

EVALUATING THE EFFECTIVENESS OF THE INTERACTIVE METRONOME® IN  
IMPROVING LIFE SATISFACTION AND REDUCING LOSS OF ATTENTION IN  
MARINES WITH MILD TRAUMATIC BRAIN INJURIES ASSOCIATED WITH POST-  
TRAUMATIC STRESS DISORDER SYMPTOMS: A PILOT STUDY OF PROTOCOLS

by

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The purpose of this pilot study was to evaluate if the series of protocols using the Interactive Metronome® and TRX® Suspension Training developed for mild traumatic brain injury associated with post-traumatic stress disorder symptoms is an effective intervention tool to affect change and improve life satisfaction and attention skills in a well population. Results indicated that changes were observed, life satisfaction improved, and attention improved. Further research is needed to provide evidence for statistical significance and to apply the protocol series to a population of Marines with mild traumatic brain injury associated with post-traumatic stress disorder symptoms.

*Keywords:* traumatic brain injury, post-traumatic stress disorder, attention, life satisfaction, Interactive Metronome®, TRX®, occupational therapy, military



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## **Introduction and Statement of Problem**

### **Introduction**

Through occupational therapy, individuals perform meaningful, everyday life activities for the purpose of engagement and participation in roles and situations in the home, school, workplace, community, and other settings (American Occupational Therapy Association, Inc., 2011). Occupational therapists are trained to work with a variety of conditions and practice settings. Individuals diagnosed with traumatic brain injuries experience a number of residual symptoms that interfere with occupational functioning and highlight the need for occupational therapy. However, most occupational therapy treatment is focused on individuals with moderate or severe traumatic brain injuries. Subsequently, there is a significant proportion of the population of individuals with traumatic brain injury being left untreated and still experiencing difficulties in everyday activities due to residual symptoms of the injury. Therefore, the focus of this study seeks to find an effective treatment tool for occupational therapists to use for individuals with mild traumatic brain injuries.

### **Statement of problem**

The occupational therapy treatment of people with traumatic brain injury (TBI) is primarily focused on individuals with moderate or severe diagnoses. Due to the significant number of individuals with mild TBI, a problem has emerged. Currently, occupational practitioners are not equipped with intervention strategies that focus on overcoming the residual symptoms that are negatively impacting the performance of everyday activities for those with mild TBI.

## **Purpose of the Study**

The purpose of this study was to evaluate the effectiveness of an intervention protocol that was designed to improve attention and life satisfaction in individuals with mild traumatic brain injury associated with post-traumatic stress disorder symptoms. The protocol series uses the Interactive Metronome® and TRX® Suspension Training during this pilot study. This research also seeks to find an appropriate therapeutic intervention that improves clients' self-reports of life satisfaction in the performance of occupations.

## **Research Questions**

1. Is the protocol series using the Interactive Metronome® along with the TRX® developed for mild traumatic brain injury associated with post-traumatic stress disorder symptoms an effective series of intervention sessions that affect change and improve attention skills in normal young adults?
2. Is the protocol series using the Interactive Metronome® along with the TRX® developed for mild traumatic brain injury associated with post-traumatic stress disorder symptoms an effective series of intervention sessions that affect change and improve life satisfaction in normal young adults?

## **Assumptions**

The results of this study were expected to show improvements in attention as well as an increase in life satisfaction in areas of occupational performance in a normal population of adults. Through a specific 12-session protocol intervention using the Interactive Metronome® (IM®) and TRX®, it is assumed that attention and overall life satisfaction of participants

belonging to a normal well population would gradually improve. Pre- and post-test assessment scores were compared using the Test of Everyday Attention, Canadian Occupational Performance Measure (COPM), Nine-Hole Peg Test, IM® Long Form and Short Form tests to provide evidence of the improvements over the course of the study. Statistical findings from the IM®/TRX® treatment protocols will show gradual increase attention and life satisfaction as well as over the course of the study. This study expects to show, with statistical significance, that the proposed intervention is effective at improving attention and life satisfaction in a normal population, and, in future research, can be applied to a population of individuals with mild TBI. This study will provide data to support the use of the protocols in the typical adult population that can be further explored in the target population: clients with mild TBI and PTSD.

### **Limitations**

This research is limited by the small sample size. Due to the small sample size, it may be difficult to generalize the results to larger populations. Another concern is the limited geographical area. The sample is generic to the eastern region of the United States because of the location in which the study was conducted (eastern North Carolina). Though some subjects may originate from other areas of the country, the fact that all participants live in North Carolina is a limitation of this study, which limits the results applicability to other areas of the United States. Due to the open-ended nature of the COPM, participants may not provide an accurate portrayal of their current occupational performance and satisfaction levels. These limitations could affect the findings and validity of the study. In order to minimize effect of the limitation, researchers informed participants of the importance of providing honest, accurate, and reliable data.

## **Terms and Definitions**

1. Traumatic Brain Injury (TBI) – refers to an individual who has been diagnosed with a mild traumatic brain injury
2. Post-traumatic Stress Disorder (PTSD) – refers to an individual who has been diagnosed with post-traumatic stress disorder
3. Traumatic Brain Injury/Post-traumatic Stress Disorder (TBI/PTSD) – refers to an individual who has been diagnosed with both a mild traumatic brain injury and post-traumatic stress disorder

When referring to TBI, PTSD, and TBI/PTSD these are difficult to distinguish between the separation of cause and effect. The outward signs and symptoms are often similar and challenging to separate one from the other. Throughout this paper, the terms can be inclusive of the other and only when they are exclusively separated should they be considered separated terms.

## **Significance of the Study**

This pilot study will help further research in the area of occupational therapy for individuals with mild traumatic brain injuries who also experience post-traumatic stress disorder symptoms. The results of this study will be used to guide researchers in the conduction of a similar study focusing on a population of Marines who have been diagnosed with mild TBI as well as demonstrate symptoms of PTSD, and experience residual symptoms that impact daily living. The findings of this research are important to the field of occupational therapy as they will yield necessary information about a population that currently has a great need for these particular health professionals. The results of the study will provide occupational practitioners

and future researchers with evidence about the effectiveness of a therapeutic tool for individuals with mild TBI associated with PTSD symptoms.



## **Review of literature**

### **Introduction**

The body of literature being presented in this document is a complete and thorough review for the anticipated population that the protocols being validated will be applied directly towards. This population will include individuals who suffer from traumatic brain injury and post-traumatic stress disorder, who often experience similar residual symptoms that affect daily occupational performance.

The unique nature of how military personnel incur combat-related injuries presents a new challenge to rehabilitative therapies and health professionals in the United States. Traumatic brain injury (TBI) and post-traumatic stress disorder (PTSD) have become the “signature” injuries of Operation Enduring Freedom and Operation Iraqi Freedom (Cifu, Cohen, Lew, Jaffee, & Sigford, 2010; Fairweather & Garcia, 2007). A shockingly large proportion of the military population is diagnosed with one or both of these impairments (Fischer, 2009). Due to the nature in which a traumatic brain injury is acquired, it is not uncommon for both PTSD and a TBI to stem from the same event (United States Department of Veterans Affairs, 2010). Both of these conditions have a variety of symptoms which greatly affect an individual’s daily functioning and performance in purposeful activities. Impairments in attention are the more commonly reported challenge by clients and caregivers affected by TBI (Chan, 2001). However, attentional impairments are symptoms of both TBI and PTSD (Conti, 2007). Individuals with attentional deficits may experience problems such as forgetting schedules, routines, or planned activities that in turn lead to issues with daily activities, work-related tasks, household management, child-rearing, and/or social relationships. As practitioners and health care professionals, it is part of

our philosophy to guide these individuals through interventions that work towards functional independence and incorporate meaningful and client-centered activities. This study evaluates the effectiveness of the Interactive Metronome® in reducing the loss of attention as well as improving overall life satisfaction through improved occupational performance in normal, healthy adults.

The following chapter reviews the given areas that are viewed as relevant to the knowledge base for this study: traumatic brain injury, post traumatic stress disorder, resulting attentional deficits, impact on occupation, occupational performance and life satisfaction, and the Interactive Metronome®.

### **Traumatic Brain Injury**

A traumatic brain injury (TBI) is an insult to the brain, not of a degenerative or congenital nature, but caused by an external physical force, that may produce a diminished or altered state of consciousness, and results in an impairment of cognitive abilities or physical functioning (Brain Injury Association of America, 2011; Conti, 2007). TBI may also cause behavioral and/or emotional impairments. Disruptions in functioning may be either temporary or permanent and cause partial or total functional disability or psychosocial maladjustment (Brain Injury Association of America, 2011). According the Centers for Disease Control and Prevention (2011), approximately 1.7 million people in the United States sustain a TBI each year, with 75% classified as a mild brain injury. TBI may result from numerous causes and factors, including vehicular crashes, violence or assaults, and/or falls (Conti, 2007).

A TBI is categorized as mild, moderate, or severe depending on the length of amnesia and/or coma as well as ratings of the Glasgow Coma Scale. The duration of Post-Traumatic

Amnesia (PTA) is one of the main indicators of the level of severity of brain injury. PTA is defined as the time it takes an individual to regain memory of daily events from the moment the injury is acquired (Tipton-Burton, McLaughlin, & Englander, 2006). A mild TBI stems from PTA lasting less than one hour. (Radomski, 2008; Tipton-Burton et al., 2006). A moderate brain injury is defined when PTA is from 1 to 24 hours. For a severe TBI classification, PTA must last greater than 24 hours (Radomski, 2008; Tipton-Burton et al., 2006).

The Glasgow Coma Scale (GCS) is a measurement that provides an objective assessment of the brain injury, using a 15-point system testing motor, eye-opening, and verbal capabilities (Radomski, 2008; Tipton-Burton et al., 2006). The examiner assigns a score for the individual's response and the total score indicates the level of severity of the brain injury (Tipton-Burton et al., 2006). An initial score of 13 to 15 is indicative of a mild brain injury (Radomski, 2008). A moderate brain injury is classified by an initial GCS score of 9 to 12 (Radomski, 2008). A severe TBI is defined when the initial GCS score is 8 or less (Radomski, 2008).

The Rancho Los Amigos Scale is another measurement commonly used with individuals who have sustained a TBI. This scale uses behavioral observations to describe the patient's level of awareness and cognitive function (Radomski, 2008; Tipton-Burton et al., 2006). The intended population for which the protocols in this study are being evaluated will be those individuals with mild TBI.

Traumatic brain injuries are also categorized by location and occurrence of injury. Primary brain injuries occur at the moment of impact (Conti, 2007). Secondary brain injuries can occur immediately or in the days to several weeks after the initial injury (Conti, 2007; Radomski, 2008). Secondary effects can include disordered cerebral energy metabolism,

intracranial hypotension, cerebral vasospasm, increase in intracranial pressure, cerebral edema, intracranial hemorrhage, ischemic brain damage, uncal herniation causing brainstem compression, abnormal autonomic nervous system responses, and numerous other effects (Radomski, 2008).

Focal and diffuse axonal brain injuries describe where and how the damage affected the brain. A focal brain injury is caused by a direct blow to the head after collision with an external object or fall, a penetrating injury resulting from a weapon, and the collision of the brain with the inner bones of the skull (Tipton-Burton et al., 2006). Focal brain injuries are specific to the area of the brain where the injury occurred, and the damaged tissue is typically associated with the site of injury (Brain and Spinal Cord.org, 2011). Contusions, lacerations of the brain, and intracranial hematomas are often associated with focal brain injuries (Radomski, 2008). An injury related to focal brain injuries is known as “coup-contre-coup”. This type of injury occurs when the force is great enough to cause the initial injury at the directly injured area, referred to as coup, and is able to move the brain to the opposite side of the skull and cause additional indirect injury, known as contre coup (Brain Injury Association of America, 2011, Tipton-Burton et al., 2006). Another type of brain injury, known as diffuse axonal brain injury, occurs when there is acceleration or deceleration and contracting waveform movements of the brain matter with accompanying fast rotational propulsion of the brain in the skull causing axonal damage (Radomski, 2008). The injury occurs when the unmoving brain lags behind the moving skull, which causes brain structures to tear (Brain Injury Association of America, 2011). Motor vehicle, bicycle, and skateboard crashes are common causes of diffuse axonal brain injuries (Tipton-Burton et al., 2006).

Due to the increased involvement of the US military in war-time operations in the past decade, there has been a significant rise in the prevalence of TBI (Fischer, 2009). According to the Defense and Veterans Brain Injury Center (Defense and Veterans Brain Injury Center, 2009), military members are more at risk for TBI because of the physically demanding environment and high exposure to improvised explosive devices, suicide bombers, land mines, mortar rounds, and rocket-propelled grenades. From the beginning of the year 2000 to May 20, 2010, there have been 178,876 recorded TBIs in the military population (Defense and Veterans Brain Injury Center, 2009). The recovery process for military personnel with combat-acquired TBI is complicated by the physically and emotionally traumatic circumstances in which the injury was obtained, the potential for repeated injuries during active duty, the high incidence of comorbid mental health conditions, and the difficulty in following recommended care due to the physical nature of the job (Lew et. al, 2008).

