

THE EFFECT OF FOCUS OF ATTENTION ON MOTOR PERFORMANCE AND LEARNING DURING A SIT  
TO STAND TASK IN INDIVIDUALS POST CHRONIC STROKE

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March 19, 2025

CLINICAL TRAILS ID NUMBER: 1799540-1

## INTRODUCTION

More than 795,000 people have a stroke in the United States each year, one every 40 seconds (Virani et al., 2020), leading to 7.6 million Americans who have had a stroke (Tsao et al., 2022). The direct and indirect yearly costs of stroke equate to 103.5 billion dollars in the United States (Girotra et al., 2020). Due to the growing aging population and the declining mortality rate the prevalence of stroke is projected to increase by 3.5 million by 2030 (Virani et al., 2020). Further, stroke remains the leading cause of long term disability (Tsao et al., 2022) with greater than 50 percent of stroke survivors being chronically disabled (Katzan, 2013; Lopez et al., 2006). In addition, ability to perform daily activities, cognition, and quality of life decline at a more significant rate in individuals post stroke than those without stroke (Dhamoon et al., 2010; Dhamoon et al., 2012; Levine et al., 2015). Many of these individuals' physical limitations depend on the impairments they sustain after their stroke.

Impairments seen post stroke depend on the area of the brain that was damaged due to ischemia. Common impairments following stroke include weakness, hypertonicity, spasticity, abnormal synergies, decreased sensation, visual changes, and changes in cognitive processing (Connell et al., 2008; Gittins et al., 2021; Ward, 2012). These impairments often lead to other limitations in function including the ability to perform bed mobility, sit to stand, transfers, and gait (LeBrasseur et al., 2006).

Sit to stand is one of the main transitions individuals make, occurring over 60 times a day in community dwelling older adults (Dall & Kerr, 2010). There is a significant relationship between ability to rise from a chair and independence with ADL's (Alexander et al., 2000). This transition is also necessary for independent ambulation. Multiple factors can limit one's ability to stand up. Riley et al. (1997) found that decreased knee extensor torque and reduced ground reaction forces are the root cause of why older adults have difficulty standing up.

Individuals post stroke demonstrate altered sit to stand and often exhibit abnormal muscle activation patterns in multiple key muscles, including the anterior tibialis, soleus (Silva et al., 2013), rectus femoris, and transverse abdominis (Lee et al., 2015). They also present with decreased knee moment on the affected side resulting in a less efficient sit to stand transition (Van Bladel et al., 2021). In addition, individuals post stroke demonstrate increased trunk displacement in the mediolateral direction towards the unaffected side and weight distribution asymmetry. Cheng et al. (1998) found that individuals post stroke who were classified as fallers took more time to stand, had more mediolateral sway, and pushed less force through the affected lower extremity during sit to stand (Cheng et al., 1998).

Sit to stand training is essential during rehabilitation post stroke to improve the ability to stand with a more normal biomechanical pattern and to positively impact other aspects of mobility. After sit to stand training, individuals post stroke were able to translate their body weight forward further with greater quadriceps activation (Kerr et al., 2019). They also had a more symmetrical weight distribution between both sides during sit to stand (Kerr et al., 2019). Several studies underline the importance of sit to stand training with a focus on increasing use of the affected lower extremity. For example, individuals post stroke who were trained with increased use of their affected side during sit to stand decreased their fall risk compared to those trained using a symmetrical foot placement (Liu et al., 2016). Forced use training of the affected lower extremity also lead to increased muscle activity in the affected limb, improved balance, gait kinematics, gait symmetry, gait velocity, and quality of life (Abdullahi et al., 2021; Billinger et al., 2010; Hsu et al., 2017; Wu et al., 2019; Yu et al., 2015).

While stroke is the leading cause of disability in the United States (US) (Virani et al., 2020), the amount of time in rehabilitation being received continues to decrease (Granger et al., 2009). The rising prevalence, high incidence, and short time in rehabilitation for individuals post stroke make the efficiency of rehabilitation for this population increasingly more important. Specifically,

therapists need to adopt effective instructional and feedback strategies to increase efficiency of motor learning.

