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# THE EFFECT OF EXTERNAL ATTENTIONAL FOCUS AND SELF-CONTROLLED FEEDBACK ON MOTOR LEARNING IN OLDER ADULTS

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**Abstract**

***Introduction.*** External focus instruction and self-controlled feedback have beneficial effects on motor learning. The purpose of the present study was to investigate the benefits of combined effects of external focus instruction and self-controlled feedback on balance performance in older adults. ***Material and Methods.*** Forty older adults (mean age: 63.21 ± 3.6 years; all female) were selected and randomly divided into 4 groups: self-controlled feedback, external attention, external attention/self-controlled feedback and control group. The task of standing on the platform of the stabilometer device and trying to keep the platform horizontally as much as possible was performed in each 30-sec. trial. The participants of self-controlled group received feedback on the timing of balance after the trials. In the external focus of attention, participants noticed the signs that were located horizontally ahead of their feet. The test was conducted in two sessions. In the acquisition phase, 10 trials of 30 seconds were performed and the retention test was completed 24 hours later as 5 trials of 30 seconds. ***Results.*** The results of mixed ANOVA on time data as an indicator of balance in the acquisition phase showed that the mixed group of external focus of attention and self-controlled feedback had better performance than the other groups ($p = 0.004$). In the retention test, the results of mixed ANOVA showed that the participants in the combined group of external focus and self-controlled feedback had better performance than the other groups ($p = 0.006$). The external focus of attention and self-controlled feedback performed similarly, and both were superior to the control group ($p < 0.05$). ***Conclusions.*** The results of this study, supporting the OPTIMAL theory of motor learning in the elderly, showed that the combination of two factors of external focus and self-controlled feedback has a double advantage over the presence of each of the factors. Therefore, it is suggested that the combinations of external focus instructions and self-controlled feedback should be used to improve performance and motor learning in the classes of practical and clinical rehabilitation fields.

**Key words:** focus of attention, self-controlled feedback, motor performance, dynamic balance, elderly, OPTIMAL theory of motor learning

## Introduction

Aging involves complex structural and functional changes in the brain that lead to reduced cognitive and motor performance [1]. The nervous system that organizes sensory inputs for balancing changes at the beginning of aging [2]. Disruption in the balancing performance is one of the secondary consequences of aging [3]. Balance is the ability to maintain the center of gravity on the surface of the body with minimal change [4]. It is also one of the indicators of independence in daily activities [5]. Weakening of the balance due to increased age is the biggest reason for falling that is a common and serious problem in the elderly [6]. Therefore, it is necessary to consider some educational strategies and plans to increase the elderly balance and reduce the risk of falling [7]. Previously, it was believed that the balance control would occur automatically, including multiple synaptic pathways within the spinal cord, brain stem and without cerebral involvement and cognitive activities of higher levels. However, a lot of research has provided evidence based on the role of paying attention and cognition in balancing control [8].

One of the ways to improve balance is to consider the focus of attention. The results of many studies showed that one of the important factors influencing the implementation and learning of motor skills is the focus of attention [9]. The instructions that guide one's attention towards body movements are referred to as internal focus of attention, and in contrast, external focus of attention refers to focusing on the effects and outcomes of movement in the environment [9]. In this regard, many studies have highlighted the external focus of attention; this superiority has been shown to increase the effectiveness (accuracy and distance) and efficiency (kinetic and kinematic indices) of movements, regardless of the skill level of the performers [9, 10]. For example, in the study on 36 children, Abdollahipour et al. [11] showed that the practice of external focus of attention instructions led to more accuracy in bowling compared to the control group and internal focus of attention. Chiviacowsky et al. [7] also concluded that the external focus of attention group had better performance than the internal focus of attention group.

Another factor that affects the implementation and learning of balance is how to receive and process feedback. Feedback can be received internally by people themselves or from an external source [12]. One way to receive feedback is through self-controlled situations (in the context of autonomy support), in which the learner receives feedback as self-control and at his/her own choice; this method can improve learning and motor performance [13]. Autonomy support is referred to as an expression of individual autonomy or the freedom of an individual to determine his/her actions [14].

