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The Effect of an External Focus of Attention on Static Balance

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by

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TITLE: THE EFFECT OF AN EXTERNAL FOCUS OF ATTENTION ON STATIC BALANCE

MAJOR PROFESSOR: Dr. Jared M. Porter

The present study tested the effects of focus of attention on static balance. The purpose of this study was to determine if altering a person's focus of attention influenced the performance of the Single Leg Stance Test.

Based on findings reported in previous research, it was hypothesized that instructing participants to direct their attention externally would result in better static balance performance compared to instructions that directed attention internally or neutrally. Additionally, it was predicted that instructing participants to direct their attention internally would result in better static balance performance compared to instructions that directed attention neutrally. Participants (19 males and 9 females) stood on an inflated disc on one foot, while given three conditions: External (i.e., perform the balance task while focusing on minimizing movement of the disc), Internal (i.e., perform the balance task while focusing on minimizing movement of your foot), and Control (i.e., perform the balance task to the best of your ability). The results of the study indicated that there were no significant differences between the three conditions.

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Introduction

More than a century ago, William James (1890) stated that, "Actions are controlled more effectively if attention is directed to the (intended) outcome of the action, or its 'remote effects,' rather than to its 'close effects,' such as kinesthetic feedback" (James, 1890, p. 520). He then illustrates this quotation with a reaching movement example stating, "Keep your eye at the place aimed at, and your hand will fetch [the target]; think of your hand, and you will likely miss your aim" (James, 1890, p. 520). Negative effects of directing the attention of the participant to their own movements have been established experimentally (Baumeister, 1984). The findings of previous studies suggest that internal focus of attention instructions may not be as effective, as compared to the external focus of attention instructions (Wulf, Höb, & Prinz, 1998).

Research in the motor behavior field investigates the underlying principles of acquisition and retention of motor skills. This enhances the understanding of how motor performance is affected by practice variables (Laufer, Rotem-Lahrer, Ronen, Khayutin, & Rozenberg, 2007)**.** Instructions given verbally are commonly utilized in movement execution settings, especially physical exercise associated with training, rehabilitation, and sports performance. When motor skills are taught, instructors usually provide an internal focus of attention, meaning that the information relayed from the instructor to the participant is related to their own movements (Laufer, et al., 2007)**.** Many studies (McNevin, Shea, & Wulf, 2003; Wulf et al., 1998; Wulf, McNevin & Shea, 2001) have established that participants with no impairments benefit by adopting instructions that direct their attention to the effect of the movement (i.e., external focus of attention). Not only have external focus of attention advantages been found in relation to internal focus of attention conditions, but these advantages have been compared to control conditions with no focus of attention instructions as well (Wulf, Weigelt, Poulter, & McNevin, 2003, Experiment 2). The benefits of learning with an external focus of attention, rather than an internal focus of attention, has been demonstrated using a variety of tasks (Shea & Wulf, 1999; Wulf, Landers, Lewthwaite, & Töllner, 2009; Wulf, McNevin, & Shea, 2001).

Many methods have been utilized in order to enhance postural control following injuries and reconstruction of ligaments, etc. These methods include detailed exercises and training on unstable surfaces. The methods may be further progressed with the application of recent findings in research about motor learning that concerns the effect of focus of attention on skill achievement (McNevin, Shea, & Wulf, 2003; Wulf, Töllner, & Shea, 2007). The learning advantage, such as when the movement effect is the main focus of attention, can be shown for a variety of motor tasks (i.e., moving the platform of a ski-simulator steadily (Wulf et al., 1998, Experiment 1), balancing on a stabilometer (Wulf et al., 2001), and standing on an inflated disc while holding a round pole (Wulf, Mercer, McNevin, & Guadagnoli, 2004). An external focus of attention is defined as instructions that focus a participant's attention to the effects that their movements have on the environment. In contrast, an internal focus of attention is defined as instructions that focus a participant's attention on the movements themselves (Wulf et al., 1998). Asking the participant to direct their attention to focusing on minimizing the movement of the disc would be the external focus of attention, whereas asking the participant to focus on minimizing the movement of their foot would be an internal focus of attention.

