non-parametric test was used, and to test the research hypotheses, a pairwise comparison of the average ranks was performed using the Wilcoxon test. Also, SPSS version 22 software was used for data analysis and the significance level for all statistical tests was considered less than 0.05.

Results

In this study, 20 girls participated, the average height of the girls was 163.25 and the average weight was 57.7. Also, the average body mass index was 21.65. In table number 1, the test statistics are reported.

According to Table 1, the average central index of balance without intervention was 2.64 in girls, and the average central index of balance with cognitive intervention was 3.56 in girls. Also, the average central index of balance with visual intervention was 3.53 in girls, and the average central index of balance with visual and cognitive intervention in girls was reported as 3.4.

According to Friedman's test results, there was no significant difference between the stability index of different situations ($P=0.179$).

In this section, the mean and standard deviation of the stability index of the participants in the four conditions of the test were discussed. Table 2 shows the descriptive statistics of the stability index in different equilibrium situations.

Discussion

The present study was conducted with the aim of investigating the effect of cognitive activity on the static balance index. The results of statistical tests did not show a significant difference between different situations and interventions on balance. Therefore, it can be said that the vision task and the simultaneous vision and cognitive task did not have noticeable effects on the stability index scores of people. These results are inconsistent with the findings of Moghadam *et al* (8), Gholami *et al* (9), and Dehghanizadeh *et al* (10). In the research of Moghadam *et al* (8) and Gholami *et al* (9) they stated that the cognitive task along with the execution of the balancing task can cause disturbances in the balancing task and result in lower grades for people. Their explanation is mostly based on the theory of the limitation of attention resources, which states that due to the lack of a sufficient source of attention in the individual, performing the secondary cognitive task causes a disturbance in the performance of the balancing task.

However, the results of a study showed that by increasing the level of difficulty of the secondary task, the stability of people's stature improves. The reasoning of the researchers was that the subjects probably reduced their posture by using the joint stiffening strategy to perform the mental task optimally (13). It should be stated that their tested samples, like the present study, were non-athletes, who probably used the strategy of tightening the joints and limiting the degrees of freedom. However, the research sample in Dehghanzadeh *et al.*'s research (10) were physical education students, and it is likely that they used other strategies to maintain balance because they had more practical experience. In general, it cannot be said that the current research is completely aligned or inconsistent with the previous research, because even in the aligned research, there were differences.

It seems that the individual differences of the participants and the amount of load created in different situations caused the participants to use different mechanisms to control the posture. And this difference has affected the results and the lack of control has destroyed the possible differences between different situations. In this research, the subjects were familiarized with the assignments and were left free in how to perform them; whereas if they had been given specific instructions to maintain balance, the findings would have been discussed in a more detailed manner. In general, due to the lack of examination of the coping mechanisms, the results cannot be clearly discussed, and it is necessary to continue studies in this field by controlling the mentioned variables to make it possible to compare the findings of the current research with the existing literature.

Limitations and suggestions

Different height control mechanisms at low, medium and high cognitive load levels should be carefully investigated.

Participants should be given specific instructions to maintain balance so that the findings can be discussed in a more detailed manner.

Table 1. Test statistics for participants

	Total test time (seconds)	Average balance index without intervention	central balance index without cognitive intervention	Average balance index with visual intervention	central balance index with visual and cognitive intervention
Girls	40	2.64	3.56	3.53	3.04

Table 2. Descriptive statistics of the studied variables

Test situations	N	Minimum	Maximum	Mean (SD)
Balance stability index without intervention	20	0.70	5.70	2.63 (1.56)
Balance stability index with cognitive task	20	0.90	7.60	3.42 (1.98)
Balance stability index with vision task	20	1.20	7.20	3.20 (1.65)
Balance stability index with complex intervention	20	0.70	6.40	2.90 (1.53)

It is possible to compare them in the same situation by determining how to perform tasks at the same time for all participants.

