TASK ORIENTED TRAINING AND EVALUATION AT HOME (TOTE HOME)

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ABSTRACT

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TASK ORIENTED TRAINING AND EVALUATION AT HOME (TOTE HOME)

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Hemiparesis following a stroke frequently leads to “learned non-use” of the weaker arm and hand. Task oriented training has been suggested as a contemporary neurorehabilitation technique. A single-subject AB series design with a follow-up was conducted to assess the effectiveness of a task oriented training program administered in participants’ homes. This intervention, Task Oriented Training at Home (TOTE Home), incorporated current experience-dependent plasticity aspects (Kleim & Jones, 2008) modeled after the ASAP protocol parameters as described in Winstein et al. (2013) and principles of task oriented training as suggested by Lang and Birkenmeier (2014). Repeated measures of accelerometry and level of confidence on a priority task were analyzed with visual analysis of changes in level, trend, and slope (Portney & Watkins, 2009). Change scores from standardized assessments for the upper extremity (Fugl-Meyer, 1980), Motor Activity Log (van der lee, Beckerman, Knol, de Vet, & Bouter, 2004), Stroke Impact Scale question of recovery (Duncan et al., 1999), Functional Test for the Hemiparetic Upper Extremity (Wilson, Baker, & Craddock, 1984), and Canadian Occupational Performance Measure (Law et al., 2005) were evaluated on data collected

at baseline, post-intervention, and follow-up time periods (Portney & Watkins, 2009). Four participants completed TOTE Home and each demonstrated improvement in movement and function of their affected upper extremity as measured by accelerometry, self-efficacy, and other standardized measures. The degree of improvement varied between each participant. A detectable change was evident in all outcome measures following intervention. Each participant's progress throughout the TOTE Home study was supported by aspects of both Motor Learning Theory (Bass-Haugen, Mathiowetz, & Flinn, 2008; Carr & Shepherd, 1989) and the Theory of Occupational Adaptation (Schkade & Schultz, 1992; Schultz & Schkade, 1992).

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Stroke is the fifth leading cause of death in the United States and is a major cause of serious long-term disability (Kochanek, Xu, Murphy, & Arias, 2014). About 800,000 people in the United States have a stroke each year (Mozaffarian et al., 2015). A stroke can be described as a bleed in the brain (hemorrhagic) or a blood clot in the brain (ischemic). Either type leads to a disruption of blood flow to areas of the brain. The Middle Cerebral Artery (MCA) is the site most commonly affected. This typically leads to a resultant weakness in the contralateral side of the body due to damage in the motor cortex. This resultant hemiparesis of the upper extremity is a common reason for disability in about half of the stroke survivor population (Kelly-Hayes et al., 2003). Learned non-use of the affected upper extremity in hemiparesis tends to be a reason for increased disability.

People with hemiparesis following a stroke often do not use their limbs even if they have residual movement. This has become known as the phenomenon of "learned non-use" (Mott & Sherrington, 1895; Taub et al., 1993). Constraint Induced Movement Therapy (CIMT) is a treatment protocol that has shown to be able to reduce hemiparesis through focused use of the affected upper extremity on people in the subacute phase of recovery (Taub et al., 1994; Wolf et al., 2006; Wolf et al., 2008). CIMT has contributed to discovery of some of the specific experience-dependent neural plasticity principles.

Other research in neuroscience has elaborated upon these principles (Kleim & Jones, 2008). Task oriented training programs, such as the Accelerated Skill Acquisition Program (ASAP) (Winstein et al., 2013) have been suggested for evidence based practice (Winstein & Wolf, 2004; Winstein, Lewthwaite, Blanton, Wolf, & Wishart, 2014) based on current Motor Learning Theories (Bass-Haugen et al., 2008). The occupational therapy Theory of Occupational Adaptation (Schkade & Schultz, 1992; Schultz & Schkade, 1992) is consistent with the evidence from task oriented training, motor learning and neuroscience. The research to date has been conducted in controlled research environments and clinics. Further research is needed to explore the effectiveness of translating current task oriented training programs to "real" context such as a participant's home.

In a pilot study by the author, CIMT was introduced in the home. The study was designed to use CIMT while performing specific tasks in the home. During the implementation, aspects such as salience in the tasks (meaningfulness) and specificity (skilled movements) affected the client's compliance with repetition and intensity of the program more so than wearing a mitt on the unaffected hand. The findings in this case study revealed more of an implementation of current Motor Learning Theory (Bass-Haugen et al., 2008) and principles of experience-dependent neural plasticity (Kleim & Jones, 2008).

Specific Aim

To determine the effectiveness of an upper extremity task oriented training program based on current Motor Learning Theory, principles of experience-dependent neural plasticity, and the Theory of Occupational Adaptation, delivered at home for people who are in the subacute recovery phase of a stroke.

Research Questions

What is the effectiveness of a task oriented training program and evaluation at home, administered to people with subacute stroke utilizing the current principles of experience dependent plasticity, Motor Learning Theory, and the Theory of Occupational Adaptation? What effects persist one month after this training?

CHAPTER II

REVIEW OF THE LITERATURE

This review of the literature includes background information that leads to current topics on the rational and research behind the neurorehabilitation of hemiparesis after a stroke. This entails a review of the principles of neuroscience and neurophysiology, including motor control, motor learning, and neuroplasticity. Current treatment approaches will be explored along with the Theory of Occupational Adaptation. The importance of context in the treatment of hemiparesis is also reviewed.

Phenomenon of Learned Non-Use in Hemiplegia

Learned non-use is a phenomenon commonly seen in upper extremity (UE) hemiplegia. It presents as predominant use of the unaffected UE during functional tasks. Compensatory behavior patterns develop after unsuccessful motor attempts lead to decreased or non-productive movement of the affected UE. This leads to a suppression of voluntary movement in the affected arm and hand and subsequently an excess of motor disability (Mott & Sherrington, 1895). As the individual gains functional use of the unaffected UE, it is used more. Consequently, the affected UE is used less which results in learned non-use.

Three general types of behavioral techniques have been employed with success in animal studies to overcome learned non-use (Taub et al., 1994). The first technique incorporates a device that restricts movement of the unaffected UE. Research shows that this approach results in almost immediate increases in voluntary use of the affected UE. The second technique incorporates conditioned-response techniques for isolated UE movements. This approach has resulted in improved active range of motion of the affected limb. The third technique incorporates shaping which provides reward for successive approximations of the desired movement. This technique improves the animal's ability to use the affected UE, not only in the training situation, but in its natural environment. The combinations of these techniques, in basic animal research on learned non-use, have been translated into a treatment for humans called Constraint Induced Movement Therapy (CIMT) (Taub, Uswatte, & Morris, 2003).

Relationships between Learned Non-Use and CIMT

CIMT is based on overcoming learned non-use of the affected UE after a neurological event, such as a stroke in humans (Taub et al., 1994). Similar to the technique used in animal studies, CIMT forces use of the affected UE through restraint of the unaffected UE and behavioral training (Winstein et al., 2003). Movement restriction of the unaffected UE reverses the learned suppression of movement of the affected UE commonly seen after stroke. Forced use encourages increased movement of the affected UE by removing the ability to use the unaffected UE (Taub et al., 1994). In conjunction with restricting movement of the unaffected limb, repetitive practice with the affected UE increases motor ability. Motor improvement is further advanced when practice involves shaping techniques to improve the efficiency of practice. Positive reinforcement for use of the affected UE results in the limb being used more in everyday situations. The techniques of shaping and limb restriction together help to overcome learned non-use as complementary and possibly synergistic techniques (Dromerick et al., 2009; Pierce et al., 2003; Reiss, Wolf, Hammel, McLeod, & Williams, 2012; Taub et al., 1994).

Overview - ExCITE RCT

The Extremity Constraint Induced Treatment and Evaluation (ExCITE) was a National Institute of Health funded randomized clinical trial (RCT) to examine CIMT as a treatment of the affected UE after subacute stroke. The ExCITE RCT established the efficacy of CIMT. It determined CIMT produces more favorable motor and behavioral outcomes than usual and customary care in stroke survivors 3 to 9 months after onset (Wolf et al., 2006; Wolf et al., 2008; Wolf et al., 2010). The 3 to 9-month window after stroke onset was defined as "subacute." After 9-12 months, the condition is considered to be "chronic."

The ExCITE trial utilized a prospective, multisite, single-blind, randomized crossover design. The treatment group received what has now become known as the signature CIMT protocol immediately after enrollment. The control group received usual and customary care for 12 months before receiving CIMT (delayed treatment). Outcomes assessed included tests of UE motor function, measures of real-world arm use, assessments of function, behavior, and compliance.

The ExCITE trial participants' demographics identify who is most appropriate for CIMT. In general, participants were required to exhibit at least 10^0 of extension in the wrist, thumb, and 2 fingers on the affected UE and report learned non-use in their affected arm and hand on a standardized assessment (Winstein et al., 2003). The protocol for CIMT as defined in the ExCITE trial includes 14 days of wearing a restraint on the less affected hand for 90% of waking hours. Training consists of practice with functional task activities structured by repetition and adaptation in a clinical research laboratory for up to 6 hours a day for 10 of the days. Participants completed a home diary in the evenings and on weekends documenting use of the affected UE during functional tasks and home practice. Participants also agreed to participate in this protocol with a signed contract (Winstein et al., 2003).

Results from the ExCITE study were significant in supporting evidence for CIMT and the CIMT protocol. The signature CIMT protocol produced immediate improvements in arm motor function greater than matched controls (Wolf et al., 2006). Further improvements from CIMT were retained or improved up to 2 years following intervention (Wolf et al., 2008). CIMT was beneficial in the subacute (early treatment, 3-6 months post CVA) and chronic (delayed treatment, 12-18 months) stages of recovery. A faster rate of change was noted with CIMT applied earlier (in the subacute phase) rather than later (in the chronic phase). However, both groups still exhibited significant improvements (Wolf et al., 2010).

Current Research on CIMT

Current research supports the use of CIMT for improving perceived arm motor function, arm movement, and decreased disability. However, a Cochrane review (Sirtori, Corbetta, Moja, & Gatti, 2009) identified two studies that did not support the persistent results of CIMT over time. Overall, the studies reviewed had many methodological limitations that make conclusive results illusive. Analysis of the research identified the need for more rigorous studies on the appropriate dosage of CIMT as well as the need for a better definition of which subgroup of participants will benefit from CIMT (Sirtori et al., 2009).

The signature CIMT protocol has practical limitations for general implementation. Patient qualifications, restraint wearing adherence, time constraints in facilities, and reimbursement issues are frequently emphasized as limitations to administration. Modified versions of CIMT emerged to address these limitations. A recent systematic review and meta-analysis of modified CIMT (mCIMT) addressed the variable intensity of treatment time in mCIMT studies. In general, the results showed that more treatment time per week produced the greatest positive effects (Peurala et al., 2012). This review was the beginning of the development of a dose-response curve for CIMT.

The variability in protocols has resulted in a lack of standardization of mCIMT. Limitations and inconsistencies among several mCIMT studies have been found (Reiss et al., 2012). A model is needed that identifies the optimal intensity, duration, and subject chronicity. Ideally, this model would produce comparable results to the signature CIMT protocol yet be effectively implemented in a standard treatment setting (Reiss et al., 2012).

Only two articles have tried to assess the qualitative aspects of CIMT (Boylstein, Rittman, Gubrium, Behrman, & Davis, 2005; Gillot, Holder-Walls, Kurtz, & Varley, 2003). Three themes were generated from Gillot, Holder-Wallis, Kurtz, and Varley (2003): 1) motivational factors and expectations represented personal desires to increase functional ability and environmental demands that created a press to participate in CIMT; 2) neurorehabilitation as an ongoing process suggested that rehabilitation should continue as long as functional deficits exist; and 3) perceived changes in function represented perceived changes in efficiency, effectiveness, and satisfaction after CIMT. In the Boylstein, Rittman, Gubrium, Behrman, and Davis (2005) study, several patterns of behavior were found to occur during participant and therapist interaction in CIMT sessions: coaching, cheerleading, reminding, changing, and contemplating. These interaction patterns indicate that learned nonuse of an affected limb does not exist in social isolation and that people who participate in CIMT routinely consider the balance of any improvement against the costs of using an affected limb that is still not fully functional.

CIMT is supported by a large body of evidence as a valid treatment for treatment of learned non-use in the UE, post-stroke. CIMT utilizes forced use and massed practice as a treatment technique. It is evident that CIMT has come a long way from animal research to the application in humans. While the ExCITE trial demonstrated the efficacy of CIMT, its effectiveness in the clinic is still lacking. Testing the efficacy of modified protocols of CIMT in clinical practice will contribute to the translation of CIMT protocols into real life settings as will further determinations of the physiological changes that may occur with CIMT.

Neuroscience

The goal of CIMT is to increase movement of the affected UE. Because of damage to the motor and/or motor association areas or connecting pathways new areas of the cerebral cortex must be modified to takeover for the damaged areas. Modification of areas of brain occurs due to neuroplasticity. The driving of recovery of motor function based on principles of neuroplasticity are supported by theories of motor control and motor learning. Think of a time when you learned a new motor skill like riding a bike, playing a sport, or learning to knit. Learning a motor skill requires practice, repetition, feedback, and more practice. The task might even be graded to become increasingly complex. Whether it is learning to ride a bike, knit, or move an arm affected by a stroke evidence supports use of Motor Control and Motor Learning Theory as a method to enhance neuroplasticity and learning. Through the use of newly developed scientific methods (such as imaging techniques and pharmacology) specific neurotransmitters and mirror neurons have been found to contribute to the field of neurorehabilitation and provide evidence of changes within the brain when use of motor learning and motor control principles are used in rehabilitation of persons with stroke.

Neurophysiology and Function/Dysfunction

Motor control incorporates many areas of the brain that are organized both hierarchically and in parallel. Sensory inputs that arise from vision, somatosensory, and vestibular systems (among others) contribute to the many functions involved with the control of movement. The sensory association cortices process incoming sensory information and communicate for output through lateral inhibition. The neuron that is excited inhibits the neurons next to it, thus enhancing contrast between excited and non-excited regions of the body or sensory field. With repeated patterns of inhibition and excitation, the processing in the sensory association cortices is modified. New networks for processing sensations are strengthened. Sensory inputs turn into action in the association cortices. While the sensory cortices perceive and interpret sensory input, the parietal lobes are most involved with processing the position of and manipulation of objects in space. Thus, purposeful movement requires processing of sensory input along with a demand for interaction with the environment. Movement is initiated mainly from networks within the cerebral cortex, basal ganglia, and cerebellum (Shumway-Cook, 2012).

Cerebral cortex. The areas of the cerebral cortex involved in motor control and the sequence in which information travels are the primary motor area, motor association area, premotor area, and supplementary motor area. The *primary motor area* is the precentral gyrus and is responsible for voluntary/conscious movement. The *motor association area* is in the anterior frontal lobe and is involved in cognitive planning of movement. The *premotor area* is anterior to the primary motor area and plays a role in motor planning or praxis. The *supplementary motor area* is part of the premotor area and is involved in bilateral control of posture. It is through the network of communication between the sensory processing areas and the motor cortex as a whole, that we identify where we want to move, how to plan the movement, and how to execute our actions.

When the motor association area is affected, storage of specific motor plans may be lost. The bilateral control of posture is compromised when there is damage to the supplementary motor area. Lesions to the premotor area result in apraxia or motor planning difficulties. Damage to the primary motor area causes a loss of voluntary movement to the contralateral body part of the motor homunculus. It may also result in a loss of the ability to implement a specific motor plan (Daskalakis et al., 2004; Gutman, 2008; Shumway-Cook, 2012).

Basal ganglia. The basal ganglia includes the caudate, the putamen, the globus pallidus, the subthalamic nucleus of the diencephalon, and the substantia nigra of the midbrain. The basal ganglia works by balancing the excitatory and inhibitory effects of dopamine and acetylcholine. It plays a role in stereotypic and automated movement patterns, tone, as well as cognitive and affective processes requiring precision timing. Dysfunction of the basal ganglia results in difficulty initiating, continuing, or stopping movement. Problems with muscle tone (e.g., rigidity) and increased involuntary, undesired movement (e.g., tremor, chorea) can also be seen (Albin, 2006; Gutman, 2008; Shumway-Cook, 2012).

Cerebellum. The cerebellum consists of 3 lobes (flocculonodular, anterior, and posterior). It acts as a comparator, i.e., a system that compensates for errors by comparing intention with performance. It modulates muscle tone, participates in the programming of the motor cortex for the execution of movement, contributes to the timing of movement, and to motor and non-motor learning. It is also involved in the control of visually triggered and guided movements. Lesions in the flocculonodular lobe of the cerebellum result in ipsilateral ataxia, ipsilateral hypotonia and hyporeflexia, dysmetria, adiadochokinesia, movement decomposition, asthenia, intention tremors, rebound phenomenon, ataxic gait, and staccato voice. Increases in extensor tone result from problems in the anterior lobe of the cerebellum. Damage to the posterior lobe results in uncoordinated trunk movements (ataxia), balance deficits, and nystagmus (Gutman, 2008; Hoshi, Tremblay, Féger, Carras, & Strick, 2005; Shumway-Cook, 2012).

Motor Control

Motor control refers to the clinical concern of the control of movement. It is the ability to regulate or direct the mechanisms essential to movement. It involves central nervous system (CNS) organization, sensory information, perceptions, and the action of muscles and joints upon the environment. It is dependent on a feedback and feedforward system that is continuously evaluating movement. Many theories have influenced how therapists utilize motor control in evaluation and treatment. These include the reflex theory (Sherrington, 1898), hierarchical theory (Keele, 1968; Magnus, 1926), motor programming theory (Keele, 1968), systems theory (Bernstein, 1967), dynamic action theory (Perry, 1998), and ecologic theory (Newell, 1991). Most recently, the task oriented approach (Woollacott & Shumway-Cook, 1990) has been identified. In the task oriented approach, normal movement emerges as an interaction among many different systems, each contributing different aspects of control. Movement is organized around a behavioral goal and is constrained by the environment. After a lesion to the motor cortex movement is initiated from the efforts of remaining systems that attempt to compensate for the loss. Specific to task oriented training (of which CIMT can be applied) is the proposal that motor learning occurs when clients intentionally attempt to solve motor problems inherent in an occupation rather than repetitively practicing normal patterns of movement. Adapting to changes in the environmental context is a critical part of recovery of function (Shumway-Cook, 2012). Thus, motor control is most concerned with the regulation or direction of the mechanisms essential to movement. Motor learning has evolved from motor control with more focus on the individual occupation, the environment, and adaptation.

Motor Learning

Motor learning is the acquisition or modification of movements which is essential in performing occupations and adapting movement. It results from the interaction of the individual with their occupation and adaptation to their environment. Several theories of motor learning have been proposed, including: Adams' closed-loop theory (Adams, 1971), Schmidt's schema theory (Schmidt, 1975), and the ecological theory of learning as exploration (Newell, 1991). Motor learning can be non-declarative (implicit) or declarative (explicit). Implicit learning can be non-associative (includes habituation and sensitization), associative (includes classical and operant conditioning), or procedural (e.g., habits). Explicit learning leads to knowledge that can be consciously recalled, and subsequently requires processes such as awareness, attention, and reflection (Shumway-Cook, 2012).

Occupation and Adaptation – Neuromechanics of Motor Learning

Through studies of motor learning, scientists have discovered that the brain is very plastic, i.e., has a great capacity to change. Neuroplasticity is the ability of neurons to change their function, chemical profile, or structure in regards to motor learning. Short-term learning results in relatively temporary changes in synaptic effectiveness, while long-term memory/learning involves structural changes in synapses. Different types of motor learning involve different circuitries. Procedural learning involves cerebellar circuitry. Declarative learning involves temporal lobe circuitry. In general, neuroplasticity involves habituation, cellular recovery after injury, and experience-dependent plasticity (learning and memory) (Shumway-Cook, 2012). All of these underlie the basis of CIMT and contribute to a person's ability to move and adapt after a neurological insult.

Habituation

Habituation is a type of non-associative learning that is defined as a decrease in response to a repeated exposure of a non-painful stimulus. During habituation, there is a decrease in the release of excitatory neurotransmitters, including glutamate, and a decrease in free intracellular calcium ions. With prolonged repetition of stimulation, more permanent structural changes occur, such as a decrease in the number of synapses. Habituation allows learning of important information to occur by tuning out unimportant information. Dysfunction of this mechanism would limit one's ability to focus on needed information (Lundy-Ekman, 2013; Rankin et al., 2009).

Cellular Recovery from Injury

When a neuron dies, as in the case of a stroke, the nervous system promotes recovery by altering specific synapses, functionally reorganizing the CNS, and changing neurotransmitter release in response to neural activity. Recovery of axonal injury in the peripheral nervous system (PNS) occurs through collateral and regenerative sprouting. This type of functional axon regeneration does not occur in the CNS. To overcome damage to the CNS, recovery at the cortical level can include reorganization of the homunculus by sensory input, experience (or use), and learning. Recovery at the synaptic level includes synaptic effectiveness, denervation hypersensitivity, synaptic hypereffectiveness, and unmasking of silent synapses. At the chemical level, neurotransmitters, such as dopamine, can protect neurons from degenerative changes. Other neurotropic factors, such as Nerve Growth Factor (NGF) may protect neurons by promoting neuron survival, resistance to injury, and plasticity. Dysfunction, due to a stroke or traumatic injury, results in death of neurons due to a deprivation of oxygen for a prolonged period of time. In addition to this initial damage, excitotoxicity (cell death caused by overexcitation of neurons) may occur. This is from the excessive glutamate that is released from oxygen-deprived neurons which kills postsynaptic neurons (Llorens, Gil, & Del Río, 2011; Lundy-Ekman, 2013).

Mirror neurons have fairly recently been attributed to being the basis of how we learn and thus facilitate motor learning (among other things). They are specialized premotor cells that have a mirroring function which fires whenever an organism observes a new behavior and then tries to imitate it. This suggests that a part of motor learning involves rehearsing all motor actions (as well as language and emotions) prior to imitation (Sugg, Müller, Winstein, Hathorn, & Dempsey, 2015). Mirror neurons related to motor learning have been found in the premotor cortex (motor planning) and parietal lobe (perception of oneself and one's relationship to the external environment) along with other areas related to social behaviors (Gutman, 2008). The activation of premotor neurons by simple observation of actions could be a simple treatment technique for motor disorder after neurologic incidents (Iacoboni & Mazziotta, 2007).

Experience-Dependent Plasticity

Learning and memory require experience-dependent plasticity which involves persistent, long-lasting changes in the strength of synapses between neurons and within neural networks. During the initial phases of motor learning, large and diffuse regions of the brain are active. With repetition of a task, the number of active regions in the brain is reduced. Eventually, when a motor task has been learned, only small, distinct regions of the brain show increased activity during performance of the task. Recovery of function after damage to specific brain regions involves experience-dependent plasticity. This involves the synthesis of new proteins, the growth of new synapses, and the modification of existing synapses. With repetition of a specific stimulus or the pairing of presynaptic and postsynaptic firing, synthesis and activation of proteins alter the excitability of the neuron and promote or inhibit the growth of new synapses, especially at dendritic spines. Mechanisms of experience-dependent plasticity include: plasticity of the intrinsic excitability of neurons by functional changes in ion channels, plasticity at inhibitory Gamma Aminobutric Acid (GABA) synapses, homeostatic plasticity to stabilize neural circuits, long-term potentiation, and long-term depression. Dysfunction of this recovery mechanism would be synapses remaining silent, or a lack of neural recovery following an injury or insult (Feldman, 2009; Lundy-Ekman, 2013).

Current neuroscience research has identified specific principles that have shown to improve experience-dependent plasticity (Kleim & Jones, 2008). A review article by Kleim and Jones (2008) summarized recent neuroscience research that support ten basic principles upon which neurorehabilitation can be based. These principles include: use it or lose it, use it & improve it, specificity, repetition matters, intensity matters, time matters, salience matters, age matters, transference, and interference.

Use It or Lose It

Intracortical microstimulation (ICMS) mapping techniques were used to derive maps of primary motor cortex (area 4) after blood vessels were permanently occluded as they entered that section of the cortical surface (i.e., induced ischemic stroke) in monkeys (Nudo & Milliken, 1996). Infarcts caused marked deficits in use of the contralateral hand, as evidenced by increased use of the ipsilateral hand, and reduced performance on a task requiring skilled digit use. These infarcts resulted in a widespread reduction in the digit representations adjacent to the lesion, and an increase in adjacent proximal representations. As a result, substantial functional reorganization was found to occur in the primary motor cortex. In the absence of training/rehab, the movements formerly represented in the infarcted zone did not reappear in adjacent cortical regions. Movements formerly represented in the zone of infarct underwent a widespread loss of cortical representation (Nudo & Milliken, 1996). Therefore, if physiological consequences of cortical infarct are use-dependent, then further loss of spared distal representation may be at least partially explained by disuse of affected musculatures. Clinically, we would refer to this as "learned non-use" which affects adaptation through exhibition of compensatory movements.

Use It and Improve It

A review article by Nudo, Plautz, and Frost (2001) summarized experimental manipulations including PNS and CNS injury, electrical stimulation, pharmacologic treatment, and behavioral experience. Conclusions lead to supporting the fact that the cerebral cortex is functionally and structurally dynamic. Functional alterations in motor cortex organization are accompanied by changes in dendritic and synaptic structure, as well as alterations in the regulation of cortical neurotransmitter system (Nudo, Plautz, & Frost, 2001). After injury to the motor cortex, as might occur in stroke, post-injury behavioral experience may play an adaptive role in modifying the functional organization of the remaining, intact cortical tissue. The specific types of behavioral experiences that induce long-term plasticity in motor maps appear to be limited to those that entail the development of new motor skills.

Nudo et al. (1996) used intercortical microstimulation (ICMS) to define maps of hand representation after infarcts induced by bipolar electrocoagulation in monkeys.

They found that rehabilitative therapy prevents further losses of hand area in the adjacent intact tissue, and may direct the intact tissue to "take over" the damaged function. This is due to either physical growth of new axonal processes or to modulation of existing synapses (Nudo & Milliken, 1996). Rehabilitative therapy after a neurological insult can help prevent or overcome "learned non-use" of the hemiplegic upper extremity as well as improve its actual movement and function by recruiting other parts of the brain that are not damaged. The animal model presented in this study supports the positive effects of rehabilitation to prevent/overcome "learned non-use" and improve movement/function in the affected upper extremity through cortical re-organization.

Focal Transcranial Magnetic Stimulation (TMS) for motor mapping of the brain after CIMT was assessed on human adults with hemiparesis of one upper extremity (Liepert, Bauder, Miltner, Taub, & Weiller, 2000). A doubling of excitable cortex yielded increased response in muscles of the hemiplegic hand and subsequent increased use of the more-affected upper extremity. Findings included an increase in the excitability of neurons already involved in the innervation of more-affected hand movements or an increase in excitable neuronal tissue in the infarcted hemisphere, or both. There was also a reduction in activity of local inhibitory interneurons and an enhancement of strength of existing synaptic connections (Liepert et al., 2000). Rehabilitation appears to lead to a recruitment of a large number of neurons in the innervation of movements of the stroke-affected extremity adjacent to those involved before therapy. This study on humans assessed therapy-induced neuroplasticity in stroke patients and found neurophysiological adaptation in the brain which results in a behavioral change of increased movement in the affected upper extremity.

Specificity

Monfils, Plautz, and Kleim (2005) did a review of neural mechanisms known to underlie motor map plasticity as a mechanism for encoding motor experience. They summarized how motor map topography reflects the capacity for skilled movement. Motor skill learning induces reorganization of motor maps in a manner that reflects the kinematics of acquired skill movement. Map plasticity in supported by a reorganization of cortical microcircuitry involving changes in synaptic efficacy. Motor map integrity and topography are influenced by various neurochemical signals that coordinate changes in cortical circuitry to encode motor experience. Motor map organization includes the following: (a) fractured somatotopy – individual movements are represented multiple times and are highly interspersed with adjacent movement representations across discrete cortical regions; (b) interconnectivity – corticospinal neurons from adjacent cortical areas are densely interconnected via intracortical afferents; (c) area equals dexterity – movements with a greater degree of dexterity are more easily evoked in response to simulation and occupy a larger proportion of the map; and (d) plasticity – motor map topography is highly dynamic & can rapidly change in response to a variety of internal & external pressures (Monfils, Plautz, & Kleim, 2005). In general, the review confirmed that synaptic efficacy within the motor cortex can be altered. Motor skill learning induces changes in synaptic strength within the motor cortex. Manipulations that alter synaptic strength in motor cortex will induce reorganization. Sensory input can modulate (i.e., adapt) motor cortex excitability and motor map topography. This may also reflect the role of sensory information (unskilled vs skilled tasks) in facilitating learning-dependent plasticity within the motor cortex which could be interpreted as adaptation. The motor cortex is critically involved in the acquisition and performance of skilled movement (at the level of the neural synapses). Stimulation-derived motor maps represent a motor engram.

Repetition Matters

Racine, Chapman, Trepel, Teskey, and Milgram (1995) conducted repeated conditioning sessions over several days using high frequency trains (stimulation with electrode directly to the rat brain, i.e., kindling-induced potentiation of cortical field potentials) to the corpus callosum. They found long term potentiation in callosal-neocortical field potentials reached desired levels after 15 days and persisted for at least 4 weeks. The hippocampus functions as a fast learning system with a limited and transient storage capacity, while the neocortex learns more slowly and more selectively, with a greater and more enduring storage capacity (Racine, Chapman, Trepel, Teskey, & Milgram, 1995). In order to elicit neural mechanistic changes and subsequent adaptive responses, repetition of stimuli must occur. It cannot be elicited after one session. This animal model demonstrates the benefits of repetition of stimulation in neural plasticity.

Intensity Matters

Repetitive Transcranial Magnetic Stimulation (rTMS) over the primary motor cortex (M1) in healthy, human adults was tested by Peinemann et al. (2004). A sufficient number of conditioning stimuli was found to be necessary to produce persistent corticospinal facilitation/excitability. Intensive stimulation to M1 is a non-invasive means of inducing persistent changes in excitability in the human corticospinal motor system (Peinemann et al., 2004). For a change in motor output to occur (i.e., adaptation), conditioning stimuli must be given repeatedly in intense measures. This study shows the importance of intensity with rTMS. This is a neuromechanical demonstration of how frequency of conditioning treatment affects motor outcomes.

Time Matters

Biernaskie, Chernenko, and Corbett (2004) used rats to compare the efficacy of social housing only, vs enriched rehabilitation initiated at 5 days, 14 days, or 30 days post focal ischemic induced stroke. They found that early initiation of enriched rehabilitation provided enhanced functional outcome relative to delays in rehabilitation. Enhanced rehabilitation initiated early after ischemic stroke resulted in marked increase in dendritic growth and complexity that corresponded to improved function of the affected limbs. Greater tissue infarction produced more dendritic growth in the undamaged motor cortex, indicating that the pattern of neuronal reorganization after ischemia seems to be dependent on the size and distribution of the injury. Nerve growth factor (NGF) and basic fibroblast growth factor (bFGF) are altered in the weeks after ischemia. This may engender the injured brain with greater plasticity, and during this period, the brain may be optimally responsive to rehabilitative experience (Biernaskie, Chernenko, & Corbett, 2004). Initiating rehabilitation earlier rather than later provides significantly greater functional compensation/recovery (or adaptation) and enhanced structural plasticity within the undamaged motor cortex. The efficacy of rehabilitative therapy after stroke is influenced by the time of its commencement. The post-stroke brain displays heightened sensitivity to rehabilitative experience early after the stroke but declines with time. Delaying commencement of rehabilitation may reduce the efficacy of treatment, ultimately limiting functional recovery in stroke patients.

Salience Matters

Weinberger and Bakin (1998) used of an auditory conditioned stimulus in guinea pigs to determine receptive fields before and at various times following aversive classical conditioning and instrumental avoidance learning. Increased neuronal responses to conditioned stimulus, specifically, learning-induced receptive field plasticity is associative, highly specific to the conditioned stimulus, discriminative, develops rapidly and is retained indefinitely. Modified Hebbian rules were invoked to explain increased responses to the conditioned stimulus frequency and decreased responses to no-conditioned stimulus frequencies: (a) if a presynaptic input and the postsynaptic cell are both active at the same time, then synaptic strength is increased; (b) if the presynaptic input is not active but the postsynaptic cell is active, then synaptic strength is weakened ("active" refers to a state of increased excitability and is not restricted to cellular discharges); (c) the amount of change in synaptic strength is proportional to the degree of post-synaptic excitability (Weinberger & Bakin, 1998). Adaptive behavior involves a continual interplay between an organism and its environment, both of which are dynamic. Sensory events provide an organism with information about both its environment and the effects of its own behavior on the environment. Thus, the mechanisms underlying the processing and storage of information about sensory events (which could include rehabilitation) are at the foundation of the neural bases of adaptive behavior. Learning-induced receptive field plasticity has the characteristics of associative memory, it is therefore referred to as "physiological memory." Rehabilitation efforts can facilitate adaptation by improving learning-induced receptive field plasticity. This can be seen at the cellular level through the model developed in this study (Weinberger & Bakin, 1998).

Age Matters

A general view of plasticity, its neural origin, function, mechanisms, changes with age and possible clinical manipulation was reviewed by Nieto-Sampedro & Nieto-Díaz (2005). As we age, it becomes more difficult to store, stabilize and retrieve memories and the memory traces decay more easily. Presynaptic terminal and neuronal activity is important for spine pruning and maintenance and neural activity can have a vast influence on the final number of spines (Nieto-Sampedro & Nieto-Díaz, 2005). Neurological age dependent changes underlie adaptations. Aging may interfere with neural plasticity processes in a number of ways and at various levels with glial cells playing a fundamental role.

Transference

Pascual-Leone et al. (1995) assessed the different effects of mental and physical practice with TMS mapping of the modulation of cortical motor areas in healthy human adults targeting muscles involved in the task of practicing a one-handed, five-finger exercise on the piano. Mental practice alone led to significant fine motor skill learning but did not result in as much performance improvement as physical practice alone. Mental practice alone led to the same plastic changes in the motor system as those occurring with the acquisition of a skill by repeated physical practice. The same neural structures (prefrontal and supplementary motor areas, basal ganglia, and cerebellum) were stimulated through physical or mental practice (Pascual-Leone et al., 1995). Therefore, combining techniques of teaching and rehabilitation for adaptation promotes skill learning. The transference of multiple rehabilitation techniques leads to greater performance improvement than singular methods alone. This study provides an example of how two different modes of training (physical practice and mental imagery) can enhance learning more together, than individually.

Interference

Practice of motor tasks with either explicit information or no explicit information was compared in humans who were healthy and humans with basal ganglian strokes by Boyd and Winstein (2006). The response to explicit information after stroke was uniformly disruptive regardless of task type or lesion location – proof of an interference effect as compared to the healthy control group. The explicit learning and memory system is mediated by the hippocampus and adjacent medial temporal lobe structures. The implicit learning and memory system is highly distributed making it nearly impossible to completely disrupt. Damage to the basal ganglia or sensorimotor cortex disrupts the capacity for explicit information to constructively influence the formation of an implicit motor plan. The integrity of the basal ganglia and sensorimotor cortical areas may be crucial in determining the efficacy of explicit task information during implicit motor-sequence learning. Certain forms of explicit information delivered before task practice may not be as useful (or adaptive) for learning as discovering the solution to the motor task with practice alone, and this is regardless of the type of task being learned (Boyd & Winstein, 2006). To facilitate adaptation, implicit learning is more advantageous than explicit teaching. In addition, explicit teaching can interfere with implicit learning. Explicit information delivered before task practice is not as useful as discovering the solution to the motor task through practice alone. This study emphasized how explicit information slowed or disrupted (interfered with) implicit learning.

Task Oriented Training (TOT)

Principles of experience-dependent plasticity can be implemented in task oriented training (TOT). One component of TOT could be Constraint Induced Movement Therapy (CIMT), which is considered to be a special class of TOT (Winstein, Wolf, & Schweighofer, 2014). The most important aspect of CIMT was found not to be the restraint, but the massed practice which occurs during training (Sterr, Freivogel, & Schmalohr, 2002), i.e., an experience dependent plasticity principle. Task specific practice is considered, even by the originator of CIMT (Edward Taub), to be more important than the constraint of the less affected UE (Taub et al., 2003). Kleim and Jones (2008) argue that the "qualities and constraints of experience-dependent neural plasticity are likely to be of major relevance to rehabilitation efforts in humans with brain damage. However, some research topics need much more attention in order to enhance the translation of this area of neuroscience to clinical research and practice" (p. S225). Task oriented training is based on these behavioral neuroscience aspects as well as recent models of motor control and motor learning.

Task oriented training has been clinically described by Lang and Birkenmeier (2014) as "involving the active, repetitive practice of functional activities to learn or relearn a motor skill" (p. xi). It has also been referred to as task specific training and repetitive task practice. All terms represent the same concept of repeated, challenging practice of functional, goal-oriented activities used for restoring or remediating upper extremity motor control. Task oriented implies that the participant is engaging in behavioral experiences that directly replicate the sensorimotor demands that need to be acted on to execute the motor skill successfully. Training implies that the behavioral experiences are not just repetition of the same thing but involve ongoing challenge to a participant's capabilities (Lang & Birkenmeier, 2014).