The studies in this area have shown that providing opportunity in determining the timing of feedback can be useful for motor skill learning. For example, Chiviacowsky and Lessa [15]

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showed that feedback choices could increase motor skill learning in the elderly. In another study on 36 elderly persons, Lessa and Chiviacowsky [14] also found that allowing elderly participants to choose the amount of practice supports their needs of autonomy and exerts a positive influence on motor learning.

Wulf and Lewthwaite [16] have recently proposed the OPTIMAL theory of motor learning. According to this theory, three important factors are mentioned that affect the acquisition and learning of motor skills. The first factor is the application of external focus of attention that is likely to facilitate learning in comparison to internal focus [9, 17, 18]. Autonomy or self-control condition is a motivational variable and it is the second effective factor in Wulf and Lewthwaite's OPTIMAL theory of motor learning. The last factor is enhanced expectancies. Based on the OPTIMAL theory of motor learning, by improving the coupling of goals with actions, motivational and attentional factors lead to improving performance and motor learning [16].

To date, numerous studies have examined individual effects of each of the three above-mentioned factors on motor learning in different groups. However, given the OPTIMAL theory of motor learning [16], this effect can be increased when these attentional (external attention) and motivational (enhanced expectancies for future performance and autonomy support) factors are used together in workouts [16]. In this regard, several studies have recently investigated the additive effects of attentional and motivational variables on performance and motor learning. For example, in adult-age research, Pascua et al. [19] showed that the performance of both groups of enhanced expectancies and external focus of attention increased in the retention test and transfer of a throwing task. In another study, Wulf et al. [13] investigated the additive effects of all three factors of the OPTIMAL theory of motor learning (external attention, self-controlled feedback and enhanced expectancies). The results of their research point once again to the positive effects of combining all three factors on motor learning and support the OPTIMAL theory of motor learning. Abdollahipour et al. [11] also studied the external focus of attention and autonomy support of collective benefits for motor performance in children. Their findings also supported the OPTIMAL theory of motor learning in children.

However, due to the lack of studies in this field and the need to do further research in order to test the OPTIMAL theory of motor learning and to review the generalizability of this theory in other age groups such as the elderly, the present study seeks to answer the following question: can the external focus of attention and self-controlled feedback, along with their individual effects, have additive effects on improving the balance of elderly people?

## Material and methods

### *Participants*

This research was a quasi-experimental study and was approved by the ethical committee of a local university for biological research. The participants were 40 healthy elderly individuals (age = 63.21 ± 3.6 years; all female) who met the criteria for entering the study. They were selected using the convenience sampling method and divided randomly into four experimental groups (each group included 10 elderly persons). The criteria for entering the study included age over 60, normal vision, no brain damage and orthopedic injuries, an ability to stand for at least one minute and walk the distance of 10 meters independently, and also an ability to follow simple commands [20]. The exclusion criterion was an inability to perform static and dynamic tasks independently and without a cane.

### *Apparatus and task*

In the present study, learning and motor performance were reported as the amount of time needed to maintain dynamic balance in the elderly. The stabilometer was used to measure dynamic balance [21]. This device includes a moving plate (platform), a chassis and a control unit. After standing on the platform, the person should hold the plate in a horizontal position. The distortion of the participant's balance and deviation to the left and right caused the stabilometer device to record the deviation from balance. At that moment, the light faced by the person changed from green to red. This device has different timings of 15, 30, 60 and 90 seconds. The timing of 30 seconds was used in the present study. This device has been used in a lot of research in the field of motor learning [7].

