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Research Article

THE EFFECT OF ATTENTIONAL FOCUS AND MANIPULATION OF SOMATOSENSORY ON EMG OF SELECTED BALANCE MUSCLES IN ELDERLY

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ABSTRACT
The purpose of this study was to determine the effect of attentional focus and Somato-sensory manipulation on postural control and EMG in elderly man. For this purpose 34 older man (mean of age = 70.7±2.6) were selected and divided into external and internal focus of attention groups randomly. The task consisted of performing balance task, on foam and on inflatable cushions. Subjects in external group instructed to focus on a picture located 6 meters from them. Subjects in internal group instructed to focus on their ankle muscles. Megawin EMG system was used for recording electromyography of Tibialis anterior, Preroneuslongus, Soleus and Gastrocnemius muscles and RMS of signals was obtained. Mixed between- within ANOVA, two independent and paired t tests were used for data analyzing. Results showed that the internal attentional focus had no significant effect on RMS in three conditions ($p>.05$). External focus of attention had significant effect in conditions of standing on foam and standing on inflatable cushions ($p<.01$). Also the effect of external attention focus was more effective in challenging conditions. In total, this study showed the external attention focus can reduce muscle activity and more economical movement. These results are in line with Constrained Action Hypothesis.

Keywords: *Attention, Postural Control, Elderly, Constrained Action Hypothesis, Performance, Electromyography*

INTRODUCTION
Elderly is a natural phenomenon that all people will feel it in their life and is along with biologic changes such as weakness, decreased muscular mass, reduced mobility, disability, disorder in motor coordination and balance. All these changes lead to increased risk in elderlies (Granacher *et al.*, 2011). One of the reasons for injuries, disabilities and death in elderlies is stumbling and falling (Bogaerts *et al.*, 2011). In overall, falling is considered as the defect and deficiency in control of height due to change in displacement of the body pressure center at the time of static and dynamic balance (Baloh *et al.*, 1998; Abrahamova *et al.*, 2008). Although, most falling downs don't lead to serious injuries, at least they affect the feeling of efficiency and life quality of individual (Deci and Ryan, 2008; Playfer, 2001). Thus, it is required to develop some training strategies and programs to increase the balance of elderlies and reduce their risk of falling (Chiviacowsky *et al.*, 2010). Standing is a motor balance skill in daily life that is controlled by subcortical nervous structures and moto-neuron pool (Lacour and Borel, 1993). Although standing is a simple postural task; however, it is well proved that standing requires cognitive resources (Lajoie *et al.*, 1993). In normal standing in young people, the least attention resources are required; however, in challenging conditions such as standing on a narrow surface or standing on one leg, postural tasks require more cognitive resources (Rushworth *et al.*, 2003).
Disruption in control of body balance and stability in elder lies due to attention deficient and disorder has been recently considered (Weeks *et al.*, 2003; Woollacott and Shumway-Cook, 2002). Undoubtedly, the elderlies require more cognitive resources at the time of performing postural tasks rather than youth (Brown *et al.*, 1999; Hoxhold *et al.*, 2006).
Two aspects of attention that are more affected by elderlies are divided attention and selective attention. Divided attention refers to the ability of simultaneously dividing attention to several assignments.

Simultaneous performing of two tasks and allocating attention to two things at the same time is probably more difficult for elderlies than youth. Concerning divided attention, elderly related changes become clear when the measuring task is complex; however, at the time of performing easy and automatic tasks, they are negligible (Hoyer and Roodin, 2009).