Lang and Birkenmeier (2014) offer the following principles for task oriented training (p. 2-3) which reflect experience-dependent neural plasticity and current models of motor control and motor learning:

- Practice of a movement results in improvement in that movement.
- Large amounts of practice are required to truly master a motor skill.
- Learning requires solving the motor problem, not rote repetition of overlearned tasks.
- Learning does not occur in the absence of feedback.
- Intrinsic feedback is optimal for promoting self-learning and generalization.
- Optimal learning occurs with high levels of motivation and engagement.
- Variable practice conditions are optimal for learning and generalization.
- Within-session, massed practice promotes learning better than within-session distributed practice.
- Practice of a whole task results in better learning than practice of parts of the task, unless the task can be broken down into clearly separable components.

Task oriented training can best be described as a top-down approach to rehabilitation. The client is viewed as an active problem-solver, and rehabilitation is focused on acquisition of skills. The desired outcome of a TOT program is skill which can be defined as "the ability to achieve a goal (the task) with consistency, flexibility, and efficiency" (Winstein & Wolf, 2004).

ASAP within ICARE

The Accelerated Skill Acquisition Program (ASAP) is one such task oriented training program that has been proposed and is currently being studied in a national, multi-center, randomized clinical trial entitled Interdisciplinary Comprehensive Arm

Rehabilitation and Evaluation (ICARE) (Winstein et al., 2013). The conceptual model of ASAP incorporates skill acquisition through task specific practice (motor learning and self-management), capacity building (impairment mitigation), and motivational enhancement (intrinsic drive) as components to enhance task performance (Winstein & Wolf, 2004). Task specific practice is considered to be the most important aspect derived from studies of CIMT (Taub et al., 2003). Impairment mitigation comes from work demonstrating the importance of fundamental impairments, including strength and control for restoring upper extremity function (Platz, Pinkowski, van Wijck, & Johnson, 2005; Platz, 2004; Winstein et al., 2004). Motivational enhancements have been shown in work on the importance of self-regulation, self-management, and self-efficacy for behavioral change that supports beneficial outcomes (Jones, 2006; Kendall et al., 2007). Typically, these motivational enhancements strengthen self-confidence and support participant control or autonomy. Overall, ASAP is an approach toward an integrated, evidence-based intervention that contains the elements of upper extremity task oriented training and the most up-to-date, neuroscience based practice.

ASAP was created from "diverse but converging, complementary, and interdisciplinary literature of basic and applied science as well as recent translational and stroke clinical trial research of upper extremity recovery" (Winstein et al., 2013), p. 9). ASAP is unique in that it includes a structured framework of intensity and progression of practice which manages and fosters participant skills and confidence through therapist-patient collaboration. It is currently being studied in a phase 3, randomized clinical trial

(ICARE) in which ASAP is compared to usual and customary therapy (Winstein et al., 2013). Participants randomized into the ASAP group are given therapy that includes challenging, intensive, and meaningful practice of activities related to participant chosen real-world tasks that engage the weaker arm and hand due to stroke. These participants are also offered a mitt to wear on the less affected hand during the time outside of therapy to promote use of the more affected upper extremity. Outside of therapy, specific assignments are given to encourage self-managed, confident, safe, and effective arm use at home and in the community (Winstein et al., 2013).

Eight overlapping operating principles of ASAP were stated in Winstein et al. (2013) as follows (p. 9):

- Ensure challenging and meaningful practice
- Address important (interfering) changeable impairments
- Enhance motor capacity through overload and specificity
- Preserve natural goal-directedness in movement organization
- Avoid artificial task breakdowns when possible
- Assure active patient involvement and opportunities for self-direction
- Balance immediate and future needs
- Drive task specific self-confidence high through performance accomplishments

Occupational Adaptation Based Practice Model

The ASAP as a task oriented treatment is aligned with the occupational therapy Theory of Occupational Adaptation (Schkade & Schultz, 1992; Schultz & Schkade, 1992) and grounded in neuroscience research. ASAP is a structured framework by which intensity and progression of practice is managed and which fosters participant skills and confidence (the person's sensorimotor, cognitive, and psychosocial systems) through therapist-client collaboration. It includes challenging, intensive, and meaningful practice of activities (press for mastery) related to participant chosen (desire for mastery) real-world tasks (demand for mastery) that engage the arm most affected by a stroke.

Occupational Adaptation incorporates both Occupational Readiness and Occupational Activities as part of interventions. Occupational Readiness consists of preparatory tasks that are components of Occupational Activities. Ultimately, Occupational Activities guide the intervention by involving the client's meaningful occupational roles. They are used to encourage active client participation that result in some kind of product, either tangible or intangible. Participation in these activities is especially focused on arm and hand use during the whole task, performed at home. Occupational Readiness tasks mainly focus on specific deficits such as movements that are difficult for the client to make that are utilized within an Occupational Activity.

Core Assumptions of Occupational Adaptation Related to Task Oriented Training

- Life roles, routines, and habits are unique to the individual.

- Occupations that are meaningful to the individual are more engaging than rote, generic tasks.
- Activities are most engaging when they are at a “just right challenge,” ie, not too easy and not too hard
- Self-efficacy (belief in one’s ability to effect the environment) is essential to achieving satisfaction in life.

Rationale of Occupational Adaptation Related to Task Oriented Training

- People who have had a stroke are striving to regain their occupational roles.
- Activities focused on occupation that include “real-world” components will encourage the needed repetitive use of the hemiplegic upper extremity.
- The most advantageous occupational challenge is one in which the difficulty of the task is just slightly greater than the skill level of the performer.
- Self-efficacy can be a form of adaptation. One must be able to independently generate, evaluate, and integrate the use of their hemiparetic upper extremity to improve relative mastery.

Premise of Occupational Adaptation Related to Task Oriented Training

- Typically, a stroke survivor learns not to use the weaker arm and hand which limits the ability to fulfill life roles.
- To increase use of the stroke survivor’s weaker upper extremity, he or she must engage in occupational activities that occur within the natural home/community

environment. Increased repetitive use of the affected upper extremity within everyday life activities is needed to make neurophysiological changes in the brain.

- A stroke survivor will become frustrated when an occupational challenge is too great. If the challenge is not stimulating enough, he or she will become bored.
- Frequently, a stroke survivor's lack of adaptation stems from a poor adaptation gestalt. The survivor has difficulty problem solving (decreased cognition) how to use the hemiparetic upper extremity (lack of sensorimotor aspect) in a socially acceptable way which can lead to "giving up" and subsequent depression (psychosocial ineptness).

Putting it all Together: Occupational Adaptation and Task Oriented Training

The Client is the Agent of Change, Therapy is a Collaborative Process

Using Occupational Adaptation in a task oriented training program, the therapist functions as a facilitator to help the client develop his or her own ability to adjust his or her adaptation gestalt (balance of sensorimotor, cognitive, and psychosocial aspects) when facing a challenging situation. If the activity demands are overbalanced in one aspect - the outcome will typically be less than desirable. For example, psychosocial issues may outweigh the individual's ability to reason through what is going and what needs to be done to adapt to decreased function in the affected upper extremity. The occupational performance yields a low level of mastery and the motivation to engage in similar or more challenging activities declines.

The client must understand and agree to be a collaborative partner with the therapist in an Occupational Adaptation influenced task oriented training program. The client will do this by identifying goals and assessing progress with the therapist. Training will utilize tasks meaningful to the client and specifically defined by the client and therapist together. The therapist will initially provide more help in managing the environment at the beginning of training, then progressively decreases the level of assistance provided to promote the individual's adaptive processes through graded, independent problem-solving, and ultimately mastery.

Facilitate Client's Problem Solving Ability by Enhancing Self-Efficacy

In a task oriented training program guided by the Theory of Occupational Adaptation, directing clients' attention to the effects of their movements (external focus of attention) would be more beneficial than directing their attention to their own movements (internal focus of attention). Therapists can best facilitate motor learning through the use of implicit instructions, as opposed to explicit instructions. Boyd and Winstein (2006) found that certain forms of explicit information delivered before task practice may not be as useful for learning as discovering the solution to the motor task with practice alone, regardless of the type of task being learned.

CIMT could also be incorporated into an Occupational Adaptation influenced task oriented training program through occupational activities (the "whole" task) and/or occupational readiness activities ("part" of the task). CIMT could address occupational activities with repetitive task practice or practice of a full functional task that may have multiple steps for completion. CIMT would define occupational readiness activities as adaptive task practice (or shaping) by focusing on repetitive trials of a specific motor movement with small steps and progressive grading of the task. Offering clients a mitt to wear or simply encouraging them to use the less affected hand during tasks could promote function of the weaker upper extremity. The client must understand the rationale and purpose of CIMT. This knowledge increases mastery of identifying and working on meaningful unilateral upper extremity activities.

A task oriented training program guided by the Theory of Occupational Adaptation would best begin with a "real-world" task list is created collaboratively between the client and the therapist. The chosen tasks would be directly linked to the client's identified occupational roles to help guide intervention. Ultimately, the role is more important than the tasks. It is through the roles that the tasks take on meaning. Tasks are graded at the appropriate challenge points for a client within their role. Learning is related to the information arising from performance, which should be optimized along functions relating the difficulty of the task to the skill level of the performer (Guadagnoll & Lee, 2004), again, within the client's chosen occupational role.

Previous work in Occupational Adaptation has provided evidence that this theory is useful within the CVA population (Gibson & Schkade, 1997) and in the home health setting (Schultz & Schkade, 1994). This practice framework uses Occupational Adaptation with clients who have mild to moderate hemiplegia from a stroke who have been discharged from inpatient rehabilitation to increase use of the affected upper extremity. The overall goal of this treatment approach is adaptation, specifically, to use meaningful occupations within a person's own occupational environment to increase the adaptive use of his or her affected upper extremity. By engaging in activities that are at the "just right challenge," the person can regain old or establish new routines, habits, and roles. Ultimately, relative mastery enables the person to continue to adapt to occupational challenges throughout his or her lifespan.

Home Setting (Context)

The home health setting is an appropriate occupational environment in which to base an Occupational Adaptation guided task oriented training program. It is at this stage of recovery that the stroke survivor is most capable culturally, socially, and physically to undergo this approach. Upon return home, the client is physically ready to participate in the necessary repetitive training required to regain functional movement in the affected upper extremity. It is here that he or she also has the time to devote to this specific training regime. Socially and culturally, the client can utilize this approach to help regain or redefine occupational roles in their living situation and within his or her return to community living. The *social context* includes the availability and expectations of significant individuals, such as a spouse or partner, friends, and caregivers, including larger social groups that are influential in establishing norms, role expectations, and social routines (Amini et al., 2014). In the home health setting, the client is more likely to want to return to familial and community roles such as spouse, parent, worker, neighbor, and friend. The *cultural context* is defined by the customs, beliefs, activity patterns, behavior standards, and expectations accepted by the society of which the individual is a member, including political aspects, such as laws, that affect access to resources or affirm personal rights (Amini et al., 2014). For example, the client's nationality and/or gender may influence how society expects him or her to act and dictates what he or she is supposed to do. Extending the environmental context outside the clinic is an important aspect of task oriented training by reinforcing the client's "real-life" benefits of improved performance.

A task oriented training program guided by Occupational Adaptation could address personal (occupation) and physical aspects of context at the immediate and proximal levels. At the immediate level, occupations include activities that are in close or direct contact with the participant, for example, grooming in the bathroom or dressing in the bedroom. (Spencer, 2002). At the proximal level, activities that pertain to specific behavior settings such as the living room and kitchen. (Spencer, 2002). The use of task oriented treatment methods could be utilized to help a person's hemiparesis by regaining physical function of their weaker upper extremity. This may be done by adapting the environment and/or tasks in personal areas inside the home (immediate) and in less private areas in and around the home (proximal) environments so that the person may participate in functional activities with their affected arm and hand. The activities to be addressed in this intervention would be functional tasks chosen in collaboration with the participant that are meaningful, personal occupations within and outside of the home. The immediate and proximal aspects of the social context would also be addressed throughout the intervention. Identifying appropriate tasks to work on within the participant's home and community environment will enhance the meaningfulness of the activities as well as promote long term compliance (adaptation gestalt) of utilizing this approach even after one-on-one training has ceased.

During one-on-one sessions involving task oriented training, participants would complete functional tasks in their home. Feedback from each task would be given by both the therapist and the participant in regards to efficiency, effectiveness, and satisfaction. Additional feedback may be given by the therapist to encourage motor learning of the affected upper extremity through overload and specificity while driving the participant's self confidence in implementing adaptation to any task. Participants would then take what they learn from the one-on-one session and practice independently outside of therapy times.

CHAPTER III

METHODS

Design

A single-subject design was implemented to assess repeated measures of arm motor movement (accelerometry) and self-efficacy throughout baseline, intervention, and follow-up phases of the Task Oriented Training and Evaluation delivered at participants' homes (TOTE Home) (see Appendix A for schematic of methods). This type of design allows collection of data during a non-intervention (baseline phase) and during an intervention phase. In a single-subject design, the participant acts as his or her own control and data are analyzed to compare change during the baseline and intervention phase. The single-subject design allows the therapist to monitor the participant's progress and the effectiveness of the intervention (Auerbach & Zeitlin, 2014). A single-subject AB design with follow-up is described by Ottenbacher and York (1984) as practice-based and practitioner-oriented. It allows the practitioner to assess changes in outcome measures with an intervention in an individual, over a course of time. Upper extremity movement and function was also assessed through other quantitative measures assessed at baseline, post-intervention, and at follow-up time periods. Field notes were analyzed for qualitative themes (Patton, 2002) in order to help better describe each participant. Veronica Rowe served as the principal investigator, recruiter, evaluator, and occupational therapist implementing the intervention and author of the field notes.

Recruitment

The participants consisted of a convenience sample and were recruited using local occupational therapists. The convenience sample was necessary for the occupational therapist to implement the intervention. Other therapists from a regional medical center who are well known to the occupational therapist doing the recruiting were provided business cards with her contact information and given a verbal explanation of the project (see Appendix B for print recruitment material and recruitment script). No other written flyer was used for recruitment. Therapists gave potential participants the occupational therapist's card along with a brief verbal explanation of the study. Therapists were asked to refer clients they had worked with, who met the inclusion criteria, and who they believed would be interested in participating in this research. These therapists had no other role in this research study. Participants were asked to make initial contact with the occupational therapist via a phone call.

Exclusion criteria was reviewed during the initial phone call and general demographics were obtained. Gender, age, date of stroke, type of stroke, living situation, dominant hand, and side affected by the stroke were recorded. Contact information (best phone number to use and address) was also recorded for logistic purposes only (see Appendix C).

Informed Consent Procedures

Screening of potential participants occurred and consent was obtained in the participants' homes after the occupational therapist had been invited during the initial phone call. When a potential participant indicated an interest in participating in this study and all of the inclusion criteria had been met, the occupational therapist explained the purpose of the study and the intervention process, including the estimated amount of time that would spent in evaluations and the intervention, the steps to maintain confidentiality, and how the information collected would be handled. The participants were given the opportunity to ask questions during this time. When the participant indicated that he or she had no more questions and that he or she understood the purpose of the study and his or her role in the process, the written consent form (approved by the IRB) was explained and offered to the participant. The purpose of the study, the potential risks, and the anticipated length of time for participation was reiterated and time was allowed for additional questions and answers. The participant was assured that participation was voluntary and that he or she could change his or her mind at any time and withdraw from the study without repercussions of any kind. Only after the consent form was signed and the participant indicated understanding of his or her involvement in the study did data collection begin.

Participants

Four participants (out of 10 recruited) were consecutively enrolled who were 3-12 months after their first CVA and had completed their home health and outpatient occupational therapy. The timing of task oriented training during the immediate post-acute period of stroke recovery was summarized by Winstein and Wolf (2004), to be optimal for the following reasons:

- Supportive interaction between processes associated with experience-dependent and injury-induced cortical reorganization that are known to influence functional recovery
- Earlier intervention may allow for more optimal cortical re-organization and potentially less use of behavioral compensatory strategies
- Prevent the detrimental effects of maladaptive compensatory strategies (learned non-use) that may with time be reinforced and become more difficulty to reverse
- Not so early as to be overly aggressive during a more vulnerable period both physiologically and psychologically
- The outpatient environment is more practical setting for a distributed, relatively high dose of upper extremity task-specific training (Winstein & Wolf, 2004, p. 275)

Inclusion and Exclusion Criteria

Participants exhibited upper extremity hemiparesis but met minimal movement criteria in the affected arm and hand (at least 10 degrees of active movement at the wrist, elbow, and shoulder movement, along with 10 degrees of active movement in the thumb and two other fingers). Minimal movement criteria were required for the participants to be able to start to work on treatment methods. The minimal movement criteria were established in the ExCITE trial (Winstein et al., 2003) (see Appendix C for inclusion and exclusion criteria - including minimal movement - form).

Other inclusion criteria included having minimal cognitive deficits as demonstrated by a 24 or higher on the Mini-Mental Status Exam (Folstein, Folstein, & Fanjiang, 2002) (see Appendix D). Cognition and memory needed to be relatively intact to be able to carry out treatment independently and safely when therapist is not present. The participants were able to identify at least five specific tasks they wish to achieve with their affected upper extremity. This was assessed with the Canadian Occupational Performance Measure (COPM) (Law et al., 2005) (see Appendix E). They had to be at least 21 years of age and able to communicate in English. The time frame of recovery was 3-12 months after their stroke which would classify them in the subacute level of recovery and all formal occupational therapy was completed.

Exclusion criteria included upper extremity pain that interfered with activities of daily living, requiring maximal assistance for mobility, arm or hand injury (unrelated to the stroke), upper extremity amputations, inability to participate due to any illness, social or geographical reason, and any other diagnosis or limiting conditions that would affect participation.

Six of the 10 participants recruited were excluded due to the inability to meet the minimal movement criteria, and/or confounding co-morbidities. Such co-morbidities included: depressive symptoms as ascertained by a score of less than 16 on the Center for Epidemiologic Studies Depression Scale – Revised (Eaton, Smith, Ybarra, Muntaner, & Tien, 2004), which could affect their reports of self-efficacy (see Appendix F); upper extremity pain that substantially interferes with ADLs; require maximum assistance for mobility; arm or hand injury; and other condition limiting use prior to stroke or could otherwise interfere with the intervention; and other medical concerns that limited their overall participation in further rehabilitation (see Appendix C).

Inclusion and Exclusion Assessment Tools

Mini-Mental State Exam (MMSE). The MMSE (see Appendix D) was developed and validated for use with adults in 1975 (Folstein, Folstein, & McHugh, 1975). Interpretive guidelines and normative information was revised in 2002 (Folstein et al., 2002). This information was derived from research with community-dwelling adults randomly selected in five U.S. cities, as well as in clinical and research studies. The MMSE has excellent validity and reliability (Tombaugh & McIntyre, 1992). Specifically, test-retest reliability of the MMSE ranges from about .80 to .95, sensitivity of at least 87%, positive predictive value of at least 79%, moderate-to-high levels of specificity, and relatively high negative predictive values (Tombaugh & McIntyre, 1992). The most widely accepted and frequently used cut-off score for the MMSE is 24, with scores of 23 or lower indicating the presence of cognitive impairment. The authors recommend using this cutoff score when interpreting an individual's performance. The MMSE was developed as a screening tool for cognitive impairment, a low score (<24) indicates a high likelihood of cognitive impairment and the need for further evaluation. The authors recommend that the following cut-off levels by used for classification purposes: normal cognitive function = 27-30, mild cognitive impairment = 21-26, moderate cognitive impairment = 11-20, and severe cognitive impairment = 0-10.

The Canadian Occupational Performance Measure (COPM). The COPM (see Appendix E) is an individualized measure designed for use by occupational therapists to detect change in a client's self-perception of occupational performance over time (Law et al., 2005; Law et al., 1990). The COPM is used to identify problem areas in occupational performance, provide a rating of the client's priorities in occupational performance, evaluate performance and satisfaction relative to those problem areas, and measure changes in a client's perception of his or her occupational performance over the course of occupational therapy intervention. The COPM is designed to measure changes in self-perception of occupational performance among clients with a variety of disabilities and across all developmental stages (Law et al., 2005). Test-retest reliability for the COPM yielded a good inter-class correlation coefficient of 0.63 for performance and an excellent inter-class correlation coefficient of 0.84 for satisfaction (Law et al., 2005). Validity of the COPM is evident in the mean change scores in performance and satisfaction being responsive to changes in perception of occupational performance by clients (Law et al., 2005).

The COPM consists of five steps. The first step in the process is to interview the client about his or her occupational performance. It is important that clients identify occupations that they want to do, need to do, or are expected to do in daily life. The therapist then asks if they are able to do those occupations or are satisfied with how they do them. The first enquiries, therefore, address the client's perceived "needs" and the second enquiries address "performance" and "satisfaction." The COPM test form is divided into three areas: occupational performance (i.e., self-care), productivity, and leisure, and each area is further subdivided. The second step consists of rating importance. The client is asked to rate the activity in terms of its importance in his or her life. Importance is rated on a ten-point scale from 1 = not important at all, to 10 = extremely important. Step three involves scoring. The client is asked to choose up to five problems that seem most pressing or important. For each of these problems, the client is asked to complete a self-evaluation of his or her current performance in that area, and a self-evaluation of his or her satisfaction with current performance. Performance is assessed by rating, "How would you rate the way you do this activity now?" on a 10-point scale from 1 = not able to do it at all, to 10= able to do it extremely well. Satisfaction is assessed by rating, "How satisfied are you with the way you do this activity now?" on a 10-point scale from 1 = not satisfied at all, to 10 = extremely satisfied. Step four is for re-assessment of performance problems after a period of time has passed. Step five consists of computing change scores in performance and satisfaction (Law et al., 2005).

For this study, a priority task was chosen by the participant, based on the COPM, to be rated throughout the participant's enrollment.

The Center for Epidemiologic Studies Depression Scale – Revised (CESD-R). The CESD-R (see Appendix F) was created in 1977 (Radloff, 1977) and revised in 2004 (Eaton et al., 2004). The 20 items in CESD-R scale measure symptoms of depression in nine different groups as defined by the American Psychiatric Association Diagnostic and

Statistical Manual, fourth edition (American & American Psychiatric Association DSM-5,Task Force, 2013). The CESD-R has established psychometric properties including high internal consistency, strong factor loadings, and consistent convergent and divergent validity with a number of mental health disorders. It has been found to identify symptoms suggestive of depression similar to epidemiological results. Psychometric tests of the CESD-R reveal it to be an accurate and valid measure of depression (Van Dam & Earleywine, 2011).

These symptom groups identified on the CESD-R are sadness (dysphoria), loss of interest (anhedonia), appetite, sleep, thinking/concentration, guilt (worthlessness), tired (fatigue), movement (agitation), and suicidal ideation. The response values for each question are: not at all or less than one day, 1-2 days, 3-4 days, 5-7 days, nearly every day for 2 weeks. The total CESD-R Score is calculated as a sum of responses to all 20 questions. People who have a total CESD-R score of less than 16 across all 20 questions can be scored as having no clinically significant depressive symptoms.

Setting

The setting of all evaluation and treatment sessions was in the participant's home. Any family members or caregivers were welcome to observe evaluation or treatment sessions as approved by the participant.

Outcome Measures

Demographics

Demographics collected included: gender, age, date of stroke, type of stroke, living situation, dominant hand, and side affected by the stroke. Contact information (phone and address) was also recorded for logistic purposes only (see Appendix C).

Target Behaviors

Target behaviors must be defined in a single-subject design. These are the specific skills the intervention is focused on improving and can be broken down into units of behavior that can be observed, counted, or measured (Auerbach & Schudrich, 2013; Portney & Watkins, 2009). Target behaviors identified for this study included upper extremity movement as measured by accelerometry for an objective measurement of arm movement, and self-efficacy ratings of priority tasks.

Accelerometry. Arm motor movement was recorded repeatedly during the baseline, intervention, and follow-up phases of this study with accelerometry as a measure of duration of behavior. Target behavior measured was the duration of upper extremity activity outside of the training sessions. This quantitative measurement eliminated the possible reporting biases from self-reports. The use of accelerometry provided a more quantitative and accurate measurement of arm movement than client report of use.

To additionally assess the clinical utility of accelerometry, two different types of accelerometers were utilized (see Appendix G). The Actigraph's Bluetooth® Smart wGT3X-BT wireless activity monitor (ActiGraph, Pensacola, FL) is considered the "gold standard" in upper extremity accelerometry movement analysis for research. The Actigraph has been shown to be sensitive and collect accurate data on upper extremity movement for research purposes (André, Didier, & Paysant, 2004; Bailey & Lang, 2013; Bailey, Klaesner, & Lang, 2014; Lang, Wagner, Edwards, & Dromerick, 2007; Lang, Edwards, Birkenmeier, & Dromerick, 2008; Uswatte et al., 2000; Uswatte et al., 2005; Uswatte et al., 2006). However, it can be considered to be expensive and interpretation of results (although detailed) might be considered to be difficult and cumbersome. A less expensive, readily available device that yields easily obtained and readily interpretable details of upper extremity movement might be more feasible in the everyday practice setting. The FitBit® Flex™ (www.fitbit.com) contains the same micro-electro-mechanical systems, 3-axis accelerometer as the Actigraph. Although the data produced by the FitBit® Flex™ are not as detailed as the Actigraph, the more simplified results may be utilized more readily in a clinic setting. To date, no comparison between these two brands has been attempted.

Accelerometers measure movement of acceleration. Acceleration is the change in speed with respect to time and is measured in gravitational acceleration units (1 g = 9.8 m/s^2). This is done by converting mechanical motion into electrical signals via piezoelectric sensors. The sensors are contained within a device, which is similar in size to a wristwatch and can be comfortably worn on the wrist. The electrical signal is converted to a digital signal called an activity count, quantifying how much movement occurred during a specific time period, called an epoch. The epoch is chosen by the clinician and can be as short as a second or as long as a few minutes. One way to measure upper extremity (UE) use is to sum activity counts per epoch as a measure of intensity of UE use (Lang, Bland, Bailey, Schaefer, & Birkenmeier, 2013). Another way to measure UE use is to choose a small epoch, such as 1 second, and determine if movement occurred during that epoch. This is done by "filtering" activity counts: if an activity count occurred during a 1-second epoch, then movement occurred during the epoch; if an activity count did not occur during the epoch, then movement did not occur during the epoch. In this way, epochs where the UE was used can be summed to determine the amount of UE use during a given time period, such as hours in a day. Percentage of UE use that occurred during the wearing time can also be determined. Epoch selection, filtering, and calculation of UE use can often be done with the software program that comes with the accelerometers (Lang et al., 2013).

Accelerometry data came from participants wearing Actigraph's Bluetooth® Smart wGT3X-BT wireless activity monitor (ActiGraph, Pensacola, FL) and the FitBit® Flex™ (www.fitbit.com) for 24-hour time periods. A 24-hour time period was chosen based on rationale from Lang et al. (2007) with justification of the length of one day to enable capturing activity that might occur outside of the typical workday or therapy hours. The Actigraph and the FitBit® Flex™ accelerometers were both placed on each upper extremity at the distal forearms, proximal to the styloid process of the ulna, which allowed both proximal (i.e., upper arm) and distal (i.e., forearm) movements to be captured. Capturing data from both arms was suggested by Uswatte and colleagues (2000, 2005, 2006) in order to calculate ratio measures. It was accepted that wearing an accelerometer on the wrist may underestimate small movements of the hands and fingers that occur without movement in the proximal upper extremity (such as typing with forearms resting on table surface).

Accelerometry is a valid and reliable measure of upper extremity activity used in stroke research that is well-established (Bailey et al., 2014; Lang et al., 2007; Lang et al., 2008; Uswatte et al., 2000; Uswatte et al., 2005; Uswatte et al., 2006). Acceleration (as measured by the Actigraph) was sampled and analyzed with techniques suggested by Bailey and Lang (2013) and Uswatte et al. (2000), which include the use of a threshold filter. Specifically, the threshold-filtered recordings measured the duration of movement accurately and with very little variability (Uswatte et al., 2000). Uswatte et al. (2000) found initial evidence for the validity of threshold-filtered accelerometer recordings for objectively measuring the amount of real-world upper extremity movement as an index of treatment outcome for rehabilitation patients. Overall, accelerometry to measure movement provides an objective, real-world index of more impaired arm activity and has good psychometric properties (Uswatte et al., 2005; Uswatte et al., 2006). Activity measures from the Actigraph were correlated with measures from the FitBit® Flex™.

The Actigraph's Bluetooth® Smart wGT3X-BT wireless activity monitor (ActiGraph, Pensacola, FL) contains a tri-axis, solid state digital accelerometer that detects acceleration in three planes. It is small (4.6cm x 3.3cm x 1.5cm), waterproof, sensitive to -6 to +6 g-force, and contains 2 GB of internal storage. Accelerometry data was downloaded to a computer using ActiLife 6 (ActiGraph, Pensacola, FL). Specifically, this study recorded movement periods, non-movement periods, hours of upper extremity activity, percentage of upper extremity activity, and the ratio of upper extremity activity from the Actigraph. ActiLife 6 was also used to visually inspect accelerometry data to ensure that the accelerometers function properly during the recording period.

The FitBit® Flex™ (www.fitbit.com) was housed on a wristband that fits wrist circumference 5.5 x 8.2 cm and weighs .45 ounces. It is water-, sweat-, and rain-resistant and is compatible with the iPhone or Android app to sync real-time results via Bluetooth® to track progress throughout the day. It also comes with a rechargeable lithium-polymer battery that lasts 5 - 7 days per charge. For this study, it tracked steps taken, calories burned, distance traveled, and minutes active based on arm movement.

Brief Self-Efficacy Rating Scale. The Brief Self-Efficacy Rating Scale (see Appendix H) was recently originated and used in the ICARE study (Winstein et al., 2013) as a measure of the participant's confidence in functionally using the weaker arm and hand. On this scale, during each phase the study, the participant is asked to provide a number between 0 and 10 in response to the question: "How confident are you that you can (fill in specific priority task activity)?" No psychometrics have been assessed for this instrument.

Participant ratings of effectiveness and occupational therapist's ratings of participant engagement on "homework." These types of ratings (see Appendix I) were also originated and used in the ICARE study (Winstein et al., 2013) to monitor how the participant felt about the effectiveness of activities assigned outside of individual training sessions, as well as the occupational therapist's assessment of the participant's engagement in these activities. At the beginning of each session during the intervention phase of TOTE Home, participants were asked to report on the effectiveness of the activities in which they participated in since the last day of training (i.e., "homework"). Participants rated the effectiveness of these outside of training activities on a scale from 1 to 4 (1=all activities ineffective, 2=some activities effective, 3= most activities effective, 4=all activities very effective). The therapist also rated the participant's engagement in these "homework" activities on a scale from 1 to 4 (1=no effort/did not attempt, 2= some effort, 3=great effort/engagement, 4=great effort/engagement, apparently practiced diligently). No psychometrics have been assessed for this instrument.

Additional Outcome Measures

Other changes of outcome were evaluated with tests of arm motor movement and function at baseline, post-intervention, and follow-up. Standardized tests included the Fugl-Meyer sensory and motor assessment for the upper extremity, the Motor Activity Log, last question on the Stroke Impact Scale, and the Functional Test for the Hemiparetic Upper Extremity. These assessments aided in completing the description of the participants as they progressed through the study.

Fugl-Meyer sensory and motor assessment for the upper extremity (FMA). The FMA for the upper extremity (see Appendix J) is an assessment based on Brunnstrom's stages of recovery from stroke. Internal validity of the FMA is supported by showing that the stages of recovery proceeded in the four stages (De Weerdt & Harrison, 1985; Fugl Meyer, Jaasko, & Leyman, 1975). Sensitivity to change was also demonstrated to be good (Rabadi & Rabadi, 2006). The estimated clinically important difference of the FMA ranges from 4.25 to 7.25 points, depending on the different facets of the upper extremity movement (Page, Fulk, & Boyne, 2012). Significant positive correlations were determined between FMA results and ADL-capacity with the Barthel Index (Fugl-Meyer & Jääskö, 1980; Fugl-Meyer, 1980; Lindmark & Hamrin, 1988; Wood-Dauphinee, Williams, & Shapiro, 1990). Predictive validity was found to be adequate for the FMA as well (Feys et al., 2000). The FMA demonstrates concurrent validity by correlating significantly with the Motor Assessment Scale (Malouin, Pichard, Bonneau, Durand, & Corriveau, 1994), the Action Research Arm Test (De Weerdt & Harrison, 1985), the Arm Motor Ability Test (Chae, Labatia, & Yang, 2003), the Stroke Rehabilitation Assessment of Movement (Wang, Hsieh, Dai, Chen, & Lai, 2002), and hand grip force ratio (Boissy, Bourbonnais, Carlotti, Gravel, & Arsenault, 1999). The FMA had a high reverse correlation with the modified Ashworth Scale (Lin & Sabbahi, 1999). As for the reliability of the FMA, Fugl-Meyer et al. (1975) found very small divergences in testing. Duncan, Propst, and Nelson (1983) found test-retest and inter-rater reliability to extremely high (Duncan, Propst, & Nelson, 1983). Lin, Hsueh, Sheu, and Hsieh (2004) found good inter-rater reliability of the total FMA. Lin, Huang, Hsieh, and Wu (2009) showed that the FMA had sufficient reliability, validity, and responsiveness for assessing impairment in participants with stroke.

The upper extremity portion of the FMA consists of 33 movements each scored on a 3-point scale in comparison to movement of the unaffected upper extremity. Scores for each movement are: 2 = full movement exactly like the unaffected upper extremity, 1 = partial movement, 0 = incomplete movement. Movements range from shoulder and elbow flexion/extension, to lateral pinch held against a force (Fugl Meyer et al., 1975).

Motor Activity Log (MAL). The MAL (see Appendix K) is a measure of real-world arm use in the format of a semi-structured interview. Stroke survivors are asked to rate how much (Amount of Use scale) and how well (Quality of Movement scale) they use their more-affected arm for 30 ADL/IADL items in the last 2 weeks. The tasks include such activities as turning on a light switch, opening the refrigerator, and eating with a fork or spoon (Taub et al., 1993). The MAL is internally consistent, relatively stable, and demonstrates reasonable construct validity in chronic stroke patients (van der lee et al., 2004).

Stroke Impact Scale (SIS). The SIS is a self-report measure obtained via structured interview that includes 64 items and assesses 8 domains (strength, hand function, ADL/IADL, mobility, communication, emotion, memory and thinking, and participation). Known as a quality of life measure, it asks that participants rate, on a scale of 1-5, how difficult, within specific amounts of time, certain tasks are to perform, and how often they have felt a certain way, among other question sets. This stroke-specific outcome measure is reliable, valid, and sensitive to change (Duncan et al., 1999).

In order to reduce the burden of extensive evaluations to the participant, only the last question concerning perception of stroke recovery was asked in this study (see Appendix L). There are few instances of the analysis of the last question of the SIS in stroke research (Fritz, George, Wolf, & Light, 2007); however, a participant based questionnaire such as this has been assessed in other studies of physical rehabilitation (Liang, 2000; Osoba, Rodrigues, Myles, Zee, & Pater, 1998).

Functional Test for the Hemiparetic Upper Extremity (FTHUE). The FTHUE (see Appendix M) is a tool used to evaluate the motor capability for function for someone with upper extremity hemiparesis (Wilson et al., 1984). The FTHUE is valid in the sense that it integrates information from several objective measures of the upper extremity ability into a single functional score (Wilson et al., 1984). With a stepwise regression analysis, 87% of the variation of the FTHUE items were accounted for (Wilson et al., 1984). Content validity was established with a determination that the 17 activities are appropriately ranked accordingly from least difficult to most difficult tasks (Wilson et al., 1984). There is a high correlation between the Fugl-Meyer Test and the FTHUE (Rho = .96, $p<.01$) (Filiatrault, Arsenault, Dutil, & Bourbonnais, 1991). The FTHUE is poorly correlated with the Barthel Index (Rho = .61, $p<.01$) (Filiatrault et al., 1991). This discrepancy was explained by the Fugl-Meyer and the FTHUE assessments both focusing on motor function of the weaker arm and hand, whereas the Barthel assessment can incorporate compensatory movements from the stronger arm and hand which can influence activities of daily living performance. Inter-rater reliability was found to be 0.976, $p<.001$ (Wilson et al., 1984).

The FTHUE consists of 19 graded tasks arranged in 7 levels by degree of difficulty, ranging from tasks such as placing the hemiparetic hand on the lap, to removing a rubber band unilaterally with the weaker hand. Grading is on a pass-fail basis. The test is stopped after a patient cannot complete a task correctly. After level 1, each task is timed in order to give an additional quantitative measure of function. The FTHUE evaluates the integrated function of the total upper extremity of an adult patient with hemiparesis (Wilson et al., 1984). It is a quick, easy to administer assessment that can be used in a variety of settings with a wide range of participant capabilities.

Originally designed, a score on the FTHUE was given as the highest level of difficulty a participant achieved by successfully completing all tasks within that level. Success of completing each task is defined by the more affected upper extremity providing functional assistance and not inferring with task outcome. More recently, results from the FTHUE have been reported as the number of tasks successfully completed out the total seventeen tasks (Winstein et al., 2004) as well as average time to complete tasks (Sugg et al., 2015). Results for this study are reported as total number completed in order to make the assessment more sensitive to change by increasing the total score to seventeen tasks, rather than seven levels.