Based on a number of studies, simply changing two to three words of instruction can lead to more effective outcomes (Wulf, 2013). This impactful change in instruction is based on focus of attention research, exploring the difference between internal and external focus instruction. An internal focus refers to thinking about one's own body movements, while an external focus is focusing on an outcome or impact on the environment. An example of internal focus is thinking about what one's shoulders or arm is doing while shooting a basketball, while an external focus would be thinking about the effect on the ball or the basket (Wulf et al., 2001). Over 80 studies have compared internal and external focus of attention (Wulf, 2013). This research has been conducted in healthy individuals of all ages, with various levels of experience, and during multiple different sports such as golf, soccer, darts, archery, tennis, and volleyball (Kakebeeke et al., 2013; Kal et al., 2013; Wulf, 2013). Despite some methodological quality concerns in some of these studies, including lack of control groups and lack of retention trials (Kal et al., 2018), research in the healthy adult and sports population, thus far, have supported that an external focus of attention leads to better outcomes (Kakebeeke et al., 2013; Wulf, 2013). Two main theories may explain why external focus is more effective than internal focus. The first is the conscious processing theory which states that having an internal focus overloads the working memory (Masters, 1992) The second is the constrained action hypothesis which proposes that having an internal focus of attention reduces automatic movement processes (McNevin et al., 2000; Wulf et al., 2001).

Whether having an internal focus is more or less effective than having an external focus of attention is generally unknown, especially in certain populations. Specifically, effects of attentional focus in motor learning after stroke is largely undetermined. Individuals post stroke may respond differently to focus of attention compared to healthy adults due to their impairments and cerebral changes. Individuals post stroke can have decreased executive function including information

processing (Zinn et al., 2007). Also, these individuals may lose some motor automaticity leading them to consciously try to control their movement (Orrell et al., 2009). This impaired information processing and loss of automaticity might result in a different response to focus of attention instruction and feedback than non-stroke populations.

The research in the stroke population related to focus of attention is sparse and contradictory. Some studies show an external focus being detrimental to movement fluency (Kal et al., 2015), while others find that an external focus leads to better outcomes (Aloraini et al., 2020; Durham et al., 2014; Fasoli et al., 2002; Mückel & Mehrholz, 2014). The remaining studies in the stroke population, however, have found no difference between internal and external foci (Kal et al., 2019; Kim et al., 2017). Most of these studies examined the effect of attentional focus during practice but did not include retention testing, thus the effects on motor learning have not been assessed. In addition, these studies have not examined the effects of focus of attention on functional movements such as sit to stand.

### **Statement of the Problem**

Impairments following stroke often lead to functional limitations such as difficulty performing a sit to stand transfer, which may affect independence in other activities of daily living. Individuals following stroke often perform sit to stand transfers less efficiently than individuals without stroke. This inefficiency is due in part to asymmetry between the unaffected and affected lower extremity. Training people to use the affected side more may increase efficiency of their movement and decrease fall risk. The type of instruction and feedback, specifically focus of attention instruction, may impact how well people following stroke learn to use the affected side more during sit to stand transfers. At this time, the effect of focus of attention instruction and feedback on the increased use of the affected side during sit to stand in individuals post stroke is unknown.

## **Purpose**

The purpose of this study is to fill some of the gaps in the literature by examining the effects of focus of attention on performance and learning of sit to stand in individuals post chronic stroke. This study will investigate whether an internal or external focus of attention can lead to improved use of the affected lower extremity during the sit to stand transition, while maintaining an upright trunk position.

## **Research Questions**

The following research questions will be addressed in this study:

1. Does an internal or external focus lead to an increased weight shift towards the affected side and upright trunk alignment during sit to stand training?
2. Does an internal or external focus lead to greater learning of increased weight shift towards the affected side and upright trunk alignment during a sit to stand task in which learning will be evaluated using a retention test? Retention will refer to the ability to perform the sit to stand task without explicit instruction five minutes and one hour after practice.
3. Does an internal or external focus lead to greater learning of increased weight shift towards the affected side and upright trunk alignment during a sit to stand task in which learning will be evaluated using a transfer test? Transfer of learning will be evaluated by exploring the effects of sit to stand training on gait symmetry.

## **Research Hypotheses**

The following hypotheses will be addressed in this study:

1. An external focus of attention will lead to a significantly greater weight shift towards the affected side during a sit to stand task than an internal focus of attention.
2. An external focus will lead to significantly more vertical trunk position during a sit to stand task than an internal focus of attention.

3. An external focus of attention will lead to a greater retention of weight shift towards the affected side during a sit to stand task than an internal focus of attention.
4. An external focus will lead to a greater retention of a more vertical trunk position during a sit to stand task than an internal focus of attention.
5. An external focus of attention will lead to a greater task transfer of weight shift towards the affected side during gait than an internal focus of attention.