Selective attention refers to focus on related information and prevention of unrelated information. Related changes to age lead to weakness in the ability to neglect unrelated information. In other words, the ability of selective attention decreases (Kramer and Madden, 2008). In past decades, various studies have shown that individual's attention has significant effect on motor learning and implementation. Attention to body movements at the time of body activity is relatively ineffective. On contrary, focus on the effects of individual's movement or environment leads to more effective implementation and learning (Zachry *et al.,* 2005). Studies have shown that early attention that is given by verbal instruction have significant effect on learning and performance of individuals (Zentgraf and Munzert, 2009). Focus of attention is referred to the act of directing attention to data sources or objects (Schmidt and Lee, 2006). The instructions that direct the attention of individual toward body movement are internal focus of attention and, on contrary, external focus of attention include directing the individual's attention to environmental effects of movement (Perkins *et al.,* 2003).

McNenin *et al.,* (2003) proposed constrained action hypothesis to describe various effects of focus of attention on implementation. This hypothesis explains that external focus of attention facilitates motor performance due to improvement of automatic control of movements. On contrary, internal focus of attention leads to conscious and deliberate control of movement that leads to disruption of automatic processing. This hypothesis explains the effect of focus of attention on implementation of most tasks and activities such as basketball shooting (Zachry *et al.,* 2005), balance tasks (Shea and Wulf, 1999; Chiviacowsky *et al.*, 2010) and vertical jumping (Wulf *et al.*, 2007; 2010).

One way to evaluate movement automaticity is analysis of movement implementation in relation with the parameters that show how movements are implemented automatically or consciously. One of these parameters is electromyography, based on this, if the movement is consciously controlled, it leads to higher electrical activity compared to the time when the movement is automatically controlled and in fact in leads to more efficiency in movement control (Wulf *et al.,* 2010). Electromyography studies have shown that external focus of attention leads to reduction of electromyography indices compared to internal focus of attention. In addition, it leads to more efficient and economic implementation of movement (Zachry *et al.*, 2005).

Vance *et al.,* (2004) showed that muscular electrical activity is less in external focus of attention compared to internal focus of attention. Zachry *et al.,* (2005) also used surface electromyography of neuromuscular system to measure the effects of focus of attention in basketball free shooting. In this test, the subjects should either pay attention to their wrist motion or to basket. In addition to improvement of precision of free shoot in external focus of attention, higher muscular electrical activity in biceps and triceps in internal focus of attention indicates muscular stiffness that disrupt fine movement control. The studies of focus of attention in some balance tasks of elderly society indicate the priority of external focus of attention. For example, Chiviacowsky *et al.,* (2010) in their study found that external focus of attention leads to rapid learning of balance skill in elderlies. In addition, external focus of attention in the elderlies affected by Parkinson disease also improved.

Landers *et al.,* (2005) measured the oscillations of the ability to maintain balance in people affected by Parkinson by a balance apparatus. The subjects under external and internal focus of attention performed balance task. The scores of balance in external focus of attention condition was better that internal focus of attention. They showed that the balance of patient affected by Parkinson cannot be improved by the instruction of external focus of attention.

So far, no study has been done investigating the electromyography pattern in balance muscles of elderlies treated by different instructions on focus of attention. Thus, the aim of this study is to investigate the effect of focus of attention on muscular electrical activity of the selected balance muscles of elderlies. Concerning the literature review, this question arises that whether the type of focus of attention can lead to more efficiency and automaticity in muscular electrical activity of the selected balance muscles in elderlies or not. In addition, whether in challenging balance conditions of daily life of elderlies such as walking on sand, walking on snow, passing the barriers and walking on narrow levels, that are assimilated in this study by walking on the foam and standing on the inflatable pillow, can be effective or not?

MATERIALS AND METHODS

Methodology

This is a semi-experimental pretest-posttest study with two test groups. The statistical population of the study includes male elderlies of age 65-75 in Tehran. To this end, from elderly male, a sample of 34 subjects was selected through simple non-probable sampling. The independent variables of the study were focus of attention (external and internal) and manipulation of body sense in three levels and the dependent variable includes the root mean square of data recorded from electromyography signal that was obtained based on “microvolt”. The evaluating muscles include antigravity muscles, Tibialis anterior, peroneus longus, soleus and gastrocnemius. After preparation of skin and installation of electrode on intended muscles and in normal standing, standing on of foam and standing on inflatable pillow positionsby MEGAWIN 6000 made in Finland, electromyography data were recorded.