### **Post-traumatic Stress Disorder**

Post-traumatic stress disorder (PTSD) is a psychological syndrome caused from exposure to a traumatic event (Conti, 2007; Miller, 1999). The traumatic event typically involves a situation where one is confronted or threatened with serious injury or death and results in the individual experiencing intense fear, helplessness, or horror (Conti, 2007; Miller, 1999). PTSD may result from a close friend or family member experiencing danger or harm, or the sudden and expected death of a loved one (National Institute of Mental Health, 2009). The traumatic event is then re-experienced through the disorder in a number of ways that cause distress on the individual, including recollections through images, thoughts, or perceptions, recurrent dreams, hallucinations, or psychological distress that occurs when external or internal cues remind the individual of the experience (Conti, 2007).

The National Institute of Mental Health (2009) categorizes the symptoms of PTSD into three groups: re-experiencing, avoidance, and hyperarousal. Re-experiencing symptoms include flashbacks, bad dreams, and/or frightening thoughts that cause the individual to relive the traumatic experience (National Institute of Mental Health, 2009; United States Department of Veterans Affairs, 2010). Avoidance symptoms may present themselves as the individual staying away from people, places, events, or objects that remind him/her of the experience or trigger memories of the event (National Institute of Mental Health, 2009; United States Department of Veterans Affairs, 2010). Individuals may also experience avoidance symptoms by avoiding thinking or talking about the event, feeling emotionally numb, feeling strong guilt, depression, or worry, losing interest in activities that were once enjoyable, and/or having difficulty remembering the traumatic event (United States Department of Veterans Affairs, 2010; National Institute of Mental Health, 2009). Being easily startled, feeling “on edge” and/or jittery, having trouble sleeping and/or concentrating, or suddenly growing irritable and experiencing problems with angry outbursts are considered hyperarousal symptoms of PTSD (United States Department of Veterans Affairs, 2010; National Institute of Mental Health, 2009).

For the total population, the prevalence of PTSD is minimal. According to results of the National Comorbidity Survey Replication, the lifetime prevalence among adult Americans is 3.5%, with PTSD occurring slightly more in females than males (Kessler, Chiu, Demler, Merikangas, & Walters, 2005). However, the prevalence is significantly higher in the military population due to the physically-demanding and life-threatening nature of the environment (United States Department of Veterans Affairs, 2010). Approximately 30% of military members who served in the Vietnam War experienced PTSD (Conti, 2007). In more current events, the Military Health System has recorded 39,365 patients diagnosed with PTSD and has spent an

estimated \$63.8 million on direct and purchased care for these patients (Fischer, 2009).

According to the California Community Foundation (2008), one in five service members who engaged in Operation Iraqi Freedom or Operation Enduring Freedom developed PTSD or major depression.

### **Resulting Attentional Deficits**

The most commonly reported symptoms of TBI by patients and caregivers are attention and memory deficits (Chan, 2001). According to Chan (2001), attentional deficits are also the most persisting symptoms of TBI and can affect patients' years after the brain injury was acquired. Depending on the cause, severity, and location of the injury, deficits in executive functioning can cause significant negative impacts on daily activities and occupational performance.

Mild traumatic brain injuries affect the executive and orienting components of attention (Donkelaar, Langan, Rodriguez, Drew, Halterman, Osternig, and Chou, 2005). According to Tipton-Burton et. al (2006), individuals exhibit clinical signs following a mild brain injury are classified as post-concussion symptoms (PCS). Many PCS are related to executive functioning, such as impaired concentration and attention, slowness and inefficiency of thought and action, and learning and memory problems (Miller, 1999). The executive component of attention, which allows individuals to make use of relevant stimuli or ignore irrelevant stimuli when preparing for an activity, is particularly susceptible to the effects of mild brain injury (Donkelaar et al., 2005). The disruption of attentional orientation affects one's ability to "move attention from the central fixation point, search alternate locations for the target point and re-engage attention at the appropriate location to respond to the target stimulus" (Donkelaar et. al, 2005). In a review of

attentional deficits in patients with post-concussion symptoms, it was identified that the main impairments occur in sustained attention, selective attention, divided attention, and attentional control processing (Chan, 2001). Sustained attention is the ability to direct and focus cognitive activity on specific stimuli (Cognitive Atlas, 2011). When multiple external sensory inputs are present, the process of dedicating cognitive and perceptual resources to one type/set of input and attenuating receptiveness to other inputs is known as selective attention (Cognitive Atlas, 2011). Divided attention is defined as the process by which an individual can perform multiple non-automatic tasks at the same time (Cognitive Atlas, 2011). Attentional control processing is responsible for the higher voluntary forms of attention, such as planning, programming, regulation, and verification (Chan, 2001).

Different regions of the brain control for these components of attention, however, they may not be fully independent of one another. Depending on the region of injury, individuals who have sustained a TBI may elicit a variety of attentional deficits. The attention and memory impairments observed in individuals with TBI are said to result from the shearing of white brain matter connections between the prefrontal cortex, parietal lobe, and cerebellum (Chan, 2005; Ghajar, Ivry, & the Cognitive and Neurobiological Research Consortium, 2008). Functions of the frontal and prefrontal lobe include attention and concentration, self-monitoring, organization, awareness of abilities and limitations, mental flexibility, problem solving, planning and anticipation, and judgment (Brain Injury Association of America, 2011). The parietal lobe controls for spatial and visual perception as well as identification of size, shapes, and colors. Coordination, balance, skilled motor activity, and visual perception are the main functions of the cerebellum. The temporal lobe and brain stem also help control attention, concentration, and memory (Brain Injury Association of America, 2011). The white brain matter connections are



critical in the generation, maintenance, and precise timing of anticipatory neural activity. The primary symptoms resulting from predictive timing deficit are decreased attention, decreased memory, decreased concentration, balance and coordination problems, decreased awareness, dizziness, tinnitus, and sensory sensitivity (Ghajar et al., 2008).

Symptoms of traumatic brain injury often overlap with post-traumatic stress disorder because of the nature in which the TBI is acquired (United States Department of Veterans Affairs, 2010). The traumatic event that caused the brain injury can lead to psychological effects that mask themselves as symptoms of the original injury (Miller, 1999). Decreased attention and concentration, impaired memory, impaired initiation and termination of activities, decreased safety awareness and poor judgment, impulsivity, and difficulty with executive functions and abstract thinking are associated with post-concussion symptoms (Tipton-Burton et al., 2006). Cognitive symptoms resulting from PTSD include impaired learning and forgetfulness, attention and concentration difficulties, slower processing speed, and a sense of being overwhelmed with tasks that were once simple (Kennedy, Jaffee, Leskin, Stokes, Leal, & Fitzpatrick, 2007). In a study of Persian Gulf War veterans diagnosed with PTSD, performance deficiencies were found on tasks that involved sustained attention, mental manipulation, initial acquisition of information, and retroactive interference (Vasterling, Brailey, Constans, & Sutker, 1998). Impulsivity, perseveration, irritability and poor control of temper, noise sensitivity, fatigue, anxiety, insomnia, depression, and social disinhibition are other commonly shared symptoms between TBI and PTSD (Conti, 2007; Kennedy et al., 2007). Individuals with post-traumatic disorder symptoms may have difficulty remembering names, lose train of conversations, and experience trouble concentrating on the task at hand such as reading or completing a work

assignment (Miller, 1999). These symptoms are quite similar to the cognitive impairments following a mild TBI.

As previously stated, TBI and PTSD can be caused by the same traumatic event. Though the residual symptoms of each condition are similar, PTSD is often seen comorbidly with TBI in the military population. In a study of post-Iraqi deployment, more than one-third of military personnel who had acquired a mild TBI were also diagnosed with PTSD or depression (Vanderploeg, Belanger, and Curtiss, 2009).

### **Impact on Occupation**

All areas of occupation, as identified in the Occupational Therapy Practice Framework, are affected by mild traumatic brain injury and post-traumatic stress disorder symptoms (American Occupational Therapy Association, 2008). Individuals have difficulty with activities of daily living (ADL), instrumental activities of daily living (IADL), education, work, play, leisure, and social participation due to impairments of attention. Attentional deficits significantly impact an individual's ability to perform ADLs and IADLs, such as self-care and grooming tasks, job performance, caring for others, financial management, and leisure and social participation. Occupational gaps occur when there is a disparity between what individuals can do and what they want and need to do (Ericksson, Tham, & Borg, 2006). A study by Ericksson et al. (2006) found the number of occupational gaps increased after an acquired brain injury from 46% to 71%. The difficulties in attention, concentration, memory, and processing speed greatly impact the ability to perform daily routines, complete work-related tasks, and maintain a social life.

Work is a performance area that can be significantly affected by residual symptoms TBI and PTSD. In a study on the role change after TBI in adults, more than 85% of the subjects reported a worker role loss that led to feelings of anger, frustration, apprehension, confusion, boredom, and fear (Hallett, Zasler, Maurer, & Cash, 1992). Work is an important area for many members of the military population, since they place great esteem and pride in their career role. Not being able to serve their country and perform active job duties takes away a significant role from their lives.

### **Occupational Performance & Life Satisfaction**

With clients with mild TBI experiencing significant changes in occupational performance, occupational therapy becomes focused on the client's personal needs, goals, and desires. The client-centered approach provides a holistic view of human behavior and allows the client to voice his or her opinion and be involved in treatment strategies and desired outcomes (Chan & Lee, 1997; Dedding, Cardol, Eyssen, Dekker, & Beelen, 2004). Client-centered practice is an important component of occupational therapy, helping to build the therapeutic relationship between therapist and client as well as guide the therapist towards the most effective and meaningful treatment strategies. This approach uses language that reflects the client as a person first, rather than the condition. The client is also offered choices and has an opinion on the direction of the treatment process. The intervention is structured to be flexible, accessible, and contextually appropriate and relevant in order to meet the client's needs. The client-centered approach also emphasizes a respect for differences and diversity (Schultz-Krohn and Pendleton, 2006).

The client-centered approach is practiced in conjunction with the Canadian Model of Occupational Performance. This model explains occupational performance by the interdependence between the person, the environment, and the activity (Canadian Association of Occupational Therapists, 2011). This framework places focus on the human holistically, where a change in one area affects the other areas. The main areas in which occupations are performed include self-care, leisure, and productivity. Performance of these occupations can be affected by different aspects of the physical, social, emotional, cultural, and spiritual environments (Canadian Association of Occupational Therapists, 2011; Law, Baptiste, McColl, Opzoomer, Polatajko, & Pollock, 1990). This study will incorporate the Canadian Model of Occupational Performance to help guide intervention.

Another model of practice that utilizes client-centered therapy is the Model of Human Occupation (MOHO). According to MOHO, occupational behavior is the result of the human system, the task itself, and the environment (Stamm, Cieza, Machold, Smolen, & Stucki, 2006). This model operates on the theory that engagement in occupation is the product of three interrelated subsystems that are each linked to occupational performance (Schultz-Krohn & Pendleton, 2006). The first component is volition, which is the client's thoughts, feelings, values, interests, personal causation, and motivation to engage in occupation (Schultz-Krohn & Pendleton, 2006). The habituation subsystem refers to the client's habits and roles. The final component, performance capacity, considers the client's lived experience and factors in previous experience, changes, and expectations of performance capacity throughout the occupational therapy process (Schultz-Krohn & Pendleton, 2006).

When using a client-centered approach, the assessment chosen should focus on measuring outcomes that are desired by the client. In order to accurately measure outcomes

based on the Canadian Model of Occupational Performance, the developers of the model created a client-centered assessment to adequately measure occupational performance. The Canadian Occupational Performance Measure (COPM) is an occupation-based assessment model that allows the client to identify problem areas and choose goals in the treatment process (Schultz-Krohn & Pendleton, 2006). This evaluation tool will be used during the study to measure self-perceived changes in occupational performance and satisfaction before and after the intervention has been administered.

As previously discussed, individuals living with a traumatic brain injury (TBI) or post-traumatic stress disorder (PTSD) experience a variety of residual symptoms, often lasting indefinitely, that impact everyday living. Due to these residual symptoms, performance of occupations is more difficult than before the injury and new challenges arise. These challenges often lead to dissatisfaction in occupational performance. A study of thirty individuals with TBI found a significant relationship between life satisfaction and social integration (Burleigh, Farber, & Gillard, 1998). This suggests that without the adequate skills to maintain social integration, a component of community integration, individuals will become less satisfied. This research demonstrates the need for the long-term rehabilitation of individuals experiencing residual symptoms of TBI and PTSD.

### **Interactive Metronome®**

The Interactive Metronome® (IM®) is an assessment and treatment tool used to improve neurological processes of motor planning, sequencing, and processing (Interactive Metronome®, 2008). Through computer-generated software, patients complete exercises that require them to synchronize hand and foot movements to a bell-like tone heard through headphones. Patients are

given feedback audibly through the headphones and visually on a computer screen. Through IM® treatment, patients learn to focus and attend for longer periods of time, increase physical endurance and stamina, filter out internal and external distractions, improve ability to monitor mental and physical actions as they are occurring, and progressively improve coordinated performance (Interactive Metronome®, 2008).

Research has proven that the IM® can be an effective therapeutic tool in helping those with impaired executive functioning. A study focusing on the use of the IM® with adolescent boys with Attentional-Deficit Hyperactivity disorder concluded that the treatments significantly improved attention, motor, and perceptual-motor functioning as well as academic performance (Shaffer, Jacones, Cassily, Greenspan, Tuchman, & Stemmer, 2000). Another study, involving a child with attention and motor coordination difficulties, showed the effectiveness of IM® treatment in improving accuracy and timing, along with positive changes in behavior (Bartscherer & Dole, 2005). Currently, no research suggests that the IM® has been used to improve the loss of attention in mild traumatic brain-injured clients also experiencing post-traumatic stress disorder symptoms. There is also no evidence that shows the use of the IM® with military personnel.

