EXAMINING THE RELATIONSHIP AMONG MEASURES OF GLOBAL COGNITION, EXECUTIVE FUNCTION, AND INSTRUMENTAL ACTIVITIES OF DAILY LIVING: CAN THEY ALL GET ALONG?

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ABSTRACT

The subtle nature of executive function deficits makes them difficult to identify in a clinical context and to measure how they impact an individual's daily life. Clinical neuropsychological assessments alone are often unable to measure how executive deficiencies impact an individual's daily life. The present study investigated the relationship among clinical screening measures of global cognition, measures of executive function, and instrumental activities of daily living (IADLs). Adults with Parkinson's disease and neurologically healthy adults completed a battery of assessments including a clinical measure of general functional ability, the Texas Functional Living Scale (TFLS), and a naturalistic shopping task, the University of Tennessee Chattanooga Multiple Errands Test (UTC-MET). TFLS performance was better able to identify functional impairment, while the UTC-MET was able to distinguish inefficient behavior in Parkinson's disease participants. Findings stress a symbiotic relationship among clinical and naturalistic measures and highlights the important role executive function plays in both.

DEDICATION

For Lee and Bev, my two favorite people in the world.

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CHAPTER I

INTRODUCTION

During a given day, people complete a number of diverse tasks, some basic and some more complex. While some tasks are unique to each individual's relationship with his or her world, others are more universal. Daily functional tasks are universal tasks that involve self-care and are generally classified into two categories, basic activities of daily living (ADLs) and instrumental activities of daily living (IADLs) (Jefferson, Paul & Cohen, 2006; Lawton & Brody, 1969). ADLs include everyday behaviors such as grooming, bathing, and dressing. IADLs enable more complex, independent living and are characterized by the execution of such tasks as shopping, financial and medication management, meal preparation, and various household duties (Jefferson et al., 2006). Cognition is particularly critical in performing IADLs. Thus, impaired cognitive abilities can undermine successful independent living (Dawson, Anderson, Burgess, Cooper, Krpan, and Stuss, 2009).

A portion of the cognitive abilities needed for completing IADLs falls under a constellation of neurological processes labeled executive function, which work together in the management of goal directed, effortful behavior (Stuss & Alexander, 2000). Abilities that fall under executive function include goal planning, initiating and executing actions, multitasking, switching between tasks, monitoring, inhibiting habitual behaviors when presented with unexpected events, as well as regulating working memory (Alverez & Emory, 2006; McCabe, Roediger, McDaniel, Balota & Hambrick 2010; Stuss & Alexander, 2008). Such abilities require real-time decisions and plan implementation while evaluating changing environmental demands, and adapting to those demands should they change (Reynolds &Gordon, 2014).

An example of executive function processes is as basic as a man driving home from work via his usual route (a habitual behavior), when he remembers his wife asked him to stop and get milk at the grocery store (an unexpected event). In this example, the man must inhibit his usual routine and then plan and execute a new action goal. Executive function processes can also be more complex, such as a mother driving her young child to school. She must pay attention to the road and her child (multitasking), and also notice that where a traffic light used to be on her regular route (a habitual behavior), there is now a stop sign (an unexpected stimulus) and act accordingly so that she does not run the stop sign and risk an auto accident. If the man forgets to stop at the grocery or the mother is not able to multitask or adapt to the unexpected stimulus, they will experience minor lapses in executive function, also known as “slips of action”. Slips of action can happen to everyone and can have mild to devastating consequences (Clark, Parakh, Smilek, & Roy, 2012; Stuss & Alexander, 2008). Moreover, those who experience executive deficits, also known as executive dysfunction, can experience more frequent slips across a variety of executive demands.

Executive Function and the Frontal Lobe

Historically, much of what is known about executive function processes has been learned through the study of individuals who have experienced neurological damage to the frontal lobe (Luria, 1972). Individuals would often perform normally when presented with clinically based tests of language, learning, reasoning, and memory, yet exhibit disorganization in everyday tasks and strategies. Early information suggested that damage to the frontal lobe, the prefrontal cortex in particular, was associated with problems in successful completion of goal directed behavior. It became assumed that poor performance on executive function tasks was the result of damage to the frontal lobes and the terms "executive function" and "frontal lobe damage" were often used interchangeably (Alverez & Emory, 2006).