In addition to the pass/fail results of each task for this study, 15 of the 17 tasks were timed. Participants were instructed to do each task in an efficient manner but not necessarily as fast as they can. This metric allows for a more specific measure of the amount of time taken for each task. Progressive improvement on subsequent FTHUE measures within participants can continue to be measured based on speed of task completion, not just the ability to complete a task or not.

Field notes. The field notes of the occupational therapist contain the description of what has been observed during the TOTE Home intervention including aspects of where the observation took place, who was present, what the physical setting was like, what social interactions occurred, and what activities took place. Specific quotations or summaries of what participants said, as well as the occupational therapist's own feelings, reactions to the experience, and reflections about the personal meaning and significance of what was observed are also included (Patton, 2002).

Research Procedures

See Appendix A for a schematic timeline of administration of assessments and intervention.

Screen

A phone screen initiated enrollment in TOTE Home and included an overview of the study, questions regarding exclusion criteria, and collection of participant demographics. Next, an in-person, initial screening took place in the potential participant's home. Here the occupational therapist gave a full explanation of the study and administered the following measures: MMSE, CESD-R, COPM, and upper extremity active range of motion. A score of 24 or greater had to be achieved on the MMSE (see Appendix C) to assure adequate cognitive ability. A score of less than 16 on the CESD-R had to be achieved to rule out depressive symptoms (see Appendix E). At least 5 specific tasks had to be identified on the COPM as goals the participant wanted to achieve with their affected arm and hand (see Appendix D). Observation of active range of motion of the affected arm and hand assessed available movement to determine if the participant had limited, but enough movement to adequately participate in the intervention and have the ability to improve in movement and function (see Appendix B).

Baseline Evaluation

After participants passed initial screening and agreed to participate in the study, assessments of upper extremity motor movement (FMA, MAL), function (FTHUE), and perception of stroke recovery (SIS) were evaluated in the participant's home. Descriptions of these assessments appear in the "Pre-, Post-, and Follow-up Outcome Measures" section above (see Appendices J, K, M, L respectively). The home context was assessed with the Safety Assessment of Function and Environment for Rehabilitation (SAFER Home v3) (see description below and in Appendix N) which acquainted the occupational therapist with the participant's living environment and assisted in identifying areas in which the participant functioned. The SAFER Home v3 was only administered during baseline and not repeated. It was not an outcome measure, but utilized as a method to start developing a therapeutic relationship with the participant by discovering the physical layout of the home and where the participant performed his or her activities. The COPM results from the screening were revisited to confirm the priority, benchmark goal that remained and was not changed throughout the study. All of these assessments were administered within approximately two hours during one day. Accelerometry data was gathered over a two-week period to obtain baseline levels of upper extremity movement; eight 24-hour periods were collected. Self-efficacy was assessed eight separate times with the Brief Self Efficacy Scale (see Appendix H) on the priority benchmark goal to obtain a baseline perception of efficacy.

SAFER Home v3. The SAFER Home v3 (Chiu & Oliver, 2006) is a checklist that assesses several aspects of the home and the abilities of the person to function in their home. The SAFER Home v3 has been found to be both reliable and valid (Chiu & Oliver, 2006). Internal consistency indicates that the 97 items all contributed to the measurement of one dimension (home safety) with an Alpha value of .859 (Chiu & Oliver, 2006). Good construct or divergent validity supports the hypothesized correlation between the SAFER Home v3 and the Functional Autonomy Measurement System (SMAF) with a weak correlation which verified the presumption that the SAFER Home v3 did not simply measure functional status (Chiu & Oliver, 2006). That is, the individual's functioning plays a role in home safety but does not explain all unsafe concerns.

In TOTE Home, the participant was asked questions pertaining to each item and was sometimes asked to demonstrate ability to perform various daily tasks. Items were rated as either being no problem, minor problem, moderate problem, or severe problem. Each rating was given a score of 0, 1, 2, or 3, respectively and then totaled for an overall score. The SAFER Home v3 was only implemented at baseline, not as an outcome measure. It was intended to facilitate discussion regarding barriers in the home that affect the participant's function. This contributed to identifying tasks that were important to the participants upon which he or she wished to improve function.

Intervention

TOTE Home included a maximum of 30 sessions of training with one-on-one, therapist and participant meetings, two to three times per week, for one hour at a time. The majority of the intervention involved the participant working on goals independently outside of therapist and participant meetings. Participants were offered a mitt to wear on the less affected hand during the time outside of therapy to promote use of the more affected upper extremity. Task-specific, self-efficacy assessments were performed each week throughout the 30 sessions using the Brief Self-Efficacy Rating Scale (see Appendix H). This assessment included the priority benchmark task identified on the COPM. The quantity of movement of the participant's affected arm and hand was assessed weekly during the intervention with 24 hour accelerometry recordings. This provided an objective measure of the amount of movement of the participant's affected arm and hand while not in direct therapy. In addition, the participant rated the effectiveness of "homework" activities and the occupational therapist rated the participant's engagement in these "homework" activities (see Appendix I) each week as was assessed in Winstein et al. (2013). See descriptions of these assessments in the "Pre, Post, and Follow-up Outcome Measures" section above.

The program began with an orientation and evaluation session to accomplish the following 10 goals (Winstein et al., 2013):

- Prepare the collaborative 'real-world' task list to be used during training derived from the COPM.
- Designate a priority or benchmark task from the collaborative task list.
- Determine fundamental impairments and the priority-task challenge threshold or movement breakdown point(s).
- Prepare a collaborative schedule for the first day of training.
- Orient the participant to the mitt and its function including safety precautions.
- Identify appropriate conditions for mitt wearing and not wearing.
- Orient the participant to a recurring brief self-efficacy question.
- Orient the participant to out-of-lab "homework" activities.
- Orient the participant to his or her collaborative role with the trainer.
- Obtain the participant's agreement to be a collaborative partner.

The intervention administered during each of the training sessions was modeled after the protocol outlined in Winstein et al. (2013) however implementation was in the participant's home setting and involved tasks in the participant's real world.

Each regular training session will begin with a collaborative ordering of the real-world tasks identified during the first session (orientation and evaluation). The real world tasks may change as interests and goals evolve over each session, however the priority task may not change for benchmarking purposes. Task and movement analysis are done for each real-world task to determine the key movement dysfunctions or impairments. The goal of intervention training is to focus attention and effort directly on the problematic area (i.e. dysfunction, impairment) to facilitate skill acquisition without simply providing a compensatory strategy as an easy and quick fix to the problem.

Classic exercise-overload principles (e.g. intensity, periodicity) are used to drive progression and build motor capacity (e.g., muscular strength and endurance, coordination). Training is collaborative and interactive with the participant providing problem identification as feasible (e.g., "What is the limiting factor when you perform that task?") and solutions through self-assessment and trainer feedback/suggestions. Confidence building and empowerment are embedded in the training and education during each session.

> Individual participant-specific “homework” activities are generated and used throughout the 30 sessions. These activities encourage specific practice in the home or community settings. Examples include finding a challenging task involving food preparation or eating or reading. At the beginning of each session, participants are asked to report on and rate the effectiveness of their activities on the next day of training. The therapist will also rate the participant’s engagement in these activities (see Appendix I) (Winstein, et al., 2013, p. 10).

The manual entitled, “Upper-Extremity Task-Specific Training After Stroke or Disability” by Lang and Birkenmeier (2014) was also utilized to give a general overview of task specific training for the upper extremity and to help guide each activity the participant chose to work on. One hundred tasks are analyzed within this manual and it served as an assist to grading activities and give ideas for related tasks. For activities not included in this manual, the therapist analyzed the activity using the same format that is represented in the manual (see Appendix O). At the end of each session, a daily task-specific training summary page was completed to summarize the total number of repetitions and the total minutes on task completed (see Appendix P). This manual and the documentation forms accompanying each task assisted in standardizing the intervention and allowing for the potential of multiple therapists to administer the training in the future.

Post and Follow-Up TOTE Home Evaluations

Immediately after the intervention, baseline assessments were repeated, including measurements of the participant's upper extremity motor movement (FMA, MAL), function (FTHUE), and perception of stroke recovery (SIS) (see Appendices J, K, M, and L, respectively). The same measurements were also repeated as a follow-up assessment one month after the completion of the intervention. See descriptions of these assessments in the "Pre, Post, and Follow-up Outcome Measures" section above. These assessments were administered in approximately two hours, within one day, at each participant's home.

Accelerometry data was gathered over a two-week period immediately after and one month following completion of the intervention to assess upper extremity movement. Eight 24-hour periods were collected at each time (post-intervention and one-month follow-up). Self-efficacy was assessed eight separate times over a two-week period with the Brief Self Efficacy Scale (see Appendix H). Ratings were based on the priority benchmark task. This occurred during the post-intervention and one-month follow-up periods to assess the retention of each participant's perception of efficacy.

Statistical Analysis

Visual analysis was utilized to assess the target behavior outcomes of the study (repeated measures of participant self-efficacy ratings on a priority task and upper extremity movement as measured by accelerometry - Actigraph and FitBit). This approach focused on the clinical significance of outcomes (Portney & Watkins, 2009).

Data was recorded and organized into charts and graphs utilizing SSD for R which is a visual and statistical software package specific to single subject designs (The R Project for Statistical Computing, n.d.). Graphing results in a pictorial representation of changes in the behavior units from the onset of recording to the termination of intervention. Charting and graphing also assists in the assessment or evaluation process because data changes reveal patterns that provide valuable information concerning various factors that may have affected performance. Graphic analysis and visual inspection are the traditional analytic tools used to present and interpret the results of single-subject design research (Ottenbacher & York, 1984). This is the most often used analysis of single-subject data (Portney & Watkins, 2009).

Target behaviors of self-efficacy, and movement on FitBit and Actigraph were analyzed within-phase and between-phase (baseline, intervention, post-intervention, and 1-month follow-up) using an OLS regression method to calculate level, trend, and slope. (Auerbach & Zeitlin, 2014). Changes in level refer to the value of the dependent variable, or magnitude of performance, at the point of intervention. Trend refers to the direction of change within a phase. The slope of a trend refers to its angle, or the rate of change within the data (Portney & Watkins, 2009). A trend line (regression line) was computed in order to select the best type of analysis. The OLS regression method was used to compute a trend (regression line) for the slope of the best-fitting line within a phase. The slope is a measure of the steepness of a line; a positive or upward slope indicates an increasing trend while a negative or downward slope indicates a decreasing trend. With single-subject data, the slope is the average degree of change in the target behavior between time points (Auerbach & Zeitlin, 2014).

The change between phases was analyzed with effect size. Assessing the degree of change is the most clinically practical way to interpret this data (Ferguson, 2009). Effect size focuses on the magnitude of change between phases rather than whether differences are statistically significant (Kromrey & Foster-Johnson, 1996). The effect size, or amount of change between phases, was calculated with a g-index (Cohen, 1988). In interpreting the g-index, a higher proportion of data points above the line of focus in the intervention compared to the baseline was desirable if an increase in the target behavior was wanted. If lower scores were desirable, then a higher proportion of scores below the line would be desirable. The g-index was calculated using the proportion of scores in the desired zone, i.e., above or below the line of focus. The size of the effect was rated as small if the index was less than .3, medium if the index was .31 to .5, and large if the index was greater than .51. (See Tables 4, 6, and 8, and Figures 3-6, 9-12, and15-18.)

A supplemental inquiry of this study was the concurrent validity of the Actigraph and FitBit accelerometers. A Pearson Product Moment Correlations and paired t-tests between FitBit and Actigraph measurements allowed an analysis of the characteristics of these two accelerometers. The number of steps per day recorded by the FitBit are correlated with Actigraph recordings of steps for all phases of the study. Paired t-tests were used to determine if there was any significant difference between the FitBit and the

Actigraph. Measurements for this analysis came from participants' affected and unaffected side. This analysis assists in describing the concurrent validity of the Actigraph and FitBit. The assumption of independence may be compromised by the fact that many data points were collected repeatedly from the same participant. So, conclusions drawn are not definitive but yield a trend that will inform future studies.

Other outcome measures gathered at baseline, post-intervention, and follow-up included the COPM, FMA, MAL, SIS (stroke recovery question only) and FTHUE. Due to the small sample size, change scores were assessed and utilized to help better describe each participant and the changes that occurred during the course of this study.

The occupational therapist's field notes were analyzed for content. Themes were derived via content analysis. A cross-classification matrix was then created with all participants to create overarching typologies that appeared throughout the study.

CHAPTER IV

RESULTS

Effectiveness using the Task Oriented Training and Evaluation (TOTE Home) intervention as a task oriented training regimen was demonstrated by improvements in movement and function in the hemiparetic upper extremities for each participant in this study. Results presented in this section include a quantitative description of the participants and the TOTE Home intervention that was implemented. Comparisons are made between the Actigraph and FitBit accelerometers and between participant's affected and unaffected sides. Target behavior analysis includes descriptive statistics, OLS regression, and effect size measurement along with visual analyses of self-efficacy ratings and accelerometry recordings. Outcomes of standardized assessments at pre, post, and 1-month follow-up are included for the Canadian Occupational Performance Measure, the Fugl-Meyer Assessment for the upper extremity, the Motor Activity Log, the Stroke Impact Scale recovery question, and the Functional Test for the Hemiparetic Upper Extremity. Finally, narrative summaries from field notes describe each participant and the specific aspects of their response to the intervention.

Participant Demographics

In order to describe the participants and the intervention of this study, demographics of all participants and characteristics of the intervention are summarized in Table 1. Information about the participants gathered at the initial screening and evaluation include: gender, age, months post CVA, CVA type, living situation, dominant side, affected side, MMSE score, CESD-R score, SAFER Home v3 score, and the priority task identified.

Table 1

Participant Demographics

	Participant 1	**Participant 2**	**Participant 3**	**Participant 4**
Gender	Female	Male	Male	Female
Age (years)	86	54	61	57
Months post CVA	4.5	4.5	8	2
CVA type	Ischemic	Ischemic	Hemorrhagic	Ischemic
Living situation	Lives with family (dtr & son-in-law)	Lives with family (wife, dtr, 2 grandsons)	Lives with family (wife)	Lives alone
Dominant side	Right	Right	Right	Right
Affected side	Right	Left	Left	Right
MMSE	28	25	24	30
CESD-R	13	39	4	17
SAFER Home	9	6	6	6
Priority task identified	Brushing teeth	Buttoning shirt	Buttoning shirt	Normal right hand use in work

CVA=Cerebral Vascular Accident, MMSE=Mini Mental Status Exam, CESD-R= Center for Epidemiologic Studies Depression scale – Revised, SAFER Home v3 = Safety Assessment of Function and Environment for Rehabilitation

Four participants were enrolled, two male and two female, ranging in age from 54-86. Half of the participants were affected on their dominant side. They were all in the subacute stage of recovery, ranging from 2-8 months post stroke onset. See Table 1 for more specific demographic descriptions.

Characteristics of TOTE Home Intervention

A quantitative description of the TOTE Home intervention is included in Table 2 with specifics about activities during and in between the one-on-one therapy sessions.

Table 2

Characteristics of TOTE Home Intervention

	Participant 1	Participant 2	Participant 3	Participant 4
Total time spent in TOTE Home (hours)	28.8	32.0	30.0	16.3
Average time spent per visit in TOTE Home (minutes)	57.5	64.0	60.0	57.6
Total # of repetitions completed during TOTE Home	2,744.0	2,371.0	2,611.0	1,265.0
Average # of repetitions completed per visit during TOTE Home	91.5	79.0	87.0	74.4
Average participant ratings of effectiveness of homework activities*	2.1	2.6	3.3	3.8
Average OT ratings of participant's engagement in homework activities**	2.1	2.4	1.8	3.8

*Participants rated effectiveness of homework activities at each visit on a scale of 1=all activities ineffective to 4=all activities very effective

**OT rated participant's engagement in homework activities at each visit on a scale of 1=no effort, did not attempt to 4=great effort/engagement, apparently practiced diligently

The total amount of time participants spent in the one-on-one intervention component of TOTE Home ranged from 16.3 to 32 hours. Participants 1, 2, and 3 received all 30 visits. Participant 4 received 16 visits due to her high level of function and readiness to return to work after 16 interventions. On average, each treatment session lasted 59.8 minutes and consisted of an average of 84.8 repetitions of upper extremity movement. See Table 2 for characteristics of each participant's TOTE Home intervention.

Target Behavior Descriptive, Regression, and Effect Size Statistics for Each Participant

The target behaviors of self-efficacy ratings and upper extremity movement as measured by accelerometry recordings (by FitBit and Actigraph) were the main outcome measures to help answer the research question inquiring about the effectiveness of the TOTE Home intervention. Descriptive statistics for central tendency and variation for all phases (baseline, intervention, post-intervention, and 1-month follow-up) were produced (mean, median, and standard deviation). Median results are reported in addition to means due to many outliers in the data. (See Tables 3, 5, and 7, and Figures 1, 7, and 13.)

A line graph was plotted to visually analyze each target behavior: repeated measures of participant self-efficacy ratings on a priority task and upper extremity movement as measured by accelerometry - Actigraph and FitBit. An OLS regression method was used to calculate level, trend, and slope of target behaviors of self-efficacy and movement on FitBit and Actigraph both within-phase and between-phase (baseline, intervention, post-intervention, and 1-month follow-up) (Auerbach & Zeitlin, 2014). Each phase was assessed for trends in the data. In this study, the regression line estimates the effect of the TOTE on the change in self-efficacy, and movement measured by the FITBIT and Actigraph (see Tables 4, 6, and 8, and Figures 2, 8, and 14). The change between phases was analyzed with effect size with a g-index (Cohen, 1988). The following will describe the results for the analysis of data for ratings of self-efficacy, FitBit steps and Actigraph steps.

Self-Efficacy Ratings of Priority Task

As one of the assessments of the effectiveness of the TOTE Home intervention, each participant rated their level of confidence (on a scale from 0 – no confidence, to 10 – complete confidence) on a priority task that remained the same throughout the study. Participants made this rating daily for 8 days at baseline, post-intervention, and at follow-up, as well as once weekly during the intervention. See Table 3 for descriptive statistics, Figure 1 for a visual analysis of the ratings, Table 4 for the OLS regression, Figure 2 for a visual analysis of the OLS regression, and Figures 3-6 for visual analysis of G Index comparisons between baseline and intervention, baseline and post-intervention, baseline and follow-up for Participant 1, Participant 2, Participant 3, and Participant 4, respectively.

Participant 1 exhibited the greatest change in rating her confidence of performing her priority task of brushing her teeth as evidenced by the large effect size calculated between all stages of the study. She rated herself very low at baseline, steadily improved during the TOTE Home intervention and post-evaluation, and reached almost complete confidence at the 1-month follow-up. Participant 2 demonstrated an improvement in his confidence to button his shirt as compared to his baseline ratings and mostly maintained that same amount of confidence throughout the study. Participant 3 rated increased confidence in buttoning his shirt throughout the TOTE Home intervention with some improvement and maintenance of performance at post-evaluation and 1-month follow-up. Both Participants 2 and 3 had medium effect sizes for their changes in confidence levels. Even though Participant 4 started the study at a higher level of function and confidence, she showed significant improvements by rating herself with complete confidence at post-evaluation and 1-month follow-up with a large effect size.

Table 3

Self-Efficacy Ratings of Priority Task – Descriptive Statistics

	Participants			
	1	**2**	**3**	**4**
Mean *(SD)*				
Baseline	0.0 *(0.0)*	2.50 *(.54)*	3.5 *(0.54)*	^6 *(na)*
Intervention	5.41 *(2.4)*	4.05 *(.99)*	5.3 *(1.24)*	^^^8.2 *(0.8)*
Post-Intervention	7.38 *(0.5)*	3.88 *(.84)*	7.5 *(0.54)*	10.0 *(0.0)*
Follow-up	9 *(0.0)*	4.00 *(.54)*	7.6 *(1.19)*	10.0 *(0.0)*
Median				
Baseline	0	2.5	3.5	^6
Intervention	6	4.0	5.5	^^^8
Post-Intervention	7	4.0	7.5	10
Follow-up	9	4.0	8.0	10

^Data collected one day, not repeated
^^^Only 6 days of measurements were accrued

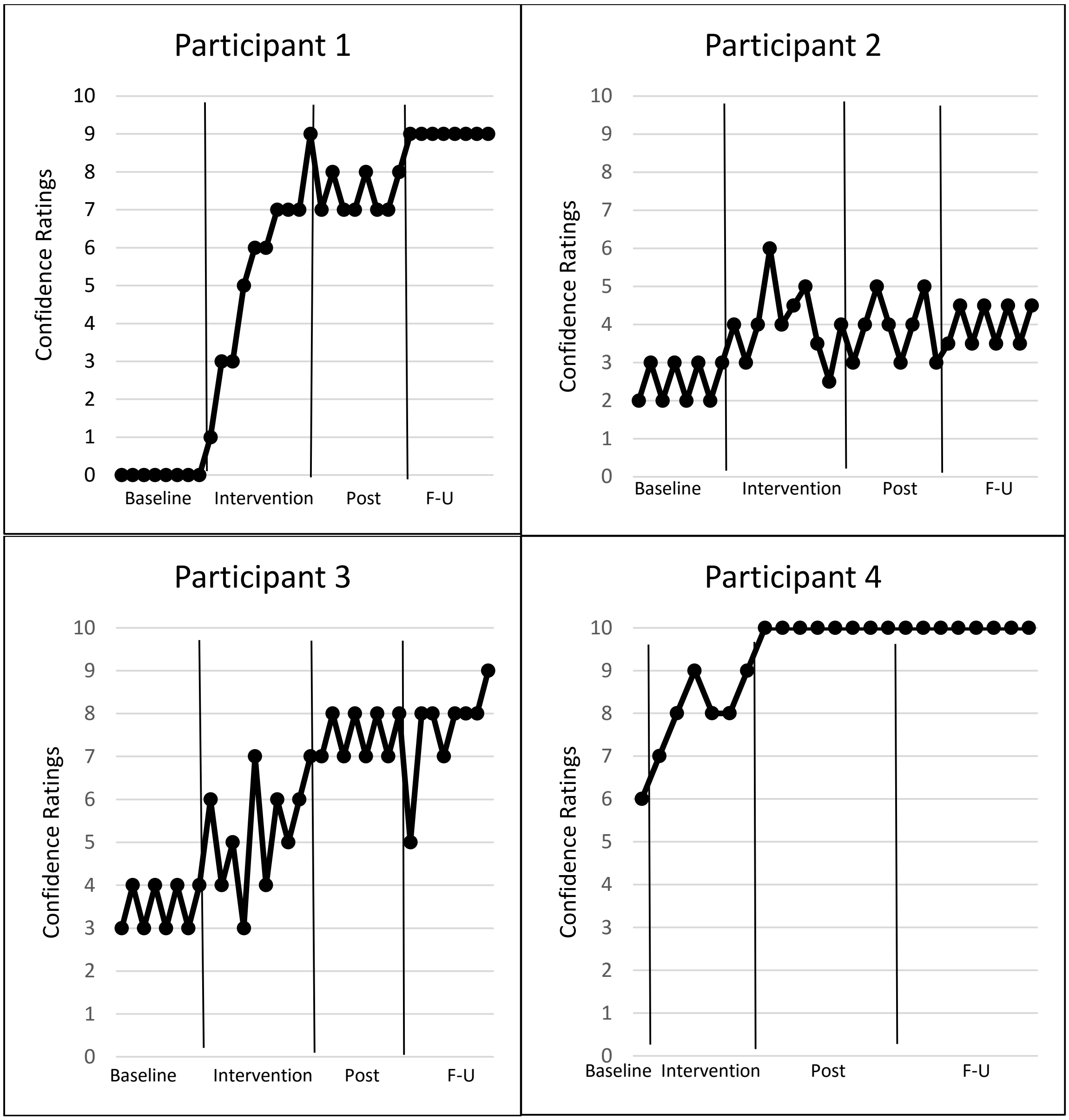


Figure 1. Self-efficacy ratings of priority task – descriptive visual analysis.

Table 4

Self-Efficacy Ratings of Priority Task – OLS Regression

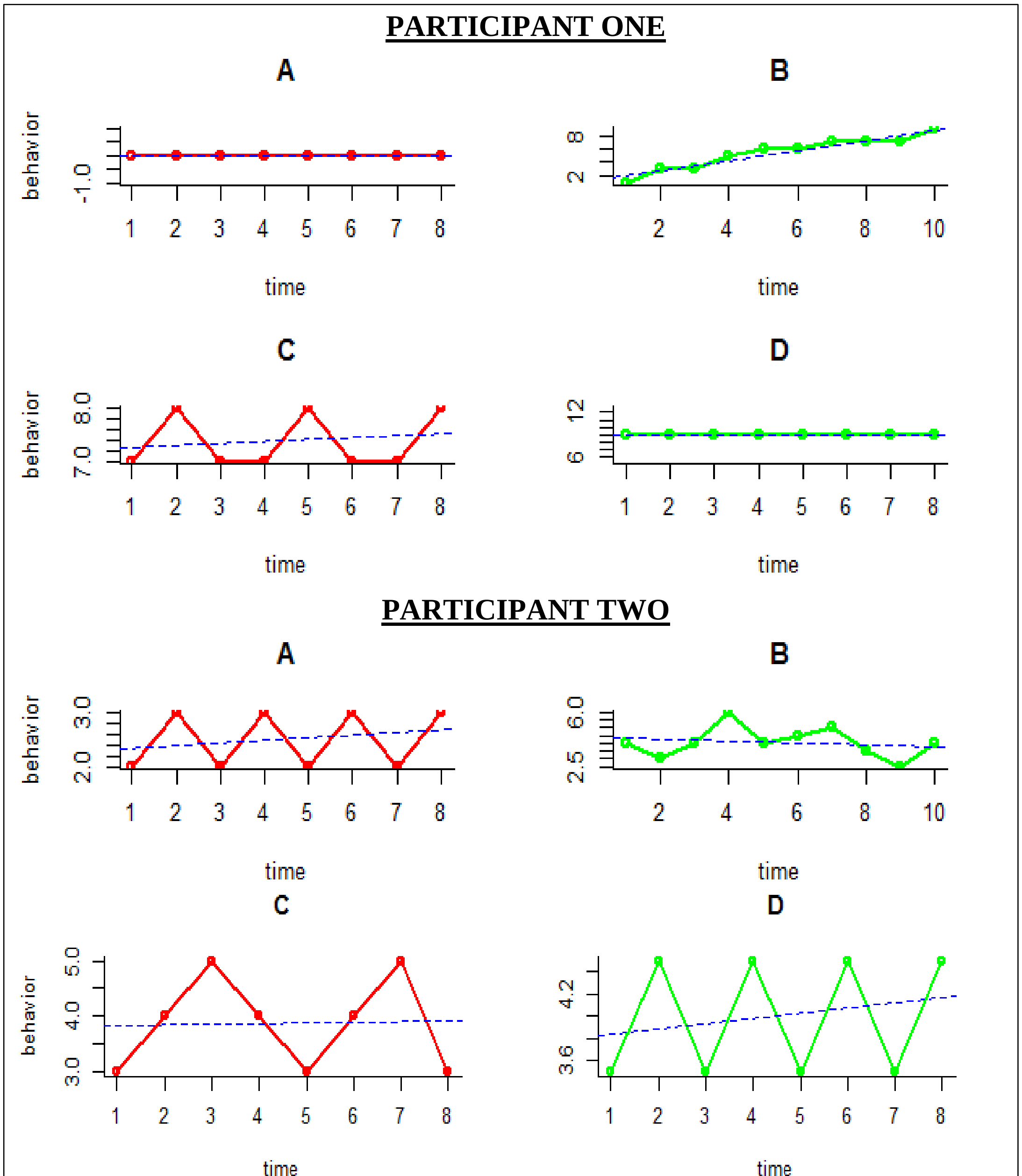
	Participants			
	1	**2**	**3**	**4**
Slope				
Baseline	0.00	0.05	0.05	$^{\wedge}$na
Intervention	0.76	-0.05	0.18	$^{\wedge\wedge\wedge}$0.26
Post-Intervention	0.04	0.01	0.05	0.00
Follow-up	0.00	0.05	0.35	0.00
Multiple R-squared				
Baseline	na	0.05	0.05	$^{\wedge}$na
Intervention	0.92^{***}	0.03	0.16	$^{\wedge\wedge\wedge}$0.41
Post-Intervention	0.03	0.00	0.05	Perfect fit
Follow-up	0.56^{**}	0.05	0.51^{*}	Perfect fit
G-index				
Baseline	na	na	na	na
Intervention	1^{+++}	0.4^{++}	0.4^{++}	1^{+++}
Post-Intervention	1^{+++}	0.5^{++}	0.5^{++}	1^{+++}
Follow-up	1^{+++}	0.5^{++}	0.5^{++}	1^{+++}

$^{+}$Small effect size = <.3, $^{++}$Medium effect size = .31 - .5, $^{+++}$Large effect size = >.51

$^{\wedge}$Data collected one day, not repeated

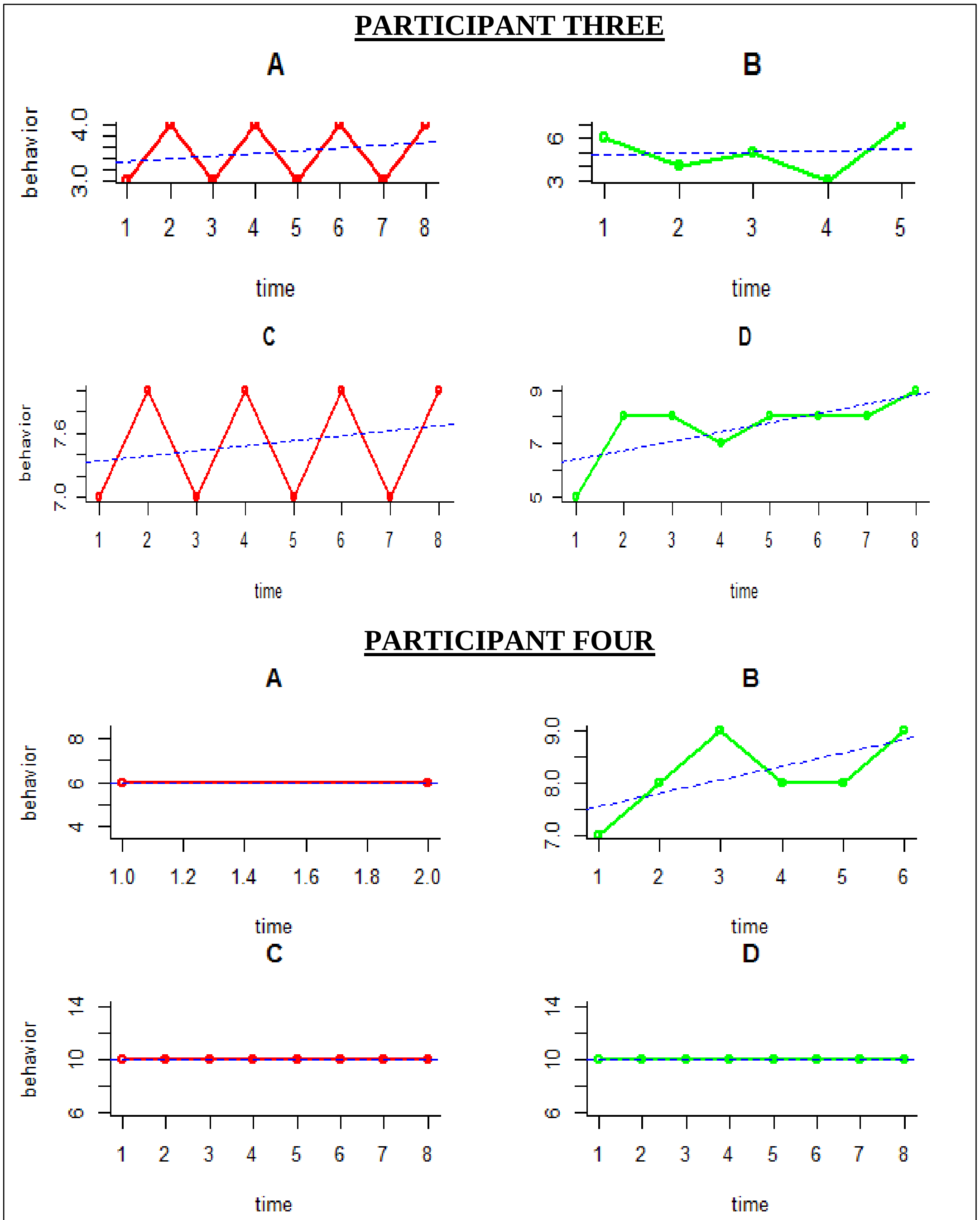
$^{\wedge\wedge\wedge}$Only 6 days of measurements were accrued

*p<.05, **p<.01, ***p<.001



Behavior = Self-efficacy ratings. Time = Days of data collection.
A = Baseline, B = TOTE Home, C = Post-evaluation, D = 1-month follow-up eval

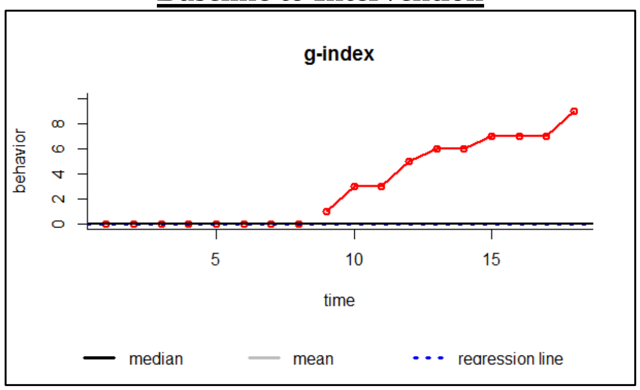
Figure 2. Self-efficacy ratings of priority task – OLS regression visual analysis.



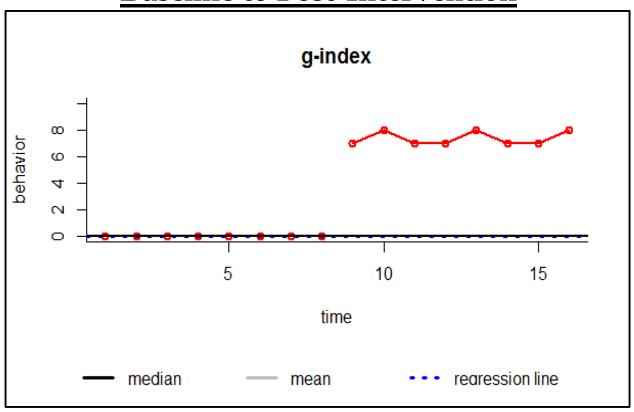
Behavior = Self-efficacy ratings. Time = Days of data collection.
A = Baseline, B = TOTE Home, C = Post-evaluation, D = 1-month follow-up eval

Figure 2. Continued.

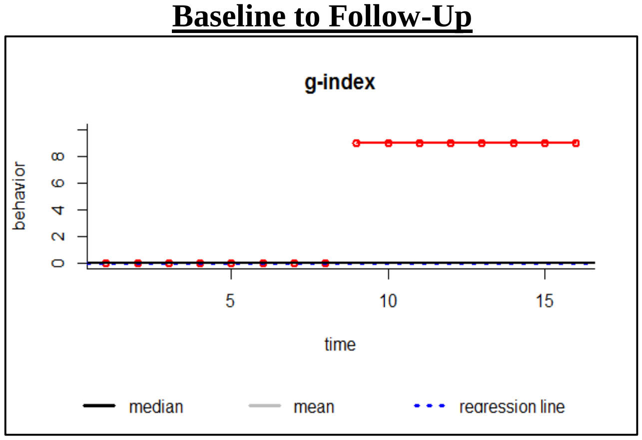
Baseline to Intervention



Baseline to Post-Intervention



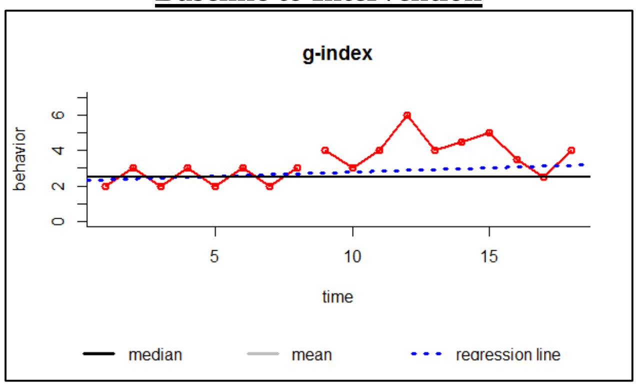
Baseline to Follow-Up



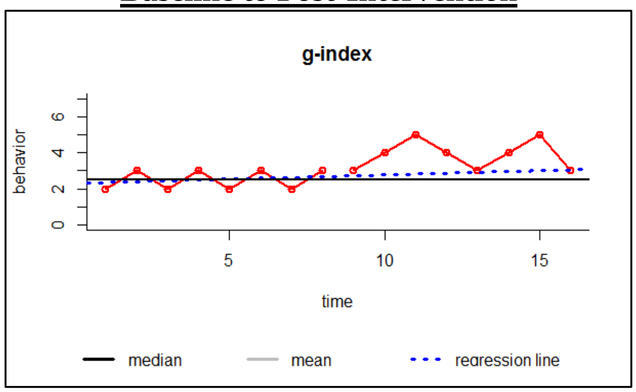
Behavior = Self-efficacy ratings. Time = Days of data collection.

Figure 3. Participant one: g index comparisons - self-efficacy ratings of priority task.