If a person's attention is aimed at the movement effect (i.e., external focus), rather than towards the actual movement (i.e., internal focus), research findings have indicated that movements tend to be more accurate and produced more efficiently (Wulf & Dufek, 2009). McNevin, Shea, and Wulf (2003) proposed that adopting an external focus of attention promoted the unconscious control of movement. In contrast, when participants adopt an internal focus of attention, they are more likely to consciously interfere in those control processes; thereby unintentionally disrupting the automatic control of motor behavior. Postural adjustments in the execution of dynamic balance tasks have shown a greater response when attention is directed externally; this is viewed as evidence of fast, reflective, and automatic control processes. Using an external focus of attention may allow the motor system to naturally "self-organize," unhindered by the interference which could be caused by conscious control attempts (Wulf et al., 2001).

A rehabilitation program, designed to aid people in returning to their pre-injury physical activity, is as important as the reconstruction surgery itself. Rehabilitation programs are implemented to assist the patient in regaining strength, flexibility, and endurance, without compromising the reconstruction or predisposing them to complications, which can re-injure the person or elongate the rehabilitation process (Seto, Brewester, Lomardo, & Tibone, 1989). As the rehabilitation process progresses, individuals follow a specific protocol, determining what they are instructed to do, depending on how far out post-operation or injury the person is.

Tyler and McHugh (2001) suggest that specific neuromuscular training is crucial in order for people to successfully return to physical activity. Neuromuscular training can comprise of any activity inciting a stimulus that produces a coordinated muscle response. During movement, dynamic stability is reached through muscle coordination and proprioception; therefore, exercises are aimed towards increasing the magnitude of neuromuscular stabilizing forces required to be created to resist the destabilizing load practical to the injured extremity (Holm, Fosdahl, Friis, Risberg, Myklebust, & Steen, 2004). Proprioceptive signals are thought to be important in sensorimotor function. The information relayed from proprioceptors are essential for conscious and unconscious control of movement of the limbs. An injury may change somatosensory information, leading to the impairment of neuromuscular control of the affected lower limb (Liu-Ambrose, Taunton, MacIntyre, McConkey, & Khan, 2003). Because of this, it is critical to provide effective rehabilitation post injury, providing sensory feedback about changes in ligament length and tension, which triggers a neuromuscular response that contributes to active joint stability.

Active joint stability is important for people; therefore, one of the main components included in rehabilitation is balance. Balance is the ability to maintain equilibrium by positioning the center of gravity (COG) over the base of support (BOS) (Murray, Seireg, & Sepic, 1975). The COG is the body’s center of mass (COM) and it evolves according to changes in positions and movements of the body segments. It is important to assess the person’s balance ability in order to accurately determine potential impairments, identifying weakness in the body's core, back, and lower extremities. Additionally, the evaluation of balance helps to identify proper treatment plans, and assess change over time. The earliest scientific studies of standing balance dates back to 1853, when a German neurologist named Moritz Heinrich Romberg conducted and observed diseases of the central nervous system by the amount of participants swayed with their eyes closed (Browne & O’Hare, 2001). The evaluation of balance disorders has an important role since it aids in understanding how the postural control system functions, in clinical diagnoses, and the assessment of treatment efficacy (Murray et al., 1975).

When performing a balance task, the constant control processes involved are the sensory system, musculoskeletal system and the central nervous system (Laufer et al., 2007). An injury to any one of those systems frequently leads to impaired balance performance, which consequently requires rehabilitation. According to Laufer et al. (2007), research with participants without impairment is better off utilizing an external focus of attention when rehabilitating following an injury which balance is impaired. One study (Landers, Wulf, Wallman, & Guadagnoli, 2005) demonstrated that the balance of participants with idiopathic Parkinson's disease was enhanced by teaching those participants to implement an external focus of attention.

Functional assessments of balance seem to be the fastest test to administer that does not require expensive equipment; however, only obvious changes in balance can be detected, making it suitable as a screening tool for identifying participants needing more thorough evaluation in addition to the initial assessment (Browne & O'Hare, 2001). There are many ways to test balance disorders, but for this particular study, the Single Leg Stance Test was utilized (Browne & O'Hare, 2001). This test assesses the participant's ability to maintain balance by standing on one foot with hands on hips (which is also known as the stork stance). The Single Leg Stance Test is performed with the eyes open and subsequently with the eyes closed; significantly reducing their BOS. In the present study, the participants were only tested with their eyes open (Browne & O'Hare, 2001). The purpose of this study was to determine if altering a person's focus of attention influenced the performance of the Single Leg Stance Test.