### *Procedure*

The participants took part in the laboratory tests according to the defined timetable. They gave their written informed consent to participate in the tests. They study included the experimental groups (external focus of attention, self-controlled feedback and external attention/self-controlled feedback) and the control group. The participants from the external attention/self-controlled feedback group yoked with the external attention group, while the self-controlled feedback group yoked with the control group. All the participants were beginners in terms of skill level and had no previous acquaintance with the task. Prior to the task performance, the participants were provided with information on the method of performance and how to receive feedback information and instructions from the external focus of attention. After seeing and hearing the basic information, the researcher demonstrated the working way on the balance device to the participants several times. The participants performed two trials of 15 seconds without feedback and attentional instruction on the balance device to familiarize themselves with the task. Subsequently, the participants stood on the balance plate in such a way that the legs were opened a little more than the width of the shoulders, and the hands were stretched along the shoulders, the trunk and the head were placed in the same direction. After being assured of the participant's readiness for the practice trials, the start button was triggered. At the same time, the light determining the balance state was hidden for the participants. Given that the participants did not see the balance keeping time and the balance light and could not use the feedback information, they were given feedback based on the placing in the particular group. The participants in the self-controlled group received feedback on the balance time after the trials. The participants paid attention to the signs on the horizontal surface, two colored circles with a diameter of 3 cm on the platform and about 20 cm ahead of the participant's feet, in the condition of external focus of attention. The participants from the external attention/self-controlled feedback group received simultaneous self-controlled feedback and external attentional instructions while performing the task. In the control group, the participants performed the balancing task without any attentional instruction and feedback. As long as the participant was keeping his balance, the stabilometer's light was green, and when the participant was not keeping his balance, the light was red. The participants completed the acquisition phase; 10 trials of 30 seconds were performed with 90 seconds of rest between the trials at this stage. The retention test was carried out 24 hours after the completion of the acquisition sessions; the participants performed 5 trials of 30 seconds on the balance device without instructions, reminders or feedback.

***Data Analysis***

After collecting the data, descriptive statistics such as mean, standard deviation, tables and charts were used to analyze the data. Also, parametric inferential statistics such as mixed ANOVA with Bonferroni posttest were used at the significant level of $p \leq 0.05$. The $\eta^2$ index was used to report the effect size and data were analyzed with SPSS software, version 22.

## Results

***Acquisition***

The results of 4 (four experimental groups) × 10 (number of practice trials) mixed ANOVA on time data as an indicator of balance at the acquisition phase showed that the main effect of the acquisition phase was significant, $F(9, 324) = 11.12$, $p = 0.0001$, $\eta^2 = 0.23$. In other words, all groups experienced significant improvements in balance performance during acquisition sessions. The main effect of the group, $F(3, 36) = 41.41$, $p = 0.0001$, $\eta^2 = 0.77$ and the interaction effect, $F(27, 324) = 1.93$, $p = 0.004$, $\eta^2 = 0.13$ were also significant. Based on the results of the Bonferroni post hoc test, it was found that the participants in the combined group of external attention/self-controlled feedback (21.59 ± 0.96) had better performance than the other groups. The external attention group (17.36 ± 0.95) showed better performance than the self-controlled feedback group (15.59 ± 0.96) and the control group (21.59 ± 0.94). However, the participants from the self-controlled group were better than the control group (Fig. 1).

***Retention***

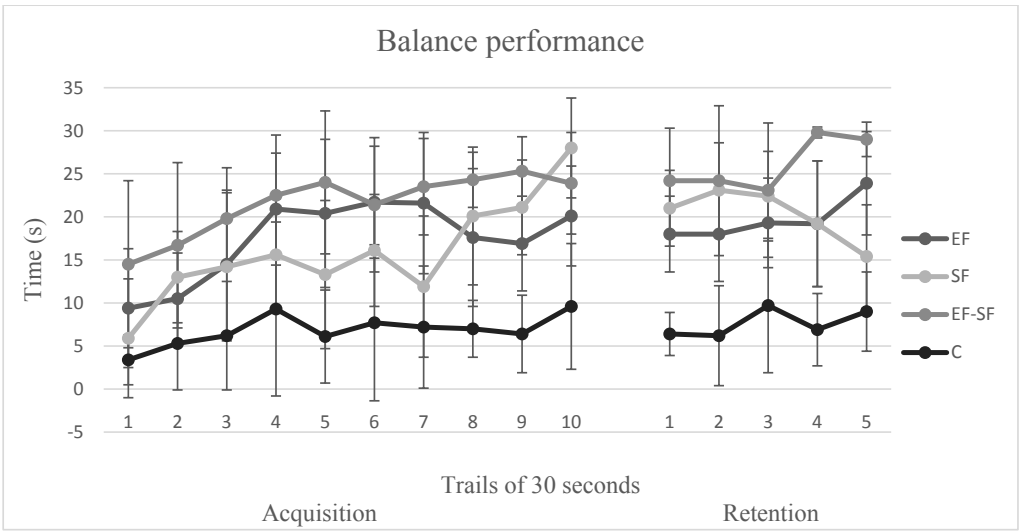
The results of 4 (four experimental groups) × 5 (number of practice trials) mixed ANOVA on time data as a balance index in the retention test showed that the main effect of the retention phase was not significant, $F(4, 144) = 0.68$, $p = 0.6$, $\eta^2 = 0.01$. The main effect of the group $F(3, 36) = 60.20$, $p = 0.0001$, $\eta^2 = 0.83$ and the interaction effect $F(12, 144) = 2.47$, $p = 0.006$, $\eta^2 = 0.17$ were significant. Based on the results of Bonferroni post hoc test, it was found that the participants in the combined group of external attention/self-controlled feedback (26.6 ± 0.99) had better performance than the other groups. The external attention group (19.68 ± 0.97) and the self-controlled feedback group (20.22 ± 0.99) performed similarly and both were superior to the control group (7.64 ± 0.98; Fig. 1).

