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Attentional Focus can affect Sway in Postural and Supra-postural Tasks in Community-Dwelling Older Adults

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ABSTRACT

Background. Previous studies have shown that postural stability can be enhanced by directing performers' attention to the effects of their movements (external focus), rather than to the body movements producing the effect (internal focus). **Objectives.** This study aimed to investigate the effects of attentional focus and a Supra postural task on postural control in older adults. **Methods.** The study method involved the focus of attention which was manipulated by instructing subjects to hold a glass full of water while focusing on either hand or glass. The center of pressure (COP) tests were performed on the participants in the following four conditions: baseline, control, the external focus of attention (EFA), and the internal focus of attention (IFA). Balance assessment and training were conducted using the Biodex Stability System (BSS). **Results.** Analysis of variance with repeated measures showed that attentional focus affected both the postural and the supra-postural task ($p<0.05$). Also, the results of independent t-test showed that no significant difference existed between internal-external focus conditions ($p<0.05$). **Conclusion.** This study suggests that application of automatic control processes can be facilitated by simply directing performers' attention away from their own movements.

KEY WORDS: ***Focus of Attention, Posture, Supra-Postural Task, Automatic Control.***

INTRODUCTION

Enhancing the performance of a motor skill is a common objective in different fields of study such as kinesiology, sports, and physical therapy. One factor to optimize learning and performance of a motor skill is to provide the right instruction to the learner. Based on the implications of new theories of perception-action coupling such as Print's action effect hypothesis, motor skill researchers had a rethink concerning the traditional approach to the provision of instructions which emphasized the actual movement pattern of the performer.

One related aspect that has been investigated over the past several years is the attention focus of a learner induced by the instructor. Research on the impression of the performer's focus of attention has demonstrated that external focus (EF) enhances motor performance and learning relative to internal focus (IF). Recent evidence suggests that removing attention from postural control using either an external focus or a cognitive task will improve stability in healthy young adults (1). In balancing tasks, evidence has shown that inducing an EF of attention enhances

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learning more than IF (2-4). For example, Wulf and colleagues (4) found that an EF condition allowed performers to perform better balancing skill and learning compared to an IF condition performed using ski-simulator and stabilometer task. Similarly, when balancing using a stabilometer, more effective learning was shown when participants attention was directed towards an external versus internal focus (3). In contrast, other studies have reported no superior benefit of EF versus IF (5, 6). For example, no difference was found on balance learning when attention was directed towards an external or internal focus while standing on a moving platform (5).

Balance is a vital element to perform most motor skills and adequate balance is assumed to be a prerequisite for success in sports. It is also suggested that balance must be enhanced for each specific task (7). Previous evidence has indicated that weak or poor balance due to aging or a pathology condition can cause falls or injuries and consequently loss of autonomy in daily activities.

Furthermore, Supra postural task has been defined as “behavioral goal that is super ordinate to the control of posture” (8). Supra postural and postural tasks have two independent behavioral goals but while being performed concurrently, there is integration between the two, especially when performed in a functional context. The performance of supra postural task is not directly linked to posture but is certainly influenced by the posture control mechanism (9, 10). This can be a reciprocating influence and the supra postural task can also influence the posture and movement control mechanisms. Recent evidence suggests that removing attention from postural control by using either an external focus or a Supra postural task will improve stability in healthy young adults. When carrying or holding loads, individuals are likely to interchange between the preferred and non-preferred hand in order to offset fatigue effects of prolonged load carriage (11). Attentional requirements of upright stance in older adults are very important, but the effect of different types of attentional focus in this population is unclear. Thus, this study aims to examine the effect of external and internal focus of attention and a Supra postural task on postural control in older adults.

This study hypothesizes that external focus of attention while performing a secondary task like steadily holding a glass full of water while standing, will promote the automatic control processes of the primary task of standing. Therefore, the effects of two methods of attentional focus on postural and supra postural task in community-dwelling older adults were examined.