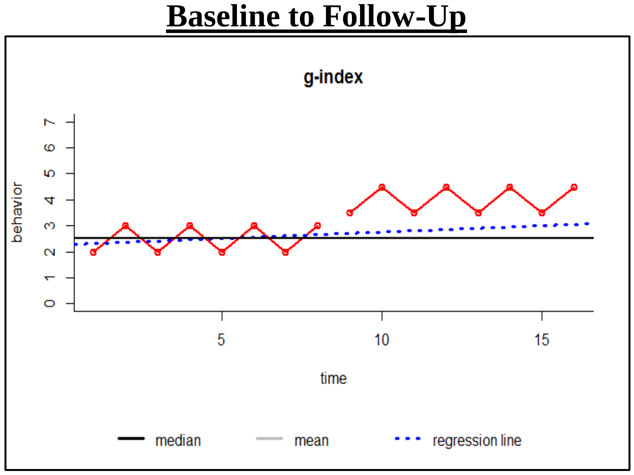
Baseline to Intervention



Baseline to Post-Intervention



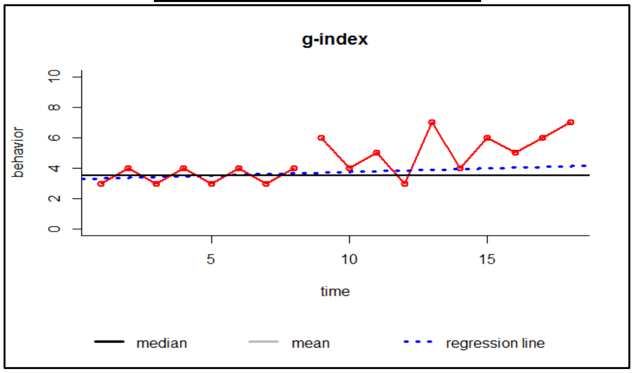
Baseline to Follow-Up



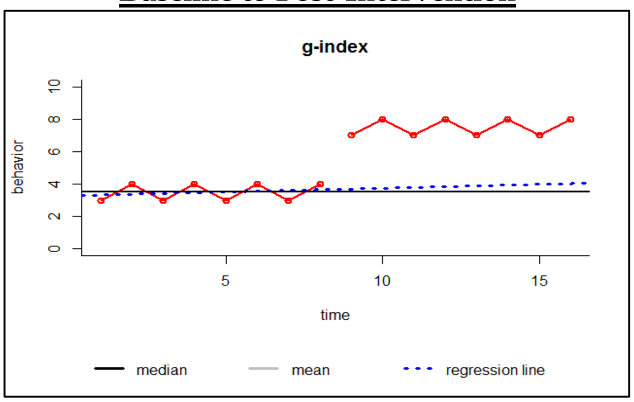
Behavior = Self-efficacy ratings. Time = Days of data collection.

Figure 4. Participant two: g index comparisons - self-efficacy ratings of priority task.

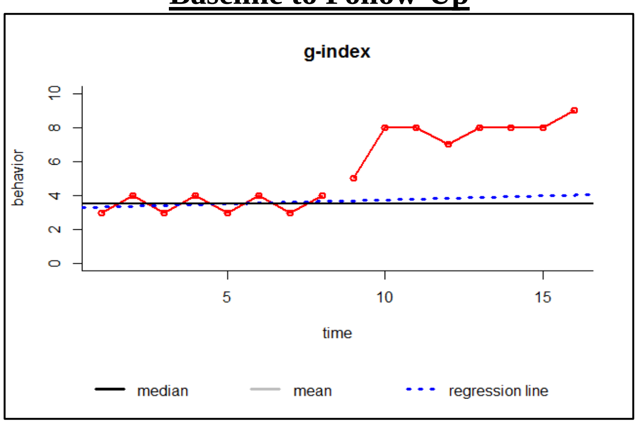
Baseline to Intervention



Baseline to Post-Intervention



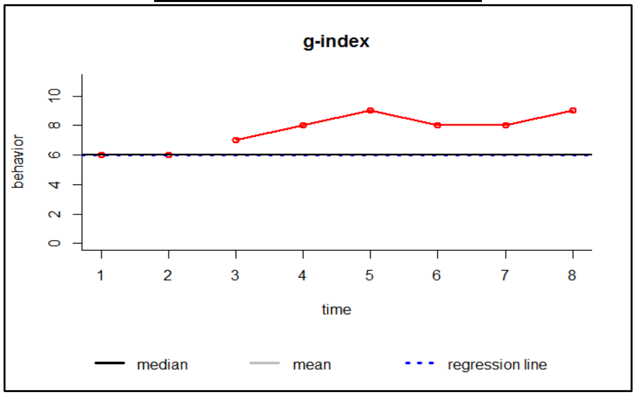
Baseline to Follow-Up



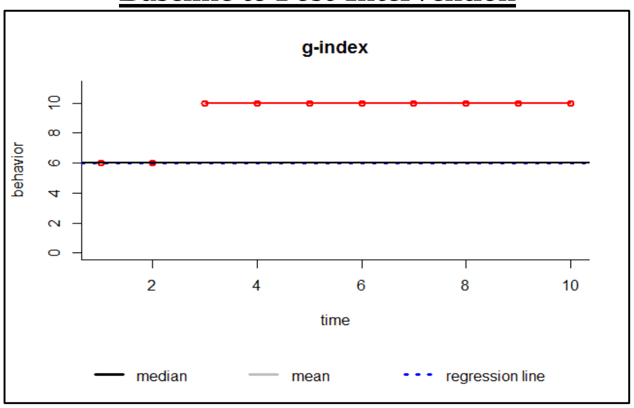
Behavior = Self-efficacy ratings. Time = Days of data collection.

Figure 5. Participant three: g index comparisons - self-efficacy ratings of priority task.

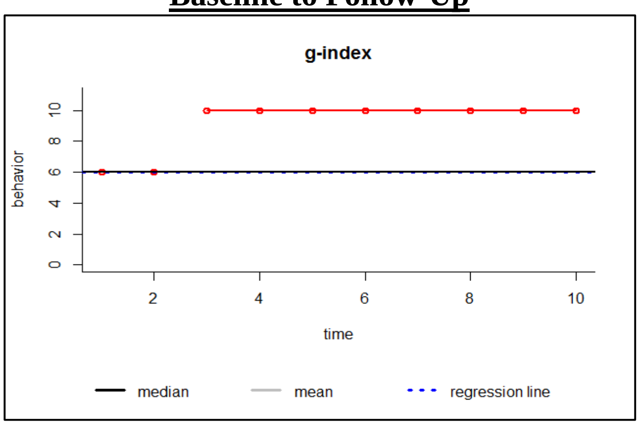
Baseline to Intervention



Baseline to Post-Intervention



Baseline to Follow-Up



Behavior = Self-efficacy ratings. Time = Days of data collection.

Figure 6. Participant four: g index comparisons - self-efficacy ratings of priority task.

Fitbit and Actigraph Steps

Each participant wore a FitBit and an Actigraph on both wrists for 8 days at baseline, post-intervention, and at follow-up, as well as once weekly, for 24 hours, during the intervention. Number of steps per day were analyzed. For the FitBit data, see Table 5 for descriptive statistics, Figure 7 for a visual analysis of the number of steps, Table 6 for the OLS regression, Figure 8 for a visual analysis of the OLS regression, and Figures 9-12 for visual analysis of G Index comparisons between baseline and intervention, baseline and post-intervention, baseline and follow-up for Participant 1, Participant 2, Participant 3, and Participant 4, respectively. For the Actigraph data, see Table 7 for descriptive statistics, Figure 13 for a visual analysis of the number of steps, Table 8 for the OLS regression, Figure 14 for a visual analysis of the OLS regression, and Figures 15-18 for visual analysis of G Index comparisons between baseline and intervention, baseline and post-intervention, baseline and follow-up for Participant 1, Participant 2, Participant 3, and Participant 4, respectively.

The amounts of movement varied for each participant over the course of the study. Effect size was small to medium when compared to baseline for both devices. Participant 1 had the biggest improvement at her 1-month follow-up as evidenced with FitBit measurements. Actigraph, however, recorded improvements in her movements starting with the TOTE Home intervention and a maintenance of this improvement throughout the rest of the study. Participant 2's data should be analyzed with caution. His ataxic movements confounded the quantitative assessment of arm motor movement. It is difficult to determine through accelerometry if a change in his motor activity was due to a change in his ataxia or due to intentional, purposeful movements. Participant 3 improved the most at his post-evaluation and maintained improvements at his 1-month follow-up as evidence through both the FitBit and Actigraph measurements. Participant 4 had a marked increase in UE movement during the TOTE Home intervention and maintained this improvement throughout post-evaluation and 1-month follow-up as evidenced through both the FitBit and Actigraph measurements. Participants 3 and 4 both chose activities that were more physically demanding than Participant 1 and thus demonstrated improvements in accelerometry.

Table 5
FitBit Steps – Descriptive Statistics

	Participants			
	1	**2**	**3**	**4**
Mean (*SD*)				
Baseline	141.5 *(248.2)*	20,713.4 *(4,302.6)*	845.6 *(394.8)*	3,460.8 *(3608.5)*
Intervention	51.1 *(58.5)*	^ 41,063.1 *(19,770.2)*	1,081.6 *(1,027.8)*	^^^5,565.5 *(2,918.1)*
Post-Intervention	78.9 *(128.2)*	^^ 34,169.3 *(13,655.3)*	1,3660.0 *(464.5)*	5,397.13 *(2,691.7)*
Follow-up	301.8 *(353.1)*	37,526.0 *(11,720.4)*	1,700.4 *(838.0)*	8,056.0 *(3,351.4)*
Median				
Baseline	16.5	21,719	854	1,255.6
Intervention	28.0	^44,143	662	^^^4,610.5
Post-Intervention	20.5	^^32,732	1,349	5,302.0
Follow-up	214.5	37,694	1,501	8,736.5

^Only 9 days of measurements were accrued due to equipment malfunction
^^Only 7 days of measurements were accrued due to equipment malfunction
^^^Only 6 days of measurements were accrued

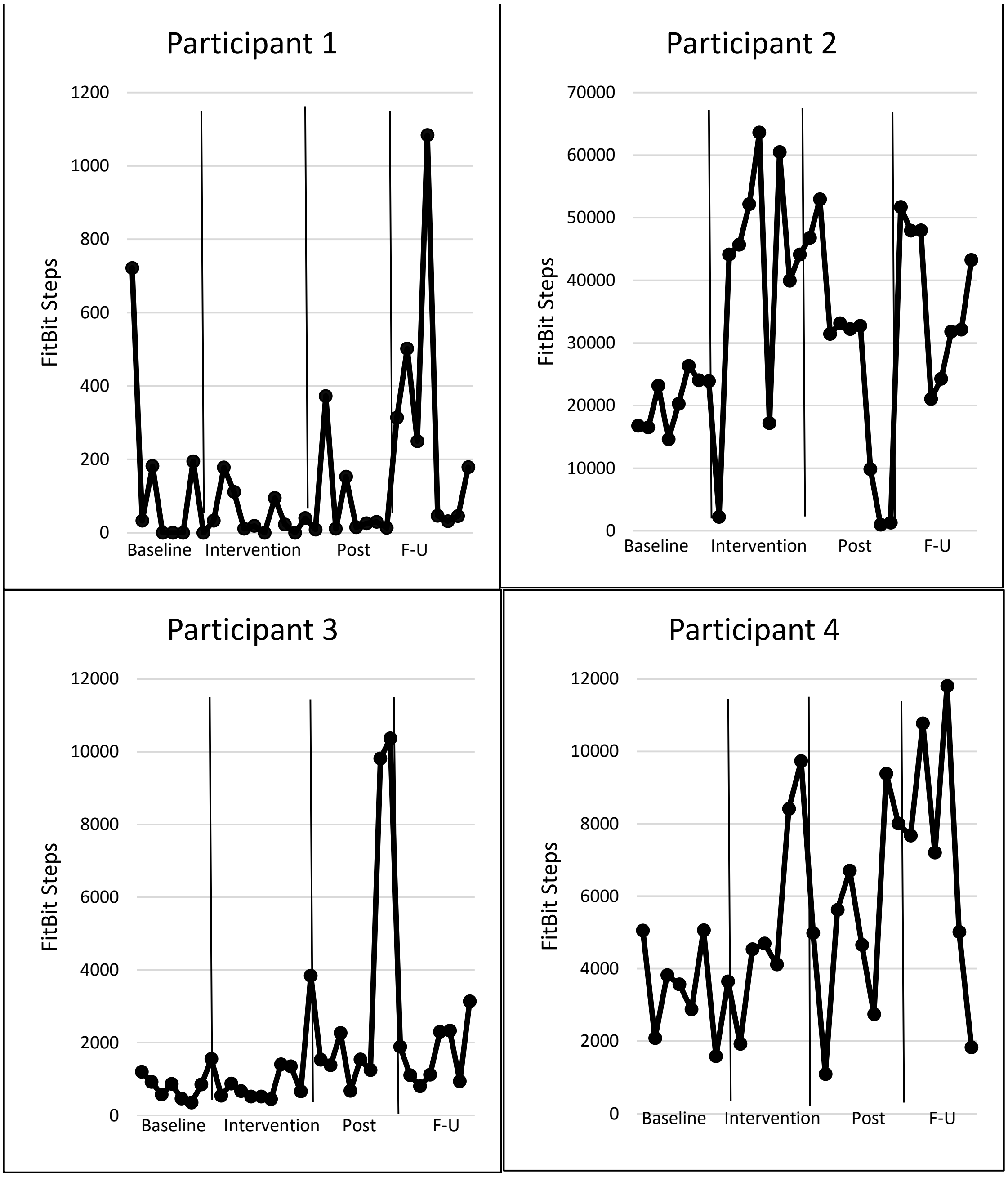


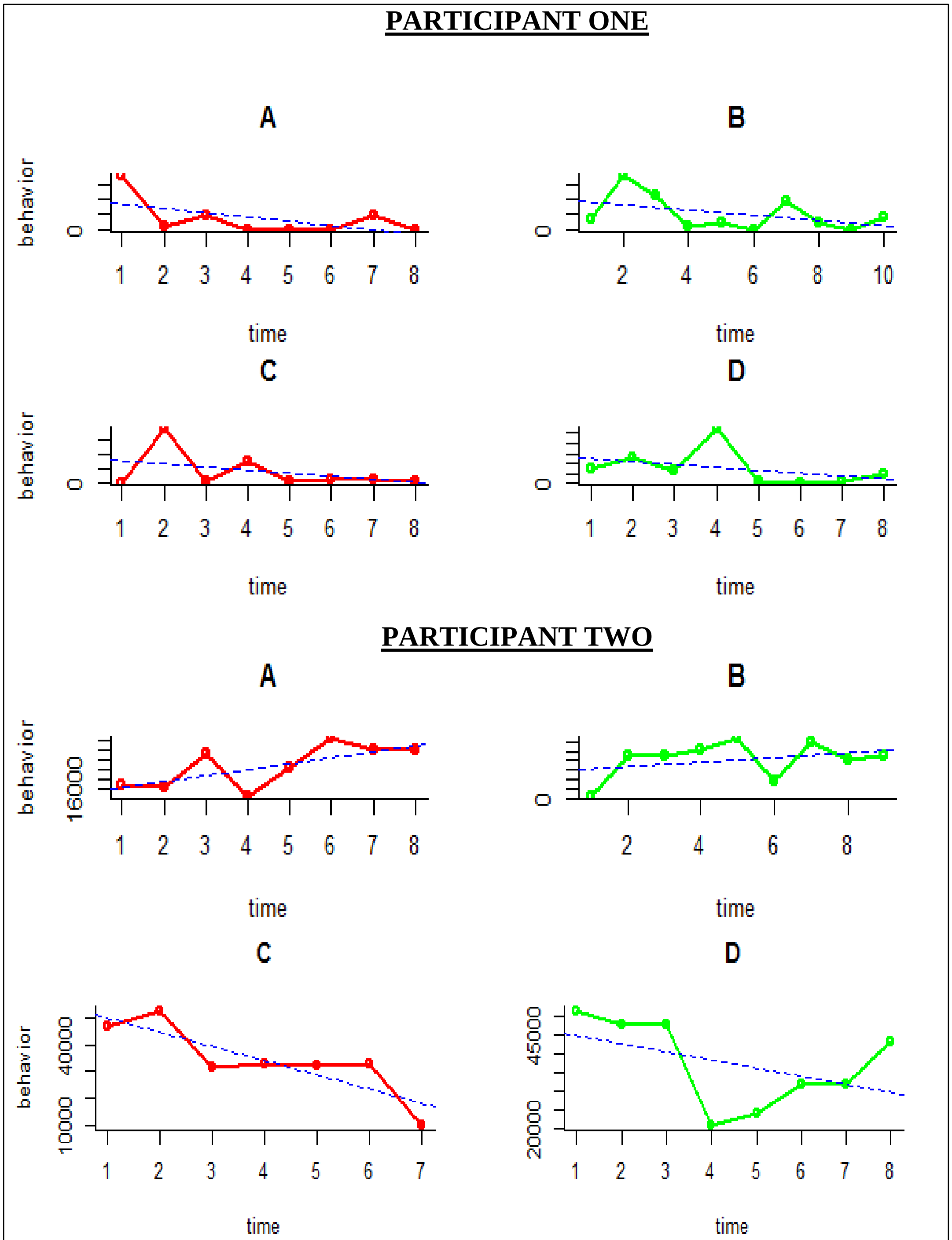
Figure 7. FitBit steps – descriptive visual analysis.

Table 6

FitBit Steps – OLS Regression

	Participants			
	1	**2**	**3**	**4**
Slope				
Baseline	-57.02	1,223	12.54	-110.4
Intervention	-8.46	[^]2,492	206.82	[^^^]1,429.9
Post-Intervention	-21.11	[^^]-5,376	-67.79	618.0
Follow-up	-58.52	-2,186	162.70	-795.1
Multiple R-squared				
Baseline	0.32	0.49*	0.01	0.05
Intervention	0.19*	[^]0.12	0.37	[^^^]0.84**
Post-Intervention	0.02*	[^^]0.72*	0.13	0.32
Follow-up	0.02	0.21	0.23	0.34
G-index				
Baseline	na	na	na	na
Intervention	0.20[+]	0.28[+]	-0.10[+]	0.33
Post-Intervention	0.00[+]	0.36[++]	0.38[++]	0.25[+]
Follow-up	0.50[++]	0.38[++]	0.38[++]	0.38[++]

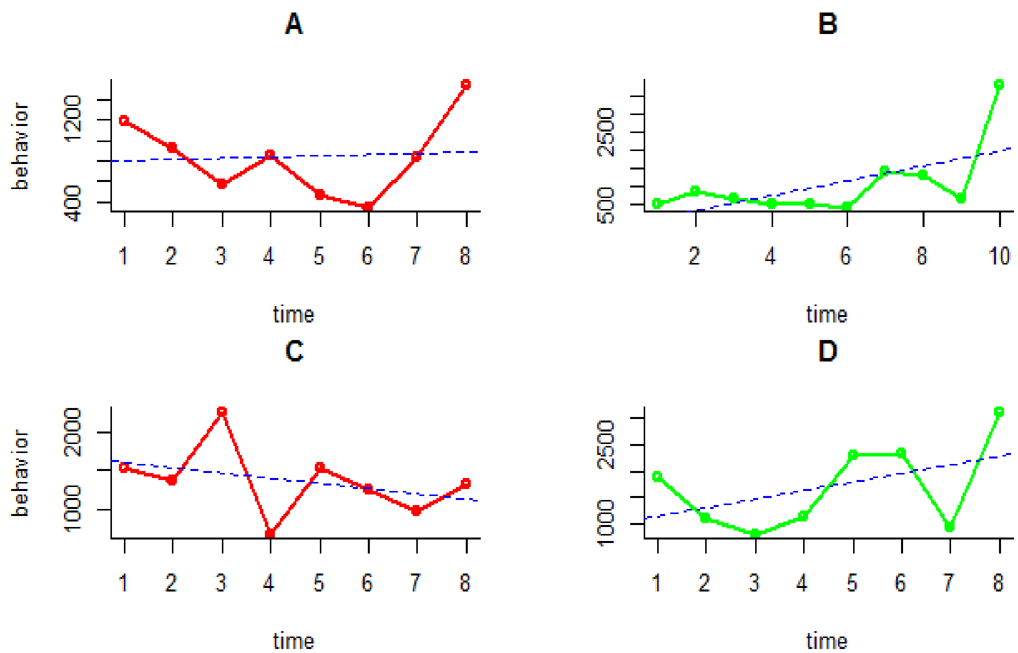
[+]Small effect size = <.3, [++]Medium effect size = .31 - .5, [+++]Large effect size = >.51
[^]Only 9 days of measurements were accrued due to equipment malfunction
[^^]Only 7 days of measurements were accrued due to equipment malfunction
[^^^]Only 6 days of measurements were accrued
*p<.05, ** p<.01, ***p<.001



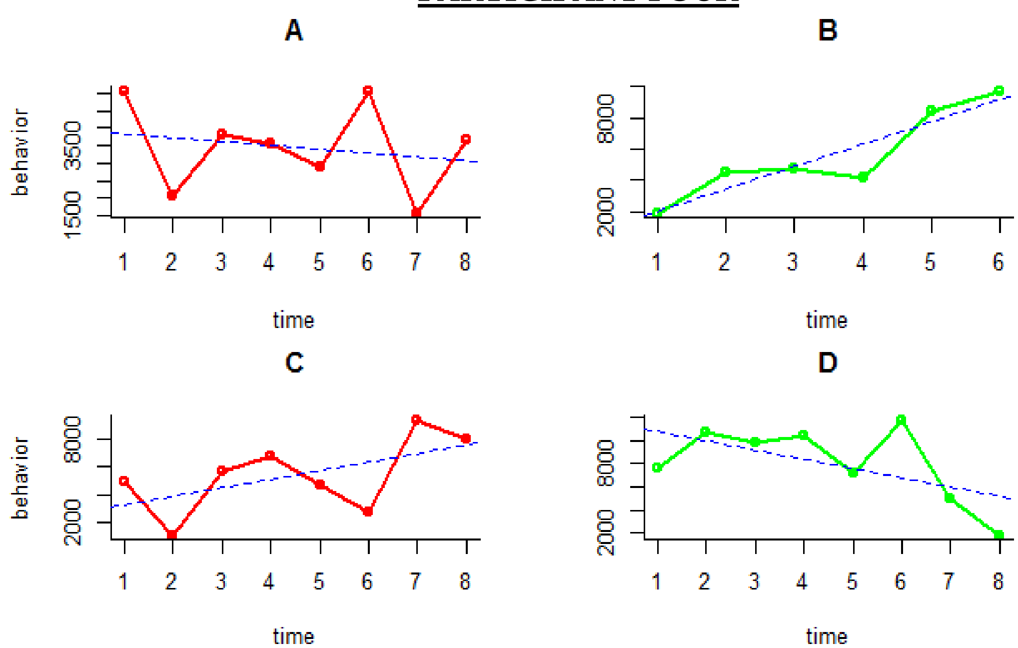
Behavior = FitBit steps. Time = Days of data collection.
A = Baseline, B = TOTE Home, C = Post-evaluation, D = 1-month follow-up eval

Figure 8. FitBit steps – OLS regression visual analysis.

PARTICIPANT THREE



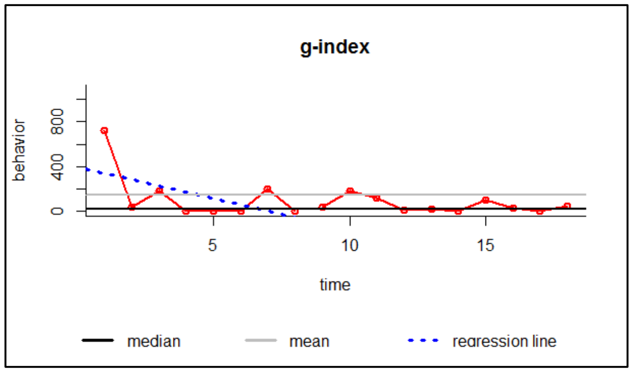
PARTICIPANT FOUR



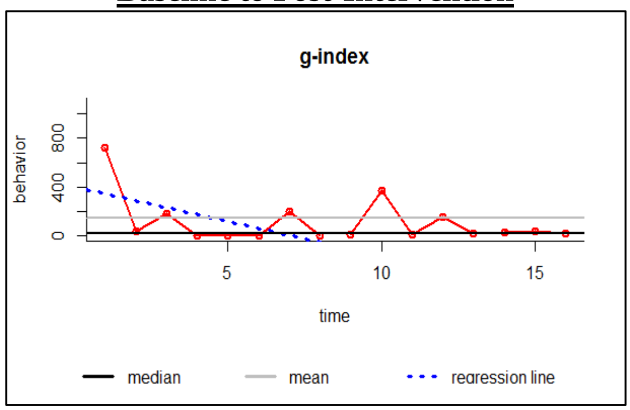
Behavior = FitBit steps. Time = Days of data collection.
A = Baseline, B = TOTE Home, C = Post-evaluation, D = 1-month follow-up eval

Figure 8. Continued.

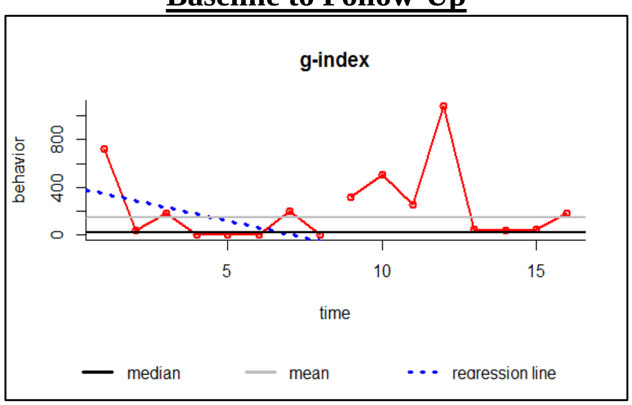
Baseline to Intervention



Baseline to Post-Intervention



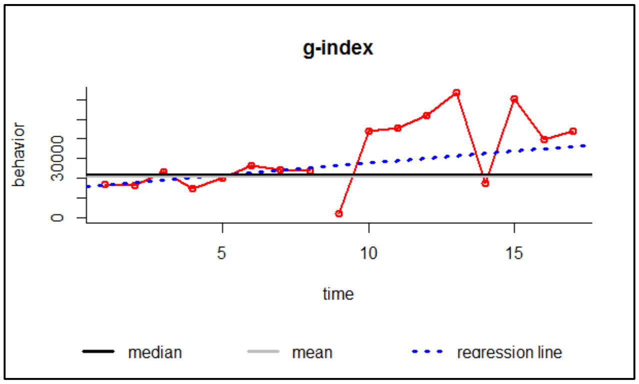
Baseline to Follow-Up



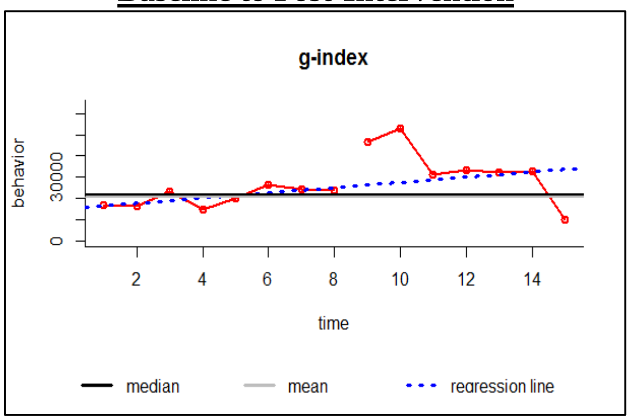
Behavior = FitBit steps. Time = Days of data collection.

Figure 9. Participant one: g index comparisons – fitbit steps.

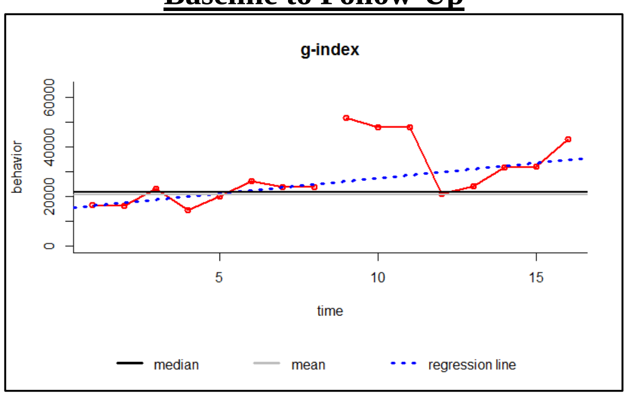
Baseline to Intervention



Baseline to Post-Intervention



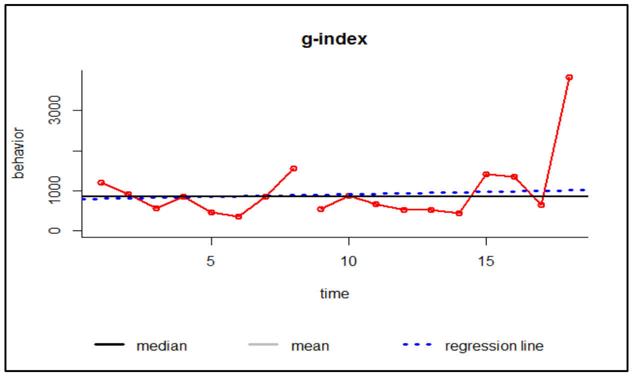
Baseline to Follow-Up



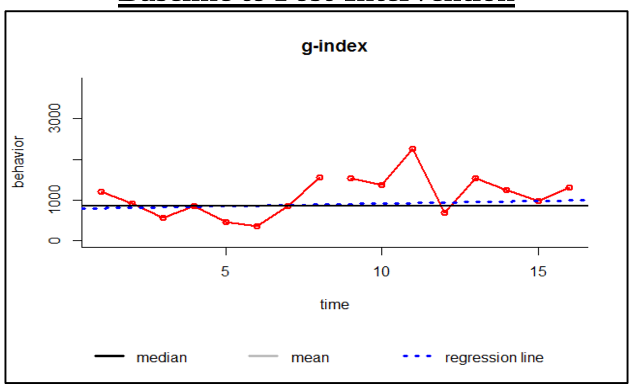
Behavior = FitBit steps. Time = Days of data collection.

Figure 10. Participant two: g index comparisons – fitbit steps.

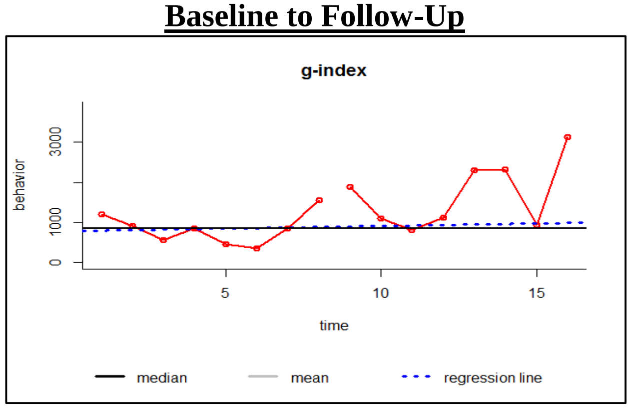
Baseline to Intervention



Baseline to Post-Intervention



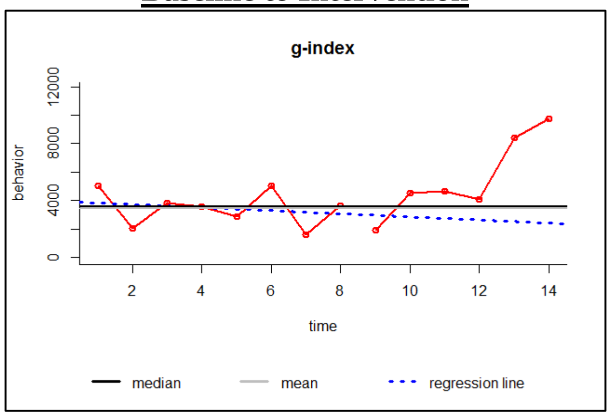
Baseline to Follow-Up



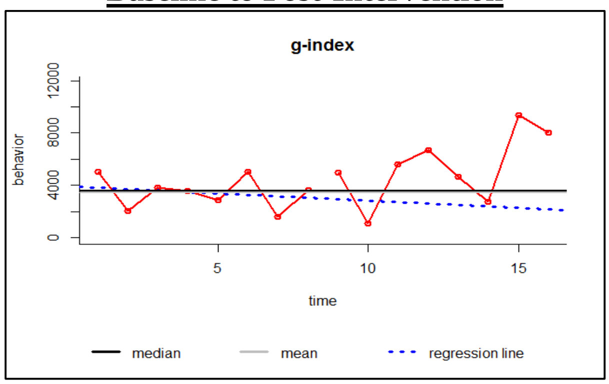
Behavior = FitBit steps. Time = Days of data collection.

Figure 11. Participant three: g index comparisons – fitbit steps.

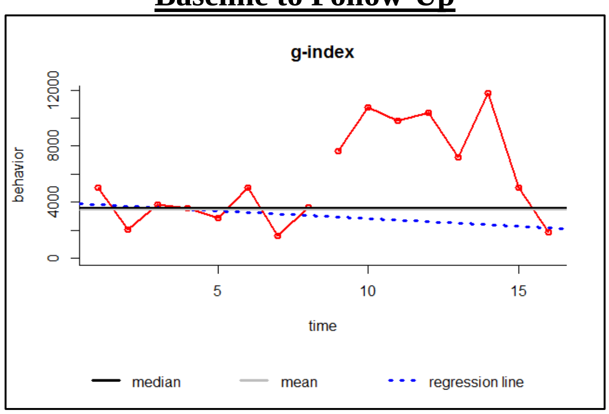
Baseline to Intervention



Baseline to Post-Intervention



Baseline to Follow-Up



Behavior = FitBit steps. Time = Days of data collection.

Figure 12. Participant four: g index comparisons – fitbit steps.

Table 7

Actigraph Steps – Descriptive Statistics

	Participants			
	1	**2**	**3**	**4***
Mean (*SD*)				
Baseline	7,350.5	51,615.5	9,989.6	17,999.3
	(1,951.9)	*(5,626.2)*	*(1,973.3)*	*(5,686.7)*
Intervention	10,768.1	61,870.2	8,773.9	^^^25,463.3
	(2,661.3)	*(17,322.6)*	*(3,337.6)*	*(6,415.0)*
Post-Intervention	11,670.8	20,759.9	12,321.6	24,663.9
	(2,475.2)	*(5,960.2)*	*(1,800.0)*	*(5,589.6)*
Follow-up	^11,884.7	54,622.4	14,193.6	23,077.0
	(2,158.7)	*(11,007.7)*	*(2,908.4)*	*(6,008.3)*
Median				
Baseline	7,069.5	50,582.5	9,749.0	19,396.0
Intervention	11,163.0	63,465.5	9,003.5	^^^26,779.5
Post-Intervention	10,994.0	18,554.0	12,068.5	23,874.5
Follow-up	^11,018.0	55,897.0	14,127.5	25,057.5

^Only 3 days of measurements were accrued due to equipment malfunction
^^^Only 6 days of measurements were accrued

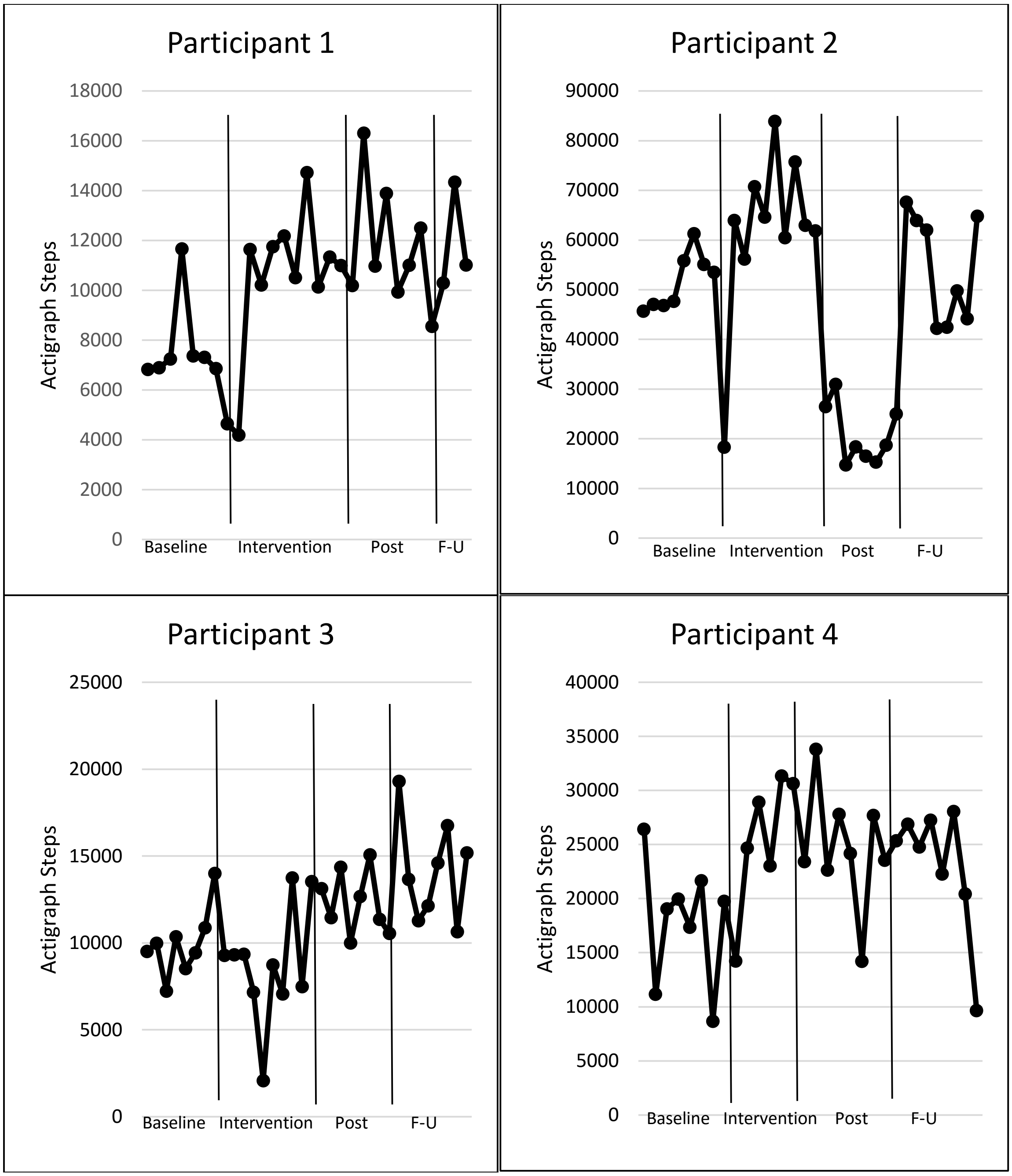


Figure 13. Actigraph steps – descriptive visual analysis.