## **Summary**

The literature reveals that individuals with mild traumatic brain injuries (TBI), often associated with post-traumatic stress disorder, experience residual symptoms that impact occupational performance. The impairments related to attention interfere with the performance and completion of occupations and can lead to individual's feeling dissatisfied with life. The significant number of individuals in the military diagnosed with these injuries discovered

through research is astonishing. These findings emphasize the importance of occupation and highlight the role of occupational therapy within this unique population. The review of literature found limited evidence of successful intervention strategies applied to individuals living with these impairments in functioning. This study seeks to provide evidence about an effective intervention tool for occupational therapists to have when working with individuals with mild traumatic brain injuries, who may also present with post-traumatic stress disorder-like symptoms.

## **Methodology**

### **Population**

A normal and well population was selected for this study. To select participants, a non-probability sampling method was utilized due to its convenience and purposive nature.

Participants were recruited from the Occupational Therapy program at East Carolina University based on their willingness to participate, good health status, and availability of time. Two males and two females were recruited by the primary investigator. Inclusion criteria for the participants included good health status, ability to sustain the specified level of physical activity, and availability of at least nine hours a week for the four consecutive weeks to complete research protocols. Participants were excluded from the study if they were considered anything other than in good health status, unable to sustain the specified level of physical activity, or could not reserve the time required to complete treatment protocols.

### **Instrumentation**

For the study, four standardized assessments were used to collect data. These assessments were the Canadian Occupational Performance Measure (COPM), Test of Everyday Attention (TEA), Interactive Metronome® (IM®) Long Form and Short Form assessments, and the Nine-Hole Peg Test (NHPT).

### **Canadian Occupational Performance Measure**

The COPM is a semi-structured interview that measures the most important areas of performance, such as self-care, productivity and leisure. This assessment was chosen because it provides a quick, yet thorough, evaluation of an individual's performance in daily activities. The



COPM is administered in a five-step process, consisting of problem definition, problem weighting, scoring, re-assessment, and follow-up. When defining problems, the therapist interviews the client to find out if there are any areas of concern in occupational performance and identifies specific activities within the performance area that are difficult. The COPM guides the therapist to discuss areas of self-care, productivity, and leisure. The client is asked to weigh the problems once they have been addressed, rating the importance of the specific activities on a 1-10 scale, with 1 meaning not at all important and 10 meaning most important. The five problems that received the highest rating of importance are then identified. The client is asked to rate his/her ability to perform those specific activities and satisfaction with that performance on the same 1-10 scale. The performance ratings for all five identified problems are added together and then divided by the number of problems, which is typically five. The satisfaction ratings for all five identified problems are added together and then divided by the number of problems. These are the baseline scores which are used to compare with the re-assessment. The re-assessment follows the intervention or treatment. During the re-assessment, the therapist asks the client to rate his/her performance and satisfaction with the identified problem areas. The therapist calculates the difference between the initial and re-assessment to evaluate change. The follow-up step of the COPM is for the therapist to plan for continuation of treatment. The therapist uses a new COPM form to find out if there are new problems with occupational performance (Law et al., 1990). The COPM scoring sheet is given in Appendix C.

This interview was conducted as a pre- and post-test evaluation measure to obtain important information involving a change in the client's self-perception of his/her occupational performance over the course of the study. Since this study utilized a normal and well population, the questions of the COPM were formatted appropriately in order to obtain accurate

data. The researchers focused the questions on relevant problem areas for healthy, young individuals, such as organization, social time, stress, and time management.

When considering the COPM, the test-retest reliability is found to be in the acceptable range for both the performance and satisfaction scores and additional research conducted has found even more encouraging reliability values of .80 for performance and .89 for satisfaction scores (Law, Baptiste, Carswell, McColl, Polatajko, & Pollock, 1998). The three types of validity evaluated for the COPM are content, criterion and construct validity. The content validity is strong based on the expression of the characteristics in how it defines occupational performance. The criterion validity was proven strong through studies saying that the COPM was more successful in identifying problems of individual occupational performance where-as open ended questions raised broader issues (Dedding, Cardol, Eyssen, Dekker, & Beelen, 2004; Law et al., 1998). The construct validity was supported through research that considered the correlations between the COPM scores and performance components, (Law et al., 1998). According to Jenkinson, Ownsworth, and Shum (2007), the COPM is a stable and sensitive measure to use with individuals with mild traumatic injuries in a community-based rehabilitation setting. This evaluation allowed for the researchers to measure the client's affect and what specific everyday tasks that the individual was finding frustrating or difficult.

### **Test of Everyday Attention**

The Test of Everyday Attention (TEA) was used to assess changes in attention. The TEA is an evaluation tool that measures selective attention, sustained attention, attentional switching, and divided attention. This instrument was used as a pre- and post-test evaluation tool and took approximately 45 minutes to administer. Within this assessment tool, there are eight subtests

designed to mimic everyday tasks and help to assess how individuals perform these activities with attentional problems. Visual selective attention, auditory selective attention, auditory-verbal working memory, attentional switching, divided attention, and sustained attention are measured with one or more of the eight subtests of the TEA. Raw scores have been translated to scaled-scores using the TEA manual according to the age of the participant (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994). Within the TEA, a higher scaled score represents better performance to the attention-related task. The TEA scoring sheet is located in Appendix D.

The eight subtests include: map search, elevator counting, elevator counting with distraction, visual elevator, auditory elevator with reversal, telephone search, telephone search dual task, and lottery. The map search subtest of the TEA is sensitive to measuring visual selective attention. This test requires the participant to search a map for specific symbols in two minutes. Two scores are produced by the first subtest. The first, MS1, is the number of symbols correctly circled in the first minute. The second score, MS2, is graded by the total number of symbols correctly circled in two minutes. The map search subtest is sensitive to measuring visual selective attention. The third subtest of the TEA measures auditory selective attention and auditory-verbal working memory. In this task, the participant is presented with a series of high and low tones and instructed to pretend he/she is on an elevator. The participant must count only the low tones, ignoring the high tones, to tell which floor the elevator is on. The raw score reflects how many answers the participant answered correctly. The raw score was translated into a scaled score. The visual elevator subtest is a sensitive measure for attentional switching, or the ability to change a train of thought. In this test, participants must count up and down as they follow a series of visually presented floors in the elevator. Like the map search subtest, this subtest has two scoring components. The first component, VE1, measures how many answers

were correct and reflects a raw accuracy score. The second component, VE2, scores timing accuracy and reflects how long it took the participant complete the task. Subtest #5, elevator counting with reversal, is designed to measure auditory-verbal working memory. This task is essentially an auditory version of the visual elevator, where the participant must count a series of tones indicating that the elevator is going up or down and conclude what floor it lands on. The raw score indicates how many floors were answered correctly, which is then translated into a scaled score. The sixth subtest of the TEA is a measure of selective attention. This test requires the participant to search through pages in a simulated telephone directory for key symbols. The number of correctly circled symbols has an equivalent scaled score. Subtest #7 requires the participant to perform the same task as in the telephone search subtest with an additional task of counting a series of tones presented audibly. This test is designed to measure divided attention and sustained attention. Performance is measured by comparing this subtest (TSC) to the previous test (TS). This comparison produced a dual task decrement, which is a measure of divided attention. This number is turned into a scaled score. The eighth subtest of the TEA is a measurement of sustained attention. Participants are presented with a 10-minute series of audibly-presented numbers and must listen for lottery numbers ending in “55”, which are presented in the form of “KM455”, and write down the first two letters. The number of correctly written down letters is transferred into a scaled score (Robertson et. al, 1994).

Reliability and validity data of the TEA are based on a sample of normal individuals and sample of individuals diagnosed with stroke. Versions A and B of the TEA have test-retest reliability ranging from 0.59 to 0.86, from a normative sample of 118 people, ages 18-80. A sub-sample of 39 people from the normative group produced a test-retest reliability coefficients ranging from 0.61 to 0.90 with Versions B and C. A sample of 74 individuals diagnosed with

stroke produced a range of test-retest reliability coefficients from 0.41 to 0.90 with Versions A and B. These numbers indicate good reliability of the TEA for almost all subtests for all samples. The dual-task decrement subtest has the lowest reliability due to the large learning effects and high sensitivity (Robertson et al., 1994).

### **Interactive Metronome® Short Form and Long Form Assessments**

The Interactive Metronome® (IM®) Short Form and Long Form assessments were used to measure the effectiveness of the IM®. The tool gives the user a score based on how closely he/she hits the switch in relation to the given auditory sound. The score is depicted by how many milliseconds (ms) the user hits the switch before or after the auditory sound tones. There are thirteen different exercises within the IM®, which are titled by the body part producing the movement. The exercises include: both hands, right hand, left hand, both toes, right toe, left toe, both heels, right heel, left heel, right hand/left toe, left hand/right toe, balance right foot/tap left toe, balance left foot/tap right toe.

The Short Form assessment of the Interactive Metronome® yields millisecond averages that can be compared throughout the study. The 10 session-protocol was designed to include the Short Form assessment at the beginning and end of each session. The millisecond averages taken from these two trials are averaged together to produce one average for the total session. Therefore, each participant has 10 millisecond averages, one for each session of the protocol. The Short Form assessment is comprised of two tasks. Task One requires the participant to clap both hands and provides no guide sounds. Task Two also requires the participant to clap both hands, but provides the participant with guide sounds that indicate whether the switch is being hit too early or too late. Both tasks produce millisecond averages that indicate how far off the target

beat the participant is. Therefore, a lower millisecond average reflects better performance. The Short Form assessment was given as a pre-, during, and post-test evaluation and yielded a similar report for each participant.

The Long Form assessment of the Interactive Metronome® (IM®) yields millisecond averages from thirteen different exercises that can be compared before and after the applied intervention. This assessment evaluates the millisecond average for each of the thirteen exercises as well as an additional exercise of both hands with guide sounds to indicate whether the user is hitting the switch too soon or too late. The score is depicted by how many milliseconds (ms) the user hits the switch before or after the auditory sound tones. The Long Form assessment was given as a pre- and post-test evaluation and produced a statistical report on each participant's score and millisecond averages for the performed exercises. This study used the generated ms averages to observe the change in performance over time.

### **Nine-Hole Peg Test**

The Nine-Hole Peg Test (NHPT) is an instrument commonly used by occupational therapists to quickly and accurately assess finger dexterity (Grice, Vogel, Le, Mitchell, Muniz, & Vollmer, 2003). The NHPT measures the time it takes for the client to place pegs individually in nine holes arranged in 15 millimeter intervals in three rows and then remove them one at a time. This instrument was chosen for the study because it is easy to administer and gives a quick assessment of a person's finger dexterity. The NHPT was used as a pre- and post-test evaluation tool during this study.

In 1985, a research study examined the reliability of the NHPT in 26 healthy young female adults (Mathiowetz, Weber, Kashman, & Volland, 1985). To examine intra-rater

reliability, participants were re-assessed with a one week interval by the same rater. Results showed excellent agreement for the right hand and adequate agreement for the left with Pearson correlations ( $r = 0.69$ ;  $r = 0.43$ ). In regards to interrater reliability, the Pearson correlation coefficients showed excellent agreement for both the right and left hand ( $r = 0.97$ ;  $r = 0.99$ ), respectively (Mathiowetz et. al, 1985). In 2003, another study was conducted to examine the reliability of the NHPT after the design was slightly modified. The interrater and test-retest reliability of the commercially available Smith & Nephew Rehabilitation version of the NHPT was established by evaluating 25 occupational therapy student volunteers (Grice et. al, 2003). Seven hundred and three subjects, ranging from 21 to 71+ years, were tested to establish norms, using the standard protocol (Grice et. al, 2003). These norms showed high interrater reliability and only moderate test-retest reliability, which support original norms previously published in the 1985 study (Grice et. al, 2003).

## **Apparatus**

The TRX® Suspension Training was incorporated into the protocols of this study. TRX® stands for “total body resistance exercise” and is a portable, light-weight, and versatile piece of exercise equipment that can be used at home, in the gym, or outside by attaching to a variety of surfaces. The TRX® allows the user to perform hundreds of functional exercises that build strength, flexibility, core stability and endurance (Fitness Anywhere®, 2011). This piece of exercise equipment was used to supplement the IM® during the treatment protocols, by mimicking the same exercises and body movements.

## **Procedure**

Before beginning the study, Institutional Review Board of East Carolina University approval was obtained by all researchers and sub-investigators. Once approved, participants were recruited, selected, and given verbal and written information of the study. Verbal and written consent was obtained from all participants. Treatment sessions were conducted in multiple settings for convenience of the participants. These settings include the Lab for the Skills of Living in the Occupational Therapy Department on the campus of East Carolina University and apartments of two of the participants. The study was conducted by graduate assistants and all procedures were overseen by the Chair of the Occupational Therapy Department of East Carolina University. Researchers obeyed confidentiality, ethical, and moral standards established by the IRB.