## Discussion

The purpose of this study was to investigate the additive effect of external focus of attention and self-controlled feedback on balance in the elderly in order to test the Wulf and Lewthwaite's OPTIMAL theory of motor learning in older adults. The findings showed that in the acquisition phase, all groups experienced significant performance improvement in the practice trials and the combined group of external attention and self-controlled feedback showed considerable performance improvement compared to the other groups. In the retention test similar to the acquisition phase, the results showed that the external attention/self-controlled feedback group had better performance than other groups. Also, the performance of the self-controlled feedback group and the external attention group was better than that of the control group.

In their research supporting the OPTIMAL theory of motor learning, Wulf et al. [22] showed that the additive effects of two factors of external attention and self-controlled feedback in adults can improve motor learning. Abdollahipour et al. [11] also studied the OPTIMAL theory of motor learning in children. The results of their study supported the theory in the children community and showed that the combination of external attention and self-controlled feedback can have more positive effects on each factor alone in improving motor learning. Recently, Ghorbani [23] has also studied the test of OPTIMAL theory of motor learning in adults and investigated the motivational effects of enhanced expectancies and autonomy support on motor learning. His research findings also supported the OPTIMAL theory of motor learning. The results of the present study by extension of the results of the research by Wulf et al. [22], Ghorbani [23] and Abdollahipour et al. [11] supported the OPTIMAL theory of motor learning even in the elderly.

Based on the OPTIMAL theory of motor learning, an attentional factor (external attention) and two motivational factors (autonomy support and enhanced expectancies) together create




Error bars indicate standard errors. EF = external focus; SF = self-controlled feedback; EF-SF = external focus/self-controlled feedback; C= control.

**Figure 1.** Time in balance (s) for the experimental groups during the acquisition phase (Day 1) and retention test (Day 2)

a more productive learning environment [16]. It seems that external attention plays a dual role by focusing directly on the purpose of the task and reducing focus on itself (like body movements). In other words, in the context of external attention, the participant, by focusing on the effects of moving in the environment, allows his/her motor system to be more self-organized in the process of automated processing and this self-organization results in improved performance and motor learning [10, 24, 25, 26]. Considering that balance keeping requires the integration of various types of sensory and motor information such as vestibular, visual and proprioceptive information, and due to the decreased efficacy of these senses in the elderly, it is believed that the adaptation of an external attentional focus has led to better use of sensory inputs and compensated to a large extent the loss of sensory systems involved in controlling balance in older adults [7].

In the OPTIMAL approach, autonomy support or self-controlled feedback conditions play an effective role in improving learning and motor performance. Halperin et al. [27], for example, showed that boxers in the condition of autonomy support with their small choices improved their motor performance. It seems that having control over practice and how to receive feedback and autonomy support leads to an increase in expectations for positive outcomes. Therefore, it can be concluded that people in autonomy conditions improve their learning and motor performance due to the fact that they have enhanced expectancies.