However, more recent research and neuroimaging evidence suggests that executive function relies on many distributed neural networks, which include frontal and posterior regions of the cerebral cortex and subcortical regions. More plainly, many illnesses and injuries that produce executive deficits can have little to no apparent frontal lobe injury, possibly due the give-and-take circuitry between the frontal lobe and other regions of the brain (Stuss, 2011). Frontal, parietal, temporal, and cerebellar regions of the brain have been implicated depending on the type of executive deficit and population (Nowrangi, Lyketos, Rao, & Munro, 2012). Thus, identifying executive deficits within the various clinical groups is of great importance.

Executive Impairments in Parkinson's Disease

One group of individuals that can experience executive dysfunction without damage originating in the frontal lobe are those who suffer from Parkinson's disease (PD). PD is a progressive neurodegenerative disorder that is related to the loss of neurons in the substantia nigra, leading to a reduction in dopamine production. Such changes in dopamine level affect the functioning of the basal ganglia, frontal lobes, and medial temporal lobes of the brain (Mathias, 2003; Soukup & Adams, 1996). The disease is traditionally associated with motor symptoms such as rigidity, slow movement, and resting tremor (Leh, Petrides, & Strafella, 2010). However, deficits of various degrees in cognitive function have also been identified, even at the early stages of the disease (Taylor & Saint-Cyr, 1995). Deficits in language, visuospatial abilities, learning, and behavioral changes have been implicated in PD. Moreover, executive deficits in working and prospective memory, attentional control, planning, and initiation of voluntary responses have been identified (Cameron et al., 2012; Monchi, 2007; Steeves et al, 2009).

PD is only one of many special groups who experience executive deficits, but because those with PD do not experience direct frontal lobe damage, their executive deficiencies stress the importance of identifying the differences and similarities of how executive impairment can present depending on neurological etiology. Thus, a goal of the present study is to investigate executive deficits in this group.

Clinical Measures of Executive Function, Global Cognition and IADLs

Clinicians and researchers evaluate an individual's functional status and identify neurological impairments through measures of global cognition and executive function. In clinical settings the term "global cognition" is used to describe overall everyday functional performance based on cognitive abilities like general knowledge, attention, language, recall and orientation (Vaughan & Giovanello, 2010). The literature on whether global screening assessments with executive function measures are a better predictor of IADLs has been mixed. For example, Grigsby, Kaye, Baxter, Shetterly and Hamman (1998) investigated the influence of executive function on self-reported and observed performance of IADLs among the community dwelling elderly. The results indicated that executive abilities were a significant predictor of IADLs over and above measures of global cognition. In a later study, McGuire, Ford and Ajani (2006) found that global cognition is a significant predictor of self-reported functional status of IADLs in older adults over the age of 65. However, it is important to note that no measures of executive function were assessed in the study. The limited findings could be due to the fact that most studies investigating the relationship of functional impairments to IADLs involve self-report measures. Such methods can involve several forms of bias, most notably lack of insight on the part of the respondent, which can result in overestimation of one's own functional performance (Pirogovsky et al., 2014). Thus, objective clinical measures are important in order to correctly identify deficits that can impact IADLs.

Two objective, brief screening assessments used to measure global cognition are the Mini-Mental State Examination (MMSE) (Folstein, Folstein & McHugh, 1975) and the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005). The MMSE is one of the most widely used screening tools. It is a 30-point assessment comprised of questions involving orientation, ability to follow commands, serial mental subtraction, phrase repetition, sentence generation, replication of a simple drawing, and recall of words after a delay. It primarily assesses memory and language skills but does not contain any items that measure executive function (Sugarman & Axelrod, 2014).

