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THE EFFECTS OF FOCUS OF ATTENTION ON BALANCE IN INDIVIDUALS WHO HAVE UNDERGONE CHEMOTHERAPY

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Approved by:

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CHAPTER 1

INTRODUCTION

Manipulation of focus of attention has been used to influence motor skill performance for decades (James, 1890). Over the years, studies have shown that an external focus of attention has consistently improved one's ability to perform and learn many motor skills (Shea & Wulf, 1999; Wulf, Hob, & Prinz, 1998). The diversity of motor skills that an external focus has shown to improve has been quite remarkable. For example, sports skills like those used in golf can benefit from the use of this method (Wulf, Lauterbach, & Toole, 1999). Complex functional tasks such as an individual's gait variability or balance can also be affected using focus of attention. (Galit, Elliot, & Einat, 2017; Wulf, Chiviacowsky, Wally, 2010).

Verbal instruction is often given in a setting where a movement is being executed and this is commonly used in an exercise environment. Research suggests that practitioners and/or coaches usually provide instructions associated to the learner's body during a movement (i.e., internal focus) (Laufer, Rotem-Lahrer, Khayutin, & Rozenberg, 2007). However, a large amount of research suggests that focusing on the effect of the movement (i.e., external focus) can produce greater efficiency (McNevin & Wulf, 2002; Shea & Wulf, 1999; Laufer et al., 2007). In addition, it has been shown that external focus of attention instruction is more beneficial compared to no attentional focus instruction at all (i.e., neutral focus) (Wulf, Weigelt, Poulter, & McNevin, 2003).

Balance is an essential factor for an independent individual. It is also a key component when an individual is working to rehabilitate following an injury: "Balance is an essential part of sitting, sit-to stand, and walking activities" (Yavuzer, Eser, Karakus, Karaoglan, & Stam, 2006, p. 961). An individual's balance is determined on the location of their center of gravity (COG)

compared to their base of support (BOS) (Murray, Seireg, & Sepic, 1975). The greater the distance between an individual's COG and BOS, the more postural sway that individual will have.

There are many different assessments of balance, and the Sharpened Romberg (SR) is a commonly used test. In a recent study, researchers found that SR with eyes open is a valid and reliable clinical assessment of balance (Gras, Ganely, Bosch, Mayer, & Pohl, 2017). The convergent validity was compared to several balance measurements, including the Berg Balance Scale (BBS). The BBS is considered the gold standard for balance testing (Podsadillo & Richardson, 1991); however, the SR test is much less time consuming and requires less equipment (Gras et al., 2017).

Individuals with balance issues can be at a greater risk of falls, which could lead to a greater chance of injuries. Therefore, it is important to know reliable and easy methods to improve balance to incorporate into daily living to decrease this risk. A literature review found that out of 18 studies, 15 reported that an external focus of attention yielded an improvement of balance. Not only did this review show that external focus leads to improved balance, it examines several different types of populations (Park, Yi, Shin, & Ryu, 2015). The only group that did not benefit from instruction were world-class acrobats, possibly suggesting that individuals who are trained at such an elite level may not benefit from additional instruction. While athletes with such finely tuned balance might not improve from this method, several different types of individuals can still benefit from this type of instruction (Park et al., 2015).

An external focus could be an application for individuals who have some type of balance deficit. For instance, individuals with Parkinson's disease are commonly known to have poor balance (Playfer, 2001). Research has shown that 90% of people with Parkinson's disease will have a fall during their life (Koller, Glatt, Vetere-Overfield, & Hassanien, 1989). More recently, a

study was able to conclude that an external focus enhanced balance in individuals with Parkinson's disease (Wulf, Landers, Lewthwaite, & Tollner, 2009). This is just one example how an external focus could be applied in a practical setting to help improve the balance of an individual who has impaired balance.

Another specific population that can have balance issues is cancer patients that have undergone chemotherapy. While the ability to enhance survival in cancer patients is improving, the impact chemotherapy has on an individual, specifically their brain/nervous system, is a phenomenon that is not well understood. There can be many names for this condition, but it is often referred to as "chemo brain" (Staat & Segatore, 2007). Unfortunately, chemo brain tends to affect several aspects of daily living. According to Raffa and colleagues (2006), "The domains of cognition most often said to be impacted include verbal and visual memory, attention, concentration, language, motor skills, multitasking and ability to organize information" (p. 129-130). The lack of concentration or the inability to focus attention is a common symptom from chemo brain (Raffa et al., 2006; Porter & Anton, 2011) and researchers have found that an external focus of attention was able to produce visuomotor skill performance (Porter & Anton, 2011).

Apart from chemo brain, chemotherapy can also cause chemotherapy-induced peripheral neuropathy (CIPN). Musculoskeletal weakness of the lower extremities, and a decrease in proprioception and sensation are all symptoms of CIPN (Tofthagen, Overcash, & Kip, 2012). Most of the research on CIPN comes from individuals with diabetes. It has been found that individuals with similar symptoms as CIPN were at significant risk for falls (Macgilchrist et al., 2010). Therefore, not only can CIPN negatively affect balance and gait, it could also increase the risk of falls (Tofthagen et al., 2012).