MATERIALS AND METHODS

Experimental Design. The experimental design selected for the present investigation was a single group with pre-test and post-test design. This design reveals marginal control. There is fairly additional structure; there is a single selected group under observation, with a careful measurement being done before commencing the experimental treatment and a repeated measurement after that. The selected tests were performed on the participants under four conditions of the study.

Participants. The 20 participants who fit the inclusion criteria were recruited from all the sedentary older adults dwelling in Tehran. Their age range was between 60 and 74 years. None of the participants were aware of the study purpose. The Human Investigation Committee at the University of Tehran approved the protocol selected for use in the research and all subjects were required to read and sign informed consent forms preceding the assessments. The exclusion criteria included pre-existing musculoskeletal disorders or diseases that can interfere with standing still. There should also be no aphasia and/or significant attention deficits.

Experimental Equipment. Balance assessment and training were carried out using the Biodex Stability System (BSS) (Biodex Medical Systems, Inc, Shirley, NY). The BSS is comprised of an unstable support platform that allows up to 20° of multiaxial surface deflection. It can be set at 8 levels of stability, with a setting of 8 being the most stable foot platform setting and a setting of 1 being the least stable setting. Prior to the intervention program, 3 measures of postural stability were obtained at stability level 2 and included: 1) overall stability index (OSI), which measures the variance of foot platform displacement in degrees in all directions (the higher the number, the greater the amount of movement during a test), 2) anterior/posterior stability index (APSI), which measures the variance of foot platform displacement in degrees for motion in the sagittal plane, and 3) medial/lateral stability index (MLSI), which measures the variance of foot platform displacement in degrees on any given level for motion in the frontal plane. The reliability of the BSS has been previously established with an internal consistency coefficient (ICC) ranging from 0.72 to 0.81 (12, 13).

Process assessment was performed before the initial training session (pre-training) and 48 hours following completion of the last training session (post-training). The assessment procedure consisted of three 30-second trials, with a 30-second rest between trials at the training levels (6 and 4) and at level 2, which was not used for training. Order of testing was the same in all tests, starting with the most stable (level 6) and ending with the least stable (level 2). Results for level 4 and 6 were obtained to measure the effect of attentional focus on acquisition, which has been previously reported (14). The results for OSI, APSI, and MLSI obtained for trials 2 and 3, for level 2, were averaged for use in the data analysis.

Experimental Protocol. Each participant was provided with three different focus instructions: control, internal, and external. The control condition always followed the baseline trial, in order to avoid the use of prior strategies that were perceived as successful by participants. Exposure to internal and external focus instructions was counterbalanced, with 50% of the participants being exposed first to the internal focus trial.

Each participant was required to hold a glass of water under the second to fourth conditions:

1) Standing on the mat without any tasks or directions (baseline condition).
2) Standing on the mat holding a glass full of water without any directions (control).
3) Standing on the mat with an internal focus of attention on the hand holding a glass full of water (IFA condition).
4) Standing on the mat with an external focus of attention on the glass full of water (EFA condition).

The task consisted of three 30-s trials. During each trial, the participant was instructed to stand quietly, with feet shoulder-width apart, on a force platform. The right upper arm was positioned to be slightly abducted, the forearm internally rotated, and the elbow flexed at 90°.

Prior to internal focus trials, participants were instructed to ‘‘try to minimize movement of the hand over the duration of the trial’’. External focus trials were preceded by instructions to‘‘try to minimize movement of the glass over the duration of the trial’’. The order of conditions was counterbalanced across participants.

The Treatment. Subjects stood barefoot in a Romberg position with their arms hanging loosely by their sides, and their feet were placed slightly apart (14 cm) on marks drawn on the force platform. Treatment was administered to all the subjects by a planned model of proprioceptive exercises prepared with the help of experts and examined reviews. The treatment in the form of cost-effective and simple exercises done on the floor as well as on the balance (wobble) board was accomplished four times a week, for a four weeks duration (sessions lasted for 30 minutes with appropriate rest break between exercises).