### **Operational definitions**

The following operational definitions apply to this study:

- Focus of attention: refers to where an individual places their attention when performing a motor task (McNevin et al., 2000).
- Internal focus of attention: refers to focusing on one's body movements when performing a motor task (Wulf et al., 1998).
- External focus of attention: indicates focusing on the effects the body has on the environment, such as an outcome or target (Wulf et al., 1998).
- Sit to stand task or training: will include the transition from sitting to standing and from standing back to sitting.
- Asymmetric weight distribution: will be defined as overutilization of one leg compared to the other during sit to stand or gait, resulting in a difference in applied force between legs. There is a tendency of individuals post stroke to use the unaffected side more during the sit to stand transition (Cheng et al., 1998).
- Lateral trunk deviation: will be determined by the amount an individual side bends or angles their torso to the side as captured by an inertial measurement unit placed on the superior aspect of the sternum directly below the sternal notch. The angle captured will be the movement around the anterior/posterior axis in the frontal plane.

- Force through the involved side: will be determined by measuring force through the affected lower extremity divided by the amount of force through both lower extremities using the Tekscan HR Pressure Mat. During each set the average percentage will be calculated.
- Gait symmetry: will be determined by percent of affected stance time divided by percent of unaffected stance time ( percent of affected stance time/ percent of unaffected stance time).
- use of the paretic lower extremity during stance phase of gait by using the equation paretic stance (percent of gait cycle)/nonparetic stance (percent of gait cycle) (Patterson et al., 2008). Using this equation numbers close to and above one will reflect a longer stance time on the affected side compared to the unaffected side.
- Motor performance: will be defined by how much force is being put through the affected lower extremity and the amount of lateral trunk deviation that occurs during the sit to stand transition. Less lateral trunk deviation and more force through the involved lower extremity will be a positive outcome for motor performance.
- Motor learning: is defined as the 'acquisition and/or modification of skilled action' (Shumway-Cook, 2017). In this study, motor learning will be defined as the ability for an individual to continue performing a motor task once the instructions are removed and the ability to carry over increased use of the affected lower extremity to a different task. It will be measured by a retention task done one hour after training and during a transfer task by assessing the effect of sit to stand training on the increased stance time of the affected side during gait.
- Retention: is defined as the 'persistence of the performance' after the acquisition or practice phase (Schmidt et al., 2019). In this study, retention will be defined as the amount of force through the affected lower extremity and upright trunk position that is maintained

during sit to stands once the specific instructions for internal or external focus of attention are removed five minutes post and one hour post training.

- Transfer of a motor task: is the application of a learned skill to a new task (Müssgens & Ullén, 2015). During this study transfer of motor learning will be determined by whether sit to stand training affects use of the affected side during gait as measured by the GAITRite. Use of the affected side will be determined by percent of affected stance time divided by percent of unaffected stance time ( percent of affected stance time/ percent of unaffected stance time).

### **Assumptions**

The following assumptions will be applied to this study:

- All participants are putting forth their best effort.
- People in each focus group, internal and external, will use the focus instructions they receive during the task.
- Individuals will understand and follow the instructions accurately.
- Sample participants being tested are representative of people post stroke.
- All individuals have been accurately diagnosed with a stroke.
- The Tekscan HR Pressure Mat will accurately measure force through the lower extremities.
- The Delsys IMU will accurately measure lateral trunk lean in the frontal plane.
- The GAITRite will accurately measure affected and unaffected stance percentage during gait.

### **Limitations**

The following limitations apply to the current study:

- All participants will be from western North Carolina, potentially limiting the generalizability to people from different areas of the country.

- Training will only involve one task so this may not carry over to other tasks such as bed mobility.
- Participants will only receive one training session for each type of focus of attention instruction.
- Individuals with neglect are excluded so the generalizability to individuals with perceptual disorders is limited.
- All participants are able to stand without physical assistance and therefore function at a higher level, potentially limiting generalizability to individuals who function at lower levels.
- Individuals who are unable to follow three step commands or have other neurologic diagnoses limiting their ability to perform the task are excluded, limiting generalizability to individuals with more cognitive involvement.
- Targets are located anterolateral to patients on the affected side during the external focus intervention so participants with visual field cuts will have to turn their heads or have limited ability to see the targets.

### **Clinical significance of the study**

Results of this study will increase understanding of what type of instructions and feedback should be used with individuals post stroke, specifically what type of focus of attention, internal or external is more effective. This study will help explicitly look at the effect of focus of attention on the increased use of the affected lower extremity during sit to stand training. Upon successful completion of this project the best type of focus of attention, internal or external, for training someone to use their affected lower extremity more during sit to stand training may be determined.