In cases where autonomy support is low and the person has no choice, the level of cortisol increases and subsequently dopamine decreases. This decrease can lead to loss of performance and motor learning. Based on the OPTIMAL theory of motor learning, individuals increase their motor performance in autonomy support conditions by improving the connection between target and action [16, 23].

In the OPTIMAL theory of motor learning, external attention and autonomy support (in addition to enhanced expectancies) are seen as key factors in the process of creating effective neural connections in order to support performance and motor learning [28]. Implementation under optimal motivational conditions (e.g., self-controlled feedback) and external focus of attention facilitate functional communication and will have specific neural connections between brain regions, which ultimately leads to improved motor learning [11, 16, 23].

It seems that effective structural connections in the brain regions provide the way for efficient connections in brain networks. The conditions of autonomy support help to strengthen the goal-efficient action connection by providing a motor system for doing the task. The practice conditions that create positive motivation with autonomy support facilitate motor learning by producing dopamine for online and offline memory consolidation and neuroplasticity changes such as structural and functional connections [28, 29]. In particular, relatively challenging practice provides conditions for enhancement and continuation of dopamine [30]. Some of the benefits of autonomy support and external focus of attention occur by facilitations in changes within and across the brain networks [13]. Proximity and connectivity of motivational and sensory-motor systems, perhaps in remarkable networks, change precision from default mode to the corresponding motor networks, which transforms into a position to strengthen the goal-action coupling.

The present study supported the OPTIMAL theory of motor learning in the elderly; however, there were some limitations. Among the limitations of this research, we can mention a small number of training sessions and a small sample size. Therefore, it is suggested that future studies should include more days and sessions, the measurements of long-term effects of learning as well as a larger sample size. It is also suggested that enhanced expectancies add to two other factors and the test of the OPTIMAL theory in the elderly in the existence of all three factors.

## Conclusion

Regarding the results of this research and the superiority of the effectiveness of the combined external attention and self-controlled feedback, it is suggested that sports coaches and physiotherapists should use the instructions of external attention and self-controlled feedback simultaneously in sports classes and in elderly clinical rehabilitation to improve learning and motor performance.

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## References

1. Egüez-Guevara P., Andrade F.C.D. (2015). Gender differences in life expectancy with and without disability among older adults in Ecuador. *Archives of Gerontology and Geriatrics* 61(3), 472-9.
2. Menz H.B., Lord S.R., Fitzpatrick R.C. (2003). Age-related differences in walking stability. *Age and Ageing* 32(2), 137-42.
3. Kaneda K., Sato D., Wakabayashi H., Hanai A., Nomura T. (2008). A comparison of the effects of different water exercise programs on balance ability in elderly people. *Journal of Aging and Physical Activity* 16, 381-92.
4. Nitz J.C., Choy N.L. (2004). The efficacy of a specific balance-strategy training programme for preventing falls among older people: A pilot randomised controlled trial. *Age and Ageing* 33(1), 52-8.
5. Petrofsky J.S., Cuneo M., Dial R., Pawley A.K., Hill J. (2005). Core strengthening and balance in the geriatric population. *The Journal of Applied Research* 5(3), 423-33.
6. Aslan U.B., Cavlak U., Yagci N., Akdag B. (2008). Balance performance, aging and falling: A comparative study based on a Turkish sample. *Archives of Gerontology and Geriatrics* 46(3), 283-92.
7. Chiviacowsky S., Wulf G., Wally R. (2010). An external focus of attention enhances balance learning in older adults. *Gait Posture* 32(4), 572-5.
8. Norrie R.G., Maki B.E., Staines R.W., McIlroy W.E. (2002). The time course of attention shifts following perturbation of upright stance. *Experimental Brain Research* 146(3), 315-21.
9. Wulf G. (2013). Attentional focus and motor learning: A review of 15 years. *International Review of Sport and Exercise Psychology* 6(1), 77-104.
10. Wulf G., McNevin N., Shea C.H. (2001). The automaticity of complex motor skill learning as a function of attentional focus. *The Quarterly Journal of Experimental Psychology A* 54(4), 1143-54.
11. Abdollahipour R., Palomo Nieto M., Psotta R., Wulf G. (2017). External focus of attention and autonomy support have additive benefits for motor performance in children. *Psychology of Sport and Exercise* 32, 17-24.