Statistical Analysis. To interpret the helpfulness of treatment given for four weeks, different statistical techniques were used. The raw data on pre-test and post-test were subjected to descriptive statistics (mean and standard deviation). Further, a t-test was employed for the comparison between mean scores of various tests on pre- and post-tests.

RESULTS

The average age of participants was 59.24 ± 5.77 years old. The mean body mass and height were 168.4 and 73.6, respectively. Also, the body mass index (BMI) of participants was calculated as 25.95. Mean, standard deviations, and change scores of the stability indexes of subjects in pre-training and post-training are presented in Table 1.

Table 1. pre-training and post-training stability indices and change score

focus of attention		pre-training	post-training	Change score (95% CI)
Internal	Overall	16.7	14.2	-2.49 (-4.98 to -1.05)
	Anterior posterior	12.5	10.3	-2.14 (-4.77 to -0.84)
	Medial lateral	11.6	9.8	-1.79 (-3.26 to -0.06)
External	Overall	16.9	11.4	-5.45 (-6.92 to -3.96)
	Anterior posterior	12.8	7.7	-5.04 (-6.32 to -3.40)
	Medial lateral	12.2	8.1	-4.11 (-5.68 to -2.65)

For all three outcome measures, the analysis of variance (ANOVA) showed that there was a significant type-by-time interaction (OSI: $F_{2, 20}$= 13.39, P= 0.003; APSI: $F_{2, 20}$= 5.14, P= 0.02; MLSI: $F_{2, 20}$= 7.74, P= 0.01) which is indicated in Figures 1 to 3.

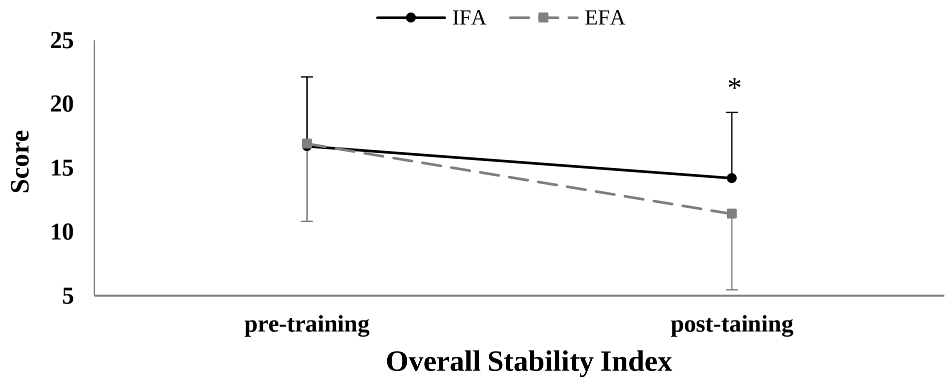

Figure 1. *Between-group differences for overall stability index.* **IFA:** internal focus of attention. **EFA:** external focus of attention. ***:** significant at $p<0.05$.