In external focus of attention, the subjects were asked to pay attention to the image that was installed on the opposite wall in 6 meter distance and in internal focus of attention; they were asked to focus on their leg muscles. Data obtained in the initial stage (normal standing without intervention) was considered as base data and the data obtained from three states of normal standing, standing on the foam and standing on inflatable pillow with instruction of focus of attention (external and internal) were compared with base level.

Kolmogorov–Smirnov test was used to determine data distribution normality and Levene statistic was used to determine the homogeneity of variances, mixed between-within ANOVA was used to determine the main and mutual effects of two variables of manipulation and type of group and paired T test was used to determine the effect of focus of attention (external and internal) on dependent variable.

RESULTS AND DISCUSSION

Results

The underlying variables of subjects in the present study include age, height, weight and rate of sport activity in week. The results showed that internal and external focus of attention has not meaningful difference in terms of mentioned underlying variables (P>.05) (table1).

Table 1: Descriptive indices of external and internal focus of attention groups in terms of qualitative underlying variables

Variable	Mean		SD	
	External	Internal	External	Internal
Age	70.7	69.4	2.4	3.2
Height (cm)	175.8	174.8	5.08	4.06
Weight (kg)	81.1	80.1	9.62	7.6
Activity per week (h)	4.6	4.2	1.26	1.3

In the present study, despite the fact that the subjects of present study were randomly placed in external and internal focus of attention groups, it was required to specify the difference between internal and external focus of attention groups in the score of main variable (RMSMAX). Thus, independent t-test was used to study the difference between external and internal focus of attention groups in RMSMAX index in base state (normal standing without instruction). The results showed that external and internal focus of attention groups had not meaningful difference in RMSMAX index at the beginning of the study (P>.05).

To evaluate the effect of focus of attention (internal and external) on various levels of manipulation (normal standing, standing on foam and standing on pillow) in electromyography index of RMSMAX, mixed between-within ANOVA (3*2) was used. The results showed that in RMSMAX index, the interaction of focus of attention and manipulation level was not meaningful in none of the muscles (P>.05). Moreover, the main effect of manipulation level and the main effect of focus of attention was meaningful in all muscles (p<.05) (table2). Furthermore, the effect factor of each of the effects has been presented in the table. As seen, all effect factors of main effects are above 0.7 that indicate relatively high effect factor (Field, 2009). To compare the mean scores before and after proposing external focus of attention instruction in RMSMAX index of leg muscle in various states, correlated t-test was used. The results showed that external focus of attention had not meaningful effect on RMSMAX index of various leg muscles in normal standing position (p>.05); however, external focus of attention had meaningful effect on this index in various muscles of leg in standing on foam position (p<.05). In standing on pillow position, the results showed that external focus of attention had meaningful effect on RMSMAX index of selected muscles of leg (p<.05). In internal focus of attention group, the results of correlated t-test showed that internal focus of attention had not significant effect on RMSMAX index of selected muscles of leg in normal standing, standing on foam and standing on infallible pillow (p>.05).

Table 2: Statistical indices related to the study of the main and interactional effects of focus of attention and manipulation levels on RMSMAX electromyography index

Leg muscles	Statistical index Effect type	Intergroup df	Intragroup df	WilksLambada	F	Eta squared
Anterior muscle	Main effect of focus of attention	1	29	---	51.5**	0.79
	Main effect of manipulation level	2	30	0.018	72.8**	0.84
	Focus of attention* manipulation level	2	30	0.51	2.14	0.15
Long fibula	Main effect of focus of attention	1	29	---	41.4**	0.76
	Main effect of manipulation level	2	30	0.015	53.2**	0.79
	Focus of attention* manipulation level	2	30	0.85	0.91	0.17
Biceps	Main effect of focus of attention	1	29	----	38.8**	0.75
	Main effect of manipulation level	2	30	0.075	45.2**	0.77
	Focus of attention* manipulation level	2	30	0.81	2.67	0.18
Soleus	Main effect of focus of attention	1	29	----	21.2**	0.72
	Main effect of manipulation level	2	30	0.021	41.5**	0.76
	Focus of attention* manipulation level	2	30	0.91	2.58	0.17