The protocols, found in Appendix B, implemented throughout this study were created by the primary investigator, sub-investigators, and graduate assistants. Before beginning the study, the researchers created and designed the specific set of protocols based on protocols developed by the Interactive Metronome® and exercises provided by TRX®. The IM® protocol that influenced this study was for individuals with attention-deficit hyperactivity disorder (ADHD), which is effective at improving attentional deficits. Based on these two sources, the researchers developed a 12-session intervention plan, with the first and last session consisting of pre- and post-testing evaluations. The remaining eight sessions were designed to include 1350-1512 repetitions with the IM® per session, which is the number of repetitions needed for effective treatment. Each session had a variety of IM® exercises complemented by a similar exercise using the TRX®. Due to the demanding physical nature of the IM®, exercises with the TRX® equipment were performed in 30 second increments with 30 seconds of break in between each



interval. Each session lasted a maximum of an hour and a half. The design of the study suggested that no more than three sessions be performed per week. The intervention plan was designed so that two participants could be treated simultaneously, therefore to encourage motivation and competition. When one participant was completing the proposed IM® exercise, the other participant would be completing the complementing TRX® exercise.

Once written and verbal consent of all participants was obtained, researchers completed pre-test evaluations on all participants using the COPM, TEA, IM® long form and short form assessments, and the NHPT. This session was also used to familiarize participants with the TRX® as well as the IM®.

Treatment sessions of the protocol were carried out over the course of three weeks. The two male participants performed each session together, as did the two female participants. Each session began with one participant completing the short form assessment of the IM® and the other participant stretching with the TRX®. Approximately nine other exercises were performed during each session (i.e. nine IM® exercises, complemented by nine TRX® exercises). In most circumstances, two researchers were present. One researcher set up the IM® equipment for each exercise and instructed the participant on what exercise to perform. The second researcher set up the TRX® equipment for each exercise, instructed the participant on what exercise to perform, and ran the stopwatch and notified the participant when to take breaks during each exercise. There were approximately 4 sessions where only one researcher was present. During these sessions, the researcher was competent to run both tasks and the sessions were completed successfully.

The last treatment session, session 12, researchers completed post-test evaluations on all participants using the COPM, TEA, IM® long form and short form assessments, and the NHPT. Once all information was obtained, researchers began the data analysis portion of the study.

### **Data Analysis**

The instruments utilized in this study produced measurable, numerical data. To analyze the data, the researchers found percentages of change from pre- to post-test. T-tests were then calculated using Microsoft Office Excel 2007 to determine whether there were significant differences between pre- and post-test scores at a 0.05 level.

## Analysis of Data

### Canadian Occupational Performance Measure

During the pre-test administration of the Canadian Occupational Performance Measure (COPM), each of the four participants identified specific areas of concern that were impacting the performance of self-care, productivity, and leisure occupations. The participants gave a self-perceived rating of level of performance and satisfaction of these specific areas of concern on a 10-point Likert scale during pre- and post-test evaluation. Table 1 reflects the identified areas of concern per participant, pre- and post-test scores, and the amount of change observed.

Table 1

#### *Pre- and Post-test COPM Scores of all Participants*

	Participant A		Participant B		Participant C		Participant D	
	Performance	Satisfaction	Performance	Satisfaction	Performance	Satisfaction	Performance	Satisfaction
Pre-test	5.75	4.25	3.75	2.75	6	5.4	6.25	7.5
Post-test	6.5	5.0	4.75	4.75	6	5.6	7.25	8
Change	0.75	0.75	1	2	0	0.2	1	0.5
Areas of Concern	time management skills, notebook organization between classes, time for the gym, time for friends and movies		time for healthy cooking, following agenda, leisure time for self and socializing with friends		time management skills, managing stress levels, budgeting finances, cooking, participating in leisure/social activities		balance and coordination, organization of finances, organization related to work, motivation and endurance during exercise	

Participant A showed an increase of 0.75 in performance and 0.75 in satisfaction.

Participant B showed a larger increase of 1 in performance and 2 in satisfaction. Participant C did not show an increase in performance, however did show a 0.2 increase in satisfaction.

Participant D demonstrated an increase in performance of 1 and an increase in satisfaction of 0.5.

The participants identified between 4 and 5 areas of concern, with a mean of 4.25 occupational performance goals for all four participants. The mean change in performance from pre- to post-test was 0.69 points (SD=0.47). The mean change in satisfaction from pre- to post-test was 0.86 points (SD=0.79). For the change to be considered a clinically important difference, there must be a change of 2 or more points on the COPM (Law et al., 1994). The results are not clinically significant because the mean result for both performance and satisfaction are below 2 points. Also, an independent-samples t-test was conducted to compare pre- and post-test performance and satisfaction scores. There was not a significant difference in the pre-test performance scores (M=5.4, SD=1.1) and post-test performance scores (M=6.1, SD=1.1);  $p = 0.06$ . There was also not a significant difference in the pre-test satisfaction scores (M=5.0, SD=2.0) and the post-test satisfaction scores (M=5.8, SD=1.5);  $p = 0.12$ .

### **Test of Everyday Attention**

The following results are discussed by each subtest in order to compare each participant's pre- to post-test scores. Raw scores have been translated to scaled-scores using the TEA manual according to the age of the participant (Robertson et al., 1994).

#### **Subtest #1: Map Search (MS1 and MS2)**

Table 2 shows the pre- and post-test scaled scores of all participants for the first component of the map search subtest. These scores are related to the number of symbols correctly circled in one minute. Participant A showed an increase in scaled score from 6 at pre-testing to 7 at post-testing, with a 17% change. Participant C also showed an increase in scaled score from 10 to 11, with a 10% change. However, Participant B and Participant D showed no improvement on this particular subtest. Participant D showed a decline in performance by -33%.

Table 2

*Pre- and Post-test Scaled Scores for TEA Subtest MS1*

	Pre-test	Post-test	Percentage of Change
Participant A	6	7	17%
Participant B	12	12	0%
Participant C	10	11	10%
Participant D	3	2	-33%

Table 3 shows the results of the second component of the map search subtest. These scaled scores represent the raw data of the total symbols circled in two minutes. Participant C showed an increase in scaled score by 29%, from 7 at pre-testing to 9 at post-testing. Participant D showed no change. Participant A and B showed decreases in scaled scores. Participant A received a scaled score of 4 before the treatment, and a 3 after the treatment, causing a change of -25%. Participant B showed a higher decrease in scaled score with a change of -44%, with a pre-test score of 9 and a post-test score of 5.

Table 3

*Pre- and Post-test Scaled Scores for TEA Subtest MS2*

	Pre-test	Post-test	Percentage of Change
Participant A	4	3	-25%
Participant B	9	5	-44%
Participant C	7	9	29%
Participant D	1	1	0%

### **Subtest #3: Elevator Counting with Distraction (ECD)**

Table 4 shows the pre- and post-test scaled scores for this subtest. Participant A showed an improvement in score by 40%, with a pre-test scaled score of 5 and a post-test score of 7. Participant B, Participant C, and Participant D all showed decreases in improvement. With a scaled score of 10 at pre-testing, Participant B received a post-test score of 9 and changed by -10%. Participants C and D showed larger decreases in score with -31% change, with each scoring 13 at pre-testing and 9 at post-testing.

Table 4

#### *Pre- and Post-test Scaled Scores for TEA Subtest ECD*

	Pre-test	Post-test	Percentage of Change
Participant A	5	7	40%
Participant B	10	9	-10%
Participant C	13	9	-31%
Participant D	13	9	-31%

### **Subtest #4: Visual Elevator (VE1 and VE2)**

Table 5 below shows the pre- and post-test scaled scores for the raw accuracy scores of the visual elevator subtest. Participant A, Participant C, and Participant D all showed improvements from pre- to post-test by 44%, increasing from 9 to 13. Participant B, however, showed a decrease in the scaled score after treatment by -18%.

Table 5

*Pre- and Post-test Scaled Scores for TEA Subtest VE1*

	Pre-test	Post-test	Percentage of Change
Participant A	9	13	44%
Participant B	11	9	-18%
Participant C	9	13	44%
Participant D	9	13	44%

Table 6 shows the pre- and post-test scaled scores for the timing accuracy of the visual elevator subtest. Participant A showed an increase from pre- to post-test by 18%. Participant C also showed improvements after treatment with a large change of 29%, increasing from a scaled score of 7 to 9. Participant B showed no change. Participant D showed a decrease in scaled score by -10%.

Table 6

*Pre- and Post-test Scaled Scores for TEA Subtest VE2*

	Pre-test	Post-test	Percentage of Change
Participant A	11	13	18%
Participant B	13	13	0%
Participant C	7	9	29%
Participant D	10	9	-10%

**Subtest #5: Elevator Counting with Reversal (ECR)**

Table 7 shows the pre- and post-test scaled scores for the elevator counting with reversal subtest. Participant A showed an increase in scaled score after treatment by 8%. Participant B

showed no change. Participant C and Participant D decreased in score from pre- to post-testing, with scores changing by -15% for Participant C and -20% for Participant D.

Table 7

*Pre- and Post-test Scaled Scores for TEA Subtest ECR*

	Pre-test	Post-test	Percentage of Change
Participant A	12	13	8%
Participant B	13	13	0%
Participant C	13	11	-15%
Participant D	10	8	-20%

**Subtest #6: Telephone Search (TS)**

Table 8 below shows the pre- and post-test scaled scores for the telephone search subtest. Participant D showed improvement from pre- to post-test, increasing by 20%. Participant A and Participant B both showed no change. Participant C showed a -14% change in scaled score after treatment, having a pre-test score of 7 and a post-test score of 6.

Table 8

*Pre- and Post-test Scaled Scores for TEA Subtest TS*

	Pre-test	Post-test	Percentage of Change
Participant A	10	10	0%
Participant B	12	12	0%
Participant C	7	6	-14%
Participant D	10	12	20%



### **Subtest #7: Telephone Search while Counting (TSC)**

Table 9 shows the pre- and post-test scaled scores for the telephone search while counting task. Participant D showed a 10% increase from pre- to post-test. However, the three other participants all showed decreases in performance for this subtest. Participant A experienced a -16% change from 13 at pre-testing to 11 at post-testing. Participant B, with a pre-test scaled score of 13, decreased by 31% to a post-test scaled score of 8. Participant C showed an even larger decrease in scaled score with a change of -50%.

Table 9

#### *Pre- and Post-test Scaled Scores for TEA Subtest TSC*

	Pre-test	Post-test	Percentage of Change
Participant A	13	11	-16%
Participant B	13	8	-31%
Participant C	17	15	-50%
Participant D	10	11	10%

### **Subtest #8: Lottery (L)**

Table 10 presents the pre- and post-test scaled scores for the lottery subtest. Participant A showed a 22% increase in score, with a scaled score of 9 at pre-test and 13 at post-test. Participant B showed no change. Participant C and Participant D both showed changes of -38% after treatment, declining from 13 to 8.

Table 10

*Pre- and Post-test Scaled Scores for TEA Subtest L*

	Pre-test	Post-test	Percentage of Change
Participant A	9	13	22%
Participant B	13	13	0%
Participant C	13	8	-38%
Participant D	13	8	-38%

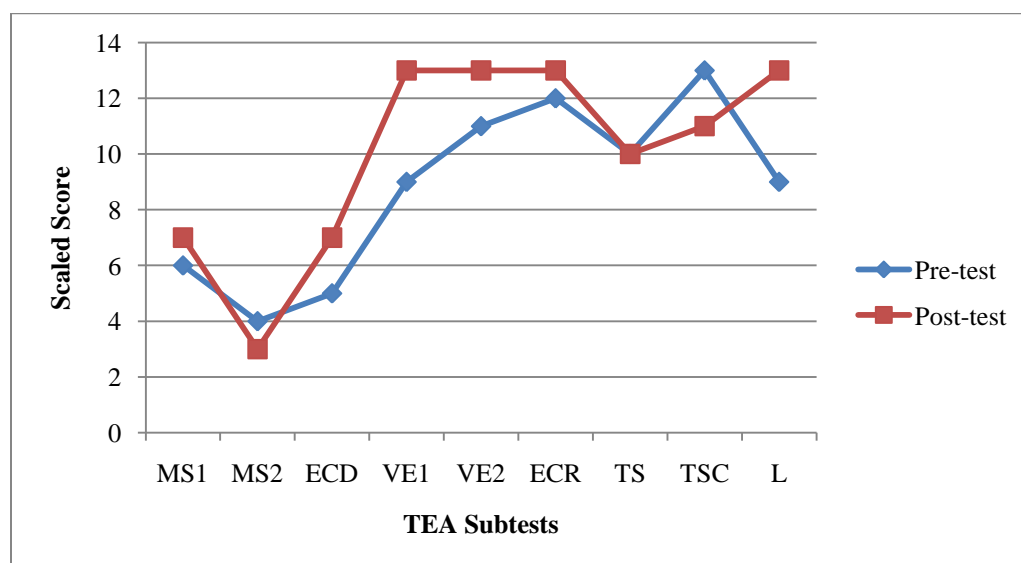
Table 11 shows the p-values calculated for each subtest of the TEA. An independent-samples t-test was conducted for each subtest to compare pre-test scaled scores to post-test scaled scores for all participants. Using a p-value of 0.05, there was not a significant difference in the pre-test scores and post-test scores for any of the TEA subtests.