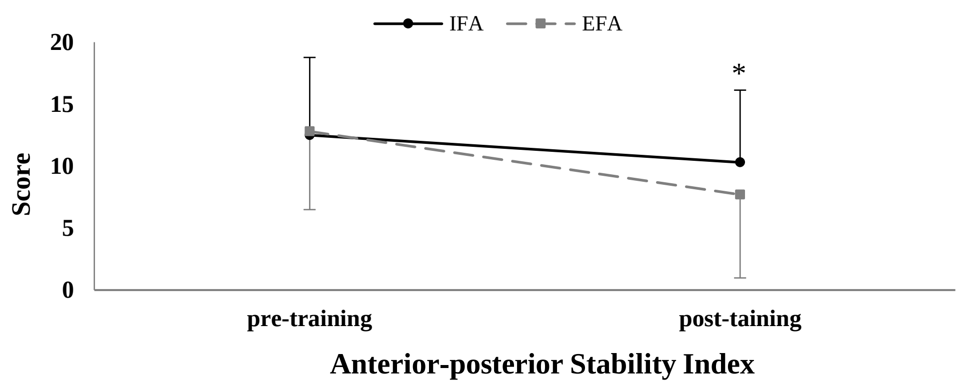

Figure 2. *Between-group differences for anterior-posterior stability index.* **IFA:** internal focus of attention. **EFA:** external focus of attention. ***:** significant at $p<0.05$.

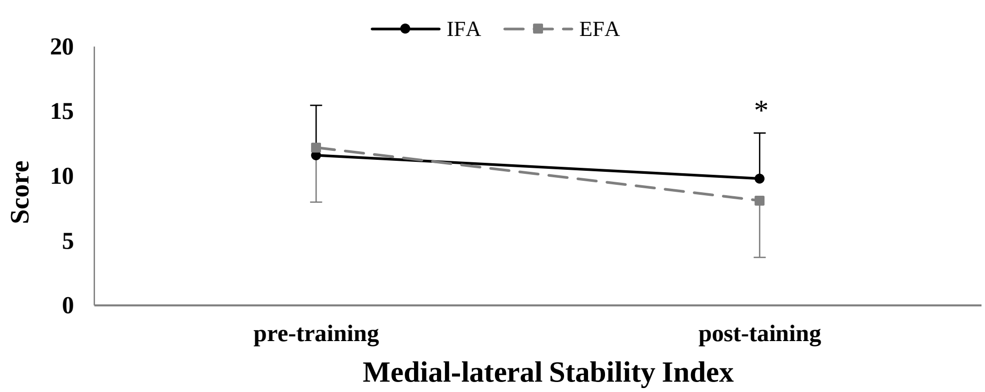

Figure 3. *Between-group differences for medial-lateral stability index.* **IFA:** internal focus of attention. **EFA:** external focus of attention. ***:** significant at $p<0.05$.

Effect of attentional focus order. A 2 (Order: external focus first, internal focus first) × 3 (Attentional focus: control, internal focus, external focus) analysis of variance (ANOVA) with repeated measures on the last factor was performed on postural sway to certify that the order of the attentional focus trials did not affect subsequent performance.

For all data sets, neither the main effects of order nor the interaction between order and attentional focus conditions was significant. Hence, data were pooled and re-analyzed, with postural sway data being analyzed in repeated measures ANOVAs on attentional focus (external vs. internal vs. control).

Effect of attentional focus on postural sway. Overall, sway was larger in the A–P direction than in the M–L direction. Also, sway was increased under both internal and external focus conditions compared to the control condition. The ANOVA results revealed main effects for attentional focus, $F_{(2,20)}= 8.549$, $p < 0.05$, and sway direction, $F_{(1,10)}=63.412$, $p < 0.05$, as well as a significant interaction between these factors, $F_{(2,20)}=26.760$. Least significant difference (LSD) post-hoc analysis on the attentional focus main effect revealed that control postural sway was significantly smaller than both internal and external focus conditions ($p < 0,01$), but was not significantly different in themselves.

DISCUSSION

The purpose of the present study was to investigate the differential effect of internal and external attentional focus instructions on postural control and supra-postural (SP) performance. Two important findings emerged from this study. First, attentional focus affected both the postural and the SP task. Second, no differential effect between internal-external focus conditions was observed.

Similar to de Lima et al., (15), the supra-postural task used in the present study required participants to hold a glass of water. Yet, participants' attentional focus was also manipulated by instructing them to either minimize the movements of the glass (external focus) or to minimize the movements of their hand (internal focus).