*** Meaningful in 0.01*

Discussion and Conclusion

The aim of this study is to investigate the effect of focus of attention and manipulation of body sense on muscular electrical activity of selected balance muscles in elderlies. Data analysis showed that focus of attention instruction had been effective on electrical muscular activity in some manipulation levels. One of the research findings showed that external focus of attention had no effect on electrical activity of selected muscles in normal standing position. The results of present study were consistent with Lohse *et al.,* (2011) and Kal *et al.,* (2013) studies and didn't match with Vanse (2004) and Zachry (2005). Lohse showed that although external focus of attention leads to less error and less muscular electrical activity in antagonist muscles, it had no effect on agonist muscles. He claimed that external focus of attention leads to effective use of muscular units and contractile in muscles has decreased; thus, the performance improves. However, in contrary, internal focus of attention has decreased effective motor control in force production; thus, contractile has increased and efficiency decreases. Kal *et al.,* (2013) studied the effect of focus of attention on the automaticity of movement. The subjects performed leg flexion and extension tasks in both states of focus of attention and simultaneously registered electromyography data of leg muscles. The results showed that although external focus of attention leads to better, effective and easier motor performance, the muscular electrical activity had no difference with each other in both focus of attention states.

Vance (2004) and Zachry (2005) claimed that external focus of attention had positive effect on muscular electrical activity in their study and external focus of attention had decreased the muscular electrical activity not only in the muscles that the subjects focused on; but also in the close muscles.

This reduced electrical activity in external focus of attention was interpreted as more economic efficiency in movement. External focus of attention (focus on wrist muscles) constrained their motor system and led to stabilization of degrees of freedom; however, EMG reduction in external focus of attention indicates more effective coordination between agonist and antagonist muscular groups (Zachery, 2005).

Although in standing on foam and pillow position, the rate of electrical activity of selected muscles increased; compared to groups in standing on foam and pillow positions and with external and internal focus of attention instruction in standing on foam and pillow positions without focus of attention instruction, the results indicate decreased electrical activity of muscle in external focus of attention state. The results in standing on foam position was consistent with Lohse (2010) and inconsistent with Wulf (2010). Lohse (2010) showed that external focus of attention leads to improvement of movement economy through reduction of agonist and antagonist muscles activity and increased change of movement. While, Wulf (2010) claimed that in vertical jumping task at the beginning of muscular activity, no meaningful difference was observed between external and internal focus of attention. According to Wulf (2010), internal focus of attention leads to false neural reactions or noise in neuromuscular system such that this noise constrains maximum power production; however, external focus of attention decreases noise in neural system and leads to more efficient and economic neuromuscular control. Lohse (2011),claimed that when the subjects select internal focus of attention, action and performance will be constrained due to ignorance of automatic control mechanisms. When individuals consciously try to control their movements, they constrain motor system through intervening in processes that naturally regulate movements; thus, automatic and effective control processes of movement will be ruined (Lohse *et al.,* 2011).

According to Masters and Maxwell (2002) hypothesis, obvious processing hypothesis, at the time of internal focus of attention, individuals pay attention to internal data sources and process external highlighted data. Thus, the internal focus of attention instruction applies more loads on working memory. More pressure or load on working memory is along with weaker performance in internal focus of attention conditions. Disruption of more skill treated by secondary task in internal focus of attention indicate high attention load related to skill on working memory since internal attention leads to accumulation of task data (Polton *et al.,* 2006).