Table 11

*P-values for TEA Subtests*

Subtests	P-values
MS1	0.64
MS2	0.59
ECD	0.31
VE1	0.19
VE2	0.39
ECR	0.39
TS	0.72
TSC	0.20
L	0.54

The following figures illustrate the pre- and post-test TEA results for each participant. Figure 1 shows the pre- and post-test TEA results for Participant A. The graph illustrates a majority of higher scaled scores during post-test assessment and lower scaled scores during pre-test assessment. There are only two subtests in which the pre-test scores are higher than the post-test scores. Though not statistically significant, these results demonstrate that Participant A did experience improved performance after the implemented protocols for most of the TEA subtests.



*Figure 1.* Pre- and Post-test TEA Results for Participant A.

Figure 2 shows the pre- and post-test TEA results for Participant B. These results illustrate a decrease in scaled scores from pre- to post-test, suggesting a decline in attention.

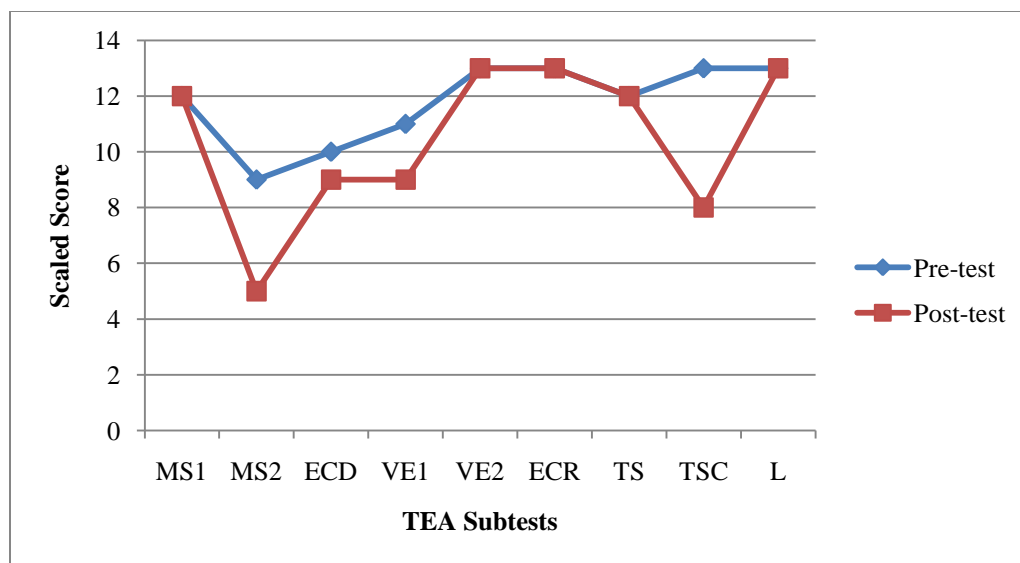


Figure 2. Pre- and Post-test TEA Results for Participant B.

Figure 3 shows the pre- and post-test TEA results for Participant C. The graph illustrates improvements in some subtests, yet declines in others after treatment. The last four subtests demonstrate a similar pattern of scores, even though the scores during post-testing are less than the scores obtained during pre-testing.

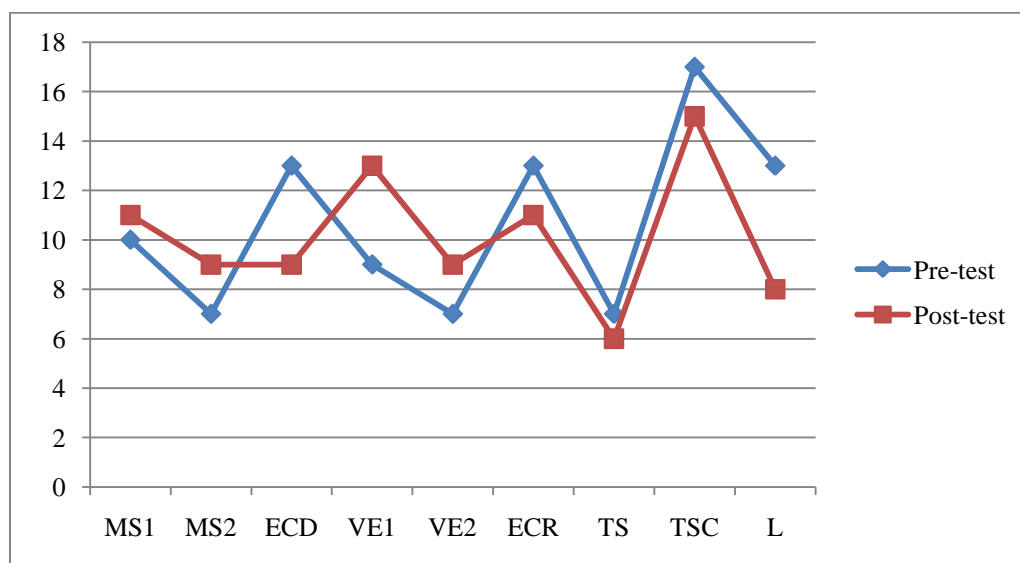


Figure 3. Pre- and Post-test TEA Results for Participant C.

Figure 4 shows the pre- and post-test TEA results for Participant D. Like Participant C, this individual experienced both improvements and declines in performance depending on the subtest. For Participant D, the first and second subtests show very low scaled scores during both pre-testing and post-testing.

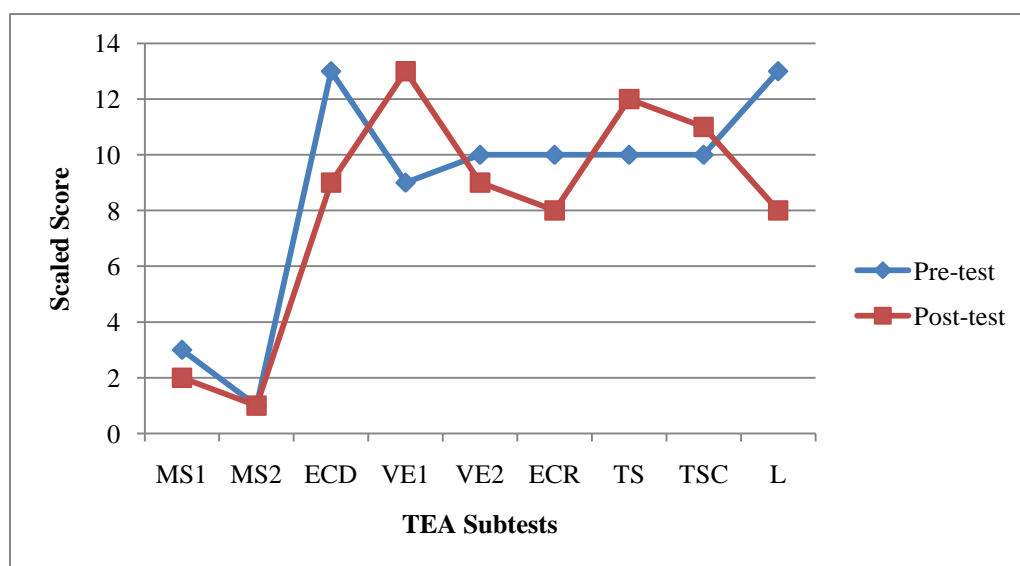


Figure 4. Pre- and Post-test TEA Results for Participant D.

### Interactive Metronome® Short Form Assessment

The Short Form assessment of the Interactive Metronome® yielded millisecond (ms) averages that could be compared throughout the study. The 10 session-protocol was designed to include the Short Form assessment at the beginning and end of each session. The millisecond averages taken from these two trials were averaged together to produce one average for the total session. Therefore, each participant had 10 millisecond averages, one for each session of the protocol. The following paragraphs explain the Short Form assessment results for each participant.

## Participant A

Table 12 presents the Short Form assessment results for Participant A. With the level of significance set at 0.05, there is no evidence of statistical significance from session to session or from each session compared to the first session.

Table 12

### *IM® Short Form Scores and P-values for Participant A*

Session	Task One ms Average	Task Two ms Average	P-value compared to previous day	P-value compared to session 1
1	39	78	N/A	N/A
2	54	65	0.95	0.95
3	45	22	0.37	0.57
4	46	50	0.48	0.67
5	45	79	0.52	0.39
6	75	59	0.87	0.81
7	46	62	0.57	0.76
8	31	53	0.16	0.30
9	31	15	0.50	0.42
10	31	19	0.74	0.31

## Participant B

Table 13 presents the Short Form results for Participant B. With the level of significance set at 0.05, there is no evidence of statistical significance from session to session or from each session compared to the first session.

Table 13

*IM® Short Form Scores and P-values for Participant B*

Session	Task One ms Average	Task Two ms Average	P-value compared to previous day	P-value compared to session 1
1	19	23	N/A	N/A
2	14	15	0.14	0.14
3	26	21	0.20	0.68
4	13	12	0.11	0.18
5	22	23	0.06	0.50
6	21	19	0.34	0.80
7	9	16	0.34	0.11
8	17	15	0.58	0.34
9	21	22	0.17	0.80
10	16	13	0.18	0.31

**Participant C**

Table 14 presents the Short Form results for Participant C. With the level of significance set at 0.05, there is no evidence of statistical significance from session to session or from each session compared to the first session.

Table 14

*IM® Short Form Scores and P-values for Participant C*

Session	Task One ms Average	Task Two ms Average	P-value compared to previous day	P-value compared to session 1
1	23	23	N/A	N/A
2	29	20	0.80	0.80
3	43	47	0.20	0.06
4	44	30	0.54	0.30
5	26	24	0.30	0.30
6	32	36	0.20	0.11
7	57	67	0.07	0.08
8	44	42	0.19	0.03
9	39	23	0.34	0.50
10	18	29	0.27	0.94

**Participant D**

Table 15 presents the Short Form results for Participant D. With the level of significance set at 0.05, there is no evidence of statistical significance from session to session or from each session compared to the first session.



Table 15

*IM® Short Form Scores and P-values for Participant D*

Session	Task One ms Average	Task Two ms Average	P-value compared to previous day	P-value compared to session 1
1	102	220	N/A	N/A
2	74	130	0.31	0.31
3	65	115	0.16	0.28
4	55	61	0.38	0.32
5	50	67	0.94	0.29
6	28	71	0.61	0.21
7	35	32	0.61	0.28
8	25	25	0.11	0.26
9	35	65	0.34	0.24
10	80	41	0.81	0.42

The millisecond (ms) averages for Task One and Task Two provided evidence to the participants' change over the course of the study as to how closely he/she hit the switch when the bell sounded. The Short Form assessment did not provide results that were statistically significant.

Figure 5 shows the Task One ms averages for each participant throughout the 10-session protocol. As demonstrated in the figure, the participants showed many increases and decreases in performance over the course of the study. Participant A began with a slight increase, plateaued, largely increased at session 6, then steadily declined in ms average until the end of the study. Participant B began by slowly increasing, briefly decreased, largely increased at session 6, and then steadily declined with one slight increase in between. Participant C experienced a steady increase until session 3, steady decline until largely increasing at session 6, and then declining in

MS average until the sessions ended. Participant D's ms averages steadily decreased in the beginning, with a few instances of increasing ms averages, and ending the study with a steady incline. Though the results of the Short Form assessment were not significant, Figure 5 illustrates an important finding of the established protocols. All participants experienced an increased ms average during session 6. For Participant A, Participant B, and Participant C, there is a large increase and then the ms averages steadily decline until the end of the study.

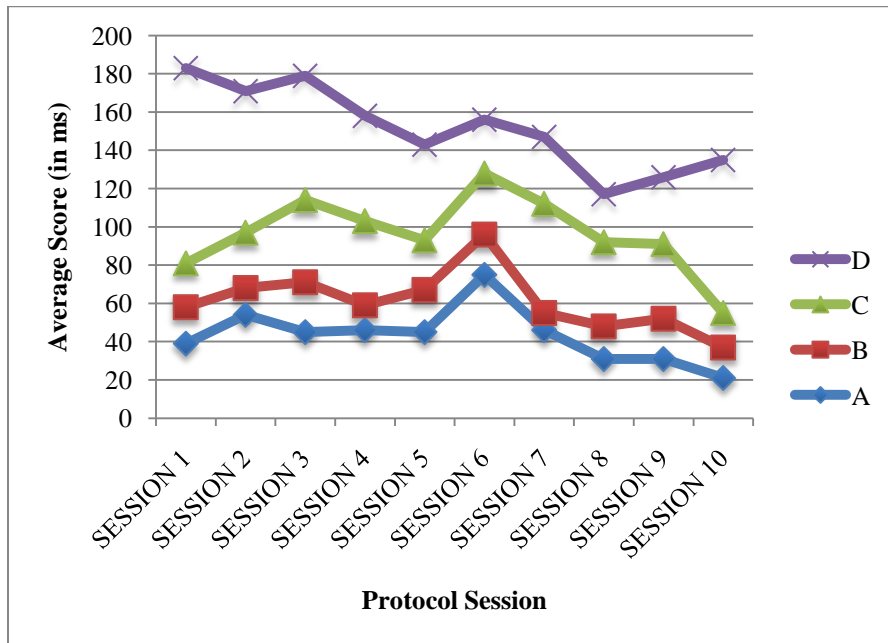


Figure 5. IM® Task One ms averages per Session per Participant.