Based on findings reported in previous research, it was hypothesized that instructing participants to direct their attention externally would result in better static balance performance compared to instructions that direct attention internally or neutrally. Additionally, it was predicted that instructing participants to direct their attention internally would result in better static balance performance compared to instructions that directed attention neutrally.

Method

Participants

Twenty-eight college aged (19 males and 9 females, *M*age = 22, age range: 18-25 years) participants were recruited from courses in the Department of Kinesiology. The protocol was approved by the Human Subjects Committee and all participants provided informed consent.

Apparatus and Task

Testing was performed on a rubber semi-inflated balance disc, which was textured on one side and smooth on the other. The rubber disc was 35 cm in diameter and was inflated to a thickness of 4 cm. The disc was placed on a carpeted flat surface, with the experimenter standing behind the participants about 2 meters away. The participants stepped on the rubber disc while being timed by the experimenter using a stopwatch. The main purpose of the task was to remain balanced for a maximum of 5 minutes. At the initiation of each trial, participants were instructed to step on the inflated disc with their dominant foot. Participants were instructed to place their non-dominant foot on their supporting knee. They did this by lifting their non-dominant leg and placing the sole of the non-dominant foot against the side of the dominant knee cap, while placing their hands on their hips. See Figure 1 for a depiction of the balance task.

Figure 1. Example of the stork stance.

Procedure

Participants were instructed that the goal was to maintain balance as long as possible within each of the following conditions: External, Control, and Internal. While in the External condition, participants were instructed to “perform the balance task while focusing on minimizing movement of the disc.” In the Internal condition, participants were instructed to “perform the balance task while focusing on minimizing movement of your foot.” When participants were in the Control condition they were instructed to “perform the balance task to the best of your ability.” Instructions were verbally provided to each participant prior to the initiation of each trial. Using a within-participant design, the ordering of conditions were counterbalanced across participants over three consecutive days of testing. Each participant was assigned a different condition each day, resulting in a total of nine trials over the three days of testing. There was a 2-minute seated rest between trials.

At the beginning of each testing session, participants were instructed to remove their shoes, but were allowed to keep their socks on. The participant was told that they would be timed until an error occured. When the participant was in the correct testing position, the testing began when the experimenter said, "go." There was a 5-minute time limit for each trial. The experimenter stopped timing the trial if one or more of the following were observed: the whole non-dominant foot left the supporting dominant knee; the participant lifted one or both hands from the hips; the participant pivoted the position of the dominant foot on the rubber disc; the participant's foot failed to remain in contact with the rubber disc; or the participant completely lost balance and stepped off the inflated disk.

Statistical Analysis

Data were analyzed with a repeated measures univariant analysis of variance (ANOVA). The three trials of each condition were averaged to get a composite score for the External, Internal, and Control conditions. Outliers were identified and removed in each of the experimental conditions.

Results

The results of the ANOVA indicated there was no main effect between the three experimental conditions, F (2, 54) =.871, p=.424. The average balance times and standard deviations for each condition are displayed in Figure 2.

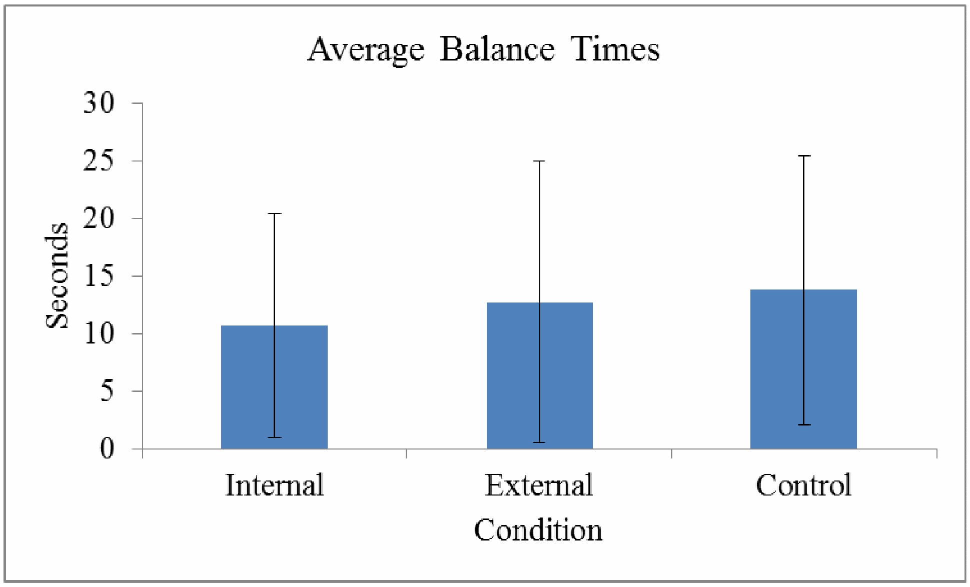

Figure 2. The average time participants were able to remain balanced in each of the three experimental conditions. Error bars represent standard deviations.