## **Methods**

Impairments following stroke often lead to functional limitations such as difficulty performing a sit to stand transition. Patients following stroke often perform sit to stand transfers less effectively than individuals without stroke, due in part to asymmetry between both lower extremities, with reduced use of the affected lower extremity. Training people to use the affected side more may increase efficiency of their movement and decrease fall risk. The type of instruction and feedback, using an internal or external focus of attention, may impact how much individuals post stroke use their affected lower extremity during sit to stand transitions. Individuals post stroke have a variety of changes, including loss of automatic processes, so they may respond differently than healthy adults to focus of attention instruction and feedback. Therefore, the first purpose of this study is to determine which type of focus of attention, internal or external, instruction and feedback will lead to an improved sit to stand performance indexed by increased use of the affected lower extremity and a more vertical trunk alignment during sit to stand training. The second purpose is to determine whether the effects of attentional focus on sit to stand performance will be maintained once cuing is removed. The third purpose of this study is to explore whether or not the instruction to increase the use of the affected lower extremity during sit to stand training transfer to impact gait symmetry. This chapter describes the study design, participants, instrumentation, study procedures, and statistical analysis used to explore these goals.

## **Research Design**

This study will be a randomized cross over study. Individuals will be randomized into either an internal or external focus condition for the first week of the study and be crossed over to the other condition in the second week. Participants will be provided instruction and feedback consistent with one type of focus of attention while they perform a training session. The training session will consist of four sets of sit to stand trials with progressive difficulty by lowering seat heights. One week later, participants will return and perform the same training activities using the

opposite focus of attention. Each training session will be the same length to ensure participants receive the same training experience across conditions. This study will receive IRB approval through Western Carolina University, Texas Woman's University and HCA Healthcare.

### **Setting**

Data collection will take place in three settings with similar environments for testing, two instructional sites at Western Carolina University and a local inpatient rehabilitation hospital. Data collection conducted in the Western Carolina University instructional sites will be in quiet instructional rooms with high-low mat tables. Data collection conducted in the local inpatient rehabilitation hospital will be in a treatment room with a high-low mat table, and initial screening will be conducted in the therapy gym. All equipment is portable to allow for the same equipment to be used for data collection in the multiple sites including the hospital setting.

### **Participants**

This study will include 16 participants post stroke <6 months, at least 18 years of age, of any gender, race, or ethnic group. Participants will be excluded from this study if they are unable to stand unassisted from a standard height, 20" chair, with or without upper extremity assistance. Individuals who are unable to ambulate 20 feet without physical assistance or have moderate to severely impaired cognition with a score of <10/30 on the Montreal Cognitive Assessment (MOCA) will also be excluded. In addition, individuals who have contraversive pushing with >1 according to the Scale for Contraversive Pushing Scale or neglect as evidenced by <44/54 on the Star Cancellation Test will be excluded. Lastly, individuals with any orthopedic or other neurologic conditions that impact their ability to transition from sit to stand will be excluded from the study. Participants will be recruited via word of mouth and advertisements in areas of inpatient/outpatient clinics, and local health centers as well as social media. Participants will also be recruited from a local inpatient rehabilitation hospital. Clinicians at this facility will assist in identifying potential candidates.

### **Power analysis**

A power analysis (G\*Power) based on pilot data indicated at least 12 participants would be sufficient to detect a moderate effect size ( $f = 0.37$ ) to compare training effects, using a mixed model repeated measures analysis of variance (ANOVA), within factors (alpha level of 0.05, beta of 0.80, 2 conditions, 4 measurements,  $r = 0.50$ ), with a nonsphericity correction  $\epsilon$  of 1. A second power analysis (G\*Power) based on pilot data to determine number of participants needed to discover if changes were maintained at one hour post training showed 10 participants needed to detect a moderate effect size ( $f = 0.49$ ), using a mixed model repeated measures analysis of variance (ANOVA), within factors (alpha level of 0.05, beta of 0.80, 2 conditions, 3 measurements,  $r = 0.50$ ), with a nonsphericity correction  $\epsilon$  of 1. With an estimated attrition rate of 25 percent based on previous data collection in this inpatient rehabilitation setting, 16 participants will be recruited to participate in this study.

### **Instrumentation**

Four instruments will be used in this study. An inertial measurement unit (IMU) sensor and a HR pressure mat will be used to quantify sit-to-stand performance. A GAITRite system will be used to determine if sit to stand training transferred to the increased use of the affected lower extremity during gait. A survey will be administered at the end of the study to examine participant's compliance with the focus of attention instructions.