In standing on pillow position, the results indicate positive effect of external focus of attention on reduction of muscular electrical activity and the results of the study matched with the results of Vance

(2004), Lohse (2011), Marchant (2009, 2011) who showed that external focus of attention leads to reduced muscular electrical activity and more efficient and effective movement (McNovin *et al.,* 2003). Marchant *et al.,* (2009, 2011) claimed that internal focus of attention leads to false neural inputs or noise in neuromuscular system and this noise constrain maximum power production. However, Zachry (2005) argued that external focus of attention decreases noise in neural system and leads to more efficient neural control, this is while if the external focus of attention leads to more automaticity than internal focus of attention, it is expected that more distinct motor ways is used or more distinct movements happen under external focus of attention condition.

The shared coding of perception and action of Prinz theory is a document on the priority of external focus of attention. This theory asserts that despite traditional opinions that assumed there are different coding systems for users and data providers, just they can be produced commonly just in a far retrieval level. It means that this is the only framework that is accepted for shared coding and planning. Perception and action planning are based on approaches that are beyond the body. He argues that if the actions are planned based on their perceived results, they will be more effective. Thus, the advantages of focus on the effects of movement instead of focus on the movement itself are along with shared coding theory (Wulf and Prinz, 2001). The results of present study showed that external focus of attention can be effective in challenging conditions for maintaining balance and efficiency. The findings can be used for rehabilitation intervention in implementation and learning of various motor skills. It is better that during rehabilitation interventions, the attention of elderly subjects be directed toward external data sources. In addition, it is possible to develop intervention programs for elderlies and train them on that during performing some tasks that require maintaining balance in challenging condition such as walking and standing on unstable levels, walking on wet surfaces and walking and standing on the snow and ice and most risky conditions, direct their attention on external data sources rather than their body. Although most previous studies have provided and offered evidences on priority of external focus of attention on reduced muscular electrical activity and thus improvement of the efficacy of the movement and its automaticity, this study also provided other evidences in this context.

REFERENCES

Abrahamova D and Hlavacka F (2008). Age-related changes of human balance during quiet Stance. *Physiology Research* **57** 957-964.

automatization: A comprehensive test of the constrained action hypothesis. *Human Movement Science* **32** 527-535.

Baloh RW, Jacobson KM, Enrietto JA, Corona S and Honrubia V (1998). Balance disorders in older persons: quantification with posturography. *Journal of Otolaryngology - Head & Neck Surgery* **119**(1) 89-92.

Bogaerts A, Delecluse C, Boonen C, Claessens AL, Milisen C and Verschueren S (2011). Changes in balance, functional performance and fall risk following whole body vibration training and vitamin D supplementation in institutionalized elderly women. A 6 month randomized controlled trial. *Gait & Posture* **33** 466–472.

Brown LA, Shumway-Cook A and Woollacott MH (1999). Attentional demands and postural recovery: the effects of aging. *Journal of Gerontology* **54** 165-71.

Chiviacowsky S, Wulf G and Wally R (2010). An external focus ofattention enhances balance learning in older adults. *Gait& Posture* **32**(4) 572-5.

Deci EL and Ryan RM (2008). Self-determination theory: a macro theory of human motivation, development and health. *Canadian Psychology* **49**(3) 182–185.

Field A (2009). *Discovering Statistics using SPSS*, third edition (Sage publication) 479-481.

Granacher U, Muehlbauer T, Gollhofer A, Kressig RW and Zahner L (2011). An intergenerational approach in the promotion of balance and strength for fall prevention – a mini-review. *Gerontology* **57** 304–315.

Hoyer WJ and Roodin PA (2009). *Adult Development and Aging,* sixth edition (McGraw Hill).