Figure 6 compares the results of Task Two for each participant throughout the 10-session protocol. Participant A showed a steady decrease, steady increase to session 5, and then progressive decline to the end of the study. Participant B showed a very similar path throughout the protocol, with a largest increase in ms average occurring in session 5. Participant C also resembles the same data as Participant A and Participant B, with increases in task average occurring in session 5 and session 7. Participant D showed a distinctive decrease in ms average,

with a slight increase at session 5. All participants showed an increase in ms average for Task Two at session 5.

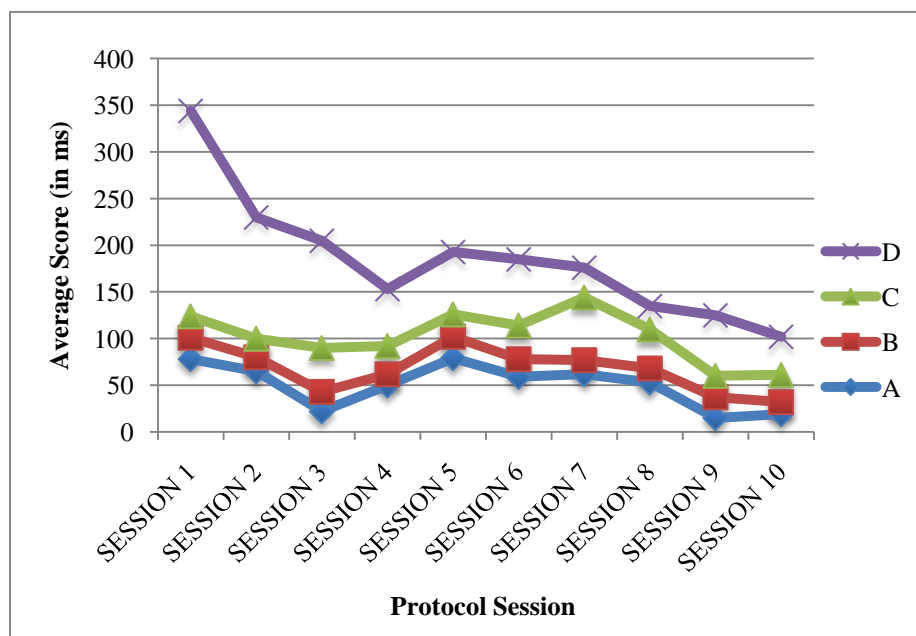


Figure 6. IM® Task Two ms averages per Session per Participant.

### Interactive Metronome® Long Form Assessment

Table 16 shows the adjusted ms averages and percentage of change from pre- to post-test for all participants using the Long Form assessment of the Interactive Metronome®. Participant A, Participant B, and D all showed negative percentages of change, meaning they showed decreases in ms averages from pre- to post-test. Therefore, a negative percentage of change indicates improved performance. Participant A showed a 30.8% decrease from pre- to post-test. Participant B also decreased in millisecond average, with a percentage of change of -29.7%. Participant D showed a larger decrease in average with a change of -31.9%. However, Participant C scored a higher ms average at pre-testing and the positive percentage of change was 26.2%.

Table 16

*IM® Long Form Adjusted ms Averages and Percentage of Change for all Participants*

	Pre-test	Post-test	Percentage of Change
Participant A	58.6	40.6	-30.8%
Participant B	24.4	17.2	-29.7%
Participant C	36.8	46.5	26.2%
Participant D	158.9	108.3	-31.9%

An independent-samples t-test was conducted to compare pre-test Long Form assessment scores to post-test Long Form assessment scores of all participants. There was not a significant difference in the pre-test scores (M=70.0, SD=61.1) and post-test scores (M=53.4, SD=38.9);  $p = 0.28$ .

### **Nine-Hole Peg Test**

The Nine-Hole Peg Test (NHPT) generated right and left hand results from all four participants, and findings are reflected in Tables 17 and 18. The results were recorded by the amount of time in seconds it took for the participant to complete the test. Improvement in hand dexterity is indicated by a decrease in the amount of time it takes to perform the NHPT. Therefore, negative percentage of change reflects improved performance.

Table 17

*NHPT Right Hand Results and Percentage of Change for all Participants*

	Pre-test	Post-test	Percentage of Change
Participant A	16.5	17	3%
Participant B	16.7	14.9	-11%
Participant C	20.8	15.6	-25%
Participant D	18	18.3	1.7%

An independent-samples t-test was conducted to compare pre-test right hand scores to post-test right hand scores of all participants. There was not a significant difference in the pre-test scores (M=18, SD=2.0) and post-test scores (M=16.5, SD=1.5);  $p = 0.33$ . This p-value is not statistically significant for improved right hand dexterity performance.

Table 18

*NHPT Left Hand Results and Percentage of Change for all Participants*

	Pre-test	Post-test	Percentage of Change
Participant A	21.6	17.7	-18%
Participant B	16.3	16.6	1.8%
Participant C	23.2	20.2	-13%
Participant D	21	19.8	-5.7%

An independent-samples t-test was conducted to compare pre-test left hand scores to post-test left hand scores of all participants. There was not a significant difference in the pre-test scores (M=20.5, SD=3.0) and post-test scores (M=18.6, SD=1.7);  $p = 0.13$ . This p-value does

not provide significant evidence of improved left hand dexterity performance from pre- to post-test.

## **Discussion of Findings**

The purpose of this study was to evaluate the effectiveness of an established protocol series using the Interactive Metronome® (IM®) and TRX® in improving life satisfaction and reducing loss of attention in a normal and well population. The results of this pilot study are expected to be applied to a future study which focuses on Marines with mild traumatic brain injuries (TBI) associated with post-traumatic stress disorder (PTSD) symptoms.

Changes were observed and recorded using a variety of instruments. The Test of Everyday Attention, Canadian Occupational Performance Measure, IM® Long Form and Short Form assessments, and the Nine-Hole Peg Test were administered during pre- and post-test evaluations. Though results collected from these instruments were not proven to be statistically significant, the changes resulting from the set of treatment protocols conveyed key information about this pilot study.

The Test of Everyday Attention (TEA) may have not produced significant changes in attention for the four participants, but important observations were made throughout this study that should be discussed. For Participant B, the results indicate that performance of the attention-related tasks declined after treatment, rather than improved. However, by looking closely at the data, it should be noted that Participant B received very high scores during pre-testing. This did not leave much room for improvement after treatment. Therefore, Participant B needed to maintain the pre-test scores or increase in score if possible during post-testing, though many of the subtest scores had reached the ceiling. The post-test assessment indicated a decrease in performance. This could be due to a number of factors, including the scores already reaching maximum potential or the participant dealing with end of semester exams. This could also be a

clear example of a well individual who is dealing with stressful life circumstances and experiencing interference in attention.

Participant C and Participant D displayed both improvements and declines from pre- to post-test with the TEA. These unexpected results may be explained by the participants being of a normal and well status. Individuals of this population experience varying levels of attention depending on a number of factors. These participants may have been given the post-test assessment at a different time of day than the pre-test, and this could have impacted his/her performance to attention-related tasks.

Participant D received strikingly low scores for the first and second TEA subtest. These subtests required the individual to scan a large map and locate specific symbols in two minutes. During pre-test administration, Participant D wore corrective lenses. During post-test administration, this individual wore glasses and was observed bringing his/her eyes close to the map. Though the researcher followed the standardized guidelines to administration, Participant D may not have fully understood the directions.

The Canadian Occupational Performance Measure (COPM) was used to assess the participants' perception of occupational performance and satisfaction before and after treatment. In this pilot study it was expected that if the loss of attention was reduced, individuals would begin to report higher levels of life satisfaction. Significant changes were not observed within this particular research study. However, this may be explained by the nature of the participants. By using a well population, it was not expected that attention would improve because these individuals did not have attentional impairments to begin with. If the treatment did not cause an improvement in attention, the individuals would not report a higher level of satisfaction or



performance when assessed by the COPM. However, though not significant, change was observed. This can be explained by the physical nature of the protocol and instruments. The IM® and TRX® are designed to provide individuals with exercise and movement to improve coordination, balance, timing, and motor ability. By completing a 10-session protocol, individuals may report improvements in satisfaction with occupations due to the physical nature of these pieces of equipment.

The Interactive Metronome® Short Form results illustrate peaks in millisecond (ms) averages during session 6 for Task One and session 5 for Task Two. These findings lend pertinent information to the impact of the protocol series on these four participants. The peak in scoring may indicate that once participants performed six sessions of the designed protocol, the ms averages began to show improvements in performance in Task One. Also, once participants performed five sessions of the designed protocol, the ms averages will began to show improvements in performance for Task Two. For Task One, Participant A, Participant B, and Participant C all showed steady decrease after the peak at session 6. Participant D did not. However, Participant D did show a steady decrease of ms average when performing Task Two. This demonstrates that Participant D most likely benefitted greatly from the guide sounds provided on Task Two.

The Interactive Metronome® Long Form assessment did not show evidence that there was significant change in timing after the specific protocols were performed. However, three of the four participants did show improvements in adjusted millisecond averages. Participant A showed a positive change of 30.8%, Participant B improved by 29.7%, and Participant C had a change of 31.9%. Participant D experienced a percentage of change of -26.2%. The percentages of change are very similar, except for Participant D who obtained a negative percentage. This

may be explained by the life events and timing of administration of the assessment for that particular participant. The assessment results may have been affected due to the participant experiencing end of semester exams, a busy schedule, a part-time job, and/or preparing for a move to another city.

## **Summary and Conclusion**

Though the results of this pilot study did not provide evidence for statistical significance, the observed changes show the effects of the designed and implemented Interactive Metronome® and TRX® protocol series. The most pertinent information can be seen in the areas of attention and life satisfaction.

The results and findings correctly answered the research questions asked at the beginning of this pilot study:

1. Is the protocol series using the Interactive Metronome® along with the TRX® developed for mild traumatic brain injury associated with post-traumatic stress disorder symptoms an effective series of intervention sessions that affect change and improve attention skills in normal young adults?
2. Is the protocol series using the Interactive Metronome® along with the TRX® developed for mild traumatic brain injury associated with post-traumatic stress disorder symptoms an effective series of intervention sessions that affect change and improve life satisfaction in normal young adults?

The intervention sessions of the designed protocol series affected attention skills and life satisfaction of the normal, young participants of the pilot study population. Change was observed using a variety of evaluation tools. The Test of Everyday Attention and the Canadian Occupational Performance Measure showed improvements in attention skills and life satisfaction of the four participants. It can be concluded that the protocols series using the Interactive Metronome® and TRX® is effective at producing change in such areas and can be applied to

clients with individuals with mild traumatic brains injuries associated with post-traumatic stress disorder symptoms.

### **Recommendations for Further Research**

The author of this pilot study has recommended a few changes if this study is to be reproduced or continued for further research. Researchers must be fully trained and knowledgeable of the Interactive Metronome® (IM®) before beginning any protocol series. All researchers of this study were IM® certified, yet experienced problems with the software. If an IM® exercise is performed twice within the same session, the data of the most recent trial will be recorded. This can be corrected by changing the computer clock to the next day before beginning the second trial of the same exercise. This problem did not skew the data of this pilot study. Another recommendation is to use a pancake switch instead of the IM® foot switch. The IM® foot switch is often inconsistent and can provide inaccurate data. The pancake switch can be easily installed to the IM® equipment. It is recommended that the physical challenge be increased for the protocol series. There are TRX® exercises within the designed protocol series that required the participants to alternate extremities. Due to the timing of the exercise, participants completed unequal number of repetitions on each extremity (ex. two squats on right leg, one squat on left leg). It is recommended the protocol exercises and/or timing be edited to correct this error. Authors received feedback from the participants that indicated the TRX® exercises could be more physically challenging. This recommendation should be directly applied to future studies focusing on military populations.

Future research is strongly encouraged to further investigate the findings of this pilot study. This study was conducted in preparation for implementation with a population of Marines

with mild traumatic brain injury associated with post-traumatic stress disorder. Further research may indicate the effects of the IM® and TRX® in improving life satisfaction and reducing loss of attention. As stated in the review of literature, the military population experiences significant occupational gaps due to the residual symptoms of mild traumatic brain injury and post-traumatic stress disorder. Occupational therapists must be well equipped with intervention and treatment strategies to assist these individuals in overcoming these residual symptoms and living as independently as possible. With further research, occupational therapists will be able to provide evidence-based practice and make significant changes in the everyday lives of this population.

### **Acknowledgements**

The author would like to thank the Interactive Metronome® and TRX® for providing equipment and software for this study. The author would also like to thank the participants for their devoted time and effort throughout this study. Lastly, the authors would like to thank Dr. Leonard Trujillo, OTR/L, FAOTA, Michelle McBride, OTS, and Jamie Joyner, OTS, for their help and knowledge in the development and implementation of the protocol series.