Table 8

Actigraph Steps – OLS Regression

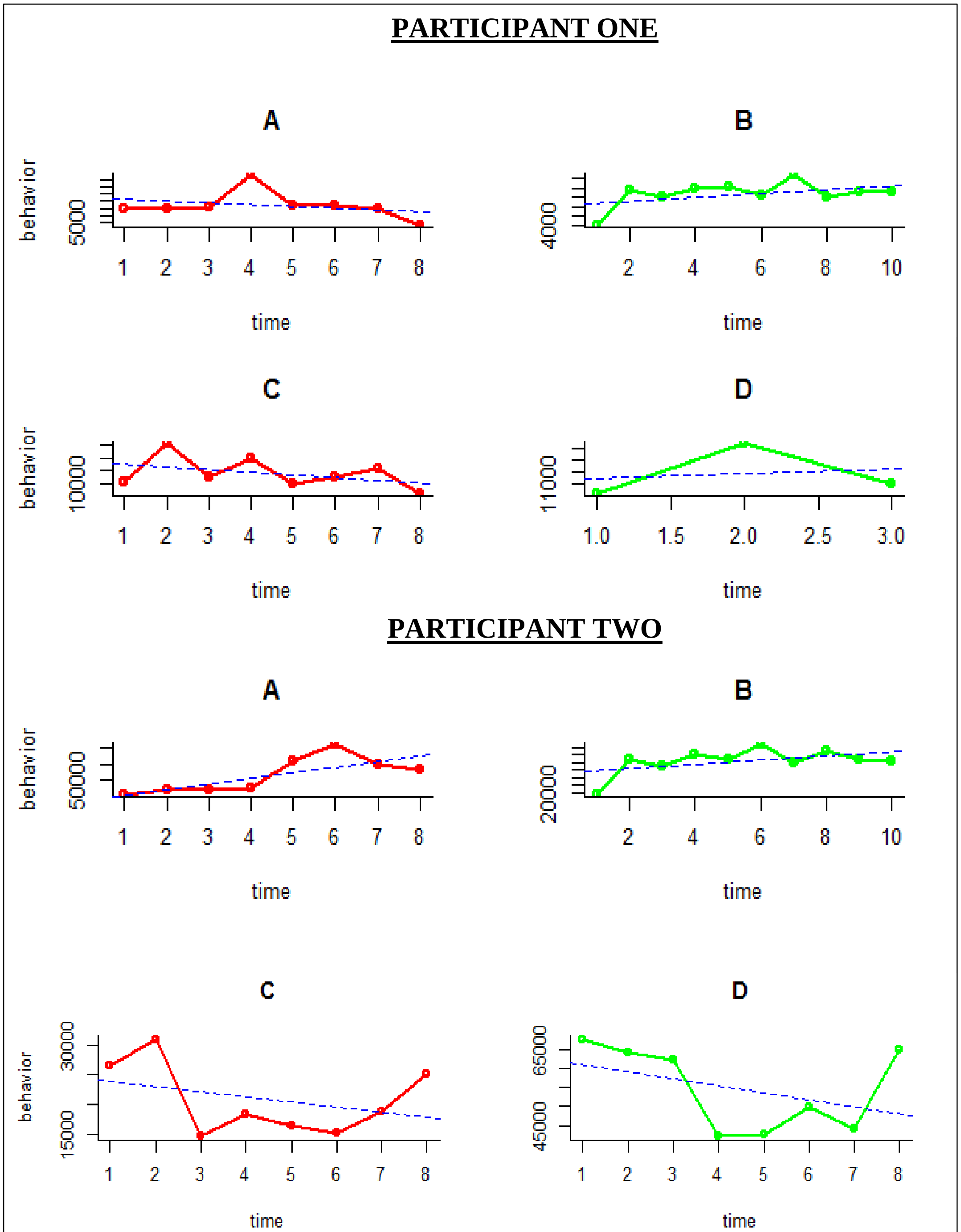
	Participants			
	1	**2**	**3**	**4**
Slope				
Baseline	-233.1	1744.9	483.2	-641.8
Intervention	399.5	2,858.0	325.8	[^^^]2,748.0
Post-Intervention	-409.1	-856.4	-163.1	-696.7
Follow-up	[^]362.0	-1,850.0	-298.0	-1,635.1
Multiple R-squared				
Baseline	0.08557	0.5771*	0.35970	0.0764
Intervention	0.20660	0.2496	0.08732	[^^^]0.6423*
Post-Intervention	0.16390	0.1239	0.04928	0.0932
Follow-up	[^]0.02812	0.1695	0.06297	0.4444
G-index				
Baseline	na	na	na	na
Intervention	0.4[++]	0.4[++]	-0.3	0.3[++]
Post-Intervention	0.5[++]	-0.5[+]	0.5[++]	0.4[++]
Follow-up	0.5[++]	0.0	0.5[++]	0.4[++]

[+]Small effect size = <.3, [++]Medium effect size = .31 - .5, [+++]Large effect size = >.51

[^]Only 3 days of measurements were accrued due to equipment malfunction

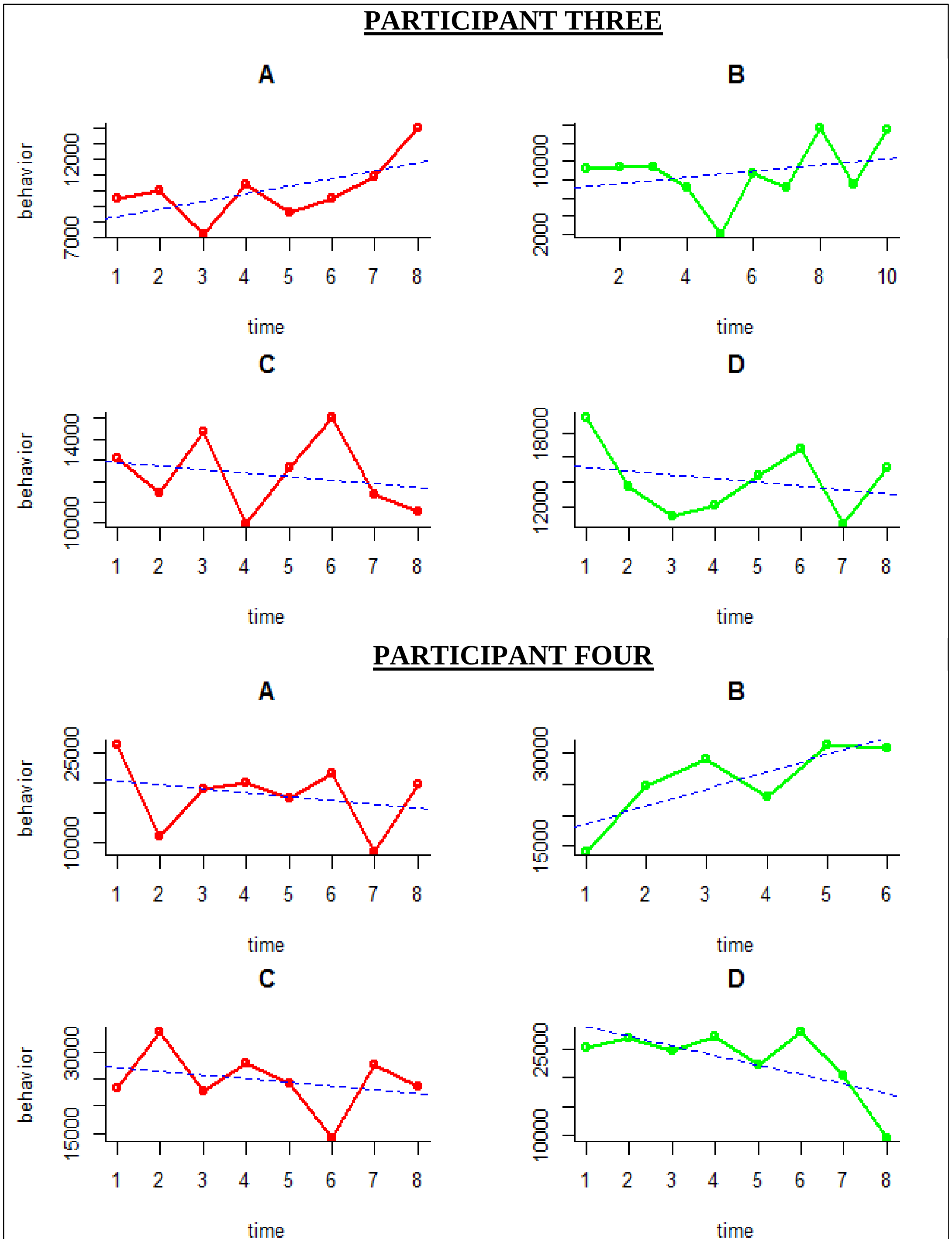
[^^^]Only 6 days of measurements were accrued

*p<.05, **p<.01, ***p<.001



Behavior = Actigraph steps. Time = Days of data collection.
A = Baseline, B = TOTE Home, C = Post-evaluation, D = 1-month follow-up eval

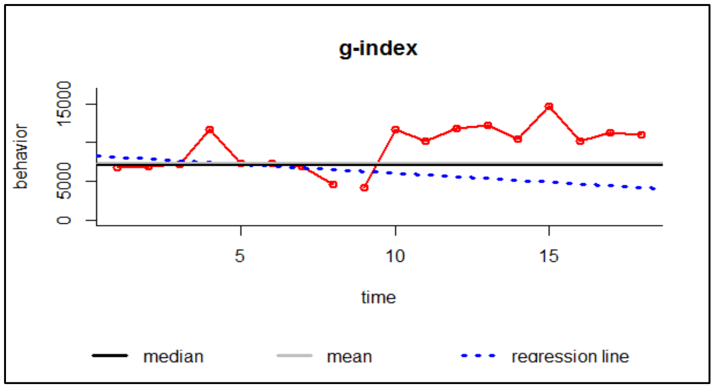
Figure 14. Actigraph steps – OLS regression visual analysis.



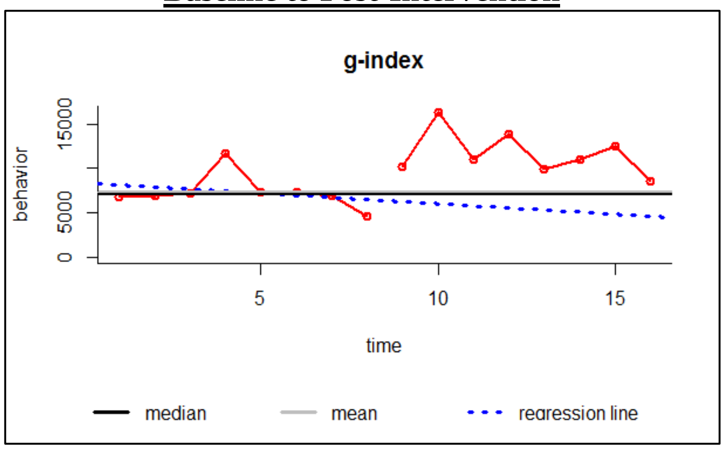
Behavior = Actigraph steps. Time = Days of data collection.
A = Baseline, B = TOTE Home, C = Post-evaluation, D = 1-month follow-up eval

Figure 14. Continued.

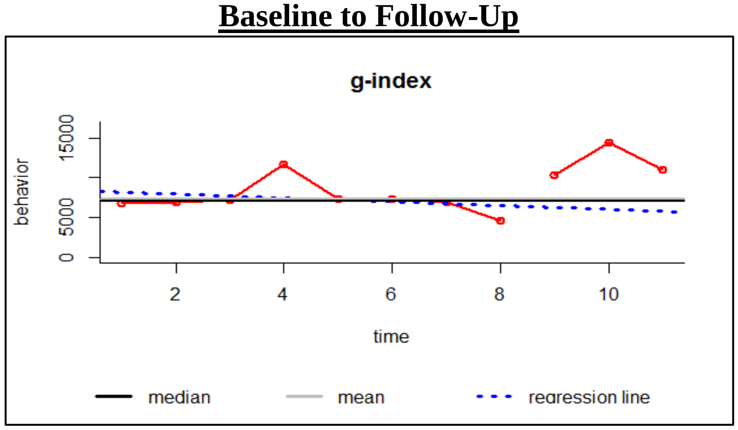
Baseline to Intervention



Baseline to Post-Intervention



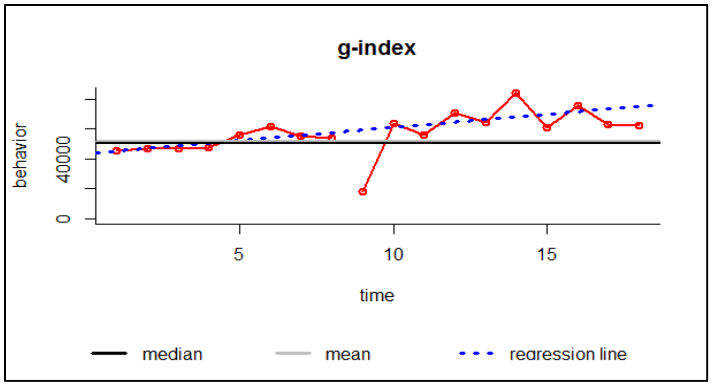
Baseline to Follow-Up



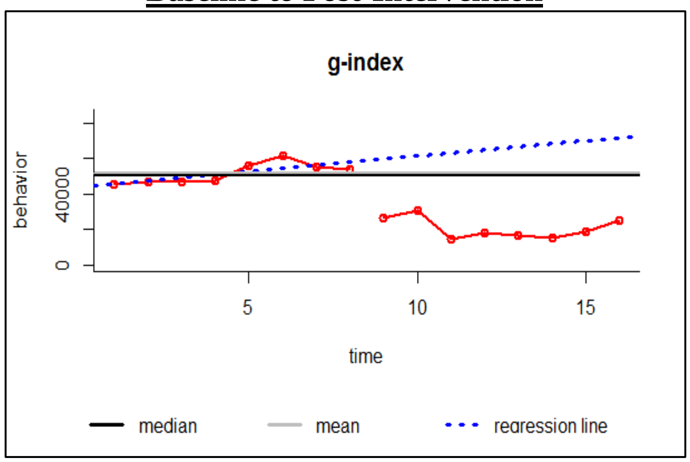
Behavior = Actigraph steps. Time = Days of data collection.

Figure 15. Participant one: g index comparisons – actigraph steps.

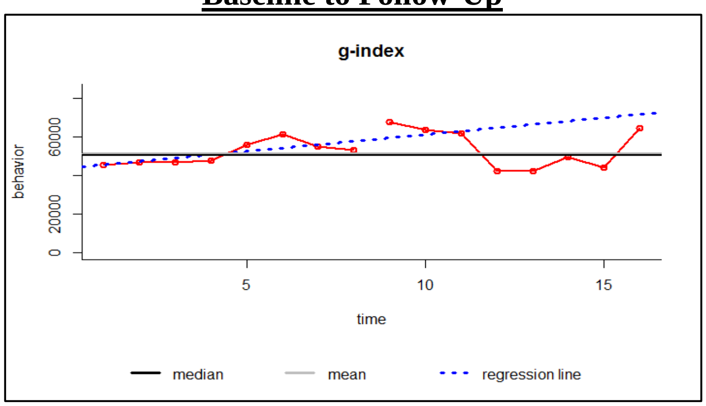
Baseline to Intervention



Baseline to Post-Intervention



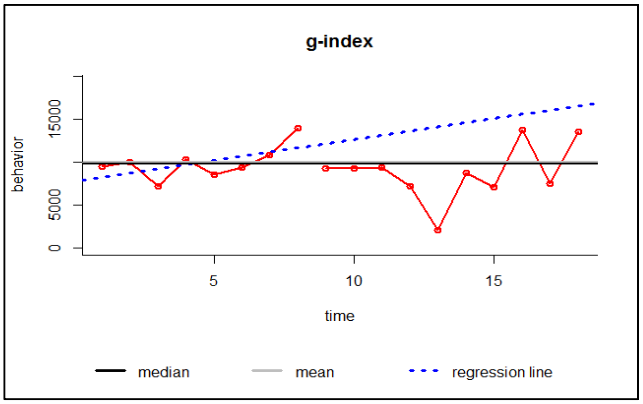
Baseline to Follow-Up



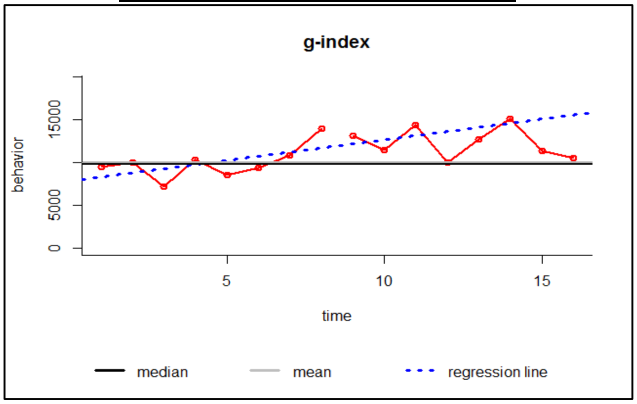
Behavior = Actigraph steps. Time = Days of data collection.

Figure 16. Participant two: g index comparisons – actigraph steps.

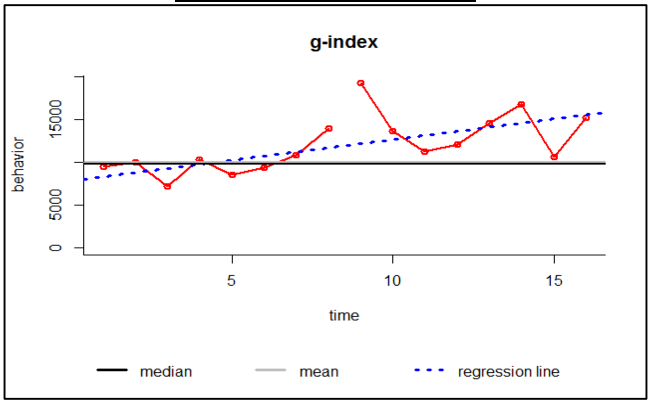
Baseline to Intervention



Baseline to Post-Intervention



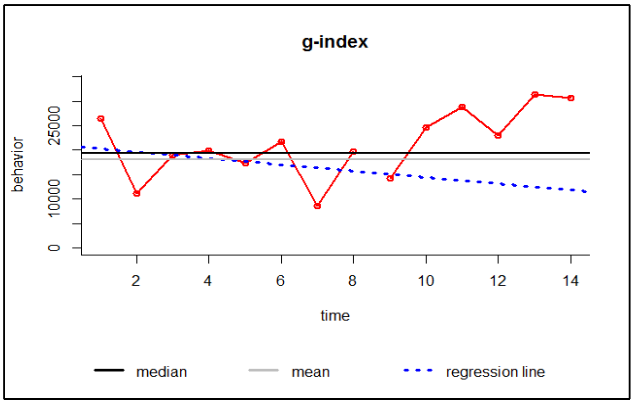
Baseline to Follow-Up



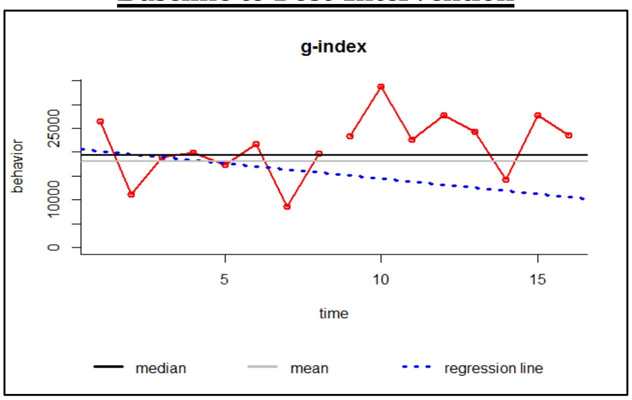
Behavior = Actigraph steps. Time = Days of data collection.

Figure 17. Participant three: g index comparisons – actigraph steps.

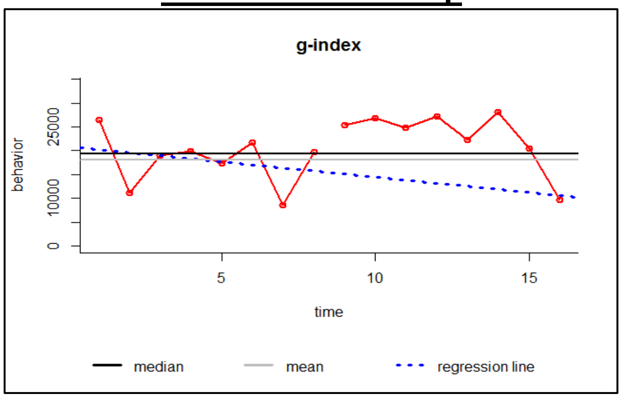
Baseline to Intervention



Baseline to Post-Intervention



Baseline to Follow-Up



Behavior = Actigraph steps. Time = Days of data collection.

Figure 18. Participant four: g index comparisons – actigraph steps.

Concurrent Validity of Actigraph and FitBit Measurements

Figure 19 reveals the average number of steps recorded by the Actigraph and FitBit for both the affected and the unaffected sides of all participants throughout the study. The relationship between the number of steps (as measured by the FitBit) and number of step counts (as measured by the Actigraph) for the right and for the left hands of all participants together throughout the study were compared using the Pearson product-moment correlation coefficient. There was a strong positive correlation for the right hand, $r = .751$, n = 127, $p < .01$. A strong positive correlation was also found for the left hand, $r = .848$, n = 114, $p < .01$.

A paired samples t-test was then conducted to investigate the difference between the number of steps recorded on an Actigraph accelerometer versus the number of steps recorded on a FitBit for the right and for the left hands of all participants together throughout the study. For the right side, there was a significant difference between the amount of steps recorded on the Actigraph (*M* =16,572.06, *SD* = 7,228.18) and the amount of steps recorded on the FitBit (*M* = 3,417.87, *SD* = 3,210.52), t (126) = 27.88, $p < .001$ (two-tailed). For the left side, there was a significant difference between the amount of steps recorded on the Actigraph (*M* = 24,547.24, *SD* =18,899.73) and the amount of steps recorded on the FitBit (*M* = 11,085.04, *SD* = 16,410.08), t (113) = 14.36, $p < .001$ (two-tailed).

When compared to the Actigraph, the FitBit data showed a significant positive correlation for both the right and left sides. However, paired sample t-tests revealed that the FitBit was significantly different from the Actigraph, again for both sides. Therefore, the FitBit would not be an equivalent measure to the Actigraph. Average step counts reveals the FitBit to not be as sensitive a measure as the Actigraph.

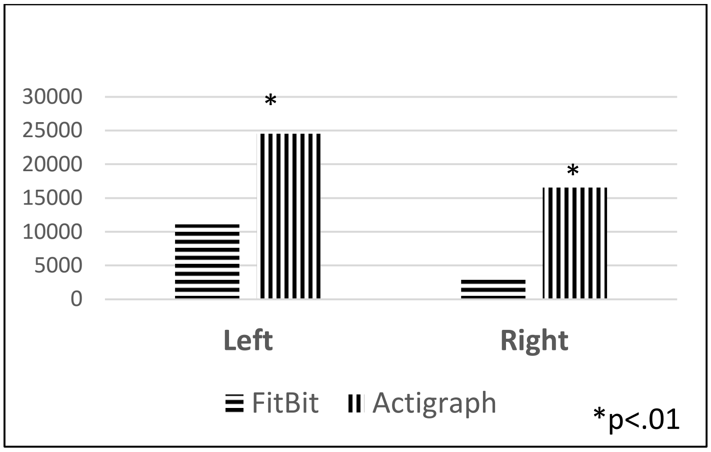


Figure 19. Average number of steps.

Accelerometry Comparisons of Affected and Unaffected Sides for Each Participant

Due to the Actigraph being more sensitive than the FitBit, Actigraph recordings were used to identify a comparison of overall activity between the right and left sides. The accelerometry recordings of the affected side were compared to the unaffected side for each participant in each phase of the study. Changes in recordings between each phase were assessed. Categories with significant changes were graphed to more easily comprehend activity level differences between the participants’ affected and unaffected sides over the course of the study (see Figure 20).

Participants 1 and 4 both showed a decrease in the percentage of time spent in sedentary activities, an increase in the percentage of time spent in light activities, and little change in the percentage of time spent in moderate activities through actigraph recordings of both upper extremities. Participant 2 exhibited changes in the percentage of time in sedentary, light, and moderate activities for his affected upper extremity – mainly a slight increase in activity during the TOTE intervention, followed by a slight decrease in activity at post-evaluation and follow-up. This participant's significant ataxia throughout his time in the study makes true interpretation of his accelerometry movement data difficult. His goal was to decrease the random ataxic movements and increase purposeful, functional movements. Results suggest improvements in decreasing ataxia might have negated functional improvements as seen in accelerometry recordings. Participant 3 demonstrated very little change over time spent in the various levels of activity with both his affected and unaffected upper extremities.

Other Outcome Measures

Other outcome measures gathered at baseline, post-intervention, and follow-up included the COPM, FMA, MAL, SIS (stroke recovery question only) and FTHUE. See Table 9 for a comparison of each participant's scores. A visual analysis of each assessment can be seen in Figure 21 (COPM), Figure 22 (FMA), Figure 23 (MAL), Figure 24 (SIS), and Figure 25 (FTHUE).

All participants rated marked improvements in performance and satisfaction on the COPM of key activities following the TOTE Home intervention. These improvements mostly continued to improve at the 1-month follow-up. Ratings exceeded the minimal detectable change of 1.7 points for performance and 2.7 points for satisfaction (Cup, Scholte op Reimer, Thijssen, & van Kuyk-Minis, 2003) at post-evaluation for Participants 1, 3, and 4, and at 1-month follow-up for Participant 2. (See Figure 21).

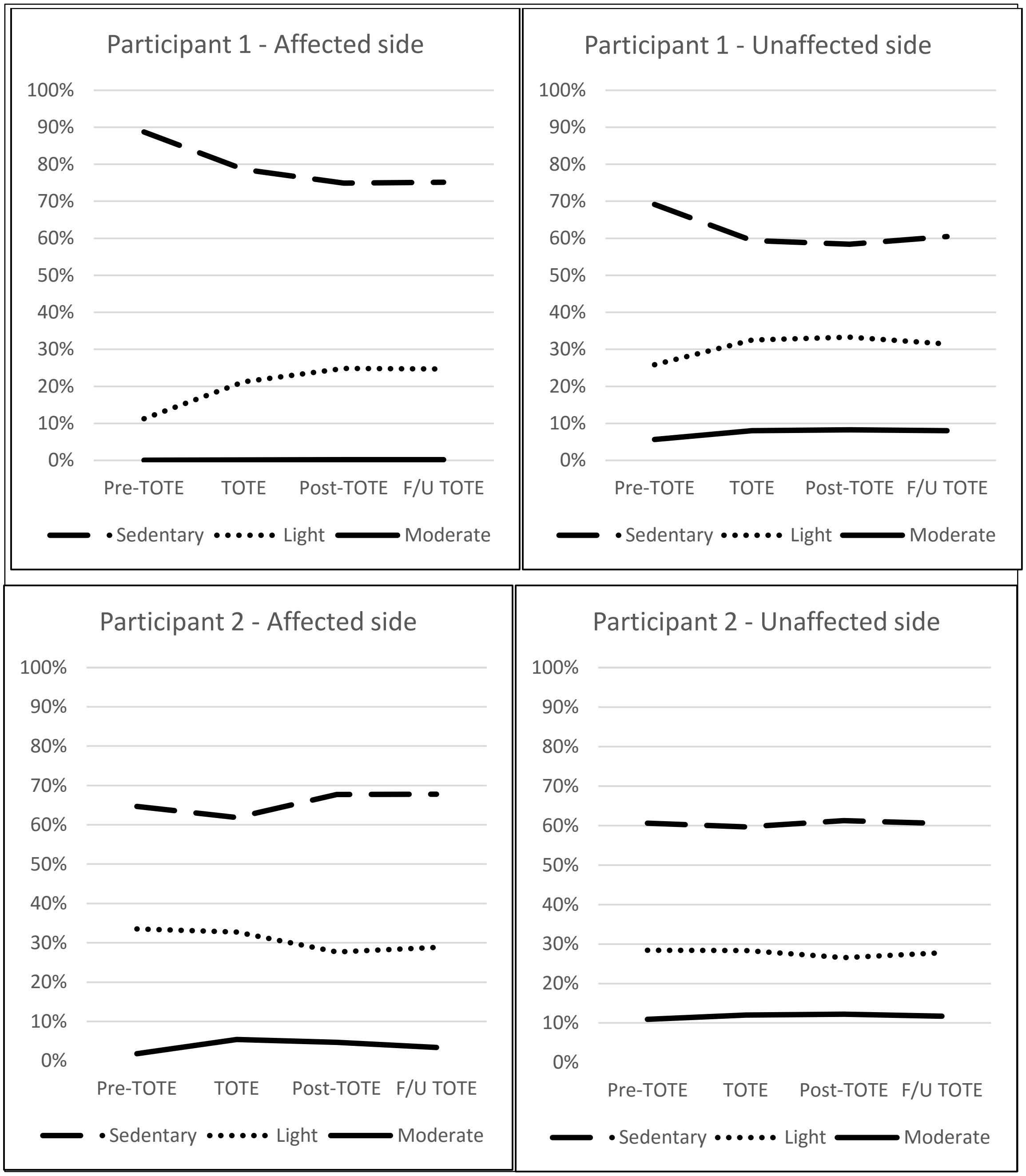


Figure 20. Percentage of time affected and unaffected sides spent in sedentary, light, and moderate activity (recorded by actigraph) for each participant.

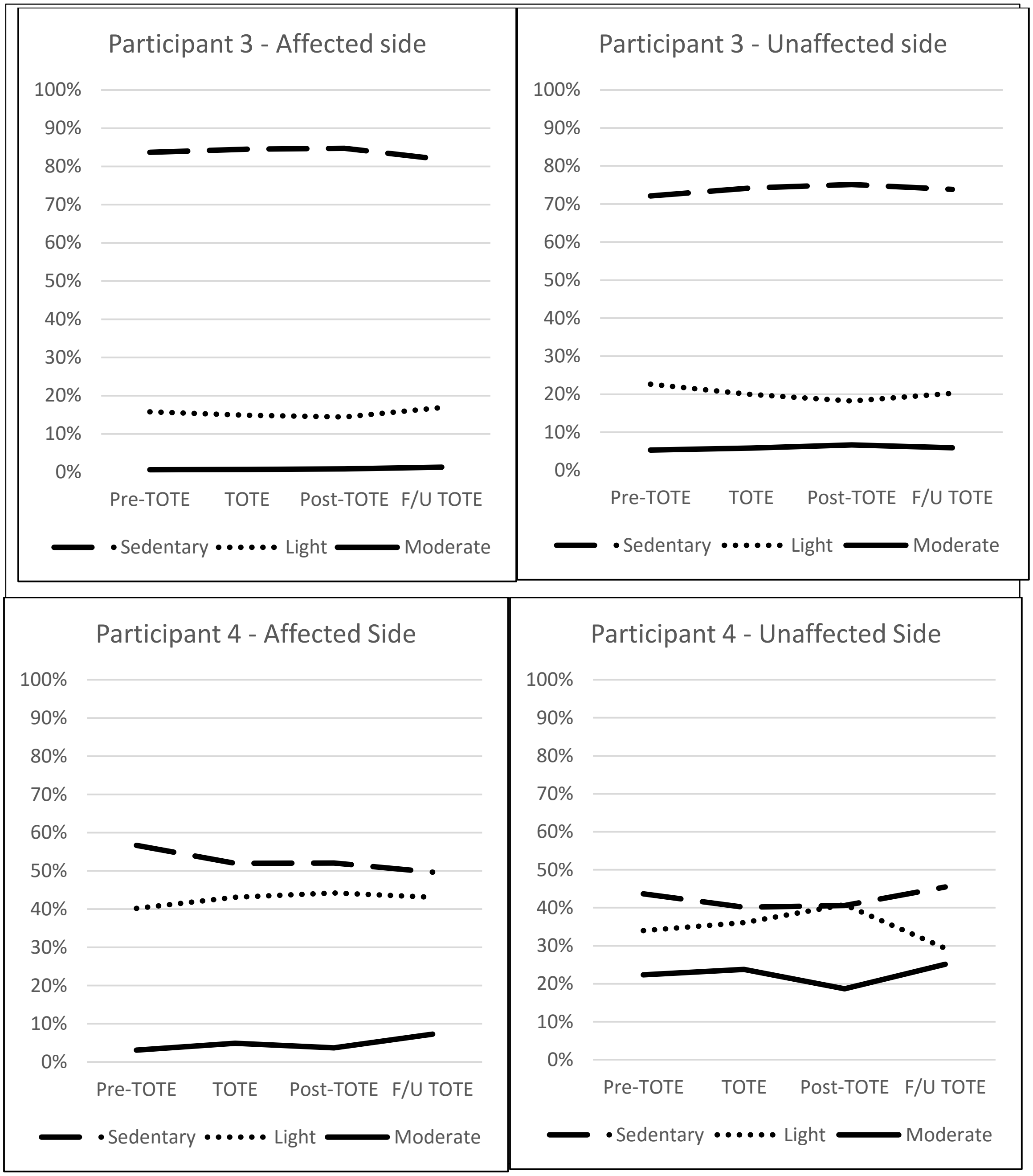


Figure 20. Continued.