The MoCA, also a 30-point assessment is much like the MMSE, but with several more complex items: drawing a clock, copying a cube, a measure of attention, naming objects, generating words, repeating a sentence, recalling words after a delay, and abstraction questions. Also unlike the MMSE, the MoCA contains items measuring executive function and awards more points to complex concepts items than simple orientation items. It is often found to be more difficult than the MMSE and more sensitive in detecting cognitive impairment (Nasreddine et al., 2005). For example, Markwick, Zamboni, and de Jager (2012) compared the MMSE and MoCA scores of 107 older adults who had no history of stroke or cognitive dysfunction. Their findings indicated that the MoCA was sensitive to cognitive deficits not detected by the MMSE. These results lend support to the theory that the more complex executive function items of the

MoCA contribute greatly to its increased sensitivity over the MMSE. This inference becomes even more apparent when the assessments are used with special samples such as PD and stroke.

Nazem and colleagues (2009) investigated MoCA performance in 100 individuals with PD who were considered to have normal global cognition based on their MMSE scores. Approximately half of the individuals who had MMSE scores that classified them as unimpaired, were found to have cognitive impairment based on their MoCA scores. Similarly, Dong et al. (2009) examined if the MoCA was more sensitive than the MMSE in detecting cognitive impairment following an acute stroke. One hundred people who were at least 14 days post stroke without significant physical disability, aphasia, dysarthria, active psychiatric illness or pre-existing dementia were assessed. Out of the 100 subjects, 57 had unimpaired MMSE scores. Thirty-two percent of those people were designated impaired based on their MoCA scores compared to 5% of people who had an unimpaired MoCA score, but were designated impaired based on the MMSE.

Further evidence that supports the connection between executive function, global cognition, and IADLs arises from studies in which multiple neuropsychological batteries were used to predict IADL performance. Cahn-Weiner et al. (2000) examined the relationship between cognitive abilities and everyday functioning using a battery of clinical cognitive assessments. Executive function measures included the Wisconsin Card Sorting Task (Heaton, 1981), which measures cognitive flexibility, and the Trail Making Test (Reitan & Wolfsen, 1985), a measure of attention and task switching. Other cognitive assessments included a measure of memory, the Brief Visuospatial Memory Test–Revised (Benedict & Groninger, 1996), a measure of a language, the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983), and a measure of visuospatial functioning, the Judgment of Line Orientation test

(JLO) (Benton, Varney, & Hamsher, 1978). Also, everyday functioning was assessed with the Instrumental Activities of Daily Living Performance Tasks of the Occupational Therapy Assessment of Performance and Support (OTAPS) (Nadler, 1993). When compared to performance on language, visuospatial skills, and memory measures, performance on executive function measures was the best predictor of IADL functioning among community dwelling elderly. Furthermore, Bell-McGinty et al. (2002) replicated these results in an independent study.

In a more recent study with a PD sample, Higginson, Lanni, Sigvardt, and Disbrow (2013) investigated if performance on executive function laboratory measures contributed to the ability to complete IADLs. Executive function performance was measured with the Trail Making Test (TMT) from the Delis-Kaplan Executive Function System (DKEFS) (Delis, Kaplan, & Kramer, 2001), while IADLs were measured by the Timed Instrumental Activities of Daily Living scale (TIADL) (Owsley, Sloane, McGwin, & Ball, 2002). The results indicated strong relationships between the TIADL and measures involving cognitive flexibility, sequencing, and scanning from the Trail Making Test of the D-KEFS.

The recurrent findings that support executive function as a vital component of IADLs should be expected, given that the constructs measured are utilized repeatedly throughout the execution of an individual’s day. As stated by Duran and Fisher (1999) executive abilities are “…the behavioral manifestations of executive functions in the context of daily life task performance, including personal or instrumental activities of daily living” (p. 104). That is, executive deficits lead to occupational deficits. Thus, identifying the various ways executive deficits present themselves within the execution of everyday tasks in real world settings is of great importance.

The Case for Naturalistic Studies

Efforts to develop more real world assessments have resulted in a diverse number of naturalistic testing paradigms that are designed to measure executive deficits. Such paradigms are constructed to observe individuals in everyday activities outside a clinically controlled setting, without experimental manipulations, and with little interference. Naturalistic assessments are often more effective at detecting deficits that are not always present within clinical contexts (Cuberos-Urbano et al., 2013). This could be for several reasons that include the structured laboratory context of the testing environment, limited observation and interaction between clinician and client, and individual differences that include emotional state, level of premorbid functioning, secondary health problems, and various demands of one's environment at a given moment (Chaytor et al., 2006). As a result, individuals who experience executive impairments may present no executive deficits in a clinical context, but display many dysfunctional behaviors when observed in everyday life situations (Cuberos-Urbano et al., 2013; Stuss & Alexander, 2008).