#### **IMU sensors**

A 27 X 37 X 13 mm Delsys Trigno Avanti inertial measurement unit (IMU) will be used to collect position data in relation to the x, y, and z axis in the sagittal, frontal, and horizontal planes, respectively. These sensors have nine built-in inertial measurement units that collect acceleration, rotation, and earth magnetic field (compass) information. The sensor is able to estimate orientation in space using the data from the 9 IMU channels (Delsys, 2021). One IMU will be placed on the superior aspect of the sternum directly below the sternal notch to capture vertical trunk alignment

throughout sit to stand and stand to sit. This unit will collect orientation data at a sampling rate of 222 Hz. The IMU data in the frontal plane around the y-axis will be used to determine how far the participant is leaning side to side with their trunk during the sit to stand transition. Numbers will be converted so positive values will indicate the individual is leaning or side bending towards the affected side. Normal movement during sit to stand is a neutral trunk position in the frontal plane so lower values indicating a vertical trunk position will be the targeted outcome.

### **HR Pressure mat**

Force symmetry under the feet will be measured using a 61.26 X 58.72 cm pedobarograph with a 48.8 X 44.7 cm active sensing area during the sit to stand transition. The mat has 3.9 sensels/cm<sup>2</sup> with a 185 Hz sampling rate (Matscan, 2021). The mat will be calibrated prior to the start of each participant session and will be placed under both feet during the sit to stand task. The force data measured from the affected foot will be divided by the sum of the force data measured from below bilateral feet (force affected/(force affected + force unaffected)). This computation will determine the percent of force through the affected lower extremity during the task. The average proportion of force will be taken throughout the three repetitions of sit to stand during baseline, 5 minutes post training, and 1 hour post training, as well as in the four sets of ten repetitions during training. This instrument has been used in previous similar studies, one of which looked at symmetry during sit to stand in individuals post acute stroke (Britton et al., 2008; Rogers et al., 2020; Sun et al., 2015; Sun & Shea, 2016). This study found the instrument to be reliable and successful in determining significant differences in affected lower extremity use.

### **GAITRite**

A 20'X 4' GAITRite will be used to analyze spatial temporal aspects of gait. The GAITRite mat is an electronic walkway which uses pressure activated sensors to map out foot placement during gait using a quadrilateral blocking system. The walkway is made up of sensor pads, each of which has 2,304 sensors arranged in 48X48 grids. The mat has a spatial resolution of 1.27 cm and a spatial

resolution accuracy of  $\pm 1.27$  cm. The mat will be set at 120 Hz sampling rate (CIR Systems, 2013). GAITRite software will be used to collect the typical gait parameters. Of interest in this study, the stance phase of the gait cycle (in percent) in both affected and unaffected lower extremities will be used. Participants will use their usual assistive device during gait trials to best capture typical performance and any effect the training has on symmetry during gait.

### **Post Training Survey**

A manipulation check survey will be given to each participant 5 minutes after all biomechanical data is collected in order to ascertain what participants were actually focused on during the sit to stand training. This survey was revised based on a previous study (Bell & Hardy, 2009) and has been successfully implemented during the pilot study. Participants will be instructed to answer questions based on what they are thinking about during training. Questions on this survey will include four questions, “To what extent were you thinking about a target that is outside of your body?”, “To what extent were you thinking about how you move your body (e.g. shoulders, hips, trunk)?”, “To what extent were you thinking about something else?”, and “if you were thinking about something else, what was it?”. They will respond to the first three questions on a Likert scale from 1, not at all, to 5, very much so. The last question is an open ended question to gather descriptive information. This data will be used to determine if participants adhered to the specific focus of attention instructions during training.

### **Star Cancellation Test**

The Star Cancellation Test will be used solely as a screening tool for this study. Individuals who score  $<44/54$  will be excluded and considered to have neglect. The Star Cancellation Test (SCT) has excellent test retest reliability, ICC (1,1) = .89, 95 percent CI .83–.93 ( $p=.001$ ) (Bailey et al., 2004), and good validity (74-76.4 percent) for identifying visuospatial neglect (Bailey et al., 2000; Halligan et al., 1990; Marsh & Kersel, 1993).

### **Fugl Meyer Motor Scale**

The Fugl Meyer Lower Extremity scale will be used to describe the patient population. This measure has excellent intra (ICC, 0.99; 95 percent CI, 0.91–1.0) and interrater reliability (ICC, 0.91; 95 percent CI, 0.69–0.97) (Sullivan et al., 2011). The Fugl Meyer is also a valid and responsive measure (Mao et al., 2002). It has good concurrent, convergent, and predictive validity ( $p=0.86-0.88$ ) when comparing it to the Berg Balance Scale, and the Postural Assessment Scale for Stroke. IN addition, it has good construct validity when compared to the Action Research Arm Test and The Wolf Motor Function Test ( $p=0.42-0.76$ ) (Hsieh et al., 2009).