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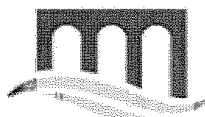
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Appendix A



EAST CAROLINA UNIVERSITY

University & Medical Center Institutional Review Board Office  
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Office 252-744-2914 • Fax 252-744-2284 • [www.ecu.edu/irb](http://www.ecu.edu/irb)

TO: Kelly Ridenhour, MS Student, Occupational Therapy Department, ECU

FROM: UMCIRB *RWB*

DATE: March 31, 2011

RE: Expedited Category Research Study

TITLE: "Evaluating the Effectiveness of the Interactive Metronome in Improving Life Satisfaction and Reducing Loss of Attention in Marines with Mild Traumatic Brain Injuries Associated with Post Traumatic Stress Disorder Symptoms: A Pilot Study of Protocols"

**UMCIRB #11-0221**

This research study has undergone review and approval using expedited review on 03/30/2011. This research study is eligible for review under an expedited category number 7 which includes research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior), or research employing survey, interview, oral history, focus groups, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: some research in this category may be exempt from the HHS regulations for the protection of human subjects 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt. The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **03/30/2011 to 03/29/2012**. The approval includes the following items:

- Internal Processing Form (dated 03/2/2011)
- Interactive Metronome Proposed Protocol (receipt date 03/25/2011)
- Informed Consent (receipt date 03/25/2011)

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

**The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.**

CONSENT DOCUMENT

Title of Research Study: Evaluating the effectiveness of the Interactive Metronome® in improving life satisfaction and reducing loss of attention in Marines with mild traumatic brain injuries associated with post-traumatic stress disorder symptoms: A pilot study of protocols

Principal Investigator: Kelly Ridenhour OT MS Student  
Institution: East Carolina University  
Address: Health Sciences Building, Occupational Therapy, Room 3305- H  
Telephone #: (252)744-6195

**INTRODUCTION**

You have been asked to participate in a research study being conducted Kelly Ridenhour OTS, CAHS. This research study is a pilot study to test the effectiveness of a specific set of protocols established by the researchers. The protocols are designed understand if participating in occupational therapy intervention of treatment can make a positive change in attention and life satisfaction in occupational performance. The information from this study will provide therapists with specific protocols that can be used with mild traumatic brain injured clients and/or individuals with post-traumatic stress disorder symptoms. Results of this study will also be valuable for therapists working with military populations.

**PLAN AND PROCEDURES**

You will be one of four participants in the study. This research will be initiated and concluded at East Carolina University Occupational Therapy Department. The actual therapy sessions, if you agree to participate, will be conducted on the East Carolina University Allied Health Sciences Campus in the OT Department's Lab for the Skills of Living. If you agree to participate in this study, you will complete four standard evaluations. The Interactive Metronome® will be used to gather data using the Long form and Short form assessments. The Test of Everyday Attention (TEA) will be used to assess changes in attention. The Canadian Occupational Performance Measure (COPM) measures the participant's self-perception of change in occupational performance and satisfaction over time. These evaluations will help the researchers to evaluate how the intervention protocols are affecting attention and life satisfaction throughout the study.

Once you have completed the standard evaluations, you will complete six protocol sessions involving the Interactive Metronome® and the TRX® Suspension Training exercise equipment. Sessions will be approximately an hour and a half, three times a week. Sessions will never last longer than 3 hours. Sessions will begin with the Interactive Metronome® for a maximum of six minutes, then perform the proposed TRX® exercise for no longer than six minutes. Due to the physical nature of the TRX®,

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participants will perform the exercise for 30 seconds, and then take a 30 second break before beginning the movement again. The TRX® will be suspended from a secure position and researchers will ensure the equipment and participant are positioned properly throughout all exercises. A sub-investigator will also be present during all sessions. After session six, the midpoint of the study, participants will be evaluated again with the Interactive Metronome® Long form and Short form assessments, TEA, and COPM. You will complete six more treatment sessions involving the Interactive Metronome® and TRX®. Upon completion of these sessions, you will be asked to return to the lab for post-test evaluation that will be of the same nature of the pre-test and interim test, with the Interactive Metronome® Long form and Short form assessments, TEA, and COPM.

#### **POTENTIAL RISKS AND DISCOMFORTS**

Some individuals experience some anxiety during rehabilitation evaluations. Sometimes this is due to the stress of knowing you are being evaluated. Also some people become anxious because they do not perform as well on the evaluation as they would have preferred. In either case, the research staff will always be available to answer questions and reassure you on your performance.

Because the Interactive Metronome® is new to most individuals, they are having to learn a new skill and may experience some anxiety about doing it right. Learning times are built into the process and these can be extended to allow you to increase your comfort with the process.

The number of repetitions in performing the Interactive Metronome® activities may become challenging for some individuals and some may not have the endurance to complete the full number of repetitions outlined in the protocols designed. However, Interactive Metronome® training provides options to lower this to a successful number to meet the capabilities of each individual.

#### **POTENTIAL BENEFITS**

You may experience improved attention and life satisfaction from completing this study. However, you may receive no benefit from this study. It is anticipated that many will improve their sense of coordination, smoothness in movement and fluid motor patterns.

#### **SUBJECT PRIVACY AND CONFIDENTIALITY OF RECORDS**

You will not be personally identified in any reports or publications that may result from this study. Any personal information about you that is gathered during this study will remain confidential to every extent of the law. A special number will be used to identify you in the study. All information from this study will be kept in a locked file cabinet within a locked office or within a password protected computer. Only the investigators and sub-investigators will have access to the files.

**COSTS OF PARTICIPATION**

There are no costs to you for your participation in this study.

**VOLUNTARY PARTICIPATION**

Participating in this study is voluntary. If you decide not to be in this study after it has already started, you may stop at any time without losing benefits that you should normally receive. You may stop at any time you choose without penalty.

**PERSONS TO CONTACT WITH QUESTIONS**

The investigators will be available to answer any questions concerning this research, now or in the future. You may contact the Primary Investigator: Leonard G. Trujillo PhD, OTR/L at 252-744-6195 or the sub investigators: Kelly Ridenhour, OTS at 704-612-1374; Michelle McBride, OTS at 440-668-6495; and Jamie Joyner, OTS at 336-413-2984. If you have questions about your rights as a research subject, you may call the Chair of the University and Medical Center Institutional Review Board at phone number 252-744-2914 (days) and/or the ECU Risk Management Office at 252-328-6858.

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**CONSENT TO PARTICIPATE**

**Title of research study:** Evaluating the effectiveness of the Interactive Metronome® in improving life satisfaction and reducing loss of attention in Marines with mild traumatic brain injuries associated with post-traumatic stress disorder symptoms: A pilot study of protocols

I have read all of the above information, asked questions and have received satisfactory answers in areas I did not understand. (A copy of this signed and dated consent form will be given to the person signing this form as the participant or as the participant authorized representative.)

Participant's Name (PRINT)	Signature	Date	Time
----------------------------	-----------	------	------

If applicable:

Guardian's Name (PRINT)	Signature	Date	Time
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PERSON ADMINISTERING CONSENT: I have conducted the consent process and orally reviewed the contents of the consent document. I believe the participant understands the research.

Person Obtaining consent (PRINT)	Signature	Date
----------------------------------	-----------	------

Principal Investigator (PRINT)	Signature	Date
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## Appendix B

Session	Interactive Metronome Proposed Protocol	TRX
Session 1	Initial Evaluation: Short Form IM Test COPM Overt TEA 9 Hole Peg Test Long Form IM Test	Getting to Know the TRX
Session 2	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 5: Right Toe (162 Reps, 3 Min) Exercise 2: Right Hand (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 6: Left Toe (162 Reps, 3 Min) Exercise 3: Left Hand (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1350 Reps, 25 Minutes</i>	TRX Stretching Chest Press toward Midline Sprinter Start Series; Right Leg only Right 1-Arm Bicep Pull/Swinging Hand TRX Stretching Sprinter Start Series; Left Leg only Left 1-Arm Bicep Pull/Swinging Hand Low Row
Session 3	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 4: Both Toes (162 Reps, 3 Min) Exercise 10: Right Hand, Left Toe (162 Reps, 3 Min) Exercise 9: Left Heel (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 8: Right Heel (162 Reps, 3 Min) Exercise 11: Left Hand, Right Toe (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1512 Reps, 28 Minutes</i>	TRX Stretching Chest Press toward Midline Sprinter Start Series; Alternating Legs Chest Press with Left Lunge Single Leg Squat; Left Leg only TRX Stretching Single Leg Squat; Right Leg only Chest Press with Right Lunge Low Row
Session 4	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 4: Both Toes (162 Reps, 3 Min) Exercise 2: Right Hand (162 Reps, 3 Min) Exercise 10: Right Hand, Left Toe (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 3: Left Hand (162 Reps, 3 Min) Exercise 11: Left Hand, Right toe (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1512 Reps, 28 Minutes</i>	TRX Stretching Chest Press toward Midline Sprinter Start Series; Alternating Legs Right 1-Arm Bicep Pull/Swinging Hand Chest Press with Left Lunge TRX Stretching Left 1-Arm Bicep Pull/Swinging Hand Chest Press with Right Lunge Low Row
Session 5	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 3: Left Hand (162 Reps, 3 Min) Exercise 7: Both Heels (162 Reps, 3 Min) Exercise 13: Balance Left Foot (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 12: Balance Right Foot (162 Reps, 3 Min) Exercise 11: Left Hand, Right Toe (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1512 Reps, 28 Minutes</i>	TRX Stretching Chest Press toward Midline Left 1-Arm Bicep Pull/Swinging Hand Single Leg Squat; Alternating Legs every 30 Seconds Left Foot Inclined Bridge TRX Stretching Right Foot Inclined Bridge Chest Press with Right Lunge Low Row
Session 6	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 5: Right Toe (162 Reps, 3 Min) Exercise 13: Balance Left Foot (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 12: Balance Right Foot (162 Reps, 3 Min) Exercise 6: Left Toe (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1512 Reps, 25 Minutes</i>	TRX Stretching Chest Press toward Midline Sprinter Start Series; Right Leg only Left Foot Inclined Bridge TRX Stretching Right Foot Inclined Bridge Sprinter Start Series; Left Leg only Low Row
Session 7	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 2: Right Hand (162 Reps, 3 Min) Exercise 12: Balance Right Foot (162 Reps, 3 Min) Exercise 3: Left Hand (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 11: Left Hand/Right Toe (162 Reps, 3 Min) Exercise 13: Balance Left Foot (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min)	TRX Stretching Chest Press toward Midline Right 1-Arm Bicep Pull/Swinging Hand Right Foot Inclined Bridge Left 1-Arm Bicep Pull/Swinging Hand TRX Stretching Chest Press with Right Lunge Left Foot Inclined Bridge Low Row

## Running Head: A PILOT STUDY OF IM® PROTOCOLS

Session 8	<i>Total: 1512 Reps, 28 Min</i>	
	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 3: Left Hand (162 Reps, 3 Min) Exercise 6: Left Toe (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 2: Right Hand (162 Reps, 3 Min) Exercise 5: Right Toe (162 Reps, 3 Min) Exercise 10: Right Hand/Left Toe (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1512 Reps, 28 Min</i>	TRX Stretching Chest Press toward Midline Left 1-Arm Bicep Pull/Swinging Hand Sprinter Start Series; Left Leg only TRX Stretching Right 1-Arm Bicep Pull/Swinging Hand Sprinter Start Series; Right Leg only Chest Press with Left Lunge Low Row
Session 9	<i>Total: 1512 Reps, 28 Min</i>	
	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 5: Right Toe (162 Reps, 3 Min) Exercise 13: Balance Left Foot (162 Reps, 3 Min) Exercise 7: Both Heels (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 6: Left toe (162 Reps, 3 Min) Exercise 12: Balance Right Foot (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1512 Reps, 28 Min</i>	TRX Stretching Chest Press toward Midline Sprinter Start Series; Right Leg only Left Foot Inclined Bridge Single Leg Squat; Alternating Legs every 30 Seconds TRX Stretching Sprinter Start Series; Left Leg only Right Foot Inclined Bridge Low Row
Session 10	<i>Total: 1512 Reps, 28 Min</i>	
	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 8: Right Heel (162 Reps, 3 Min) Exercise 10: Right Hand/Left Toe (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 9: Left Heel ((162 Reps, 3 Min) Exercise 11: Left Hand/ Right Toe (162 Reps, 3 Min) Exercise 4: Both Toes (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1512 Reps, 28 Min</i>	TRX Stretching Chest Press toward Midline Single Leg Squat; Right Leg only Chest Press with Left Lunge TRX Stretching Single Leg Squat; Left Leg only Chest Press with Right Lunge Sprinter Start Series; Alternating Legs Low Row
Session 11	<i>Total: 1512 Reps, 28 Min</i>	
	Short form test Exercise 1: Both Hands (216 Reps, 4 Min) Exercise 12: Balance Right Foot (162 Reps, 3 Min) Exercise 3: Left Hand (162 Reps, 3 Min) Exercise 5: Right Toe (162 Reps, 3 Min) Exercise 1: Both Hands (162 Reps, 3 Min) Exercise 13: Balance Left Foot (162 Reps, 3 Min) Exercise 2: Right Hand (162 Reps, 3 Min) Exercise 1: Both Hands (324 Reps, 6 Min) <i>Total: 1512 Reps, 28 Min</i>	TRX Stretching Chest Press toward Midline Right Foot Inclined Bridge Left 1-Arm Bicep Pull/Swinging Hand Sprinter Start Series; Alternating Legs TRX Stretching Left Foot Inclined Bridge Right 1-Arm Bicep Pull/Swinging Hand Low Row
Session 12	<i>Total: 1512 Reps, 28 Min</i>	
	Final Evaluation: Short form IM test COPM Overt TEA 9 Hole Peg Test Long form IM test	

TRX Exercises-30 seconds work, 30 seconds off

Appendix C

# CANADIAN OCCUPATIONAL PERFORMANCE MEASURE

**Authors:**

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

The Canadian Occupational Performance Measure (COPM) is an individualized measure designed for use by occupational therapists to detect self-perceived change in occupational performance problems over time.