All participants exceeded the minimal detectable change of 5.2 points (Wagner, Rhodes, & Patten, 2008) for the upper extremity portion of the Fugl-Meyer assessment from baseline to 1-month follow-up. In fact, this change was close to being made for all participants at the post-evaluation immediately following the intervention. (See Figure 22)

All participants rated an improvement in the amount of use and the quality of movement of the affected upper extremity from pre-test to post-test for the ADLs and IADLs queried on the Motor Activity Log. At the 1-month follow-up evaluation, Participants 1, 3, and 4 reported a continued increase in the amount they used their affected arm and hand. Participant 2 reported only a very slight decrease in the amount of use. In rating the quality of movement for these items, Participant 1 rated a large improvement at post-test and maintained that improvement at 1-month follow-up. Participant 2 noted a slight decrease in quality of movement at post-test, but then reported a large increase in quality of movement at the 1-month follow-up. Participant 3 rated a steady increase in the quality of his movements from pre to post to follow-up evaluation; however, changes were very nominal. Participant 4 rated much improvement in her quality of movement at post-test. Maintenance and some improvement was noted at 1-month follow-up as well. (See Figure 23)

The Stroke Impact Scale rating of recovery has been used to dichotomize perception of recovery of the weaker arm and hand following a stroke as greater than or less than 50% rating of recovery (Fritz et al., 2007). Participants 1, 2, and 3 began this study with a perceived recovery of their more affected upper extremity at ≤50%. All participants rated an improvement in their recovery of the weaker arm and hand following the TOTE Home intervention with 3 out of the 4 participants' post-test ratings being >50%. At 1-month follow-up, Participants 1 and 4 reported a continued perceived improvement in recovery, while Participant 2 reported a maintenance of his recovery, Participant 3 noted a slight decrease in his perceived recovery. (See Figure 24)

Results of the FTHUE were inconsistent and difficult to interpret. Differences in the number of tasks that each participant was able to complete were nominal at each stage of evaluation. (See Figure 25)

Table 9

Change Scores of Standardized Tests

PARTICIPANT 1	Change Pre to Post	Change Pre to F/U
COPM Performance	4.6	7.0
COPM Satisfaction	3.6	5.8
FMA-UE	5.0	10.0
MAL Amount	2.2	2.6
MAL How Well	1.8	1.8
SIS recovery question	30.0	40.0
FTHUE Score	3.0	0.0
PARTICIPANT 2	**Change Pre to Post**	**Change Pre to F/U**
COPM Performance	0.8	3.2
COPM Satisfaction	0.5	3.0
FMA-UE	4.0	6.0
MAL Amount	1.2	0.7
MAL How Well	-0.5	0.4
SIS recovery question	21.0	21.0
FTHUE Score	-2.0	0.0
PARTICIPANT 3	**Change Pre to Post**	**Change Pre to F/U**
COPM Performance	2.8	3.0
COPM Satisfaction	1.8	2.6
FMA-UE	9.0	13.0
MAL Amount	0.1	0.8
MAL How Well	0.4	0.7
SIS recovery question	20.0	10.0
FTHUE Score	1.0	0.0
PARTICIPANT 4	**Change Pre to Post**	**Change Pre to F/U**
COPM Performance	4.0	6.4
COPM Satisfaction	7.6	8.2
FMA-UE	12.0	12.0
MAL Amount	0.7	0.8
MAL How Well	1.2	1.4
SIS recovery question	25.0	29.9
FTHUE Score	2.0	2.0

COPM=Canadian Occupational Performance Measure, FMA-UE=Fugl-Meyer Assessment for the Upper Extremity (motor score), MAL=Motor Activity Log (average ratings), SIS=Stroke Impact Scale, FTHUE=Functional Test for the Hemiparetic Upper Extremity

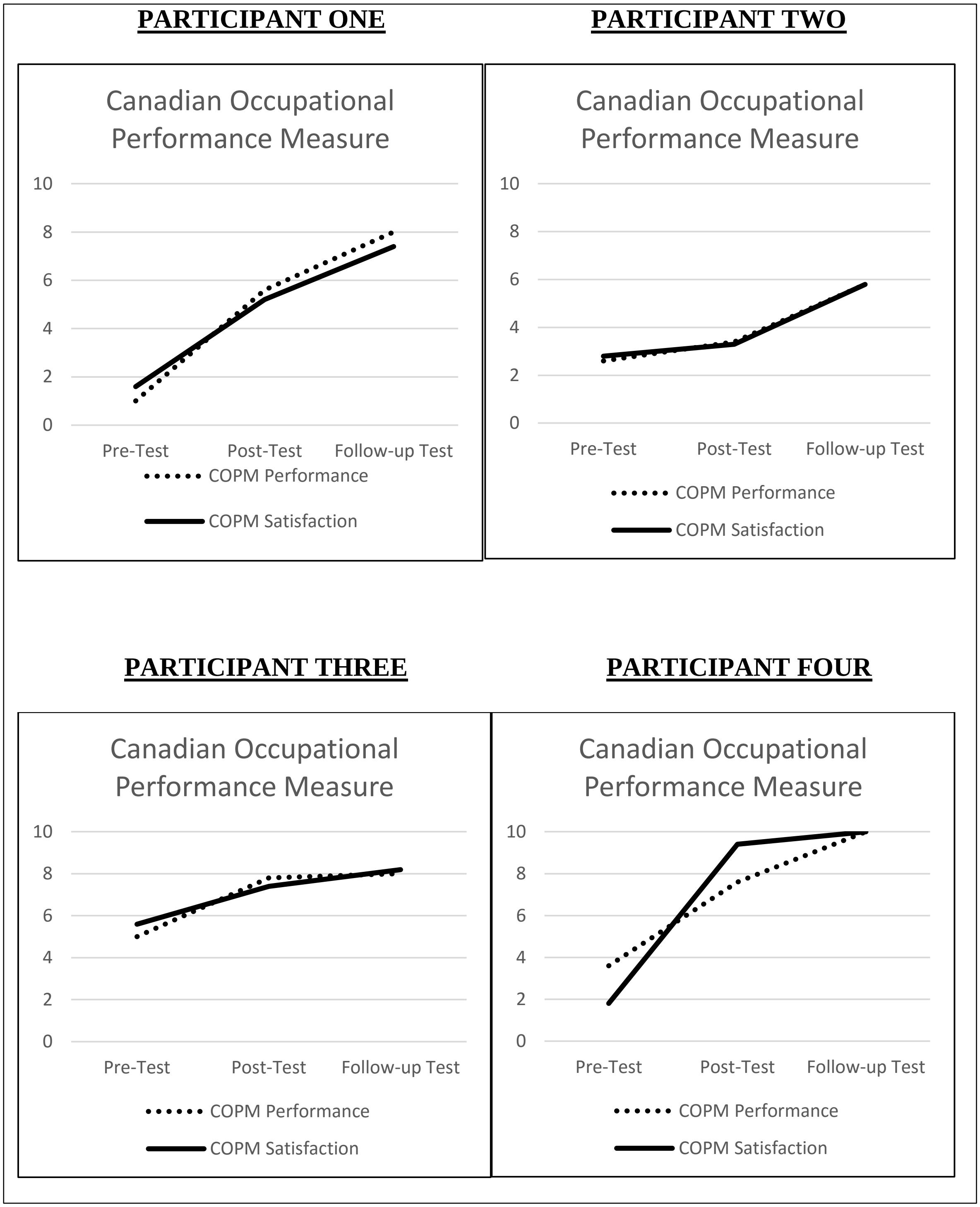


Figure 21. Canadian occupational performance measure.

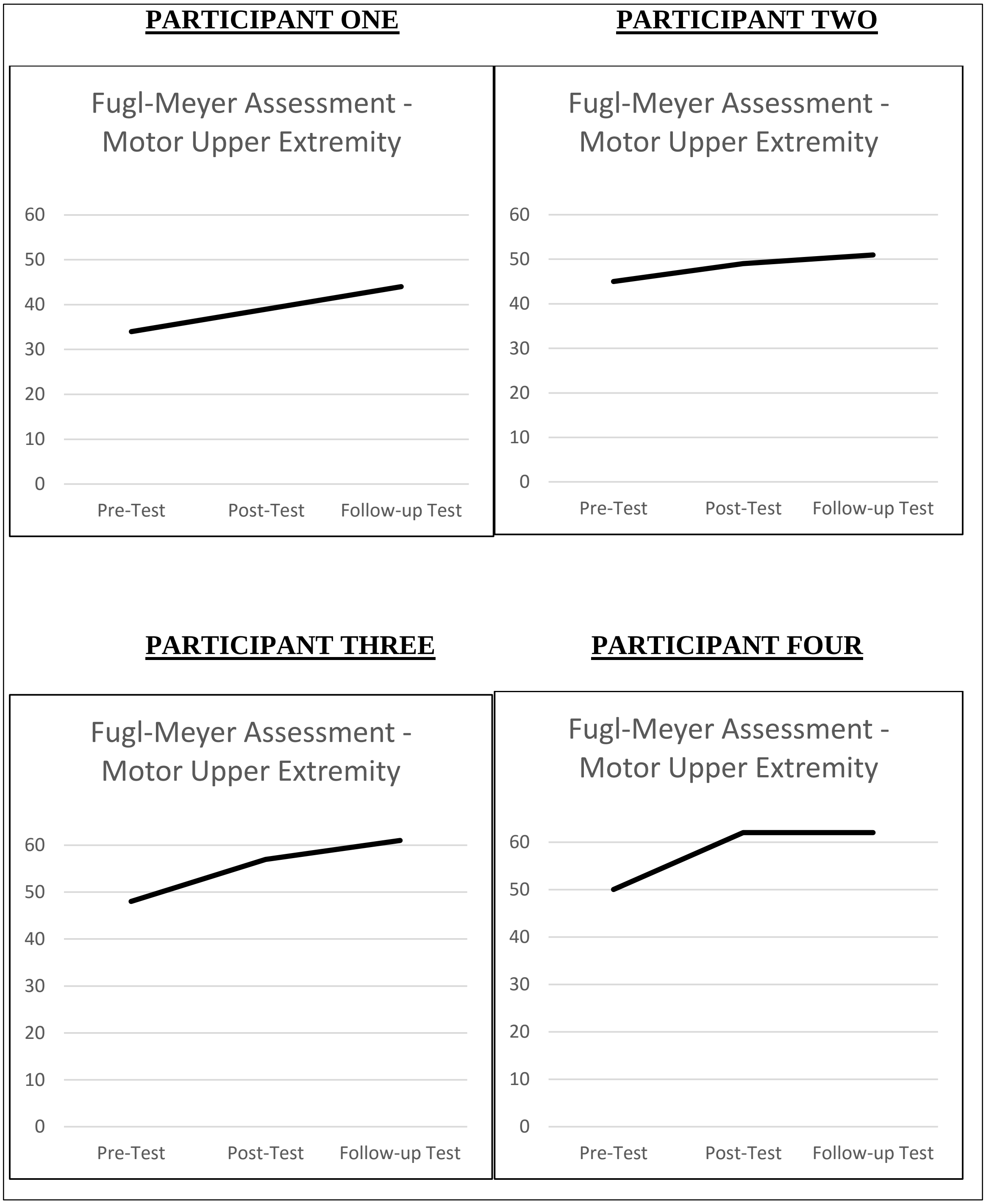


Figure 22. Fugl-Meyer assessment – motor upper extremity.

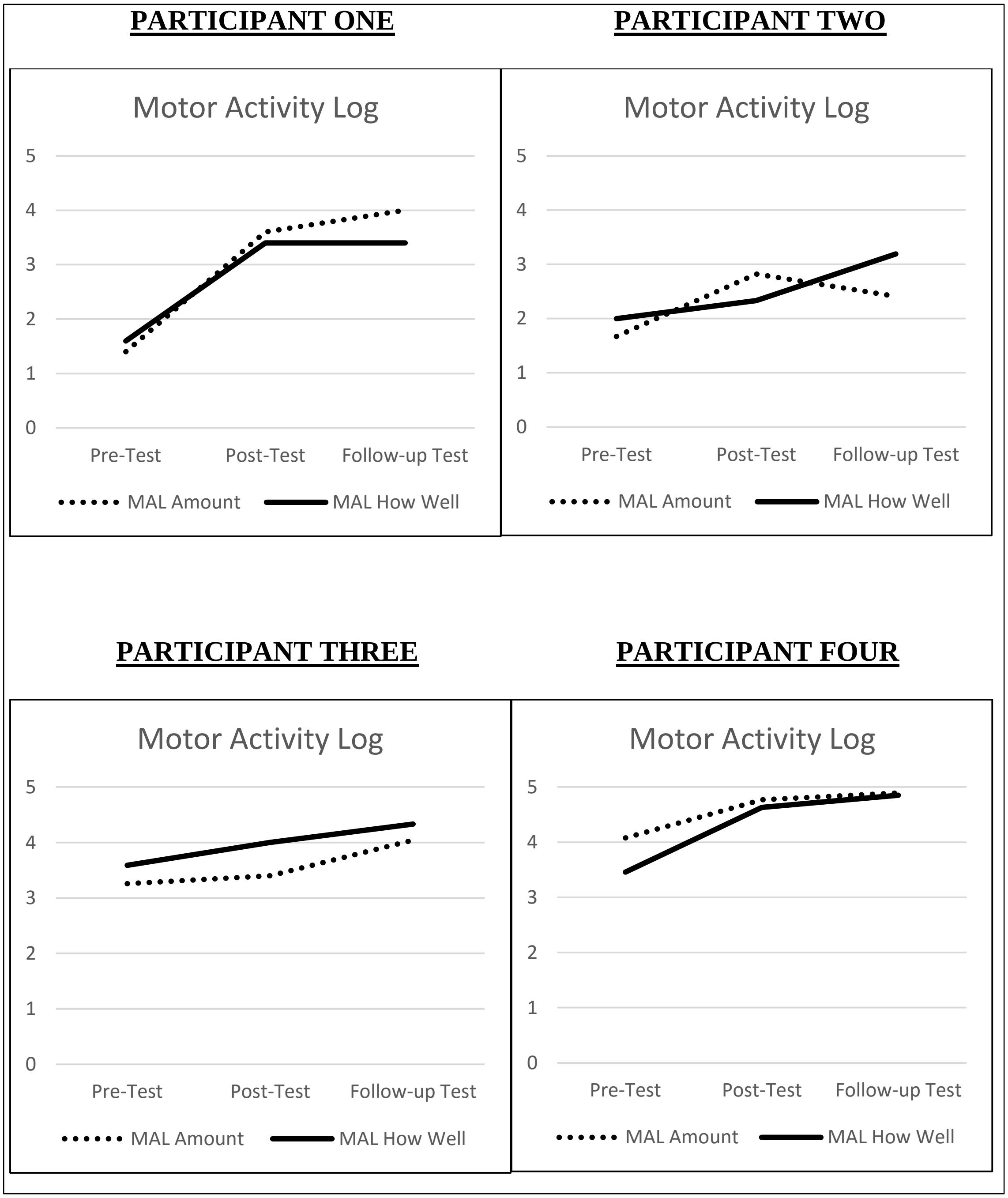


Figure 23. Motor activity log.

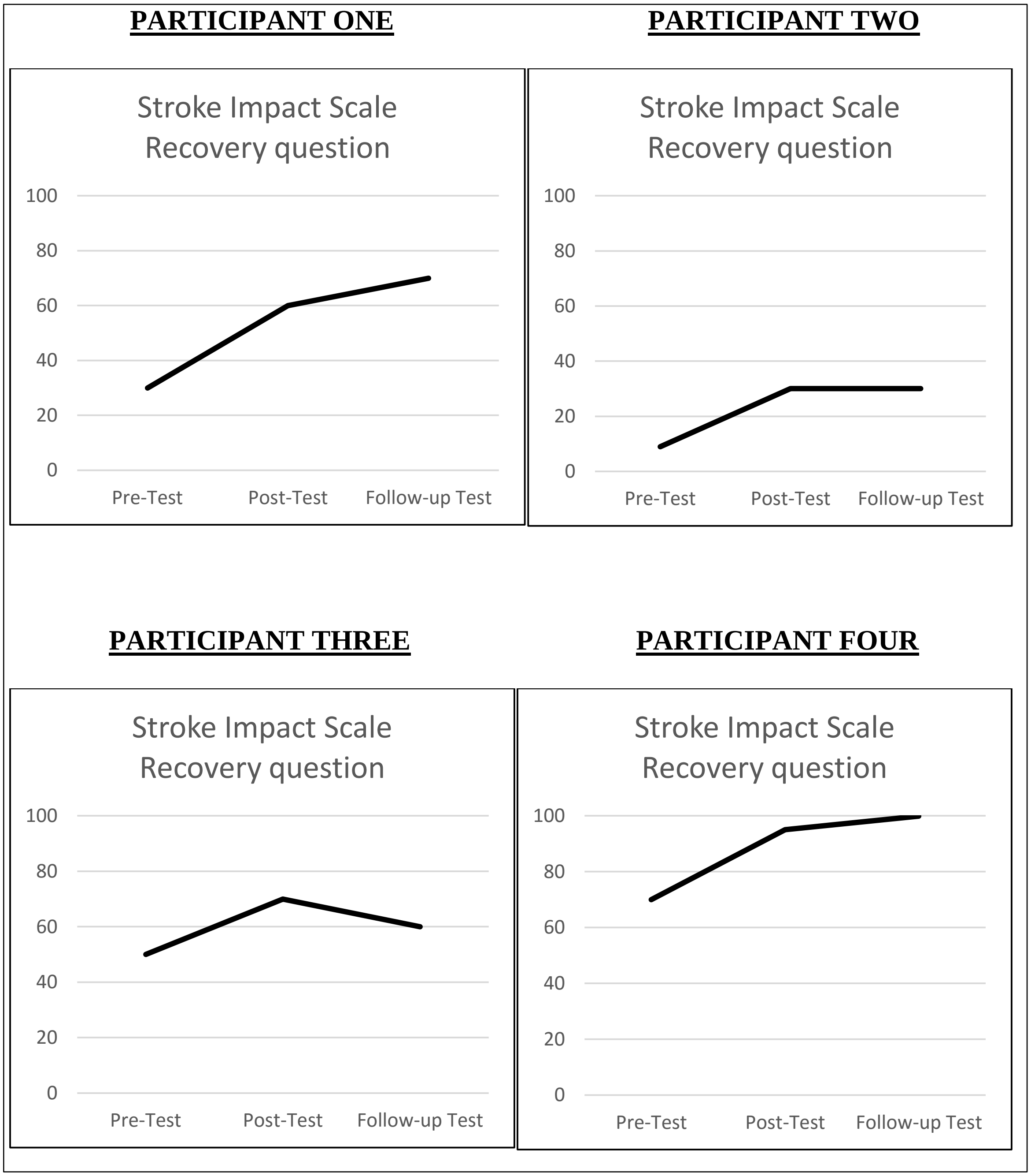


Figure 24. Stroke impact scale recovery question.

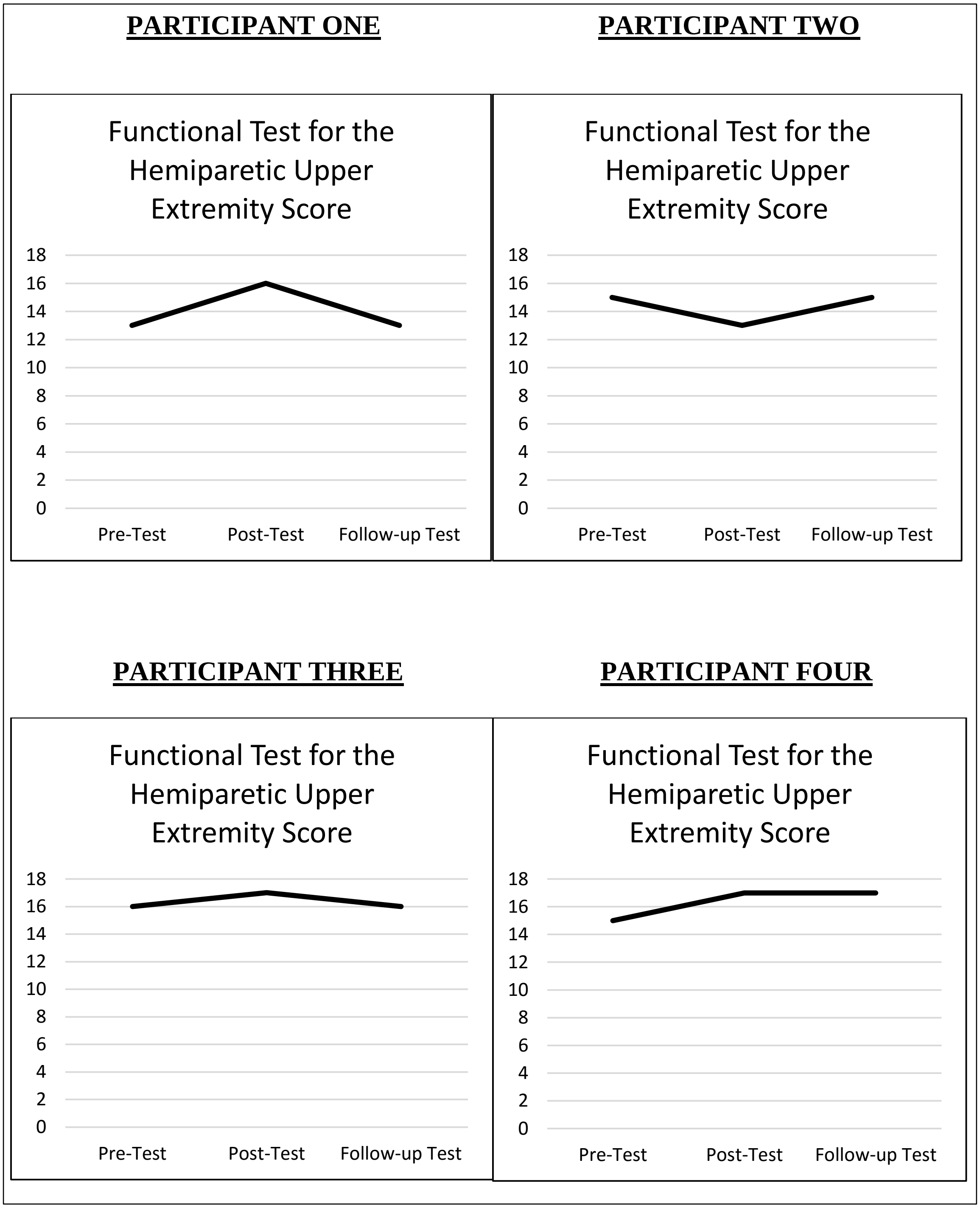


Figure 25. Functional test for the hemiparetic upper extremity.

Narrative Summary of Therapist and Participant Comments and Aspects of TOTE Home Intervention

Anecdotal reports from the occupational therapist and the participants help to complete the description and further explain outcomes. Conversations, observations, and direct quotes from field notes written by the occupational therapist are summarized for each participant. The following behaviors were identified via content analysis as themes for each participant from the occupational therapist's notes.

Participant One

The following themes were identified from the occupational therapist's notes regarding the first participant's learning and aspects of the intervention.

Grading tasks. The participant problem solved how to make tasks easier or harder to accommodate the learning process – evidence of her adaptive response generation subprocess. For example, the participant made tooth brushing easier in order to be able to complete the task with the unaffected hand by propping the toothbrush against something while performing in-hand manipulation. Tasks were made more difficulty by utilizing each finger individually – evidence of incorporation of a response into her occupational environment.

Identifying aspects of activities that need improvement. The participant was able to identify occupational challenges, or specific physical components and motor movements that needed to be improved upon in order to complete tasks. While brushing teeth, the participant identified a decreased ability to turn brush in the hand to get to all areas of mouth. Specifically, difficulty with 4^{th} and 5^{th} digits to turn/manipulate the brush was cited as the reason for the lack of performance. The participant also demonstrated and verbalized movements and analysis of movement (adaptive response evaluation) that where felt to need improvement, such as the ability to open fingers (extend) when throwing objects (e.g., trash into can, clothes into hamper, nightgown onto bed). This led to independently creating activities to improve finger extension, such as spreading a rubber band out.

Use of personal "equipment." The participant preferred and worked harder with items found in her own occupational environment, such as a personal dry-erase lab tray rather than the one provided by the therapist. Pens and markers belonging to the participant were identified and utilized rather than foam built-up grips supplied by the therapist. Additionally, the participant identified personal items that were difficult to manipulate such as a keychain clip and a cell phone.

Evaluating self. Evidence of the participant's adaptive response evaluation subprocess occurred when self-evaluation occurred. For handwriting, the participant stated, "If I take my time, I do better." The participant anecdotally stated the "homework" was more effective "because I can do more with that hand now." Other statements of satisfaction portraying success with the intervention included: "I have more strength in my hand because I can hold a glass of water with my right hand," and "I have enough strength to flush the commode now!" At the final evaluation, the participant had compared a check written at the beginning of the intervention to a check written at the end of the intervention and noted a significant improvement. In fact, the participant was very satisfied with the improvement in handwriting but still identified the need to get better and faster. This is an example of a realistic goal she incorporated into her occupational environment.

Participant Two

The following themes were identified from the occupational therapist's notes regarding the second participant's learning and aspects of the intervention.

Reliance on self and the motivation to be independent. The participant insisted from the beginning of treatment that he would use left upper extremity more and did not want to wear the mitt – the adaptive response generation subprocess. Understanding was verbalized by the participant of the importance of using his left upper extremity by stating, "I'm only cheating myself by not using my left side." Frequently, the participant refused help from the occupational therapist stating that the therapist wouldn't always be with him, so he needed to be able to do things on his own. He realized the need to adapt was related to his own self efficacy which would ultimately increase his relative mastery.

The use of traditional and contemporary approaches of motor control and motor learning. Both traditional and contemporary approaches to motor control and motor learning were interspersed during treatment. Traditional approaches from Rood included weight bearing and relaxation techniques to decrease ataxia in the left upper extremity. The participant frequently reported "just" performing exercises outside of treatment visits. He reported feeling better and exhibiting increased movement when his body was warm, ie, doing exercises/activities. However, he appeared much more engaged while doing "projects" such as washing the car, mowing the grass, clearing an area for a garden, blowing weeds, and moving rocks.

More contemporary approaches of motor learning were evident when the participant would engage in mental imagery such as "using his imagination" or simulating activities such as painting. Mirror movements were employed by purposefully painting with his right (unaffected) upper extremity to see how holding the brush would be "normal." Although these activities held some value, they did not appear as meaningful and thus, the participant did not persist with these activities over time.

The participant frequently stated stretching made him feel better. Towards the end of treatment, the participant requested and appeared to benefit from the occupational therapist performing passive range of motion and prolonged stretches to his left upper extremity while the participant focused on relaxation of left upper extremity. He did, in fact, exhibit a decrease in ataxia during and in relation to these activities.

Holistic aspects of the participant monitoring his progress – it's not just about the weak arm and hand! Periodically, the participant would state he wanted to walk, either to work on his stiff left leg or to blow off some steam from being angry with his wife. He understood our main goal was to work on movement and function of his left upper extremity; however, he appropriately identified times in which it was most appropriate for him to take a walk and stretch his leg. During these outings, the occupational therapist would encourage gesturing with his left upper extremity or carrying objects in his left upper extremity. The participant used these opportunities to express his feelings such as: frustration, hopes for the future, and religious beliefs. The psychosocial components of the person are just as important as the sensorimotor aspects.

Although the upper extremity functional movement was not always addressed during treatment sessions, the participant was very independent in identifying his desire for mastery. For example, one day the occupational therapist asked the participant, "What do you need to work on today?" The participant immediately identified left lower extremity stretching and the need to walk. The participant carried an umbrella in his left hand for half of walk and then independently gave it back to the occupational therapist stating, "that's enough."

Rarely, but occasionally, the participant stated feeling like he wasn't getting any better, i.e., that the occupational therapist would be better helping others. Lengthy conversations were had explaining the slow pace of recovery, and the small improvements made. After activities and sometimes manual treatments, including passive stretching and weight bearing, the participant would state an improvement in mood and emotion. Again, addressing the participant's psychosocial needs had to be balanced with the sensorimotor deficits within his person.

Structuring of activities – meaningful work and projects. The participant was extremely motivated to participate in activities in and out of treatment sessions, i.e., his occupational response. He once stated, "I got so into doing the work (pulling weeds) that I forgot I was sick (had a stroke)." He would creatively use previously learned techniques and activities, such as karate, as repetitive activities, such as breaking pieces of wood, or playing with nunchucks. He also appropriately used methods of relaxation and focused attention to help decrease his ataxia. He also independently came up with games to improve movement and function such as hitting a ball on the ground with bat. He exhibited problem solving abilities such as using a belt instead of a bat to practice nunchuck moves. These examples are evidence of his ability to adapt and apply principles of motor learning to all activities.

Activities in treatment sessions frequently consisted of the participant performing "heavy" jobs requiring gross strength interspersed with "light" jobs requiring more fine motor coordination. This is an example of the Rood approach with the Theory of Motor Control and Motor Learning (Rood, 1956). The participant stated he preferred heavy weighted tasks (which tended to decrease his ataxia) opposed to light fine motor coordination activities. However, the participant correctly identified the need to increase precision movement in his left upper extremity. He acknowledged his increased strength, but admitted he needed to improve on "hitting the target" such as when trying to use a "Karate chop" to break wood pieces.

Over time, the participant reported his left upper extremity feeling stronger than his right upper extremity. He frequently compared the size and tone of his arm and hand muscles to each other and correctly identified the improved strength in his left upper extremity. He also referred to the need to toughen up his left hand skin by doing work and making it feel "more like a man, not a baby." Statements such as this alluded to the participant's description of his occupational roles.

The participant periodically complained of pain in his left arm and hand related to increased or overuse activity with the left upper extremity. Cramping, pain, tightness, and soreness appeared when he had done an excessive amount of work. Fortunately, it did not limit what he was willing to do. Focus towards the end of the treatment sessions was on the need to balance work and rest with frequent, short breaks. He was educated on the need to balance work and rest by emphasizing and practicing taking rest breaks periodically during treatment sessions. This is evidence of balancing the person's desire for mastery with the occupational environment's demand for mastery. The participant confirmed the need to rest periodically and not do too much with the left upper extremity to cause severe soreness, fatigue, and ultimately limited use and increased discomfort for several days. The participant demonstrated this balance during the final treatment sessions. He reported he continued to take frequent rest breaks to drink water, alternating between heavy and light work, and sit to rest during the final follow-up evaluation. Towards the end of the intervention, he was appropriately incorporating his occupational responses into his occupational environment.

Occupational environment – physical and social. The participant stated he does better (performance of left upper extremity) when he is at his own home (i.e., he's more relaxed) as opposed to living at his daughter's house. Four treatment sessions were held at the participant's original residence where he preferred to be. The locale is a mobile home out on a rural area with very uneven grounds and lots of overgrowth. The participant and his wife stated this is where the participant prefers to be but the locale is not ideal for living, especially in the winter (it is hard to get to - by car and walking up to home) and there is no running water and a questionable heat source. The participant's daughter wants them to stay with her or move into one of her rent houses in town. The occupational environment (physical, social, and cultural) affected the participant's performance. Physically, the participant didn't feel like he had ownership of his physical surroundings to perform activities such as home and yard maintenance. Socially, he did not feel like the paternal head of the family, nor that he had the ability to uphold the roles that typically went along with that title. Culturally, his Hispanic heritage held him as eldest male to be the main person in the home to be in charge which he felt he was unable to do given his weakened condition.

While at the participant's home, he quickly identified and performed numerous activities, adjusted how he did them in order to be successful, and only occasionally needed reminding to use left upper extremity. He worked on activities such as blowing leaves on a very steep hillside which was meaningful to him and improved his overall balance, endurance, and functional use of upper extremities, bilaterally and unilaterally. The participant appeared significantly more comfortable and functional in this environment. If he could stay here, the occupational therapist thought his recovery would be significantly faster with increased movement in his left side, decreased ataxia, and certainly less complaints of physical ailments and an improved, very pleasant affect.

His initial signs of depressive symptoms may have stemmed from his daughter's home environment in which he was significantly less active and had less purposeful activities to do (or which he chose to do). It was obvious that the reason the participant preferred his own home was due to all the activities (mainly yard work and home maintenance) that he wanted to do. He had very little to do at daughter's home and/or he did not feel like it was his place to do similar activities at her house. He had more of a demand for mastery in his own home environment than he did in his daughter's home environment. His role expectations also changed drastically at each locale.

The participant's family members (especially his wife whom the occupational therapist was around the most) are very supportive and appear to have a good, strong, positive relationship. The participant's wife speaks English a bit better than the participant, even though the participant is able to communicate adequately and understands English well on his own. Whenever the participant's wife was present, the participant instantly reverted to speaking in Spanish and having his wife translate. He said he feels he can be clearer with what he means. He did exhibit frustration occasionally with his wife's translations but continued to have her translate frequently. The participant's wife was somewhat of an enabler when she would translate for the participant; however, the occupational therapist believed she realized this and most often removed herself from the treatment sessions which encouraged the participant to engage directly with the occupational therapist. The occupational therapist encouraged direct engagement by attempting to speak Spanish or encouraging the participant to teach the occupational therapist Spanish in order to better communicate with him. The social and cultural environment with his family present during treatment affected his performance.

One day the participant's grandson was present throughout the entire treatment session. He quickly understood the focus of treatment and offered good suggestions to increase "target" movement such as shovel dirt in a certain spot, throw/catch/bat ball, and hold hose to put water in bucket. He also came up with ideas to increase left upper extremity strength and movement such as holding the shovel with the left upper extremity closer to the spade and carrying the water bucket. The occupational therapist discussed the TOTE Home goals (in general) with the grandson. The participant appeared to have a close relationship with all family (daughters, wife, grandsons) and joked frequently and easily with them. This supportive social occupational environment was a key component to the participant's recovery.

At end of the TOTE Home treatment sessions, the participant reported his left side (especially his proximal left upper extremity) not moving as much (evidence of some decreased ataxia). Indeed, a decrease in his intention tremor was noted when he was actively engaged and his hand and fingers get close to a target. The participant still complained and exhibited a resting tremor. However, his statement, "When I'm working, I forget I am sick (had a stroke)" epitomizes the meaning of occupational therapy and the need for meaningful activities in one's life.

Participant Three

The following themes were identified from the occupational therapist's notes regarding the third participant's learning and aspects of the intervention.

Lack of adaptation in functional activities. The participant verbalized motivation for recovery of his weaker arm and hand (desire for mastery) and was always compliant during therapy sessions. Numerous attempts were made to collaborate with the participant on why he was having difficulty with completing functional movements, such as buttoning his shirt. He would inconsistently identify specific component deficits that affected function, for example, decreased pinch strength. When given tasks to complete, he usually was able to determine what aspects were easier or more difficult, such as identifying larger coins as easier to pick up than smaller coins. His lack of adaptation stemmed from a deficit in his adaptive response subprocess.

Regularly during TOTE Home, the occupational therapist discussed with the participant the need for him to come up with ideas for things to work on. Motor Learning and Occupational Adaptation theories both stress the need for tasks to be client-centered. If pressed, the participant would identify things such as a weed eater as needing lots of left UE movement and strength. In addition, the participant identified fishing as a hobby and also stated he wanted to make a garden in his backyard with plans to use a tractor and backhoe, and to remove trees. The lack of adaptation in generating an adaptive response by pursuing these activities was the participant not coming up with beginning steps of activities that fit his level of function. When the participant identified meaningful goals he desired to master, he could not independently generate a logical plan of treatment (adaptive response) to achieve them.

Towards the end of treatment sessions, the occupational therapist stressed the need for the participant to be able to come up with and perform activities on his own. He verbalized needing to bulldoze trees down to clear land, fix cars, and clean off the deck but couldn't really identify a process to work towards these activities. For example, physical demands were discussed for clearing land and the participant came up with the need to use a chainsaw. The occupational therapist suggested starting with a regular saw (because the participant did not offer any ideas); however, the participant was reluctant to initiate this task. The collaborative nature of the therapist-participant relationship that the therapist tried to foster frequently failed.

Perceived occupational role expectations as a patient limits participation. The participant expressed difficulty with getting out of the "hospitalized patient" role. He said it was difficult to even start thinking about being able to do things after being in a bed for so long and not being able to do anything. During the time he spent as a patient in the hospital/rehab/nursing home, he said it was easier NOT to think about what he couldn't do and now it was hard to get out of that limiting occupational role expectations and think about doing things again. His statements about still feeling like a patient were accurate reflections of his actions in asking his wife about almost anything, excessive sleeping, and general lack of activity.

The participant admitted that he needed to "get off his lazy butt." The occupational therapist encouraged and said the participant needed to push himself to walk and do something every day and to further wean himself off using a walker. The occupational therapist felt like the participant was physically capable to participate more in everyday activities, but possibly his psychological state of "being sick" and "needing to rest" superseded his motivation to get better. He did not appear to be able to regain his occupational role of husband and contributor of his household like he was before the stroke.

The participant frequently stated that he will do things "when he is better," such as fix a car engine, repaint a car, and handyman work under his house. However, he was not able to generate an adaptive response to "get better," except to rest. He verbalized understanding of benefits of moving and doing things but did not appear to carry out activities or movement at all without specific direction from occupational therapist or his wife. The occupational therapist felt like his lack of progress came from his lack of internal motivation to produce an occupational response. For example, when left alone one day, the participant reported literally staying in bed until his wife returned. In fact, the participant reported sleeping a lot (sometimes due to poor weather) and appeared very passive in his recovery efforts. This was his main plan in, "Trying to get well."

On the last treatment session, the participant knew therapy was ending and became slightly more active after possibly realizing he has to do more on his own (self-efficacy). This made the occupational therapist wonder if she had been a crutch or an excuse for him. Perhaps having a therapist visit regularly perpetuated the idea that as long as a person is still receiving some kind of care, he or she is still “sick,” i.e., a perpetuation of the “patient” occupational role expectation.

Participant’s wife as both enabler and encourager. The participant’s wife was present throughout the entire study and very interactive. She frequently offered encouragement and suggestions of how the participant could use his left upper extremity, such as making her a sandwich. She was very grateful and complimentary of all of the participant’s actions. The occupational therapist recommended the participant do 1-2 chores that his wife comes up with every day because he wasn’t coming up with activities on his own. The wife made up a large part of his social occupational environment. The participant and his wife reported doing many more activities such as finishing taking down an outside ramp, and working on the water system for the house outside of therapy. They both said the wife was encouraging the participant to do more with his left hand, such as feeding himself french fries. The participant’s wife came up with an idea to have the participant put stickers on her Avon catalogs as a functional, worthwhile task that required repetitive fine motor movements. The participant agreed it was better to do something useful and to help out his wife instead of just laying around all day. In fact, it was the participant’s wife who encouraged him to continue with therapy by noting the improvements she saw in him.

Indeed, the participant’s wife was both instrumental and helpful in suggesting functional activities for the participant to do. The participant looked to and asked her for almost everything, referring to her as "the boss." For example, when asked to rate his level of exertion after an activity, he wanted his wife to answer for him. The participant appeared to turn to his wife for all decision making. He also frequently stated that it was easier to let his wife do many household chores rather than attempt them himself (a limitation of his occupational environment). In addition, the occupational therapist observed the participant's spouse to quickly say the participant needed to rest even after nominal activity.