The effects of focus of attention on balance is a topic that has been researched to a certain extent, however, the majority of the research reviews younger populations or older populations. Individuals with Parkinson's disease and multiple sclerosis have been the subjects of most of the clinical patient research, but there is a lack of research on other clinical populations. Individuals who have undergone chemotherapy during cancer can have poor balance caused by a variety of issues due to the treatment (Tofthagen et al., 2012; Raffa et al., 2006). Despite the poor balance within this population, the effects on balance through the use of focus of attention has not been tested. (Porter & Anton, 2011).

The purpose of this study was to determine if altering an individual's focus of attention had an effect on balance performance on individuals who have undergone chemotherapy. Based on prior findings, it was hypothesized that an external focus of attention would lead to a better balance performance compared to an internal or neutral focus of attention. It was also hypothesized that matched individuals who had not gone through chemotherapy would have a better balance performance than those who had gone through the treatment protocol.

CHAPTER 2

METHODS

Participants

Eleven individuals (age range: 47-81) who have undergone chemotherapy and eleven age-matched healthy individuals (age range: 42-79) were recruited from the Strong Survivors Program database at Southern Illinois University Carbondale (SIUC). Strong Survivors is a program at SIUC that uses exercise as a therapeutic tool for cancer patients and caregivers to help them get through treatment and the recovery process. The SIUC Human Subjects Committee approved the protocol and all participants signed an informed consent.

Apparatus, task, and procedure

The balance task took place in a well-controlled lab without any distractions. Only one participant was in the lab at a time with the researcher during the test. All the participants were informed that the goal Sharpened Romberg (SR) test was to maintain their balance for as long as they can, or until they reached 60 seconds (recently tested for validity and reliability, Gras, Ganely, Bosch, Mayer, & Pohl, 2017). The participant was instructed to stand with one foot directly in front of the other with heel of the front foot touching the big toe of the rear foot. The participant was able to self-select which foot will go in front. The researcher demonstrated the balance task before giving the instructions. Once the participant assumed the proper position for the SR the timer was started. The researcher stopped the timer if one or both feet of the participant moved from the original position. The timer was also stopped if the maximum amount of time was reached.

Following the instructions, the participant was given the appropriate cue for the specific condition. Using a within subject design, every participant performed the balance task in three separate conditions: external, internal, and a controlled condition. There was a 2-minute rest period between each condition. During the external condition, the participant was told “focus on minimizing the movement of your shoes”. During the internal condition, participants were told “focus on minimizing the movement of your feet”. In the control condition, the participants were told “perform the balance task to the best of your ability”. The attention instructions were given to the participants in a counter-balanced order to control for the effects of the order. All participants were told to look straight ahead during the task and focus on the given instruction. This was an attempt to avoid any visual attention influence (Wulf, 2007). The Sharpened Romberg (SR), which was just recently tested for validity and reliability, was used as the balance protocol (Gras, Ganely, Bosch, Mayer, & Pohl, 2017). The participant was instructed to stand with one foot directly in front of the other with heel of the front foot touching the big toe of the rear foot. The participant was able to self-select which foot will go in front. The researcher demonstrated the balance task before giving the instructions. Following the instructions, the participant was given the appropriate cue for the specific condition.

CHAPTER 3

RESULTS

Data Analysis

Independent groups t-tests were performed to compare the Chemo and Control groups on mean age. Because of the skewed distributions of the time able to perform task, non-parametric statistical tests were utilized and medians and inter-quartile ranges (IQRs) reported. Specifically, Wilcoxon signed rank tests were used to compare the three focus conditions (internal vs. external, internal vs. neutral and external vs. neutral) across both groups as well as within groups. Given that the time to perform task was limited to a maximum of 60 seconds, the focus conditions were compared to one another using McNemar tests for correlated proportions to determine whether the proportions of subjects reaching 60 seconds differed significantly. Additionally, Wilcoxon rank sum tests were used to compare the time able to perform task between the Chemo and Control groups (within each focus condition), while Fisher exact tests were used to assess whether the 2 groups differed on the proportion of subjects reaching 60 seconds. Results were considered statistically significant for $p < 0.05$. SAS v9.4 software was used to perform all statistical comparisons. (SAS Institute Inc., Cary, NC, USA)

Results

The ages of the 2 groups (Chemo – mean=65.1, std=9.5 vs Control - mean=63.8, std=10.4) did not differ significantly (p=0.7675). Overall, time to perform task did not differ between the 3 focus conditions: internal (median=47.86, IQR=29.54-60) vs. external (median=57.16, IQR=31.12-60), p=0.6788; internal (median=47.86, IQR=29.54-60) vs. neutral (median=60, IQR=33.21-60), p=0.1726; external (median=57.16, IQR=31.12-60) vs. neutral (median=60, IQR=33.21-60), p=0.4548. In examining the proportion of subjects reaching a

maximum time of 60 seconds, internal (36.4%) did not differ significantly from external (50.0%), p=0.1797, nor did external (50.0%) vs. neutral (59.1%), p=0.4142. However, a significantly greater proportion of subjects under the neutral focus condition (59.1%) reached 60 seconds than when under the internal focus (36.4%), p=0.0253.