### **Montreal Cognitive Assessment**

The Montreal Cognitive Assessment (MOCA) will be used as a screening tool and assist in describing the population being studied. Individuals who score  $<10/30$  will be considered too cognitively impaired to follow the training instructions and will be excluded from the study. The MOCA has moderate to excellent interrater reliability in individuals post stroke, varying by item (Cumming et al., 2020). It also has excellent internal consistency (Chronbach's  $\alpha = 0.78$ ) (Toglia et al., 2011) and excellent criterion validity with the Mini Mental State Exam (MMSE) ( $r = 0.79$ ) and Cognitive Functional Independence Measure (FIM) ( $r = 0.67$ ) (Toglia et al., 2011).

### **Procedures**

Participant demographics and clinical information will be collected, including age, gender, weight, height, location of stroke, how long ago the stroke occurred, and fall history. All participants will consent to participation in this study. The Star Cancellation Test and Montreal Cognitive Assessment (MOCA) will be used to determine eligibility. Gait speed and the Fugl Meyer Motor Scale for the lower extremity, excluding reflexes, will also be completed to help describe the sample. Blood pressure, heart rate, and oxygen saturation, via a pulse oximeter, will be taken and a gait belt will be placed on the participant prior to the start of baseline measures. Temporospatial gait parameters will be collected using the GAITRite mat at baseline, 5 minutes after training, and 1 hour after training. Temporospatial gait parameters will be averaged across four passes over the

GAITRite mat at each measurement session. Participants will be instructed to ‘walk past the end of the mat at your normal comfortable pace’. Gait speed will be recorded at baseline as part of the individuals’ baseline measurements.

Participants will then be seated on a hi-lo table with their feet on the HR pressure mat for baseline assessment of sit to stand. Initial mat height will be determined by raising or lowering the mat table until the femur is parallel to the floor. In order to determine this, a level will be lined up from the greater trochanter to the lateral femoral condyle, while the fibula, from fibular head to lateral malleolus, is perpendicular to the floor. This initial mat position will be the height used during each reassessment at baseline, 5 minutes after training, and 1 hour post training. This height will also be used to decide the mat positions needed during training. After the initial mat height is achieved and recorded, an IMU marker will be placed on the superior third of the sternum directly inferior to the sternal notch.

After the mat table height is set, participants will be asked to stand up and sit down to determine comfortable foot placement in relation to their knees. The toe of the affected lower extremity will be lined up with the toe of the unaffected side once they have achieved a comfortable foot placement. Tape marks will be placed in front of the toes and on the lateral edges of both feet as well as around the buttocks to allow for a standardized starting position for all assessment timepoints. For all data collection during baseline, 5 minutes post, and 1 hour post training, participants will be instructed to “please stand up three times at your normal speed without your arms if possible”. The average force under the affected foot and the average overall force beneath both feet during the sit to stand transition will be captured by the HR pressure mat. The maximal lateral trunk position will be captured throughout this transition by the IMU marker. If individuals need to use their upper extremities this should be recorded.

After baseline data collection, participants will be randomized into either the internal or external focus condition. Initial group allocation will be determined by a random number generator

(<https://www.random.org>), blocks of 6 with a 1:1 ratio. Group assignment will be sealed in envelopes numbered for each participant by an independent researcher, who will otherwise not be involved in this research study. Group allocation envelopes will be opened directly prior to acquisition trials so baseline assessors will be blinded to group assignment of participants. Participants will be blinded to initial group assignment throughout the entirety of the sessions.

## **Training**

Prior to training, a demonstration of the task will be provided to the participants. Those in the external focus condition will be told, “as you stand up and as you sit down try to bring the targets together like this”. Those in the internal focus condition will be told, “as you stand up and as you sit down bring your right/left (R/L) shoulder and R/L hip as far to the R/L as possible.” Participants will be asked to perform one repetition with the question “can you show me?”. The demonstration is only provided before the first set but these same instructions will be given prior to the start of each successive set during training.

During training trials, individuals will perform four sets of ten sit to stand repetitions. During the external focus condition, foam circles will be taped to the participant’s lateral shoulder and lateral hip. In order to define this distance, participant girth will be measured in a seated position, by measuring the distance between bilateral outer thighs, using greater trochanters as landmarks. When the individual is standing in midline targets will be placed half of this girth measurement plus 10 centimeters away from the lateral tip of their acromion and another target placed the same distance away from their greater trochanter.