Functional mobility affects participation in activity (but did it?). Initially, it appeared that the participant was limited in his performance of daily functional activities by his reliance on the walker and wheelchair for functional mobility. Increasing his independence in functional mobility was addressed by decreasing his use of walking aides (from a wheelchair and walker, to a quad cane, to a straight cane, to no aides). Methods taken from Motor Learning Theory helped progress the participant's independence in functional mobility. The occupational therapist and participant discussed the fact that increasing independence in functional mobility would hopefully increase the opportunity to participate in different activities to use left upper extremity. Also, holding a cane in the participant's right hand forced him to use his left hand to do things such as open/close doors, turn on/off light switch, and carry things. It was anticipated that improvement in functional mobility would increase his occupational responses in general and subsequent use of his left upper extremity during functional activities. The participant stated, "It has been a long time since I've been able to walk around and pick stuff up" (said when beginning use of quad cane). However, follow-through between treatment sessions was not consistent. The participant frequently reverted back to using an assistive device that offered more stability (such as the walker) in between treatment sessions.

Towards the end of TOTE Home, the participant needed only contact guard assist to complete activities without the use of a gait aid. His had incorporated his improved independence in functional mobility into his occupational environment by demonstrating a need for less assistance during gait. However, his occupational responses in functional activities did not appear to have significantly increased with his level of independence in functional mobility, as the occupational therapist had anticipated.

Sensation in left arm and hand and general malaise. The participant was excessively focused on the change in sensation experienced in his left arm and hand. He did admit to the sensation improving by stating, "I'm getting more feeling back in my left arm and hand." The participant reported being able to wash his hands and pick up things better. "It actually works!" However, he also consistently reported it as feeling, "funny," "weird," "extra sensitive," and sometimes "painful." Despite the occupational therapist encouraging him to work through the odd sensations and adapt to them, his response to this alteration in sensation was to mostly want to rest his left upper extremity. This appeared to be a continuation of his "patient" role expectations.

Participant Four

The following themes were identified from the occupational therapist's notes regarding the fourth participant's learning and aspects of the intervention.

Focused, intense use of affected upper extremity during activities improves overall function. Initially, the participant participated in a modified form of CIMT by keeping a mitt on her unaffected hand for extended periods of time. She was very eager to wear it and agreed that if it would make her use her right hand more, it would be worth it. After about a week, she no longer needed the mitt due to her ability to make herself use her affected arm and hand without the mitt to remind her. Some specific quotes from her include: "Activities are making me be more aware and use my right arm and hand more!" "I did almost everything with my right hand!!!" "I've even been conscious about swinging my right arm while walking." "I use my left hand to compensate for my right hand but I'm getting better and using my right hand more and more."

In fact, the participant performed very well with various activities requiring only minimal reminders to use her right arm and hand. The occupational therapist encouraged the participant with Motor Learning Theory components to try to just use her right upper extremity even for tasks that were normally done bilaterally. She then demonstrated use of her affected arm and hand to pick up items but when her affected side needed assistance, she used her unaffected side to offer only minimal assist and then she completed the majority of the task with her affected upper extremity.

“Homework” - independent practice outside of therapy sessions was important. The participant was excellent at coming up with activities that she desired to master to work on independently. She spent a considerable amount of time working on use of her affected arm and hand outside of therapy with excellent follow through of activities suggested during treatment sessions, but performed on her own. She actively evaluated and integrated her adaptive response subprocess in her occupational responses. She even texted the occupational therapist about her successes outside of therapy, such as, holding her coffee cup. She stated that she couldn’t wait to tell the occupational therapist about her performance. Frequently the participant would have activities decided upon before the occupational therapist arrived in order to show the occupational therapist what she could do. This was evident of her extreme motivation to improve movement and function in her affected arm and hand.

Problem solving (Adaptation). The participant came up with great ideas to advance her progress in movement and adapting to new situations including difficulty with throwing and said she would purchase a large ball and basket to play with and maybe a paddle ball set. This was evidence of independent problem solving, breaking tasks down, and appropriately working on parts of tasks. After purchasing a large ball, the participant independently came up with appropriate ways to incorporate its use into her occupational environment to help increase her coordination, timing, and overall strength. The participant subsequently reported being able to dig up mud with a shovel at work and throw it with accuracy in a bucket - evidence of ability to throw better and generalizing, or mastering, skills from home exercise to functional work activities.

The participant reported using a hand exerciser and resistive clothespins while watching TV. While this is an example of nonfunctional tasks, it still exhibited good Motor Control and Learning aspects of repetition and intensity to work on a specific movement that *she* determined was deficient, such as decreased strength of pinch between the 4^{th} and 5^{th} digits and thumb.

The participant also made connections between occupational readiness activities to practice on and how they are similar to occupational work activities, such as bending low to open drawers, and using a lock wrench to get items out of drawer. She exhibited excellent problem solving, or adaptation, for methods of performing tasks, such as manipulation of tools, by removing a screw from a board by changing hand and object positions independently.

Towards the end of the intervention, the participant demonstrated adaptation by identifying to the occupational therapist difficulty at work stepping into holes with her right leg to replace water meters. The occupational therapist suggested practicing stepping with her right leg at home while standing on the living room ottoman. The participant said it would be better for her to start on a shorter step stool, then work up to stepping off stacked bricks she had in yard, and then practice stepping off the living room ottoman. She was able to independently grade the task (Motor Learning Theory) and identify ways to achieve success better than the occupational therapist (incorporating occupational adaptation into her environment).

The occupational therapist best served as a guide, support, and someone to hold the participant accountable. The participant expressed gratitude for the assistance from the occupational therapist throughout the study. She felt it was important for the occupational therapist to be involved in all aspects of her life. “I think it’s important for you to see me in my work environment.” She commented on how she felt like she needed the occupational therapist’s guidance in her final stage of recovery and return to work because she didn’t know what to do after her formal therapies ended. She admitted that she did most of the work, but wouldn’t have been able without the structure and support of the occupational therapist. The therapist made up a large part of the participant’s occupational environment. The participant stated that she appreciated the “moral support” of the occupational therapist and felt like towards the end of therapy, she didn’t need anymore “physical” suggestions, but hopes to continue the psychological support offered by the occupational therapist.

Self-efficacy – Confidence. The participant summed up how important it was for her to have confidence in her abilities by stating: “Every day I feel more confident!” “I’m doing something new every day!” “I feel like my old self, but with improvements!”

CHAPTER V

DISCUSSION AND IMPLICATIONS

The following discussion of results and implications for future research is framed in the aim of this study. The aim of this study was to examine the effectiveness of an upper extremity task oriented training program delivered at home based on current Motor Learning Theory, principles of experience-dependent neural plasticity, and the Theory of Occupational Adaptation.

The Task Oriented Training and Evaluation (TOTE Home) intervention was found to be an effective task oriented training regimen to increase functional movement in the hemiparetic upper extremity in this single-subject research study design. Contemporary Motor Learning Theory procedures that enhance neural plasticity made up the principle based rehabilitative intervention demonstrated in this study. Motor Learning Theory has evolved to combine neural science, cognitive/information processing, and psychological components of motivation and self-efficacy. This theory was strengthened even more when associated with the occupational therapy Theory of Occupational Adaptation. The translation of motor learning research into applied neurorehabilitation practice has most recently supported advances in sustainable and generalizable gains in motor skills and associated behaviors (Winstein et al., 2014). This includes an increase in not only physical activity, but also increases in habits and role-defining behaviors that contribute to true functional recovery after stroke.

TOTE Home Participants

Participants in TOTE Home demonstrated improvement in movement and function of their affected upper extremity in daily tasks that were important to each participant. The degree of improvement varied between each participant due to types of activities that were important to them (some chosen tasks were more physically taxing than others). From an Occupational Adaptation view this would represent a desire for mastery, motivation within their environment (demand for mastery), and the ability to regain or develop personally meaningful roles (press for mastery). Review of each participant's progress throughout the TOTE Home study exemplified many aspects of both Motor Learning Theory (Bass-Haugen et al., 2008; Carr & Shepherd, 1989) and the Theory of Occupational Adaptation (Schkade & Schultz, 1992; Schultz & Schkade, 1992). Kleim and Jones in their 2008 paper described many of the aspects of experience-dependent neural plasticity that was emphasized in this study. Schade and Schultz's papers from 1992 describe many of the theoretical underpinnings seen in this study as well. The schematic in Appendix Q summarizes many of the items identified in this discussion.

Participant One

Participant 1 was an 86-year-old woman motivated to recover from her stroke and was active for her age. She demonstrated significant increases in the use of her weaker arm and hand for tasks that were not as physically demanding, but still important to her (desire for mastery). The trend of her results mirrored those seen in other task oriented training interventions (Waddell, Birkenmeier, Moore, Hornby, & Lang, 2014; Winstein et al., 2016). Monitoring upper extremity movements in Participant 1 appeared more accurate with the Actigraph rather than the FitBit possibly due to her relatively sedentary lifestyle. Overall, this participant exhibited success as described in the Occupational Adaptation framework (see Appendix Q for Theory of Occupational Adaptation schematic) and appeared to achieve relative mastery in many of her chosen activities, such as brushing her teeth, sewing, writing, and cleaning her home. She generated appropriate occupational responses to various occupational challenges such as grading the task of throwing items in her living space to a "just right challenge," implementing repetitive task practice by throwing paper away in trash, and independently creating alternative methods to improve motor skills such as extending her fingers using a rubber band for resistance. She evaluated and integrated her adaptive responses by using her affected arm and hand in all activities throughout each day which increased the efficiency and effectiveness of her upper extremity movements leading to satisfaction with herself (self-efficacy). She also assessed her response outcomes of increased use of her arm and hand and incorporated the success of improved motor movement into her occupational environment thus exhibiting and rating herself as achieving relative mastery as can be seen in her self-efficacy ratings and COPM score improvements.

Participant Two

Participant 2 was a 56-year-old male who was also motivated and worked hard in his rehabilitation (similar to Participant 1). However, Participant 2 presented with ataxic movement in his affected arm and hand (sensorimotor limitations within his person). His living situation also appeared to have affected his outcomes and the amount of follow through with his therapy (occupational environment). He was currently living with his daughter and her family in a large, well-appointed home. Even though he had a good relationship with his daughter and her family, he frequently stated that he didn't feel "at home" and didn't have anything to do because it was "her house." At his original residence (prior to the stroke), he said that despite its small size, disrepair, and lack of heat, water, and safety, he felt more "at home" and had numerous tasks that he liked to perform. He enjoyed yard work, repairs, and remodeling of his own home. He did not feel like it was appropriate for him to do these kinds of tasks at his daughter's home. Participant 2 demonstrated improvements similar to those found in other studies looking at intensive therapy for individuals with ataxia from stroke (Richards et al., 2008). The significant ataxia that he exhibited was best addressed through an emphasis in heavily weighted activities in the task oriented training. His outcomes were similar to the results found in Richards et al., 2008 who concluded that individuals with ataxia from stroke can improve their motor function with intense motor practice. Because of the ataxia, the accelerometry movement measurements should be interpreted with caution. It is difficult to determine if changes in the amounts of movement where due to an increase in functional, purposeful movement or changes related to his ataxia both during the intervention and at follow-up. Using the Theory of Occupational Adaptation, this participant had the most difficulty in his physical and social occupational environment (see Appendix Q). His occupational environment impacted his motivation to increase the amount and intensity of repetitive use of his affected arm and hand, as well as regaining his roles as husband and head of his family. When Participant 2 was at his own home, he was much more active and appeared happier than when he was staying with his daughter in her home. The environmental aspects as well as the ataxia in his person component within Occupational Adaptation limited his ability to achieve relative mastery. The self-efficacy ratings and COPM scores show some improvement in relative mastery, but not to the full extent. In addition, some depressive symptoms were noted by Participant 2 on the CESD-R which could have also contributed or stemmed from these limitations. Referrals were made as appropriate. It was also questionable if the CESD-R translation into this participant's native language was adequate.

Participant Three

Participant 3 was a 61-year-old male who showed improvements, but to a lesser degree, than all other participants. This participant verbalized motivation to increase movement and function. However, he appeared to be stuck in the "sick patient" role instead of regaining his role as husband and employed worker (occupational role expectations). This was evident in the occupational therapist's lower ratings of the participant's engagement in homework activities. He expressed a low relative mastery of priority tasks despite an outward appearance of minimal physical limitations. He exhibited some of the depressive symptoms frequently cited post-stroke (Vermeer et al., 2016) that may have been exacerbated by his stay at a sub-par nursing home that offered little to no rehabilitation and appeared to encourage dependence as a resident, i.e., the nursing lacked providing occupational challenges. His current occupational environment at home was healthy with a supportive wife. She, too, however, had difficulty expecting him to meet or return to his occupational role expectations by frequently not wanting him to “overdo it” at the beginning of the study. Towards the end of the study, she appeared somewhat frustrated that the participant wasn’t generating appropriate occupational responses to meet or create occupational role expectations and preferred to sleep most of the day. Thus, she might have contributed to some of his improvement at his one-month follow-up by encouraging him to participate in functional tasks more. Overall, this participant improved, however, the lack of achieving relative mastery as described by the Theory of Occupational Adaptation may have been due to his difficulty meeting his occupational role expectations (see Appendix Q).

Participant Four

Participant 4 exemplified the need for occupational therapist to expand rehabilitation beyond the acute management of stroke to address full participation in work, family, and community life (Wolf, Baum, & Connor, 2009). She was a 57-year-old female who was mildly affected by her stroke and held a desire for mastery to return to her work (which was very physical in nature) with no limitations. She was discharged from traditional therapy protocols due to her high level of function, however, she exhibited and expressed difficulty with complex activities (occupational role expectations) that were required for her to completely return to work, care for family members, and contribute to her community. Her desire for mastery was enhanced by her motivation and intense work ethic which subsequently led to her significant improvements in movement and function even after fewer treatment sessions compared to the other participants. She was able to generate, evaluate, and integrate adaptive responses that ultimately lead to an increase in relative mastery. For example, she independently graded tasks she needed to do for work such as digging, manipulating tools, and maneuvering around difficulty physical situation to her "just right challenge" and then implemented lots of repetitive task practice to enhance her motor movement in order to complete the task as she needed to in her job (occupational challenge). According to the Theory of Occupational Adaptation, this incorporation of occupational responses into her occupational environment helped her to improve post intervention by adapting and ultimately reaching relative mastery (see Appendix Q). Hers is a shining example of the impact a mild stroke can have on participation in meaningful activity and the subsequent impact on life satisfaction (Edwards, Hahn, Baum, & Dromerick, 2006). This participant's mastery and self-efficacy had returned to her pre-stroke levels as evidenced by her ratings on her priority task and the COPM. Clear evidence of adaptation, self-efficacy, and relative mastery was noted.

TOTE Home in Relation to Theories and Other Research

Motor Learning - ExCITE and ICARE

TOTE Home had some similar results as other recent studies involving task oriented (or task specific) training (Waddell et al., 2014; Winstein et al., 2016). The repetition and intensity of training implemented in TOTE Home contributed to the improvement in motor function similar to the findings of Waddell et al. 2014. The ASAP protocol from ICARE (Winstein et al., 2013) was used as the model for TOTE Home and both studies noted improvements after task oriented training (Winstein et al., 2016) with the focus on impairment, task specificity, intensity, engagement, collaboration, client-direction, and client centered care. The ICARE study reported no significance in improving motor function or recovery beyond either an equivalent or a lower dose of usual and customary care of upper extremity rehabilitation (Winstein et al., 2016). However, there was an improvement noted in all groups of the ICARE RCT which could be evidence of the effectiveness of occupational therapy and possibly indicate components of task oriented training (such as those listed above) are aspects of usual occupational therapy treatment. TOTE Home advanced the use of the ASAP training beyond the integration of motor learning, neuroscience, and the psychology of behavior change to include implementation in the home environment to promote generalization and ongoing adaptation which could have contributed to the positive outcomes.

Both the ExCITE and ICARE randomized clinical trials were based on and supported Motor Learning Theory (Winstein et al., 2016; Wolf et al., 2006; Wolf et al., 2008). TOTE Home was guided by these trials. The demographics of the participants in ExCITE and ICARE were similar to the sample studied in TOTE Home (Winstein et al., 2013; Winstein et al., 2004). The samples studied were stroke survivors with mild to moderate hemiparesis in the subacute phase of recovery. In general, these studies focused on participants with sufficient cognition to understand and adequately participate in the interventions required through motor learning. Gender and hand dominance did not affect participation. Specifically, for TOTE Home, the participants represented males and females equally. They were between the ages of 56 and 86, and in the subacute stage of recovery (2-8 months) post stroke (3 ischemic and 1 hemorrhagic in nature). Right hand dominance pervaded, with half the participants being more affected on their dominant side. Hand dominance may have played a role in the outcomes as Participants 1 and 4 (whose dominant hand was affected) showed more improvement than Participants 2 and 3 (whose non-dominant hand was affected). The ExCITE trial showed no significant differences for concordance or disconcordance in regards to hand dominance (Wolf et al., 2006). However, in TOTE Home, the tendency to use the dominant hand could have aided recovery by increasing the repetition and intensity of practice with the affected hand. Cognition was within a range from 24-30 which is considered normal in all participants as measured by the MMSE (Folstein et al., 2002). All participants identified multiple meaningful goals for movement and function of their affected upper extremity. Motivation to recover functional motor movement was pervasive throughout the ExCITE, ICARE, and TOTE Home studies which contributed to the success using the Motor Learning Theory.

Salience and specificity are experience dependent neuroplasticity principles that are key to motor learning. These principles are directly related to how a participant rates the effectiveness of activities they perform in rehabilitation. It is important that participants engage in activities they feel are meaningful and at the appropriate skill level in order to foster these neuroplasticity principles. The ASAP intervention in ICARE focused on meaningful tasks to encourage motivation and improve self-efficacy. Similarly, in TOTE Home, activities focused on client directed tasks. For TOTE Home, ratings from the participants and the therapist regarding effectiveness and engagement in work outside of treatment sessions varied greatly between each participant. The therapist's ratings of engagement mostly matched that of each participant's ratings of effectiveness, with the exception of Participant 3 (he tended to rate effectiveness higher than the therapist rated his engagement). The ratings were based on the participant's overall feeling, and the occupational therapist's perceived evidence of the work done by the participant.

Upper extremity movement outcomes. Ultimately, the goal of Motor Learning Theory is to improve movement and function in the affected limb after a neurological incident. The ExCITE trial noted improvements in upper extremity movement after constraint induced movement therapy as measured by the Wolf Motor Function Test, the Motor Activity Log, and the Stroke Impact Scale (Wolf et al., 2006; Wolf et al., 2008). The ICARE study found increases in arm and hand functional movements as noted by the Wolf Motor Function Test and the Stroke Impact Scale after task oriented training (Winstein et al., 2016). TOTE Home also found improvements after task oriented training as measured by accelerometry.

All participants in TOTE Home demonstrated an increase of upper extremity movement of the affected arm and hand as recorded by accelerometry (FitBit and Actigraph) from baseline to 1-month follow-up. Several significant differences were noted between study phases in Actigraph recordings with mostly medium effects. Most participants showed an increase in the amount of movement recorded by number of Actigraph steps from baseline, through intervention, and to post-intervention. Most improvements were at least maintained, or increased through 1-month follow-up. Overall, more of a change in movement was noted with each participant's affected side. Most improvements were evident in a decrease in the percentage of time spent in sedentary activity and an increase in the percentage of time spent in light activity. The percentage of time spent in moderate activity did not vary as much throughout the study. With current evidence suggesting increases in levels of activity to reduce the risk of stroke, this is a critical finding on the overall importance of therapy to increase motor function and participation in meaningful occupations.

The way in which upper extremity movement is measured varies somewhat between studies. In TOTE Home, the Actigraph recorded significantly more movements than the FitBit, which is reflective of previous studies citing the Actigraph as the "gold standard" measurement for upper extremity movement research (Bailey & Lang, 2013). This difference in Actigraph measurement compared to Fitbit was most evident with participants who had less movement overall, possibly reflective of the sensitivity of the Actigraph to measure finer movements compared to the FitBit. Participant 1, in particular, demonstrated less movement overall due to the activities she prefers requiring less physical movement. She is an example of how the Actigraph would be a more accurate device to detect her minimum movements. For researchers, this would endorse the use of the Actigraph as a more accurate measurement of motor function in the upper extremity from a lower functioning level client. Although the FitBit is capable of yielding a cursory evaluation of upper extremity movement clinically and might be found to yield acceptable outcomes, however, further testing is required.

An easily accessible and simple accelerometer like the FitBit could be a way to clinically monitor a client's upper extremity movement as a quantifiable outcome measure. This study found that while the FitBit and Actigraph were correlated, there was a significant difference in the number of steps counted by each accelerometer. The FitBit measured significantly fewer steps than the Actigraph. Further studies are needed to determine the sensitivity of the FitBit to measure small increments of movement compared to more gross motor movement. Additional testing may reveal certain types of movements or certain patient populations may better benefit from a device like the Actigraph or the less expensive FitBit.

Occupational Adaptation – Relative Mastery

While the Motor Learning Theory provides the principles in which to base task oriented training intervention, the Theory of Occupational Adaptation provides a framework for interpreting the progress of each participant. Previous studies utilizing the Theory of Occupational Adaptation with clients who have had a stroke have found clients being discharged to less restrictive settings (Gibson & Schkade, 1997), an increase in dynamic standing endurance with participation in meaningful tasks (Dolecheck & Schkade, 1999), and improved functional mobility along with increased internal adaptation, generalization, and relative mastery (Johnson & Schkade, 2001).

In TOTE Home, the amount of adaptation experienced by the participants appeared to be directly related to the amount of relative mastery that was achieved. This is most evident in participant's ability to problem solve, i.e., identifying areas that need improvement, figuring out ways to improve upon deficits, altering the environment to facilitate that "just right challenge", and utilizing repetition and intensity of practice to gain motor skills. Self-efficacy was also a common theme that pertained to all participants. The more confident that the participant felt in their abilities, the more satisfied and successful they were with their performance.

In regards to self-efficacy or confidence as a repeated measure, Participant 1 had no confidence in brushing her teeth with her affected hand prior to the intervention. She steadily improved during the intervention, maintained her self-efficacy during the post-intervention evaluation, and slightly improved to almost complete confidence 1-month later. At the completion of her participation, she stated that she wasn't exactly perfect with brushing her teeth yet, but close to it. Participant 2 did not show as much change in his self-efficacy for buttoning his shirt. There was some increase in confidence exhibited during the intervention that was mostly maintained at the post-intervention evaluation and after 1-month, however, the participant could still not button his shirt with his affected hand and thus did not achieve complete confidence in completing this task. His ataxia appeared to limit his function and thus his confidence to complete tasks that were important to him. Participant 3 also chose buttoning his shirt as his priority task. He started with more function and confidence in his affected arm and hand and exhibited a steady increase in self-efficacy for this task throughout the rest of the study. His ratings of confidence at the end of the study was almost at the ceiling, but he cited a lack of efficiency and speed in buttoning that decreased his confidence. Participant 4 began the study with a much higher level of self-confidence compared to the other participants. The priority task she chose (to use her affected arm and hand normally at work) was much more strenuous physically than the other participant's chosen tasks. Despite this more difficult activity, Participant 4 expressed a steady increase in her confidence during the intervention, and complete self-efficacy for this large task during the post-intervention evaluation that was maintained 1-month later. Overall, participants rated an improvement in function for their priority task which emphasizes relative mastery as interpreted by the Theory of Occupational Adaptation.

Other TOTE Home Outcomes Interpreted through the Theory of Occupational Adaptation. Change scores can be utilized to access differences between baseline, post-intervention, and 1-month follow-up phases of the TOTE Home study. Each standardized measure is better understood within TOTE Home when interpreted through the Theory of Occupational Adaptation.

Canadian Occupational Performance Measure (COPM). The COPM (see Appendix D) is designed to detect change in a client's self-perception of occupational performance over time (Law et al., 2005). The COPM was an excellent measure used in TOTE Home to set specific participant-centered goals in occupational performance such as brushing teeth, buttoning buttons, and completing work activities. The COPM was also used to provide a rating of the participants' priorities in occupational performance, evaluate performance and satisfaction relative to those problem areas, and measure changes in the participant's perception of his or her occupational performance over the course of the intervention. The COPM helped participants to define specific activities that represented their desire, demand, and press for relative mastery. It also helped monitor Participants' adaptive response generation subprocess and incorporation of occupational responses into their occupational environment. All participants exceeded the minimal detectable change on the COPM. This is evidence of an increase in relative mastery through each participant's self-perception of occupational responses over time in relation to the intervention which persisted for at least one month.

Fugl-Meyer Assessment for the upper extremity (FMA). The FMA for the upper extremity (see Appendix J) is an assessment based on Brunnstrom's stages of recovery from stroke (Fugl-Meyer, 1980) and was used in the TOTE Home study as an outcome measurement of motor recovery. All participants exceeded the minimal detectable change on the upper extremity portion of the Fugl-Meyer which is remarkable evidence of post-stroke hemiplegic recovery of the affected upper extremity. This is an analysis of the sensorimotor element within the person which directly affects one's desire for mastery.

Motor Activity Log (MAL). The MAL (see Appendix K) was utilized as a standardized measure of real-world arm use before and after TOTE Home intervention. Participants were asked to rate how much (Amount of Use scale) and how well (Quality of Movement scale) they used their more-affected arm for 30 ADL/IADL items (Taub et al., 1993). A minimal detectable change has not been determined for the MAL. However, an average rating of "3" (used weaker arm about half as much as before the stroke) was used in the ExCITE clinical trial to define learned non-use of the affected upper extremity for inclusion criteria (Winstein et al., 2004). Half of the participants in this study (Participants 1 and 2) began with scores that met this criterion and participant 3 almost met this criterion at baseline. Immediately following the intervention, all participants rated the amount of use of their affected upper extremity higher than a "3" which could indicate their overcoming "learned non-use." The MAL goes beyond determining how much a person uses their affected arm and hand during functional tasks, but also asks how well the person thinks they are performing the tasks. The "how much" score could be interpreted as use of time and energy, while the "how well" score could be interpreted as effectiveness and satisfaction to self and others. The Occupational Adaptation definition of relative mastery includes use of time and energy towards an effective, desired result that is satisfying to self and others. So the MAL could be used as an excellent indicator relative mastery.

Stroke Impact Scale (SIS) – Recovery question. The SIS (Duncan, Goldstein, Matchar, Divine, & Feussner, 1992) recovery question was used as a rating of recovery of the affected arm and hand in the TOTE Home study. Only the last question concerning perception of upper extremity hemiparesis recovery was asked in this study (see Appendix L). This measure appears to be reflective of the amount of overall improvements noted in various outcomes for each participant. Participants 1 and 4 steadily improved throughout the study and report activities that would allude to their continued recovery. Participants 2 and 3 appeared with some improvement in recovery, but questionable follow-through with sustained recovery. Occupational Adaptation could interpret this score as an overall, general measure of relative mastery. It is a very global score, but one that could be assessed first in order to delve further into the specifics of why a person feels they have (or have not) recovered.

Functional Test of the Hemiparetic Upper Extremity (FTHUE). The FTHUE (see Appendix M) (Wilson, 1984) was used to evaluate the functional motor capability of the participants in TOTE Home. The use of this assessment seemed better at clinically evaluating the perceived motor capability of function by the occupational therapist and the participant. The process utilized by each participant gave both parties insight into capabilities and inabilities that were used in functional tasks, much like the way the FTHUE was utilized in the ICARE clinical trial (Winstein et al., 2013). This measurement best served this study as a subjective tool to assist in treatment planning rather than an objective measurement of function. In this way, the FTHUE can help operationalize the process outlined in the Theory of Occupational Adaptation. It can help both the client and the therapist identify the press for mastery, occupational challenges and responses, as well as the adaptive response and assessment of response processes.

Home Environment

TOTE Home utilized tasks that were meaningful to the participants and specifically defined by each participant and therapist together within the participant's home environment. Participants understood and became a collaborative partner with the therapist. The participants did this by identifying goals and assessing progress with the therapist that directly related to activities in the participant's home. The therapist initially provided more help in managing the environment at the beginning of TOTE Home, then progressively decreased the level of assistance provided to promote the participant's adaptive processes through graded, independent problem-solving, and ultimately mastery.

The chosen tasks worked on during TOTE Home where directly linked to each participant's identified occupational roles within their social and cultural environment to help guide intervention. Ultimately, the role was found to be more important than the tasks. It was through the roles that the tasks took on meaning. Tasks were graded at the appropriate challenge points for each participant within their role.

The physical and social environment interaction also played a major role in facilitating or hindering progress. Activities within specific living environments were pursued based on participant's motivation and encouragement from others. For example, Participant 2 was not able to fully achieve his role of head of the household while living in his daughter's house. Participant 3 could not overcome the "patient" role and frequently referred to himself as "sick" or able to do things when he was "better."

How TOTE Home Can Advance Practice

The results from the single-subject design implemented in TOTE Home can help to advance neurorehabilitation practice both with its findings and with its methodology. The single-subject design is an ideal method to evaluate interventions as they are delivered into practice settings with actual clients. It allows one to objectively monitor specific client characteristics over time in order to better understand and predict individual performances. It is a formal research methodology that supports evidence based practice by bringing more rigor into clinical work for improved service to clients. In this way, using a single-subject design while implementing task oriented training bridges the translational research gap between group research design and actual clinical practice. By applying theories such as Motor Learning and Occupational Adaptation in a clinically feasible way, TOTE Home can serve as an example of how to further the science of occupational therapy. Hopefully the findings from TOTE Home can be replicated and improved upon with further study on task oriented training.

Strengths and Weaknesses

This study implemented several aspects of current evidence based practice from the fields of neuroscience, psychology, and physical rehabilitation. It was conducted in the participant's home which makes it convenient for clients and appropriate for real life activities to be addressed. Encouraging adaptation in the participant's home setting also facilitates long term generalization beyond when the structured therapy sessions end. Although more participants would be needed to better validate TOTE Home to a larger population, this sample was equally representative of genders and hand dominance. Implementing 30 treatment sessions may also not be representative of traditional home health occupational therapy length of service, however, it allowed proof of concept.

Summary

The overall goal of TOTE Home was adaptation, specifically; to use meaningful occupations within a participant's own occupational environment to increase the adaptive use of his or her affected upper extremity. By engaging in activities that were at the "just right challenge," the participants regained old or establish new routines, habits, and roles. Ultimately, relative mastery enabled the participants to continue to adapt to occupational challenges which will affect them throughout his or her lifespan. This study contributes to the effectiveness of task oriented training. It also reinforces the patterns of behavior exhibited by the therapist under the Motor Learning Theory of coaching, cheerleading, reminding, changing, and contemplating (Boylstein et al., 2005).

Implications for Future Research

Future research in this area is needed to determine the ideal "dose" of task oriented training. The exact amount of practice needed to yield positive results needs to be determined based on a variety of factors such as client characteristics, environment, and severity of stroke. The idea of neurorehabilitation as an ongoing process, as concluded by Gillot in 2003 (Gillot et al., 2003), may be reinforced with secondary results from TOTE Home. The idea that the factor of hand dominance may contribute to the amount of motivation also warrants further examination. Are people more motivated to use their dominant upper extremity when it is affected by a stroke more so than those whose non-dominant arm and hand are affected? Continued analysis of the components of task oriented training need to be further clarified and perhaps related to physiological measures of brain plasticity through the use of functional MRIs. The clinical utility of accelerometry as a measure of functional motor improvements still warrants more study to consider the types and amounts of movements assessed. Accelerometers also may appear to serve as a motivator if they can provide clients with feedback about their progress. Finally, preparatory and/or alternative contemporary motor learning interventions need to be assessed in conjunction with task oriented training to see if they can enhance or quicken results. Perhaps treatments such as mirror therapy, action observation, and transcranial magnetic stimulation could be used with task oriented training or used prior to training for those individuals who do not exhibit the minimum amount of movement needed for task oriented training.

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APPENDIX A

Schematic of Methods

<u>TOTE Home (AB single subject design with follow-up)</u>

	Session 1	Sessions 2-31	Session 32	Session 33
<u>Screen</u>	**<u>Baseline</u>**	**<u>TOTE Home</u>**	**<u>Post TOTE Home</u>**	**<u>Follow-up (1 month)</u>**
Minimal movement MMSE CESD-R COPM	FMA MAL FTHUE SIS SAFER-Home Revisit COPM Orientation to TOTE Home	30 tx sessions (3x/wk for 10 wks)	FMA MAL FTHUE SIS COPM	FMA MAL FTHUE SIS COPM
	Accelerometry 8 data points	Accelerometry 10 data points	Accelerometry 8 data points	Accelerometry 8 data points
	Self-Efficacy Rating Scale 8 data points	Self-Efficacy Rating Scale 10 data points	Self-Efficacy Rating Scale 8 data points	Self-Efficacy Rating Scale 8 data points
		"Homework" Participant rates effectiveness (30 data points) OT rates engagement (30 data points)		
	2 weeks	10 weeks (3x/week)	2 weeks	2 weeks

APPENDIX B

Recruitment Material and Script

Veronica T. Rowe business card to be used for recruitment:

<u>Recruitment script</u>

You are being asked to participate in a research study for Mrs. Veronica Rowe at Texas Woman's University and the University of Central Arkansas. The purpose of this research is to find out if an at-home treatment method is helpful in increasing the use of the weaker arm and hand that results from a stroke. You have been asked to participate in this study because you have had a stroke and have a weaker arm and hand.

As a participant in this study you will be asked to be evaluated at the beginning and end of treatment and 1 month later with different tests about how your stroke has affected you. Each evaluation session will last about 2 hours. The different tests will require you to move your arms and hands, do various daily activities with your arms and hands, and answer some questions about how you feel since your stroke. You will also be asked to wear 2 devices that are about the size and shape of a wristwatch (see picture below) on both wrists for 24 hour periods. You will be asked to wear these 8 times before treatment begins, once weekly during treatment, 8 times immediately after treatment, and 8 times one month following the end of treatment. They can withstand all of your regular daily activities, including getting wet. You can continue normal, everyday activity while wearing the devices. If they bother you at all, you may remove them at any time.

This is what the devices that go on your wrists look like:

There will be up to 30 treatment sessions in your home that last about 1 hour. The total minimum amount of time required for you to participate would be 36 hours (2 hours for the first evaluation, 30 hours of treatment sessions, 2 hours for the second evaluation, and 2 hours for the final evaluation 1 month later). During treatment sessions, you will be asked to work on activities around your home involving repetitively using your weaker arm and hand possibly wearing a soft, easily removable mitt on (see picture below) on your stronger hand during activities that you agree on and at times that are safe for you to do so. The mitt will be a reminder to you to use your weaker arm and hand. You may remove the mitt at any time. The mitt will not cost you anything.

This is what the mitt looks like:

All therapy and setup of activities that we do during treatment will not cost you anything. During any session, you will be allowed and encouraged to take frequent rest breaks as needed. You will also be asked to work on using your weaker arm and hand on your own when Veronica Rowe is not with you. You may become tired during testing and/or treatment sessions. You may take as many rest breaks as you want. You may also stop participating at any time.

In order to be a participant in this study, you must be at least 21 years of age or older, have had a stroke, and have a weaker arm and hand because of the stroke. Only general demographic information will be collected and recorded including your gender, age, time since stroke, type of stroke, living situation, dominant hand, and side affected by the stroke. Any data collected that contains your name or any specific identifiable information will be kept separate from the study data.

Your involvement in this study is completely voluntary and you may withdraw from the study at any time. With your participation, you will receive the treatment being studied for weaker arms and hands after a stroke. This study will help determine if it is possible and helpful to do this therapy at home using everyday activities. This will assist the therapists in the future who treat people who have had a stroke.

APPENDIX C

Demographics, Inclusion, and Exclusion Criteria Form

Participant code:________________

Contact information:

Phone:____

Address:____

Gender: Male Female

Age:________

Date of stroke:____________

Type of stroke:_____________________________

Living situation:____

Dominant hand: Right Left

Side affected by the stroke: Right Left

	Yes	No
Minimal Movement criteria		
10 degrees of wrist movement		
10 degrees of elbow movement		
10 degrees of shoulder movement		
10 degrees of movement in the thumb		
10 degrees of movement in 2 other fingers (index, middle, ring, little)		
Inclusion criteria		
21 years of age or older		
English speaking		
3-12 months post CVA		
Completed formal occupational therapy		
MMSE - score 23 or greater		
COPM – identified 5 goals/tasks		
Exclusion criteria		
CESD-R – score less than 16		
Upper extremity pain interfering with ADLs		
Maximum assistance for mobility		
Arm or hand injury		
Amputation		
Other diagnoses or limiting conditions that would affect participation		
Inability to participate due to any illness, social, geographic, etc., reason		

APPENDIX D

Mini-Mental Status Exam Form (MMSE), 2nd Edition

MMSE™

Date of Examination ____ / ____ / ____ Examiner ____________________

Name ______________________________ Age ______ Years of School Completed ______

Instructions: Words in boldface type should be read aloud clearly and slowly to the examinee. Item substitutions appear in parentheses. Administration should be conducted privately and in the examinee's primary language. Circle 0 if the response is incorrect, or 1 if the response is correct. Begin by asking the following two questions.

Do you have any trouble with your memory? **May I ask you some questions about your memory?**

ORIENTATION TO TIME

		RESPONSE	SCORE (circle one)	
What is the...	**year?**	____________	0	1
	season?	____________	0	1
	month of the year?	____________	0	1
	day of the week?	____________	0	1
	date?	____________	0	1

ORIENTATION TO PLACE*

Where are we now? What is the...

state (province)**?**	____________	0	1
county (or city/town)**?**	____________	0	1
city/town (or part of city/neighborhood)**?**	____________	0	1
building (name or type)**?**	____________	0	1
floor of the building (room number or address)**?**	____________	0	1

*Alternative place words that are appropriate for the setting and increasingly precise may be substituted and noted.