Discussion

The purpose of this study was to determine if altering a person's focus of attention influenced static balance. It was hypothesized that instructing participants to direct their attention externally would result in better static balance performance compared to instructions that directed attention internally or neutrally. It was also hypothesized that instructing participants to direct their attention internally would result in better static balance performance compared to instructions that direct attention neutrally. There have been studies (Wulf et al., 1998, Experiment 2; Wulf et al., 2004) that investigated how balance performance is influenced by altering focus of attention, but there was some curiosity in knowing if not only altering a person's focus of attention will influence static balance on an inflated disc. The task of standing on an inflated disc was chosen because it is related to common tasks used in athletic training to rehabilitate muscles involved in balance. Injuries are associated with an impairment of neuromuscular function. Neuromuscular rehabilitation is an important component of injury rehabilitation, thus it was valuable to assess if the performance of this commonly used task to evaluate neuromuscular function could be enhanced through the use of an external focus of attention.

In theory, the external focus of attention should increase postural stability which could augment the rate at which one progresses in rehabilitation. External focus of attention is deemed to be more favorable for skills that postural instability tend to be large and the participants seem to be more prone to intervene into automatic control processes (Wulf, Töllner, & Shea, 2007). When performing a balance task, there has been a greater response when the participant is told to focus their attention externally. An external focus of attention allows the motor system to self-organize logically, unrestricted by the interference of the conscious control attempts.

As stated above, the present study was performed to assess if using an external focus of attention would be most effective when performing a task (i.e. standing on an inflated disk) that is commonly used in rehabilitative settings. The goal of the balance task was to maintain balance on an inflated disc for a maximum time of 5-minutes. This study concluded that, unlike previous focus of attention studies (Wulf et. al, 1998, 1999, 2001) where findings demonstrated that instructions inducing an external focus of attention resulted in the most effective balance performance, there was no significant difference between the three tested conditions.

The balance task used in the current study, compared to those used in previous studies (Wulf et al., 1998, Experiment 2; Wulf et al., 2004; Wulf et al., 2009), was more challenging since participants performed the task standing on one foot, rather than standing on both feet. Because of the enhanced complexity of the prescribed task used in the current study, the participants may have ignored or failed to comprehend the given instructions. This failure to follow or understand the instructions may have contributed to the lack of statistical difference between the three experimental conditions. In the future, it may be valuable to initially have participants practice the balance task with both feet on the inflated disc. Then after a period of familiarization, have the participant practice standing on one foot. The procedures could be performed in such a manner to allow participants to better understand the concept of the balance task on the inflated disc with both feet, and then they may progress to the more complex variation of the task (i.e. balancing on one foot). Following such a progression may result in participants being able to more effectively use the prescribed instructions resulting in a performance enhancement for the trials completed in the external condition relative to the control and internal conditions.

In conclusion, even though the data did not indicate that eliciting an external focus of attention resulted in better static balance performance on an inflated disc, further research is needed to better understand this learning and performance phenomena. In the future, a larger sample size and an increased amount of practice trials are recommended. Doing this would increase statistical power and allow researchers to more thoroughly examine the performance differences that may be imbedded within and between the various conditions. An increased amount of practice trials can prepare participants or aid them in interpreting the instructions for each condition. Also, an increased amount of practice trials may help the researcher clarify to the participants any confusion that may arise. If the instructions are interpreted correctly, then this may potentially facilitate a significant difference between the conditions. It is also recommended that participants initially practice the balance task on a stable surface (e.g., carpeted floor) and gradually work their way up to practicing the balance task on an unstable surface (e.g., inflated disc). As discussed above, it is very possible that the prescribed task was too challenging for the participants. As a result, the prescribed instructions may have not been properly utilized by the participants, possibly causing the lack of observed group differences. If participants systematically practiced their way through increasingly more complex variations of the balance tasks, future studies may be able to more accurately measure potential motor behavior differences between the different focus of attention conditions.

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