During training, participants will perform four sets of sit to stand transitions with the mat at progressively lower seat heights to increasingly challenge the participants, with instruction and feedback consistent with their condition allocation. The four sets will occur in the following sequences: 130 percent of the initial mat height determined at baseline assessment (see Table 1), 120 percent, 110 percent and 100 percent. Each set will end after the tenth repetition or when the

participant reports a RPE rating of >15/20. If participants are unable to complete 10 repetitions, the number completed will be recorded for each trial. Two minute rest breaks will occur between each set or until the participant reports a rate of perceived exertion (RPE) of <12/20 on the Borg RPE scale. During training, one verbal correction will be given during each set after the 2<sup>nd</sup>, 4<sup>th</sup>, and 7<sup>th</sup> trials, based on patient performance and condition allocation. See table 2. The feedback provided will be recorded.

Immediately after the training, participants will take a 5 minute break followed by the post-5 minute retention test in which instrumented sit to stand and gait will be administered. Following the retention test, individuals will complete a general health questionnaire. Approximately one hour after the training ends, 1-hour retention testing will be administered consisting of 3 instrumented sit to stands and gait over the GAITRite. After the immediate long term data collection, the participants will complete the post manipulation questionnaire to determine what the participants were focusing on during training.

One week later participants will return and complete the same protocol in the opposite attentional condition to which they were initially randomized. Each session should last 90 to 120 minutes.

### **Data Analysis**

Data will be analyzed using IBM SPSS version 28. Descriptive statistics for all demographic and clinical data will include means, standard deviations, and ranges for parameters of interest including age, height, weight, and time since stroke. Counts will be utilized for nominal data such as gender and side of stroke. Assumptions will be tested including the Kolmogorov-Smirnov test for Normality and Mauchley's test for sphericity. Main effects for group, internal or external focus, and for time points, dependent on what hypothesis, will be tested. Interaction effects will also be explored, and post hoc analysis for simple effects will utilize the Bonferroni correction to look at

pairwise comparison, when indicated. For all tests, statistical significance will be set at  $p=.05$  and partial  $\eta^2$  and Cohen's D will be used to determine effect size as appropriate.

The average force through the affected lower extremity divided by the average force beneath bilateral lower extremities will be calculated for all instrumented sit to stands including baseline, training, and post-training assessments. Participants maximal lateral trunk position will be analyzed using the IMU data that captures lateral bending around the y-axis.

For Research Question 1, two repeated measures analysis of variance (ANOVA) will be conducted. A 2 (focus of attention) X 4 (sets) repeated measures ANOVA will be utilized to explore if there were any differences between the use of the affected lower extremity with internal and external focus of attention during the four training sets. Main effects of sets and type of focus of attention will be examined. Simple effects will be analyzed using a Bonferroni correction, based on main or interaction effects. A second 2 (focus of attention) X 4 (sets) repeated measures ANOVA will also be used to determine if any significant main or interaction effects for group and sets for vertical trunk alignment existed. Simple effects will be analyzed based on main or interaction effects using a Bonferroni correction.

For Research Question 2, two additional repeated measures ANOVAs will be conducted. A 2 (focus of attention) X 3 (baseline, 5 minutes post, and 1 hour post) repeated measures ANOVA will determine if there were significant differences from baseline to 5 minutes post and 1 hour post training, in the amount of affected lower extremity use during sit to stand depending on type of focus used. Interaction and main effects for type of focus of attention and changes over time will be explored as well as simple effects, when indicated, using a Bonferroni correction. A 2 (focus of attention) X 3 (baseline, 5 minutes post, and 1 hour post) repeated measures ANOVA will also be used to look at vertical trunk alignment changes during baseline, 5 minutes post, and 1 hour post training, based on type of focus of attention used. Interaction and main effects will be explored further based on the results of the repeated measures ANOVA.

For Research Question 3, two more repeated measures ANOVAs will be utilized. A 2 (focus of attention) X 3 (baseline, 5 minutes post, and 1 hour post) repeated measures ANOVA will explore whether gait symmetry is affected by the focus of attention condition during sit to stand training. Use of the paretic lower extremity during stance phase of gait will be determined by paretic stance (percent of gait cycle)/nonparetic stance (percent of gait cycle) (Patterson et al., 2008). Again, interaction and main effects for type of focus of attention and changes over time will be explored as well as simple effects, when indicated, using a Bonferroni correction.

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**WESTERN CAROLINA UNIVERSITY (WCU)  
CONSENT TO PARTICIPATE IN RESEARCH**

Title: The Effect of Focus of Attention on Motor Performance and Learning During a Sit to Stand Task in Individuals Post-Stroke

Principle Investigator: Ashley Watamura, PT, DPT, PhD, NCS.....awhyatt@wcu.edu  
717-682-9710

Co-Investigators: Elijah Albright, SPT, Hannah Bernier, SPT, Erica Massaro Heinricy, SPT, Acacia Houle, SPT, Isabelle Lytle, SPT, Shauna Mignella, SPT, Maxwell Tinkley, SPT, Lauren Santangelo, SPT

**Study Summary and Key Information**

I, \_\_\_\_\_, agree to be in a study led by Dr. Ashley Watamura, Assistant Clinical Professor. This study looks at the best way to help people learn how to stand up and sit down.