Huxhold O, Li SC, Schmiedek F and Lindenberger U (2006). Dual tasking postural control: aging and the effects of cognitive demand in conjunction with focus of attention. *Brain Research Bulletin* **69** 294-305.
Kal EC, Kamp J and Houdijk H (2013). External attentional focus enhances movement
Kramer BJ and Madden DJ (2008). Attention, In: *Hand Book of Aging and Cognition*, 3rd edition, edited by Craik FIM and Salthouse TA 189-249.
Lacour M and Borel L (1993). Vestibular control of posture and gait. *Archives Italiennes de Biologie* **131** 81-104.
Lajoie Y, Teasdale N, Bard C and Fleury M (1993). Attentional demands for static and dynamic equilibrium. *Experimental Brain Research* **97** 139-144.
Landers M, Wulf G, Wallman H and Guadagnoli MA (2005). An external focus of attention attenuates balance impairment in Parkinson's disease. *Physiotherapy* **91** 152–185.
Lohse KR, David E and Sherwood Alice F Healy (2011). Neuromuscular Effects of Shifting the Focus of Attention in a Simple Force Production Task. *Journal of Motor Behavior* **43**(2) 173-84.
Lohse KR, Sherwood DE and Healy AF (2010). How changing the focus of attention affects performance, kinematics, and electromyography in dart throwing. *Human Movement Science* **29** 542–555.
Marchant DC (2011). Attentional focusing instructions and force production. *Frontiers in Psychology* **1** 210.
Marchant DC, Greig M and Scott C (2009). Attentional focusing instructions influence force production and muscular activity during isokinetic elbow flexions. *Journal of Strength & Conditioning Research* **23** 2358-2366.
McNevin NH, Shea CH and Wulf G (2003). Increasing the distance of an external focus of attention enhances learning. *Psychological Research* **67** 22-29.
Perkins CN, Steve R, Passmore SR and Lee TD (2003). Effects of focus of attention depend on golfers' skill. *Journal of Sports Science* **21** 593-600.
Playfer JR (2001). Falls and Parkinson's disease. *Age Ageing* **30**(1) 3–4.
Poolton JM, Maxwell JP, Masters RSW and Raab M (2006). Benefits of an external focus of attention: Common coding or conscious processing? *Journal of Sport Sciences* **24**(1) 89-99.
Rushworth MFS, Johansen Berg H, Göbel SM and Devlin JT (2003). The left parietal and premotor cortices: motor attention and selection. *NeuroImage* **20** 89-100.
Schmidt RA and Lee TD (2006). *The Learning Process: Motor Control and Learning*, 4th edition (Champaign, Illinois, United States: Human Kinetics).
Vance J, Wulf G, Tollner T, McNevin N and Mercer J (2004). EMG activity as a function of the performer's focus of attention. *Journal of Motor Behavior* **36**(4) 450-459.
Weeks DL, Forget R, Mouchnino L, Gravel D and Bourbonnais D (2003). Interaction between attention demanding motor and cognitive tasks and static postural stability. *Gerontology* **49** 225- 32.
Woollacott M and Shumway-Cook A (2002). Attention and the control of posture and gait: a review of an emerging area of research. *Gait & Posture* **16** 1-14.
Wulf G and Prinz W (2001). Directing attention to movements' effects enhances learning: A review. *Psychonomic Bulletin and Review* **8** 648-660.
Wulf G, Dufek J, Lozano L and Pettigrew C (2010). Increased jump height and reduced EMG activity with an external focus. *Human Movement Science* **29**(3) 440-8.
Wulf G, Zachry T, Granados C and Dufek J (2007). Increases in jump-and-reach height through an external focus of attention. *International Journal of Sports Science & Coaching* **2** 275-284.
Zachry T, Wulf G, Mercer J and Bezodis N (2005). Increased movement accuracy and reduced EMG activityas the result of adopting an external focus of attention. *Brain Research Bulletin* **67** 304-309.
Zentgraf K and Munzert J (2009). Effect of attentional focus instructions on movement kinematics. *Psychology of Sport Exercise* **10** 520-5.
Zentgraf K and Munzert J (2009). Motor Imagery and its Implications for Understanding the Motor System. *Progress in Brain Research* **174** 219-229.