The present results are in line with those of previous studies (16-18) which demonstrated supra-postural task effects on postural sway. That is, both attentional focus conditions (internal, external) resulted in greater postural sway than was the case without the addition of the supra-postural task (control). Importantly in the present context, postural sway did not appear to be differentially influenced by either attentional focus condition. This is not in line with our prediction that the individual's attentional focus on the supra-postural task might differentially affect postural sway. However, even though the specific goals of the attentional focus instructions were different, participants would still have to rely on the tactile sensation produced by their touch to monitor the success or failure in achieving the goal. As such, the overriding goal would be to monitor tactile sensation and to use this information to make the appropriate postural adjustments.

In the last decade, several studies have examined the influence of directing the performer's attention on motor performance (and learning). A predominant assumption resulting from this study seems to be that the application of automatic control processes can be facilitated – thereby enhancing performance and learning – by simply directing performers' attention away from their own movements. Some studies (2) have argued that, when given too many instructions, learners are more likely to adopt a controlled mode of information processing, which is detrimental to performance. In this condition, learners are typically prevented from acquiring explicit knowledge about the task by having them perform attention-demanding secondary tasks. Existing findings actually provide some support for the notion that preventing learners from focusing on their movements or simply not directing attention to their movements is more beneficial than directing their attention to those movements (18). Studies demonstrating supra-postural task effects on postural control are in line with these results, in that they also demonstrate the effectiveness of automatic control processes for motor performance. In fact, one could argue that declines in postural sway were observed in those studies because the supra-postural tasks served to distract participants from focusing on standing still.

Nevertheless, there is some evidence to suggest that a superior advantage of directing attention to the movement effect exist, compared to not focusing on the movements themselves. Wulf et al., (19) for example, compared the effectiveness of two external attentional focus and found that an external focus was more effective when it referred to the movement effect than when it did not. Furthermore, in a recent study, Shafizadeh et al., (20) observed that preventing learners from focusing on their movements, by having them perform a concurrent task, was no more effective than internal focus or control conditions, whereas an external focus on the movement effect (i.e., markers on the platform) resulted in clearly superior balance learning. The present findings are in agreement with this view by showing that the effects of supra-postural tasks are qualified by the attentional focus they induce.

Thus, the present results confirm the results of previous supra-postural task studies by demonstrating that the attentional focus on a supra-postural task that is induced by the instructions given to participants influence postural control. It is clear that the wording of instructions can significantly affect the performers' focus of attention and, consequently, the control strategies adopted by them. Also, through a within-participant design, the present findings demonstrate that attentional focus has a direct and immediate effect on postural control. While previous studies (21) examining external and internal attentional focus effects exclusively used learning paradigms (with different groups of a participant performing under different attentional focus conditions), the present findings show that attentional focus can directly influence performance even on well-learned tasks such as standing.

The advantage of an external focus compared with an internal focus of attention has been explained as resulting from performers' utilizing more automatic (reflexive and/or self-organizing) control processes. Conversely, when participants focus on their body movements – and perhaps also when they are not given any attentional focus instructions – they are more likely to consciously intervene in these control processes and may inadvertently disrupt relatively automatic control processes (3, 22).

CONCLUSION

The present results demonstrated that postural stability can be influenced by the addition of a supra-postural task, but also, they showed that the type of attentional focus adopted by participants plays a crucial role in this context. When the supra-postural task was coupled with an external focus, an increase in COP was observed – implying that postural stability was enhanced via increased muscle/joint stiffness, the product of which is a system capable of responding to environmental perturbations. Future studies could directly probe postural stability as a function of attentional focus by applying perturbations to the system. Based on the present results, one might expect to see faster reactions to such perturbations and perhaps more effective adjustments when an external than an internal focus is adopted. Overall, the present findings show how apparently minor variations in the individual's focus of attention can impact postural stability.

APPLICABLE REMARKS

- Attentional focus training without emphasis on the internal and external aspects of attention can be used to improve the balance in sedentary older adults.

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