It can be continue to deal with the topic of cognitive task and its mechanisms by controlling the mentioned variables. To compare the findings of the present research with the existing literature.

By choosing a larger statistical population, the possibility of meaningfulness of the results increases and it can be generalized to the society as well.

Conclusion

According to the model of inter-domain competition, competition between balance control and cognitive activity to achieve attention resources causes a change in situational performance in dual task conditions, and since attention resources are divided, balance performance is less efficient in dual task conditions. Although postural balance is considered an automatic activity, doing balance tasks at the same time causes the efficiency of balance activities to decrease. According to the statistics obtained from this test, we had the highest stability index (best balance) in the condition without intervention (control conditions) and the lowest stability index in the condition with cognitive intervention.

In total, there was no significant difference between different situations and interventions on balance. Therefore, it can be said that the vision task and the simultaneous vision and cognitive task did not have noticeable effects on the stability index scores of people. In this research, the subjects were familiarized with the tasks and were left free in how to perform them; whereas if they had been given specific instructions to maintain balance, the findings would have been discussed in more detail. In general, due to the lack of examination of the coping mechanisms, the results cannot be clearly discussed, and it is necessary to continue studies in this field by controlling the mentioned variables to make it possible to compare the findings of the current research with the existing literature.

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Ethical considerations

This study was conducted following all relevant ethical guidelines and regulations to ensure the protection of participants' rights and confidentiality.

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Conflict of interest

None.

Authors' contributions

M. R, M. Kh, N.J: data curation, formal analysis, investigation, and methodology, writing, original draft. M. Kh: supervision, resources, and writing, original draft S.K: resources, and writing, original draft, investigation, and methodology; M.R, M. Kh: writing, review, and editing.

References

- Deviterne D, Gauchard GC, Jamet M, Vançon G, Perrin PP. Added cognitive load through rotary auditory stimulation can improve the quality of postural control in the elderly. *Brain research bulletin*. 2005;64(6):487-92.
- Lacour M, Bernard-Demanze L, Dumitrescu M. Posture control, aging, and attention resources: models and posture-analysis methods. *Neurophysiologie Clinique/Clinical Neurophysiology*. 2008;38(6):411-21.
- Willardson JM. Core stability training: applications to sports conditioning programs. *The Journal of Strength & Conditioning Research*. 2007;21(3):979-85.
- Wb K. The role of core stability in athletic function. *Sports Med*. 2006;36:189-98.
- Okada T, Huxel KC, Nesser TW. Relationship between core stability, functional movement, and performance. *The Journal of Strength & Conditioning Research*. 2011;25(1):252-61.
- Willson JD, Dougherty CP, Ireland ML, Davis IM. Core stability and its relationship to lower extremity function and injury. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*. 2005;13(5):316-25.
- Leumann A. Chronic ankle instability in the Swiss orienteer. 2010.
- Jackson C. The general health questionnaire. *Occupational medicine*. 2007;57(1):79.
- Jensen AR, Rohwer Jr WD. The Stroop color-word test: a review. *Acta psychologica*. 1966;25:36-93.
- Moghadam, Mousavi, Vaez Mak, Zadeh, Namazi M. The effect of task difficulty and focus of attention instruction on balancing task performance. *movement* 2008; 36.
- Gholami, Amin, Farkhi, Sadeghi, Haider, Naimikia, et al. The effect of sensory (vision, physical sense) and cognitive manipulations on the control of the height of wrestlers with different skill levels. *Research in sports science*. 2010;40(7):113-30.
- Dehghanizadeh, Jalal, Samadi, Mohammadzadeh, Qari, Burhan. Investigating the effect of sensory and cognitive manipulation on the performance of dynamic balance task. *Research in educational sports*. 2014;7(2):57-70.
- Vuillermé, N. and Nafati, G. (2005). How attentional focus on body sway affects postural control during quiet standing. *Psychol Res*; 71(2): 192-200.