REGISTRATION*

Listen carefully. I am going to say three words. You say them back after I stop. Ready? Here they are... APPLE [*pause*], **PENNY** [*pause*], **TABLE** [*pause*]. **Now repeat those words back to me.** [*Repeat up to 5 times, but score only the first trial.*]

APPLE	____________	0	1
PENNY	____________	0	1
TABLE	____________	0	1

Now keep those words in mind. I am going to ask you to say them again in a few minutes.

*Alternative word sets (e.g., PONY, QUARTER, ORANGE) may be substituted and noted when retesting an examinee.

ATTENTION AND CALCULATION [Serial 7s]*

Now I'd like you to subtract 7 from 100. Then keep subtracting 7 from each answer until I tell you to stop.

What is 100 take away 7?	[93]	____________	0	1
If needed, say: **Keep going.**	[86]	____________	0	1
If needed, say: **Keep going.**	[79]	____________	0	1
If needed, say: **Keep going.**	[72]	____________	0	1
If needed, say: **Keep going.**	[65]	____________	0	1

*Alternative item (WORLD backward) should only be administered if the examinee refuses to perform the Serial 7s task. ⟶

PAR Psychological Assessment Resources, Inc. • 16204 N. Florida Avenue • Lutz, FL 33549 • 1.800.331.8378 • www.parinc.com

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Substitute and score this item only if the examinee refuses to perform the Serial 7s task.

Spell WORLD forward, then backward.
Correct forward spelling if misspelled,
but score only the backward spelling.

____	____	____	____	____	______
(D = 1)	(L = 1)	(R = 1)	(O = 1)	(W = 1)	(0 to 5)

RECALL	RESPONSE	SCORE *(circle one)*	
What were those three words I asked you to remember? [*Do not offer any hints.*]			
APPLE	______________________	0	1
PENNY	______________________	0	1
TABLE	______________________	0	1

NAMING*

What is this? [*Point to a pencil or pen.*]	______________________	0	1
What is this? [*Point to a watch.*]	______________________	0	1

*Alternative common objects (e.g., eyeglasses, chair, keys) may be substituted and noted.

REPETITION

Now I am going to ask you to repeat what I say. Ready? "NO IFS, ANDS, OR BUTS." Now you say that.
[*Repeat up to 5 times, but score only the first trial.*]

NO IFS, ANDS, OR BUTS.	______________________	0	1

Detach the next page along the lengthwise perforation, and then tear it in half along the horizontal perforation. Use the upper half of the page (blank) for the Comprehension, Writing, and Drawing items that follow. Use the lower half of the page as a stimulus form for the Reading ("CLOSE YOUR EYES") and Drawing (intersecting pentagons) items.

COMPREHENSION

Listen carefully because I am going to ask you to do something.
Take this paper in your right hand [*pause*], **fold it in half** [*pause*], **and put it on the floor (*or* table).**

TAKE IN RIGHT HAND	______________________	0	1
FOLD IN HALF	______________________	0	1
PUT ON FLOOR (*or* TABLE)	______________________	0	1

READING

Please read this and do what it says. [*Show examinee the words on the stimulus form.*]

CLOSE YOUR EYES	______________________	0	1

WRITING

Please write a sentence. [*If examinee does not respond, say:* **Write about the weather.**] 0 1

Place the blank piece of paper (unfolded) in front of the examinee and provide a pen or pencil. Score 1 point if the sentence is comprehensible and contains a subject and a verb. Ignore errors in grammar or spelling.

DRAWING

Please copy this design. [*Display the intersecting pentagons on the stimulus form.*] 0 1

Score 1 point if the drawing consists of two 5-sided figures that intersect to form a 4-sided figure.

Total Score = ________
(Sum all item scores.) (30 points max.)

Assessment of level of consciousness.

Alert/ Responsive	Drowsy	Stuporous	Comatose/ Unresponsive

APPENDIX E

Canadian Occupational Performance Measure (COPM)

Canadian Occupational Performance Measure (COPM)

Authors: Mary Law, Sue Baptiste, Anne Carswell, Mary Ann McColl, Helene Polatajko, Nancy Pollock

Client Name:		
Respondent (if not client:)		
DOB:	ID#:	Gender:
Date of Assessment:	Planned Date of Reassessment:	Actual Date of Reassessment:

Therapist:
Facility/Agency:
Program:

STEP 1: IDENTIFICATION OF OCCUPATIONAL PERFORMANCE ISSUES

To identify occupational performance problems, ask clients to identify daily activities which they **want to do, need to do** or **are expected to do** but **can't do, don't do,** or **aren't satisfied with how they do.**

STEP 2: RATING IMPORTANCE

Using scoring card provided, ask client to rate, on a scale of 1 to 10, the importance of each activity

STEP 1A: Self-Care

IMPORTANCE

Personal Care
(e.g., dressing, bathing, feeding, hygiene)

Functional Mobility
(e.g., transfers, indoor, outdoor)

Community Management
(e.g., transportation, shopping, finances)

STEP 1B: Productivity

IMPORTANCE

Paid/Unpaid Work
(e.g., finding/keeping a job, volunteering)

Household Management
(e.g., cleaning, laundry, cooking)

Play/School
(e.g., play skills, homework)

DOB:	ID#

STEP 1C: Leisure

	IMPORTANCE
Quiet Recreation (e.g., hobbies, crafts, reading)	
Active Recreation (e.g., sports, outings, travel)	
Socialization (e.g., visiting, phone calls, parties, correspondence)	

STEP 3: SCORING

Confirm with the client the 5 most important problems and record them below. Using the scoring cards, ask the client to rate each problem on performance and satisfaction, then calculate the total scores. Total scores are calculated by adding together the performance or satisfaction scores for all problems and dividing by the number of problems.

STEP 4: RE-ASSESSMENT

At an appropriate interval for re-assessment, the client again scores each of the problems selected for performance and satisfaction.

Initial Assessment: Occupational Performance Problems:	PERFORMANCE 1	SATISFACTION 1	**Reassessment:** PERFORMANCE 2	SATISFACTION 2
1.				
2.				
3.				
4.				
5.				

SCORING:	PERFORMANCE SCORE 1	SATISFACTION SCORE 1	PERFORMANCE SCORE 2	SATISFACTION SCORE 2
Total score = Total performance or satisfaction scores / Number of problems (1-5)	/ =	/ =	/ =	/ =

STEP 5: COMPUTING CHANGE SCORES

CHANGE IN PERFORMANCE = Performance Score 2 ____ − Performance Score 1 ____ = ____

CHANGE IN SATISFACTION = Satisfaction Score 2 ____ − Satisfaction Score 1 ____ = ____

ADDITIONAL NOTES AND OBSERVATION:

Initial Assessment:

Reassessment:

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APPENDIX F

Center for Epidemiologic Studies Depression Scale-Revised (CESD-R)

Below is a list of the ways you might have felt or behaved. Please check the boxes to tell me how often you have felt this way in the past week or so.	LAST WEEK				Nearly every day for 2 weeks
	Not at all *or* Less than 1 day	1-2 days	3-4 days	5-7 days	
My appetite was poor.	○	○	○	○	○
I could not shake off the blues.	○	○	○	○	○
I had trouble keeping my mind on what I was doing.	○	○	○	○	○
I felt depressed.	○	○	○	○	○
My sleep was restless.	○	○	○	○	○
I felt sad.	○	○	○	○	○
I could not get going.	○	○	○	○	○
Nothing made me happy.	○	○	○	○	○
I felt like a bad person.	○	○	○	○	○
I lost interest in my usual activities.	○	○	○	○	○
I slept much more than usual.	○	○	○	○	○
I felt like I was moving too slowly.	○	○	○	○	○
I felt fidgety.	○	○	○	○	○
I wished I were dead.	○	○	○	○	○
I wanted to hurt myself.	○	○	○	○	○
I was tired all the time.	○	○	○	○	○
I did not like myself.	○	○	○	○	○
I lost a lot of weight without trying to.	○	○	○	○	○
I had a lot of trouble getting to sleep.	○	○	○	○	○
I could not focus on the important things.	○	○	○	○	○

To be scored via the internet at: http://cesd-r.com/ (Eaton, Ybarra, & Schwab, 2012)

APPENDIX G

Image of Accelerometers

Actigraph'sBluetooth® Smart wGT3X-BT
wireless activity monitor
(ActiGraph, Pensacola, FL)

The FitBit® Flex™
(www.fitbit.com)

APPENDIX H

Brief Self-Efficacy Rating Scale

Brief Self-Efficacy Rating Scale

On a scale of 0 - 10, how confident are you that you can

____?
(fill in specific PRIORITY activity)

Circle a number below to indicate your confidence level.

0	1	2	3	4	5	6	7	8	9	10
no confidence					Moderate confidence				complete confidence	

What can we do this week to make you more confident?____________________________

____

____

____

APPENDIX I

Participant Ratings of Effectiveness and Occupational Therapist Ratings of Participant Engagement Pertaining to "Homework" Activities

<u>Participant ratings of effectiveness of "homework" (assessed at the beginning of each training session).</u>

On a scale of 1 - 4, rate the effectiveness of the activities you did since our last meeting.

1	2	3	4
all activities ineffective	some activities effective	most activities effective	all activities very effective

<u>Occupational Therapist ratings of participant's engagement in "homework" (assessed at the beginning of each training session).</u>

On a scale of 1 - 4, rate the participant's level of engagement in activities outside of the training sessions since the last meeting.

1	2	3	4
no effort, did not attempt	some effort	great effort/engagement	great effort/engagement, apparently practiced diligently

APPENDIX J

Fugl-Meyer Assessment (FMA) of Upper Extremity Form

FUGL-MEYER ASSESSMENT OF UPPER EXTREMITY FUNCTION FORM

<table>
<tr><th colspan="5">JOINT MOTION & PAIN</th></tr>
<tr><th>JOINT</th><th>MOVEMENT</th><th>ROM SCORE</th><th>PAIN SCORE</th><th>SCORING CRITERIA</th></tr>
<tr><td rowspan="4">6. Shoulder</td><td>Flexion</td><td>a.</td><td>b.</td><td rowspan="6">ROM Scoring
0-Only a few degrees of motion
1-Decreased passive range of motion
2-Normal passive range of motion</td></tr>
<tr><td>Abduction to 90^0</td><td>c.</td><td>d</td></tr>
<tr><td>External Rotation</td><td>e.</td><td>f.</td></tr>
<tr><td>Internal Rotation</td><td>g.</td><td>h.</td></tr>
<tr><td rowspan="2">7. Elbow</td><td>Flexion</td><td>a.</td><td>b.</td></tr>
<tr><td>Extension</td><td>c.</td><td>d.</td></tr>
<tr><td rowspan="2">8. Wrist</td><td>Flexion</td><td>a.</td><td>b.</td><td rowspan="6">Pain Scoring
0-Marked pain at end of range or pain through range
1-Some pain
2-No pain</td></tr>
<tr><td>Extension</td><td>c.</td><td>d.</td></tr>
<tr><td rowspan="2">9. Fingers</td><td>Flexion</td><td>a.</td><td>b.</td></tr>
<tr><td>Extension</td><td>c.</td><td>d.</td></tr>
<tr><td rowspan="2">10. Forearm</td><td>Pronation</td><td>a.</td><td>b.</td></tr>
<tr><td>Supination</td><td>c.</td><td>d.</td></tr>
<tr><td colspan="2">11. Total Scores:</td><td>a.</td><td>b.</td><td></td></tr>
</table>

<table>
<tr><th colspan="4">SENSATION</th></tr>
<tr><th>TYPE OF SENSATION</th><th>AREA</th><th>SCORE</th><th>SCORING CRITERIA</th></tr>
<tr><td rowspan="2">12. Light Touch</td><td>Upper Arm</td><td>a.</td><td rowspan="2">0-Anesthesia
1-Hyperesthesia / dysesthesia
2-Normal</td></tr>
<tr><td>Palm of Hand</td><td>b.</td></tr>
<tr><td rowspan="4">13. Proprioception</td><td>Shoulder</td><td>a.</td><td rowspan="4">0-No Sensation
1-75% of answers are correct, but considerable difference in sensation relative to unaffected side
2- All answers are correct, little or no difference</td></tr>
<tr><td>Elbow</td><td>b.</td></tr>
<tr><td>Wrist</td><td>c.</td></tr>
<tr><td>Thumb</td><td>d.</td></tr>
<tr><td colspan="2">14. Total Score:</td><td></td><td></td></tr>
</table>

MOTOR FUNCTION (in sitting)			
TEST	ITEM	SCORE	SCORING CRITERIA
14. Reflexes	Biceps	a.	0-No reflex activity can be elicited
	Triceps	b.	2-Reflex activity can be elicited
15. Flexor Synergy	Elevation	a.	0-Cannot be performed at all
	Shoulder retraction	b.	1-Performed partly
	Abduction (at least 90^0)	c.	2-Performed faultlessly
	External rotation	d.	
	Elbow flexion	e.	
	Forearm supination	f.	
16. Extensor Synergy	Shoulder add./int. rot.	a.	0-Cannot be performed at all
	Elbow extension	b.	1-Performed partly
	Forearm pronation	c.	2-Performed faultlessly
17. Movement combining synergies	Hand to lumbar spine	a.	0-No specific action performed 1-Hand must pass anterior superior iliac spine 2-Performed faultlessly
	Shoulder flexion to 90^0, elbow at 0^0	b.	0-Arm is immediately abducted, or elbow flexes at start of motion 1-Abduction or elbow flexion occurs in later phase of motion 2-Performed faultlessly
	Pronation/supination of forearm with elbow at 90^0 & shoulder at 0^0	c.	0-Correct position of shoulder and elbow cannot be attained, and/or pronation or supination can-not be performed at all 1-Active pronation or supination can be performed even within a limited range of motion, and at the same time the shoulder and elbow are correctly positioned 2-Complete pronation and supination with correct positions at elbow and shoulder
18.Movement out of synergy	Shoulder abduction to 90^0, elbow at 0^0, and forearm pro- nated	a.	0-Initial elbow flexion occurs, or any deviation from pronated forearm occurs 1-Motion can be performed partly, or, if during motion, elbow is flexed, or forearm cannot be kept in pronation 2-Performed faultlessly
	Shoulder flexion 90-180^0, elbow at 0^0, and forearm in mid-position	b.	0-Initial flexion of elbow or shoulder abduction occurs 1-Elbow flexion or shoulder abduction occurs during shoulder flexion 2- Performed faultlessly

MOTOR FUNCTION (continued)			
TEST	ITEM	SCORE	SCORING CRITERIA
18.Movement out of synergy	Pronation/supination of forearm, elbow at 0^0 and shoulder between $30\text{-}90^0$ of flexion	c.	0-Supination and pronation cannot be performed at all, or elbow and shoulder positions cannot be attained 1-Elbow and shoulder properly positioned and pronation and supination performed in a limited range 2-Performed faultlessly
19. Normal reflex activity (This stage is only included if the patient attains a score of 6 in stage V)	Biceps and/or finger flexors and triceps		0-At least 2 of the 3 phasic reflexes are markedly hyperactive 1-One reflex is markedly hyperactive, or at least 2 reflexes are lively 2-No more than one reflex is lively and none are hyperactive
20. Wrist	Stability, elbow at 90^0, shoulder at 0^0	a.	0-Patient cannot dorsiflex wrist to required 15^0 1-Dorsiflexion is accomplished, but no resistance is taken 2-Position can be maintained with some (slight) resistance
	Flexion/extension, elbow at 90^0, shoulder at 0^0	b.	0-Volitional movement does not occur 1-Patient cannot activley move the wrist joint throughout the total range of motion 2-Faultless, smooth movement
	Stability, elbow at 0^0, shoulder at 30^0	c.	0-Patient cannot dorsiflex wrist to required 15^0 1-Dorsiflexion is accomplished, but no resistance is taken 2-Position can be maintained with some (slight) resistance
	Flexion/extension, elbow at 0^0, shoulder at 30^0	d.	0-Volitional movement does not occur 1-Patient cannot activley move the wrist joint throughout the total range of motion 2-Faultless, smooth movement
	Circumduction	e.	0-Cannot be performed 1-Jerky motion or incomplete circumduction 2-Complete motion with smoothness
21. Hand	Finger mass flexion	a.	0-No flexion occurs 1-Some flexion, but not full motion 2-Complete active flexion (compared with unaffected hand)

TEST	ITEM	SCORE	SCORING CRITERIA
21. Hand	Finger mass extension	b.	0-No extension occurs 1-Patient can release an active mass flexion grasp 2-Full active extension
	Grasp I - MCP joints extended and proximal & distal IP joints are flexed; grasp is tested against resistance	c.	0-Required position cannot be acquired 1-Grasp is weak 2-Grasp can be maintained against relatively great resistance
	Grasp II - Patient is instructed to adduct thumb, with a scrap of paper interposed, all other joints at 0^0	d.	0-Function cannot be performed 1-Scrap of paper interposed between the thumb and index finger can be kept in place, but not against a slight tug 2-Paper is held firmly against a tug
	Grasp III - Patient opposes thumb pad against the pad of index finger, with a pencil interposed	e.	0-Function cannot be performed 1-Pencil interposed between the thumb and index finger can be kept in place, but not against a slight tug 2-Pencil is held firmly against a tug
	Grasp IV - The patient should grasp a can by opposing the volar surfaces of the 1st and 2nd digits	f.	0-Function cannot be performed 1-A can interposed between the thumb and index finger can be kept in place, but not against a slight tug 2-Can is held firmly against a tug
	Grasp V - The patient grasps a tennis ball with a spherical grip or is instructed to place his/her fingers in a position with abduction position of the thumb and abduction flexion of the 2nd, 3rd, 4th & 5th fingers	g.	0-Function cannot be performed 1-A tennis ball can be kept in place with a spherical grasp but not against a slight tug 2-Tennis ball is held firmly against a tug
22.Coordination/ Speed- Finger to nose (5 repetitions in rapid succession while patient is blindfolded	Tremor	a.	0-Marked tremor 1-Slight tremor 2-No tremor
	Dysmetria	b.	0-Pronounced or unsystematic dysmetria 1-Slight or systematic dysmetria 2- No dysmetria
	Speed	c.	0-Activity is more than 6 seconds longer than unaffected hand 1-(2-5) seconds longer than unaffected hand 2-Less than 2 seconds difference

23. Total Motor Score:________________

APPENDIX K

Motor Activity Log (MAL) Form

Introductory paragraph:

"The purpose of this test is to examine how much and how well you use your more-affected arm when you are not in our laboratory. You will use two separate rating scales to describe how much and how well you use your weaker arm while you are doing specific activities. Please note that you can give half ratings if that best describes the activity in question. If for some reason, you do not perform these tasks, we will try to determine why. We will first discuss how much you do each of the activities with your weaker arm and then we will discuss how well you do each of the activities when using your weaker arm. I will be showing you a film of other people, who had a stroke, carrying out the activities on the questionnaire and at different levels of ability. I would like for you to use the ratings of these different levels of performance as the basis for forming a judgement of how well you do these activities yourself. It is important that you realize that these questions are about what you actually do outside of the laboratory setting – not what you think you may be able to do with your weaker arm. There are no right or wrong answers; simply select the ratings you believe best describes what you do. Please understand that I must follow a script with this procedure. So, I will ask you the same questions frequently and will be unable to discuss details of how much or how well you do an activity. I will be happy to discuss such things with you after we complete this procedure. Do you have any questions?"

Amount Scale

0 - Did not use my weaker arm for that activity **(not used).**

.5

1 - Occasionally tried to use my weaker arm for that activity **(very rarely).**

1.5

2 - Sometimes used my weaker arm for that activity but did most of the activity with my stronger arm **(rarely).**

2.5

3 - Used my weaker arm for that activity about half as much as before the stroke **(half pre-stroke).**

3.5

4 - Used my weaker arm for that activity almost as much as before the stroke **(3/4 or 75% pre-stroke).**

4.5

5 - Used my weaker arm for that activity as much as before the stroke **(same as pre-stroke).**

How Well Scale

0 - My weaker arm was not used at all for that activity **(of no use).**

.5

1 - My weaker arm was moved during that activity but was not helpful **(very poor).**

1.5

2 - My weaker arm was of some use during that activity but needed some help from the stronger arm or moved very slowly or with difficulty **(poor).**

2.5

3 - My weaker arm was used for that activity but movements were slow or were made with only some effort **(fair).**

3.5

4 - The movements made by my weaker arm for that activity were almost normal but not quite as fast or accurate as normal **(almost normal).**

4.5

5 - My ability to use the weaker arm for that activity was as good as before the injury **(normal).**

"Using the Amount Rating Scale, tell me how you would rate the amount *you used your weaker arm to…* (state the activity)."

"Using the How Well Rating Scale, *tell me how you would rate* how well *you used your weaker arm to… (*state the activity*)"*

EXCITE MAL Score Sheet

	AS	HW	
1. Turn on a light with a light switch	____	____	if no, why? (use code) ________________________ Comments ________________________________
2. Open drawer	____	____	if no, why? (use code) ________________________ Comments ________________________________
3. Remove an item of clothing from a drawer	____	____	if no, why? (use code) ________________________ Comments ________________________________
4. Pick up phone	____	____	if no, why? (use code) ________________________ Comments ________________________________
5. Wipe off a kitchen counter or other surface	____	____	if no, why? (use code) ________________________ Comments ________________________________
6. Get out of a car (includes only the movement needed to get body from sitting to standing outside of the car, once the door is open).	____	____	if no, why? (use code) ________________________ Comments ________________________________
7. Open refrigerator	____	____	if no, why? (use code) ________________________ Comments ________________________________
8. Open a door by turning a door knob	____	____	if no, why? (use code) ________________________ Comments ________________________________
9. Use a TV remote control	____	____	if no, why? (use code) ________________________ Comments ________________________________
10. Wash your hands (includes lathering and rinsing hands; does not include turning water on and off with a faucet handle).	____	____	if no, why? (use code) ________________________ Comments ________________________________

Codes for recording "no" responses:

1. "I used the unaffected arm entirely." (assign "0").
2. "Someone else did it for me." (assign "0").
3. "I never do that activity, with or without help from someone else because it is impossible." For example, combing hair for people who are bald. (assign "NA" and drop from list of items).
4. "I sometimes do that activity, but did not have the opportunity since the last time I answered these questions." (carry-over last assigned number for that activity).
5. Non-dominant hand hemiparesis. (assign "NA" and drop from list of items).

11. Turning water on/off ____ ____ if no, why? (use code) ______________________
with knob/lever on faucet Comments ______________________________

12. Dry your hands ____ ____ if no, why? (use code) ______________________
Comments ______________________________

13. Put on your socks ____ ____ if no, why? (use code) ______________________
Comments ______________________________

14. Take off your socks ____ ____ if no, why? (use code) ______________________
Comments ______________________________

15. Put on your shoes ____ ____ if no, why? (use code) ______________________
(includes tying shoestrings and fastening straps) Comments ______________________________

16. Take off your shoes ____ ____ if no, why? (use code) ______________________
(includes untying shoestrings and unfastening straps) Comments ______________________________

17. Get up from a chair ____ ____ if no, why? (use code) ______________________
with armrests Comments ______________________________

18. Pull chair away from ____ ____ if no, why? (use code) ______________________
table before sitting down Comments ______________________________

19. Pull chair toward table ____ ____ if no, why? (use code) ______________________
after sitting down Comments ______________________________

20. Pick up a glass, bottle, ____ ____ if no, why? (use code) ______________________
drinking cup, or can (does not need to include drinking)

Codes for recording "no" responses:

1. "I used the unaffected arm entirely." (assign "0").
2. "Someone else did it for me." (assign "0").
3. "I never do that activity, with or without help from someone else because it is impossible." For example, combing hair for people who are bald. (assign "NA" and drop from list of items).
4. "I sometimes do that activity, but did not have the opportunity since the last time I answered these questions." (carry-over last assigned number for that activity).
5. Non-dominant hand hemiparesis. (assign "NA" and drop from list of items).

Comments ____________________

21. Brush your teeth ____ ____ if no, why? (use code) ____________
(does not include preparation of toothbrush or brushing dentures)
Comments ____________________

22. Put on makeup base, ____ ____ if no, why? (use code) ____________
lotion, or shaving cream on face Comments ____________________

23. Use a key to ____ ____ if no, why? (use code) ____________
unlock a door Comments ____________________

24. Write on paper ____ ____ if no, why? (use code) ____________
(if dominant arm was most affected, " do you use it to write?": if non-dominant arm was most affected, drop the item and assign "NA"). Comments ____________________

25. Carry an object in ____ ____ if no, why? (use code) ____________
your hand (draping an item over the arm is not acceptable) Comments ____________________

26. Use a fork or ____ ____ if no, why? (use code) ____________
spoon for eating (refers to the action of bringing food to the mouth with fork or spoon)
Comments ____________________

27. Comb your hair ____ ____ if no, why? (use code) ____________
Comments ____________________

28. Pick up a cup ____ ____ if no, why? (use code) ____________
by a handle Comments ____________________

29. Button a shirt ____ ____ if no, why? (use code) ____________
Comments ____________________

Codes for recording "no" responses:

1. "I used the unaffected arm entirely." (assign "0").
2. "Someone else did it for me." (assign "0").
3. "I never do that activity, with or without help from someone else because it is impossible." For example, combing hair for people who are bald. (assign "NA" and drop from list of items).
4. "I sometimes do that activity, but did not have the opportunity since the last time I answered these questions." (carry-over last assigned number for that activity).
5. Non-dominant hand hemiparesis. (assign "NA" and drop from list of items).

30. Eat half a sandwich or finger foods ____ ____ if no, why? (use code) ______________________

Comments ________________________________

Codes for recording "no" responses:

1. "I used the unaffected arm entirely." (assign "0").
2. "Someone else did it for me." (assign "0").
3. "I never do that activity, with or without help from someone else because it is impossible." For example, combing hair for people who are bald. (assign "NA" and drop from list of items).
4. "I sometimes do that activity, but did not have the opportunity since the last time I answered these questions." (carry-over last assigned number for that activity).
5. Non-dominant hand hemiparesis. (assign "NA" and drop from list of items).

APPENDIX L

Stroke Recovery Question from the Stroke Impact Scale (SIS)

Participant ID:____Visit#:_______________

9. Stroke Recovery

On a scale of 0 to 100, with 100 representing full recovery and 0 representing no recovery, how much has your most affected arm and hand recovered from your stroke?

_____ 100 Full Recovery

_____ 90

_____ 80

_____ 70

_____ 60

_____ 50

_____ 40

_____ 30

_____ 20

_____ 10

_______ 0 No Recovery

APPENDIX M

Functional Test of the Hemiparetic Upper Extremity (FTHUE) Form

LEVEL	TASK	DATE: GRADE	TIME	DATE: GRADE	TIME	DATE: GRADE	TIME
1	Patient is unable to complete higher level tasks						
2	A. Associated reaction						
	B. Hand into lap						
3	C. Arm clearance during shirt tuck						
	D. Hold a pouch		(15 sec)		(15 sec)		(15 sec)
	E. Stabilize a pillow						
4	F. Stabilize a jar						
	G. Stabilize a package						
	H. Wringing a rag						
5	I. Hold a pan lid						
	J. Hook and zip a zipper						
	K. Fold a sheet						
6	L. Blocks and box						
	M. Box on shelf						
	N. Coin in coin gauge						
7	O. Cat's cradle						
	P. Light bulb						
	Q. Remove rubber band						

APPENDIX N

Safety Assessment of Function and the Environment for Rehabilitation, v3 (SAFER Home v3) Form

VHA Home HealthCare
Creating More Independence

SAFER HOME
Safety Assessment of Function & the Environment for Rehabilitation
Health Outcome Measurement and Evaluation

Client Name: ______________________________ Type of housing: __ Apartment
__ House
Date of Assessment: ________________________ __ Other

No identified problem	Following observation, interview and/or task performance, no safety concern was identified at time of assessment, including not applicable items.
Mild problem	When an identified safety concern has never been a problem and is unlikely to be so in the future. (1% - 33% chance of negative consequences)
Moderate problem	A safety problem that needs to be addressed but is not likely to cause immediate danger to the client and/or the environment. (34% - 66% chance of negative consequences)
Severe problem	When a safety problem requires urgent attention or when it could put the client, others or their environment in immediate danger. (67% - 100% chance of negative consequences)

		No	Mild	Moderate	Severe	COMMENTS
LIVING SITUATION (3)						
1	Security & screen /admit visitors					
2	Living conditions/occupants					
3	Availability/quality of support					
	Total					
MOBILITY (10)						
4	Walking/devices					
5	Wheelchair/scooter/transfers					
6	Chair/bed transfers					
7	Positioning/repositioning					
8	Accessibility of entrances					
9	Indoor stairs/ramps/railings					
10	Outdoor stairs/ramps/railings					
11	Venturing outdoors					
12	Public/accessible transportation					

		No	Mild	Moderate	Severe	COMMENTS
13	Vehicle/driving/transfers					
	Total					
ENVIRONMENTAL HAZARDS (13)						
14	Clutter					
15	Electric blanket/heating pad					
16	Electrical wiring/plugs/outlets					
17	Fire exit					
18	Furnace/heater/fireplace					
19	Infestation/unhygienic conditions					
20	Lighting/night lights					
21	Pets					
22	Scatter rugs/flooring					
23	Smoke/carbon monoxide detectors					
24	Smoking/candles/signs of burns					
25	Storage of dangerous substances					
26	Trailing wires/cords					
	Total					
KITCHEN (8)						
27	Kettle - manual/electric/auto-off					
28	Toaster/small appliances					
29	Microwave					
30	Stove - gas/electric					
31	Storage - accessible/safe					
32	Knives/scissors - storage/use					
33	Food supply/storage					
34	Garbage storage/disposal					
	Total					
HOUSEHOLD (9)						
35	Hot drink preparation					
36	Meal preparation					
37	Carrying drinks/meals					
38	Bed making					
39	Cleaning					
40	Laundry/ironing					
41	Indoor/outdoor maintenance					
42	Shopping					
43	Money management					

		No	Mild	Moderate	Severe	COMMENTS
	Total					

EATING (2)						
44	Feeding/swallowing					
45	Nutrition					
	Total					
PERSONAL CARE (8)						
46	Dress/undress					
47	Appropriate clothing					
48	Appropriate footwear					
49	Hair care					
50	Nail care					
51	Oral hygiene					
52	Shaving					
53	Feminine hygiene					
	Total					
BATHROOM & TOILET (11)						
54	Bath/shower method					
55	Bath/shower transfers					
56	Seating equipment					
57	Bath/shower grab bars					
58	Non-slip aids					
59	Bladder/bowel continence					
60	Toileting method					
61	Toileting transfers					
62	Raised toilet seat					
63	Toilet grab bar/safety frame					
64	Lock/unlock door					
	Total					
MEDICATION, ADDICTION & ABUSE (3)						
65	Prescribed/non-prescribed drugs					
66	Addictive behaviour					
67	Abuse of client/self/others					
	Total					
LEISURE (1)						

		No	Mild	Moderate	Severe	COMMENTS
68	Hobby safety/tools/method					
	Total					
COMMUNICATION & SCHEDULING (3)						
69	Telephone use/emergency no.					
70	Ability to tell time					
71	Ability to schedule					
	Total					
WANDERING (3)						
72	Supervision					
73	Environment					
74	Wandering Registry/return plan					
	Total					

SAFER-HOME Summary Table

Categories (Number of items)	**Number of safety problems**			
	No	**Mild**	**Moderate**	**Severe**
Living situation (3)				
Mobility (10)				
Environmental Hazards (13)				
Kitchen (8)				
Household (9)				
Eating (2)				
Personal Care (8)				
Bathroom & Toilet (11)				
Medication, Addiction & Abuse (3)				
Leisure (1)				
Communication & Scheduling (3)				
Wandering (3)				
	Total			
		X 1	X 2	X 3
	Weighted Score	=	=	=

SAFER-HOME score =

Summary

APPENDIX O

Task Analysis Form

Task Anaylsis

Task: ____

Key Impairments Addressed:

1.

2.

3.

Materials:

Task Description:

1.

2.

3.

Grading Task: ______________________________________

Increase difficulty ________________ Decrease difficulty ________________

Task Mastery:

1.

2.

____

Idea for related task ____________ **Rationale** ____________

APPENDIX P

Daily Task-Specific Training Summary Form

Daily Task Specific Summary

Client: ____ **Practitioner:** ____	**Date:** ______________________

REPETITIONS

Total Repetitions Task 1: ___________

Total Repetitions Task 2: ___________

Total Repetitions Task 3: ___________

Total Repetitions Completed for Session: ___________

MINUTES ON TASK

Total Minutes Task 1: ___________

Total Minutes Task 2: ___________

Total Minutes Task 3: ___________

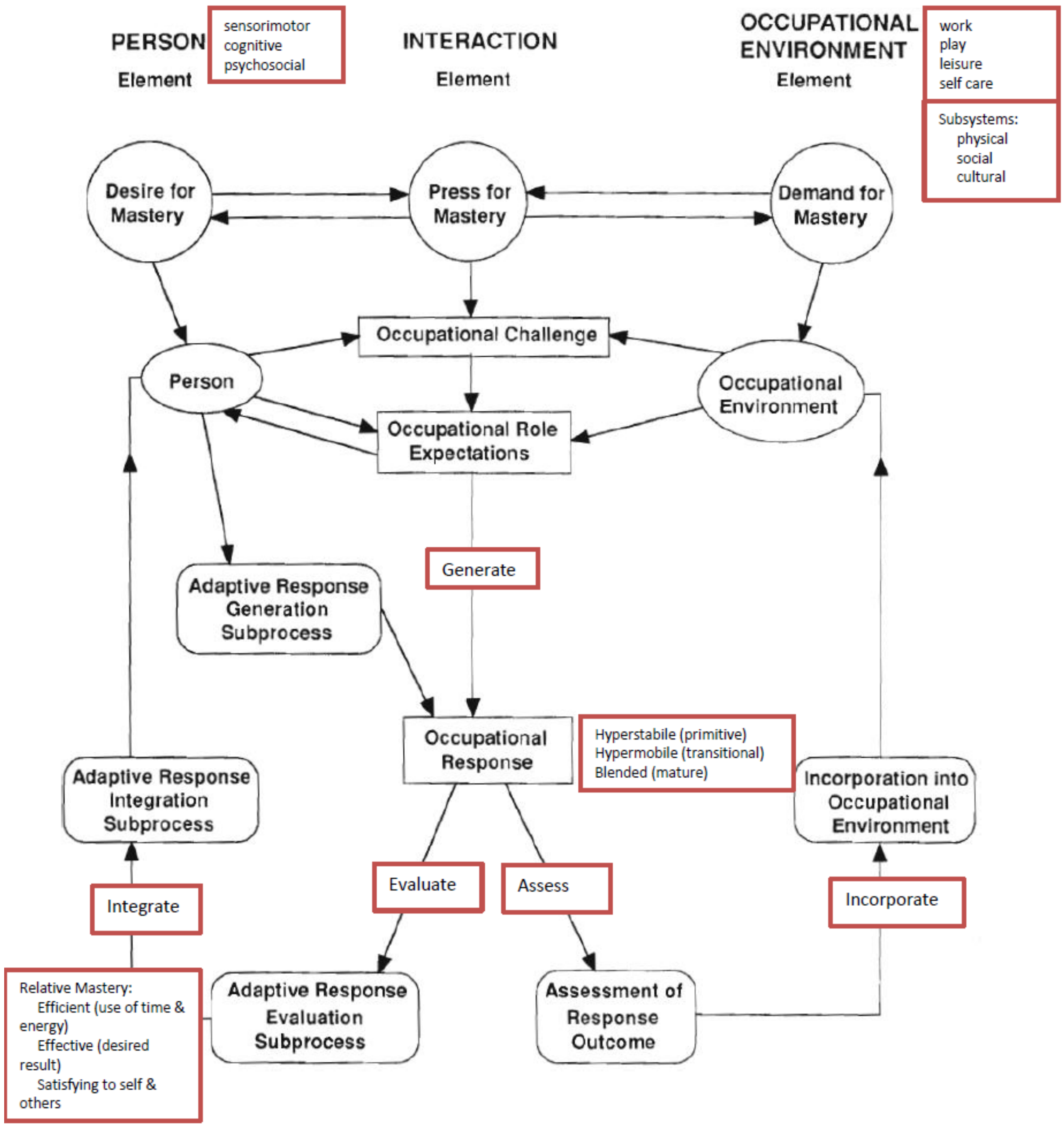
Total Minutes Completed for Session: ___________

Comments:

APPENDIX Q

Schematic of the Theory of Occupational Adaptation

(Schkade & Schultz, 1992; Schultz & Schkade, 1992)


PERSON
Element
sensorimotor
cognitive
psychosocial
INTERACTION
Element
OCCUPATIONAL
ENVIRONMENT
Element
work
play
leisure
self care
Subsystems:
physical
social
cultural
Desire for Mastery
Press for Mastery
Demand for Mastery
Occupational Challenge
Person
Occupational Environment
Occupational Role Expectations
Generate
Adaptive Response Generation Subprocess
Occupational Response
Hyperstabile (primitive)
Hypermobile (transitional)
Blended (mature)
Adaptive Response Integration Subprocess
Incorporation into Occupational Environment
Integrate
Evaluate
Assess
Incorporate
Relative Mastery:
Efficient (use of time & energy)
Effective (desired result)
Satisfying to self & others
Adaptive Response Evaluation Subprocess
Assessment of Response Outcome