Client Name:		
Age:	Gender:	ID#:
Respondent (if not client):		
Date of Assessment:	Planned Date of Reassessment:	Date of Reassessment:
Therapist:		
Facility/Agency:		
Program:		

## STEP 1: IDENTIFICATION OF OCCUPATIONAL PERFORMANCE ISSUES

To identify occupational performance problems, concerns and issues, interview the client, asking about daily activities in self-care, productivity and leisure. Ask clients to identify daily activities which they want to do, need to do or are expected to do by encouraging them to think about a typical day. Then ask the client to identify which of these activities are difficult for them to do now to their satisfaction. Record these activity problems in Steps 1A, 1B, or 1C.

## STEP 2: RATING IMPORTANCE

Using the scoring card provided, ask the client to rate, on a scale of 1 to 10, the importance of each activity. Place the ratings in the corresponding boxes in Steps 1A, 1B, or 1C.

### STEP 1A: Self-care

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

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

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

### IMPORTANCE










### STEP 1B: Productivity

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

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

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

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### STEP 1C: Leisure

#### Quiet Recreation

(e.g., hobbies,  
crafts, reading)

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---

#### Active Recreation

(e.g., sports,  
outings, travel)

---

---

---

#### Socialization

(e.g., visiting,  
phone calls, parties,  
correspondence)

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---

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#### IMPORTANCE

### STEPS 3 & 4: SCORING - INITIAL ASSESSMENT and REASSESSMENT

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. At reassessment, the client scores each problem again for performance and satisfaction. Calculate the new scores and the change score.

#### Initial Assessment:

##### OCCUPATIONAL PERFORMANCE PROBLEMS:

1. 

---
2. 

---
3. 

---
4. 

---
5. 

---

##### PERFORMANCE 1

##### SATISFACTION 1

#### Reassessment:

##### PERFORMANCE 1

##### SATISFACTION 1

#### SCORING:

Total score =  $\frac{\text{Total performance or satisfaction scores}}{\text{\# of problems}}$

##### PERFORMANCE SCORE 1

##### SATISFACTION SCORE 1

##### PERFORMANCE SCORE 2

##### SATISFACTION SCORE 2

$\frac{\quad}{\quad}$   
=   

$\frac{\quad}{\quad}$   
=   

$\frac{\quad}{\quad}$   
=   

$\frac{\quad}{\quad}$   
=   

CHANGE IN PERFORMANCE = Performance Score 2    - Performance Score 1    =   

CHANGE IN SATISFACTION = Satisfaction Score 2    - Satisfaction Score 1    =

---

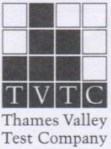
**ADDITIONAL NOTES AND BACKGROUND INFORMATION**

**Initial Assessment:**

**Reassessment:**



## Appendix D



The  
**Test**  
of  
**Everyday Attention**

## Scoring sheet

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**Subject and test details**

Name

Age

Date of test


Version ☐ A ☐ B ☐ C

---

**Score summary and scaled-scores**

<b>• Subtest 1: Map Search</b>	Scaled-scores	Percentile
<input style="width: 50px;" type="text"/>	<b>MSI</b>	<input style="width: 50px;" type="text"/>
Symbols circled in one minute	see Appendix 1 Manual page 23	
<input style="width: 50px;" type="text"/>	<b>MS2</b>	<input style="width: 50px;" type="text"/>
Symbols circled in two minutes	see Appendix 2 Manual page 24	
<b>• Subtest 2: Elevator Counting</b>		
<input style="width: 50px;" type="text"/>	7 = normal	
	6 = possibly abnormal	
Correctly-counted strings	≤5 = abnormal	
<b>• Subtest 3: Elevator Counting with Distraction</b>		
<input style="width: 50px;" type="text"/>	Scaled-score	Percentile
	<b>ECD</b>	<input style="width: 50px;" type="text"/>
Correctly-counted strings (Rule out hearing impairments)	see Appendix 3 Manual page 25	
<b>• Subtest 4: Visual Elevator</b>		
<input style="width: 50px;" type="text"/>	Scaled-scores	Percentile
	<b>VE1</b>	<input style="width: 50px;" type="text"/>
Raw accuracy score	see Appendix 4a Manual page 25	
<input style="width: 50px;" type="text"/>	<b>VE2</b>	<input style="width: 50px;" type="text"/>
Timing score	see Appendix 4c Manual page 26	
<b>• Subtest 5: Elevator Counting with Reversal</b>		
<input style="width: 50px;" type="text"/>	Scaled-score	Percentile
	<b>ECR</b>	<input style="width: 50px;" type="text"/>
Correctly-counted strings	see Appendix 5 Manual page 27	
<b>• Subtest 6: Telephone Search</b>		
<input style="width: 50px;" type="text"/>	Scaled-score	Percentile
	<b>TS</b>	<input style="width: 50px;" type="text"/>
Time per target score	see Appendix 6 Manual page 27	
<b>• Subtest 7: Telephone Search While Counting</b>		
<input style="width: 50px;" type="text"/>	Scaled-score	Percentile
	<b>TSC</b>	<input style="width: 50px;" type="text"/>
Dual task decrement	see Appendix 7 Manual page 28	
<b>• Subtest 8: Lottery</b>		
<input style="width: 50px;" type="text"/>	Scaled-score	Percentile
	<b>L</b>	<input style="width: 50px;" type="text"/>
Number of responses with	see Appendix 8 Manual page 29	

**Scaled-scores summary plot**



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London WC2R 0RL

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# Running Head: A PILOT STUDY OF IM® PROTOCOLS

- 'We are interested in your concentration on a range of everyday tasks. I want you to imagine that you are on a long trip to Philadelphia (United States). I will ask you to do various tasks such as looking at maps and looking up telephone directories while you are on this imaginary trip. Let me explain the first task.'

## Subtest 1: Map Search

For full text and procedure see Manual page 13.

- Show subject the target symbol cue (version A, B or C in the test materials book).
- 'The symbol here shows where restaurants / garages / gas (petrol) stations can be found in the Philadelphia area. There are many symbols like this on the map.'
- Show map and then turn over.
- 'Let's say you are with a family member or a friend...'
- Give subject the map and red pen.
- After one minute swap red pen for blue pen.
- Stop after one further minute.

### Raw score

Total symbols circled  
in one minute (red)

### Raw score

Total symbols circled  
in two minutes (red + blue)

## Subtest 2: Elevator Counting

For full text and procedure see Manual page 14.

- 'Imagine you are in an elevator (lift) in your hotel...'
- Play first example (ensure you are using tape A, B or C).
- 'That's right, you would be on the third floor.'
- (Or play tape again.)
- Play second example.
- (Rewind and repeat, counting with the subject at first, until they get the correct answer on their own.)
- 'Now I would like you to do the same thing with another series of elevator tones.'

	1	2	3	4	5	6	7
A	3	5	6	8	11	9	14
B	4	6	7	9	12	14	10
C	5	7	6	8	10	14	12

### Raw score

Score 1 for each  
correctly-counted string  
(maximum = 7)

## Subtest 3: Elevator Counting with Distraction

For full text and procedure see Manual page 15.

- 'This time you will hear the same elevator tone but now there are also higher pitched tones...'
- Play first example.
- 'That's right, you would be on the third floor.'
- (Or play tape again.)
- Play second example.
- (Rewind and repeat, counting with the subject at first, until they get the correct answer on their own.)
- 'Now I would like you to do the same thing with another series of elevator tones.'

	1	2	3	4	5	6	7	8	9	10
A	2	4	6	8	7	10	9	12	11	14
B	3	5	7	9	8	11	10	14	12	8

## Subtest 4: Visual Elevator

For full text and procedure see Manual page 16.

- 'Try to imagine that during your trip, you decide to stay in a large hotel...'
- Show subject the first Visual Elevator practice item (labelled 'Practice 1' in version A, B and C in the test materials book).
- 'Look at this series of pictures...'
- Go through Practice 1.
- Repeat Practice 1 as often as necessary until the subject gets the correct answer on their own.
- 'That's right, you would be on the second floor.'
- 'Now try this next example.'
- Show 'Practice 2' (next page of test materials book).
- 'That's right, you would be on the fourth floor.'
- 'Now try and do the same with the next set of pictures...'
- Prepare stopwatch to time each item.
- Subjects are allowed to make one correction on each item.

	1	2	3	4	5	6	7	8	9	10
Response										
✓/✗										
Time (sec)										
Answers A	8	5	6	6	5	8	6	6	4	10
B	8	3	2	5	8	4	9	2	10	6
C	4	3	8	6	8	4	6	8	10	4
Switches A	3	2	3	4	5	3	6	6	4	4
B	4	2	3	3	4	3	5	3	6	4
C	3	2	3	4	4	3	4	6	4	4

### Raw accuracy score

Score 1 for each correctly-counted item  
(maximum = 10)

Total time taken for  
correct items (seconds)

$$\frac{\text{Total time taken for correct items (seconds)}}{\text{Total number of switches for the correct items}} = \text{Timing score (seconds per switch)}$$

Total number of switches  
for the correct items

## Subtest 5: Elevator Counting with Reversal

For full text and procedure see Manual page 18.

- Do not test subjects with severe brain damage.
- 'Now we are going to try something similar but a bit more complicated. Look again at what you did here.'
- Point to Visual Elevator Practice 1 item.
- 'Remember how the big arrows tell you whether the elevator is going up or down? Now we are going to try an auditory (sound) version of this...'
- Play first practice item, and count out loud: 'one - two - up - three - four - down - three - two...: so the answer is two.'
- Rewind and play again for subject, pausing after each beep.
- Play second example. 'The answer is three.'
- Play third example. 'The answer is three.'
- Repeat the examples until the subject gets the correct answers on their own.

	1	2	3	4	5	6	7	8	9	10
A	3	1	3	5	8	2	6	2	6	8
B	2	5	2	2	8	2	8	4	6	8



# Running Head: A PILOT STUDY OF IM® PROTOCOLS

## Subtest 6: Telephone Search

For full text and procedure see Manual page 19.

- 'In this exercise, you should imagine that you are using a telephone directory to look up various services while you are on your trip.'
- 'Here we have the yellow pages you would see in a telephone directory, in this case it lists plumbers/restaurants/hotels.'
- Show subject the target symbol cues (in the test materials book), the relevant yellow pages sheet, and a pen.
- 'Imagine that during your vacation (holiday)...'
- Prepare stopwatch.
- 'Begin'
- Start watch as subject makes first mark.
- Stop watch when subject puts cross in box.

Time taken (seconds)

$$\frac{\text{Time taken (seconds)}}{\text{Total number of correctly-circled symbols (ignore any false positives)}} = \text{A Raw score (time per target score)}$$

Total number of correctly-circled symbols (ignore any false positives)

## Subtest 7: Telephone Search While Counting

For full text and procedure see Manual page 20.

- 'Now you will search through a different set of yellow pages for the same double symbols as in the last subtest. But this time, I will ask you to do a second and equally important task at the same time – counting a number of series of tones on the tape recorder...'
- Show subject the restaurants/hotels/plumbers yellow pages.
- Play practice item, and count with the subject.
- 'So you will be looking for the same double symbols...'
- 'Get ready...'
- Prepare stopwatch.
- Subject starts when tape-voice says 'Ready...'
- Start watch as subject makes first mark.
- Stop watch when subject puts cross in box.
- Note the number of strings of tones which the subject attempts in the box marked **C** below.

Response

✓/X									
Answers A	4	8	3	6	1	12	2	5	7
B	6	1	12	2	5	7	5	9	2
C	2	5	7	5	9	2	6	11	3

Response

✓/X									
Answers A	5	9	2	6	11	3	6	3	5
B	6	11	3	6	3	5	5	4	8
C	6	3	5	5	4	8	3	6	12

Time taken (seconds)

$$\frac{\text{Time taken (seconds)}}{\text{Total number of correctly-circled symbols (ignore any false positives)}} = \text{B Time per target score}$$

Total number of correctly-circled symbols (ignore any false positives)

Number of strings of tones correctly counted

$$\frac{\text{Number of strings of tones correctly counted}}{\text{Number of strings of tones attempted}} = \text{C} = \text{D Proportion correctly counted}$$

Number of strings of tones attempted

Re-enter **B** here

$$\frac{\text{Number of strings of tones attempted}}{\text{Time per target weighted for accuracy of tone-counting}} = \text{E}$$

Re-enter **D** here

Re-enter **E** here

$$\text{Dual task decrement} = \text{Dual task decrement}$$

Subtract Re-enter **A** here

## Subtest 8: Lottery

For full text and procedure see Manual page 21.

- 'While you are on your trip, you become interested in the state lottery...'
- Show subject the target cues (version A, B or C in the test materials book) and give the subject a piece of paper and a pen.
- 'The radio programme goes on for quite a long time...'
- Play the tape.
- Stop after first number ending in 55 / 88 / 33.

Rewind and repeat until the subject responds correctly.

	1	2	3	4	5	6	7	8	9	10
A	HH	EA	LV	DR	CF	QO	TS	FN	FA	XT
B	WG	WA	LW	CT	YK	UF	CM	UA	RN	HY
C	FN	AT	XW	YG	EA	WN	RC	FO	HU	IT

**Raw score** Score 1 for each response with at least one letter correct and in the correct position (maximum = 10)