Within the chemotherapy group, time to perform task did not differ between the 3 focus conditions: internal (median=36.37, IQR=25.5-60) vs. external (median=60, IQR=22.89-60), p=0.4609; internal (median=36.37, IQR=25.5-60) vs. neutral (median=60, IQR=23.56-60), p=0.3125; external (median=60, IQR=22.89-60) vs. neutral (median=60, IQR=23.56-60), p=0.8125. The proportion of subjects reaching a maximum time of 60 seconds, internal (27.3%) did not differ significantly from external (54.5%), p=0.0833, nor did internal (27.3%) differ significantly from neutral (54.5%), p=0.0833, nor did external (54.5%) vs. neutral (54.5%), p=1.0000.

Within the control group, time to perform task did not differ between the 3 focus conditions: internal (median=58.39, IQR=32.12-60) vs. external (median=54.32, IQR=35.12-60), p=0.8125; internal (median=58.39, IQR=32.12-60) vs. neutral (median=60, IQR=33.21-60), p=0.4375; external (median=54.32, IQR=35.12-60) vs. neutral (median=60, IQR=33.21-60), p=0.3125. The proportion of subjects reaching a maximum time of 60 seconds did not differ between the 3 focus conditions: internal (45.5%) vs. external (45.5%), p=1.0000; internal (45.5%) vs. neutral (63.6%), p=0.1573; external (45.5%) vs. neutral (63.6%), p=0.1573.

Group comparisons

Within the internal condition, time to perform task did not differ between the 2 groups: Chemo (median=36.37, IQR=25.5-60) vs. Control (median=58.39, IQR=32.12-60),

p=0.2522. No difference in the proportion of subjects reaching a maximum time of 60 seconds, Chemo (27.3%) vs Control (45.5%), p=0.6598.

During the external condition, time to perform task did not differ between the 2 groups: Chemo (median=60, IQR=22.89-60) vs. Control (median=54.32, IQR=35.12-60), p=1.0000. No difference in the proportion of subjects reaching a maximum time of 60 seconds, Chemo (54.5%) vs Control (45.5%), p=1.0000.

Within the neutral condition, time to perform task did not differ between the 2 groups: Chemo (60, IQR=33.21-60) vs. Control (median=60, IQR=33.21-60), p=0.7163. No difference in the proportion of subjects reaching a maximum time of 60 seconds, Chemo (54.5%) vs Control (63.6%), p=1.0000.

CHAPTER 4

DISCUSSION

The purpose of this study was to determine the effects of focus of attention on balance, specifically in individuals who have undergone chemotherapy. According to researchers, this was an area that was still understudied. The analysis of the data indicated that there was not a statistical significance on the time to perform the task between any of the focus of attention conditions (opposite of the hypothesis). However, when comparing the proportion of the individuals who reached the maximum time, the neutral condition was statistically greater compared to the internal condition, which falls in line with previous research. When comparing the chemotherapy group to the control group, there was no significant difference between any of the conditions, which was also contrary to the hypothesis.

Limitations

There are several limitations to consider for this current study. First, the balance protocol used, is not the best option for measuring balance. While the Sharpened Romberg may be useful to assess the level of an individual's balance, this current assessment needed more precision than the Sharpened Romberg test could offer. In prior studies, researchers measured balance by using a force plate to determine the individual's amount of postural sway (Wulf, 2008). This protocol is more accurate and should be recommended if it is available. Due to the poor accuracy of the force plate in the lab where this current study took place, a different protocol needed to be used.

Secondly, the participants were recruited from a program that uses exercise as rehabilitation and therapy. Participants may have received specific balance training in the past, and this might have enhanced their ability to perform the balance task. It is possible that this would be different for individuals who have not gone through a training program. Additionally, it

is possible the chemotherapy side effects will appear when the treatment is more recent. Therefore, it is suggested that the proximity of the treatment sessions should be controlled for.

The homogeneity regarding the chemotherapy that is received is also a limitation. Certain treatments are more neuro-toxic and likely trigger balance issues worse than others. In addition, the dosage should also be considered. When the dosage of the treatment is high, there will likely be greater balance issues occurring.

Lastly, the number of participants was a definite limitation during the study. After analyzing the data, the statistical comparisons to find significant differences between the internal focus and external focused trials for the chemotherapy patients appears to be somewhat underpowered. If this protocol is used, there would need to be 90 participants in the chemotherapy group in order to achieve the appropriate power.

Conclusion

In conclusion, there was no statistical difference between the focus of attention conditions as well as no difference between the chemotherapy group and control group. While prior research is rather consistent in the significant findings, the non-significant differences are possibly due to the limitations previously mentioned. Future research should use the more established protocol used by Wulf (2008). Additionally, a larger number of participants should be included in order to increase the likelihood of detecting a statistically significant effect. Furthermore, an inclusion criterion should be set to control for the amount of physical activity the individuals have received as well as the proximity of the chemotherapy treatment sessions.

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