12. Magill R.A., Anderson D.I. (2007). *Motor learning and control: Concepts and applications.* New York: McGraw-Hill.
13. Wulf G., Lewthwaite R., Cardozo P., Chiviacowsky S. (2018). Triple play: Additive contributions of enhanced expectancies, autonomy support, and external attentional focus to motor learning. *Quarterly Journal of Experimental Psychology* 71(4), 824-831.
14. Lessa H.T., Chiviacowsky S. (2015). Self-controlled practice benefits motor learning in older adults. *Human Movement Science* 40, 372-80.
15. Chiviacowsky S., Lessa H.T. (2017). Choices over feedback enhance motor learning in older adults. *Journal of Motor Learning and Development* 5, 304-18.
16. Wulf G., Lewthwaite R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic Bulletin and Review* 23(5), 1382-414.
17. Marchant D.C. (2011). Attentional focusing instructions and force production. *Frontiers in Psychology* 1, 210, PMID: 21833266, DOI: 10.3389/fpsyg.2010.00210.
18. Lohse K.R., Sherwood D.E., Healy A.F. (2010). How changing the focus of attention affects performance, kinematics, and electromyography in dart throwing. *Human Movement Science* 29(4), 542-55.
19. Pascua L.A.M., Wulf G., Lewthwaite R. (2015). Additive benefits of external focus and enhanced performance expectancy for motor learning. *Journal of Sports Science* 33(1), 58-66. DOI: 10.1080/02640414.2014.922693.
20. Ràbago C.A., Wilken J.M. (2011). Application of a mild traumatic brain injury rehabilitation program in a virtual reality environment: A case study. *Journal of Neurological Physical Therapy* 35(4), 185-93.
21. Brouwer R., Kal E., van der Kamp J., Houdijk H. (2019). Validation of the stabilometer balance test: Bridging the gap between clinical and research based balance control assessments for stroke patients. *Gait Posture* 67, 77-84. DOI: 10.1016/j.gaitpost.2018.09.025.
22. Wulf G., Chiviacowsky S., Drews R. (2015). Human Movement Science External focus and autonomy support: Two important factors in motor learning have additive benefits. *Human Movement Science* 40, 176-84. DOI: 10.1016/j.humov.2014.11.015.
23. Ghorbani S. (2019). Motivational effects of enhancing expectancies and autonomy for motor learning: An examination of the OPTIMAL theory. *The Journal of General Psychology* 146(1), 79-92. DOI: 10.1080/00221309.2018.1535486.
24. McNevin N.H., Shea C.H., Wulf G. (2003). Increasing the distance of an external focus of attention enhances learning. *Psychological Research* 67(1), 22-9.
25. Ghorbani S., Dana A., Christodoulides E. (2020). Effects of external focus of attention on learning static balance among girls with ADHD. *Biomedical Human Kinetics* 12(1), 69-74.
26. Abdollahipour R., Land W.M., Cereser A., Chiviacowsky S. (2019). External relative to internal attentional focus enhances motor performance and learning in visually impaired individuals. *Disability and Rehabilitation* 8, 1-10. DOI: 10.1080/09638288.2019.1566408.
27. Halperin I., Chapman D.W., Martin D.T., Lewthwaite R., Wulf G. (2017). Choices enhance punching performance of competitive kickboxers. *Psychological Research* 81(5), 1051-8.
28. Dayan E., Cohen L.G. (2011). Neuroplasticity subserving motor skill learning. *Neuron* 72(3), 443-54. DOI: 10.1016/j.neuron.2011.10.008.
29. Wise R.A. (2004). Dopamine, learning and motivation. *Nature Reviews Neuroscience* 5(6), 483-94.
30. Saddoris M.P., Sugam J.A., Cacciapaglia F., Carelli R.M. (2013). Rapid dopamine dynamics in the accumbens core and shell: Learning and action. *Frontiers in Bioscience - Elite* 5(1), 273-88.

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