**What Will You Do?**

First, we will check your thinking, memory, and attention. We will also test the strength and feeling in your weaker leg. In this study, you will practice standing up and sitting down. You will do four sets of ten sit-to-stands. You will also get tips to improve. This study is safe, but it may feel hard depending on your strength.

**Who Can Join?**

You can join if you had a mild or moderate stroke more than six months ago and can stand and walk without help. You cannot join if you had a severe stroke, have trouble paying attention to your weak side, cannot follow many instructions, or have other health problems that make standing up hard.

**Why Are We Doing This Study?**

We want to find the best way to teach people who have had a stroke how to stand up and sit down.

**What Will Happen?**

This study will take place at a Western Carolina University location. A licensed physical therapist or faculty member will be with you. You will take some tests, including a thinking test. We will check your blood pressure, heart rate, and oxygen levels. You will sit on a table with a mat under your feet to measure how you stand up. A small marker will be placed on your chest to track your movements. You will stand up, sit down, and walk 80 feet on a special mat.

**Treatment 1:** You will be randomly given one of two types of instructions. You will be shown how to stand up, then you will do four sets of ten sit-to-stands. You will rest as needed. After five minutes and after one hour, you will stand up and sit down three more times and walk on the mat four times. Then, you will complete a survey.

**Break:** After the first treatment, you will come back one week later for Phase 2.

**Treatment 2:** One week later, you will get the second type of instruction and repeat the same steps.

### **How Long Will It Take?**

- The first tests will take 30-60 minutes.
- Training will take another 30-60 minutes.
- You will rest for one hour, then do a five-to-ten-minute activity.
- The total time will be under three hours.
- You will return one week later for another session, which will take less than two hours.

### **Risks and Safety:**

You may feel tired or sore, but you will get rest breaks. We will check your blood pressure and heart rate. You will wear a safety belt, and someone will be with you to help if needed. We will do our best to keep you safe. If anything goes wrong, tell us right away.

### **Emergency Care:**

- Call 911 or extension 8911 (if on the Cullowhee campus) if you need emergency care. Tell the doctors you are in a research study and give them the Principal Investigator's name. Bring a copy of this consent form.
- If you do NOT need emergency care but feel sick or hurt, call Dr. Ashley Watamura at 717-682-9710 as soon as possible. Go to your regular doctor if needed and let them know you are in this study. Bring a copy of this consent form.

Western Carolina University will not cover medical costs if you get hurt. Your insurance may not pay for costs related to research. You should check with your insurance company.

### **Possible Benefits:**

You may not see a difference, but this study could help others in the future. You might get stronger and improve how you sit, stand, and walk.

### **Privacy:**

We will keep your information private, but we cannot promise complete privacy. Only the research team and those who fund or check the study may see your information. If required by law, we may have to share your information. Your name will not be in reports or articles.

We will collect information through interviews and surveys. It will be stored in a locked office at Western Carolina University. Your name will be kept separate from your data in a secure file.

**When We Must Share Information:**

We must report to authorities if:

1. We believe a child, elderly person, or disabled person is being abused or neglected.
2. You make a serious threat to hurt yourself or others.

**Future Use of Your Information:**

Your personal details may be removed from your data, and the data could be used for future research without your additional consent. However, there is still a small chance someone could identify you.

**Voluntary:**

Joining this study is your choice. You will not be paid for participating. You can leave at any time, and your information will stay private.

**Cost:**

You will not have to pay anything to be in this study. The Department of Physical Therapy at Western Carolina University covers all costs.

**Questions?**

- If you have questions about the study, contact Dr. Ashley Watamura at 717-682-9710 or [awhyatt@email.wcu.edu](mailto:awhyatt@email.wcu.edu).
- If you have concerns about your rights as a participant, contact the Western Carolina University Institutional Review Board at 828-227-7212 or [irb@wcu.edu](mailto:irb@wcu.edu).

**Consent:**

I am at least 18 years old, have read this form, and had the chance to ask questions. I agree to be in this study.

**Participant's signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Investigator's signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

A researcher can read this form to you and act as a witness if needed. You will get a copy of this form.

*If you want to receive study results, tell us where to send them:* Email:

\_\_\_\_\_ Address: \_\_\_\_\_