Conversely, neurologically impaired individuals may present a deficit according to their standardized neuropsychological test scores, but be able to independently perform IADLs. This could be because clinical test designs often do not allow for the use of compensatory strategies and abstract responding (Chaytor, Schmitter-Edgecombe, & Burr, 2006). Due to such factors, researchers have recently moved toward investigating naturalistic assessments, as these studies provide the opportunity to identify real world deficits and strategies and utilize that information when constructing rehabilitative techniques for neurologically impaired groups (Chevignard, Taillefer, Picq Poncet, Noulhiane, & Pradat-Diehl, 2008; Knight, Alderman & Burgess, 2002; Rand, Rukan, Weiss, & Katz, 2009).

McAlister and Schmitter-Edgecombe (2012) investigated multi-tasking in an older adult population with the Day out Task (DOT) (Schmitter-Edgecombe, McAlister, & Weakley, 2012). The DOT simulates prioritizing, initiating, and completing various subtasks in an apartment type setting in preparation for a day out of running errands. Their results indicated that compared to younger adults, older adults took longer to complete tasks and were less efficient, suggesting that executive and prospective memory deficits contribute to age-related everyday functional decline.

Lamberts, Evans and Spikman (2010) developed the Executive Secretarial Task (EST) to assess neurological impairments in execution of occupational tasks among a brain injury sample. The EST simulates a job assessment procedure and aims to distinguish brain injury participants from healthy participants. It requires individuals to organize and prioritize multiple tasks, while dealing with delayed intentions, interruptions, and deadlines. The results of their initial study indicated that the EST was able to distinguish between healthy and brain injury participants.

One of the more widely conducted naturalistic assessments of cognitive impairment is the Multiple Errands Test (MET) (Shallice & Burgess, 1991). Shallice and Burgess (1991) developed the MET to investigate the real world performance of people who had suffered a brain injury. The MET requires participants to complete a list of tasks in a shopping context while adhering to a list of rules. Results from Shallice and Burgess' initial case study of three individuals indicated that those with a brain injury were less organized and less efficient than healthy participants. Moreover, findings from various site-specific versions of the MET have demonstrated that it is able to identify neurologically impaired populations such as those who have suffered a stroke or traumatic brain injury (TBI). The success of the MET could be attributed to the fact that it utilizes everyday occupational tasks in a familiar environment (shopping center), but it also involves tasks that can be completed in a variety of ways while providing specific rules (Burgess et al., 2006, Morrison et al., 2013). As previously discussed, this is far different from clinical assessments that use standardized procedures that emphasize control. The MET identifies executive failures by scoring items such as distractibility (a measure of attention), inefficient task completions (planning, goal execution), and breaking rules (inability to inhibit) (Cuberos-Urbano et al., 2013; Knight, Alderman & Burgess, 2002; Shallice & Burgess, 1991).

Given the above findings, one of the aims of the present study is to develop and investigate the utility of a University of Tennessee at Chattanooga version of the MET (UTC-MET). Since the original study by Shallice and Burgess (1991), the MET has been modified to meet the naturalistic parameters of many testing sites, usually hospital atriums. The UTC-MET will be the first version of the MET administered on a college campus.

Given the real world nature of assessments like the MET, some would argue that the lack of experimental control can be problematic (Pickens, Ostwald, Murphy-Pace & Bergstrom, 2010) while others believe control is not critical when measuring real world performance (Chaytor, Schmitter-Edgecombe & Burr, 2006). Therefore, the question often arises when investigating the relationship between traditional and naturalistic measures of executive function and IADLs: Is clinical control necessary to identify executive deficits in everyday tasks? A recently developed clinical assessment may provide insight.

The Texas Functional Living Scale

The Texas Functional Living Scale (TFLS) (Cullum et al., 2001) is a clinical assessment that was originally designed for use with individuals suffering from dementia. It evaluates functional ability with 24 basic items including: using a calendar and an analog clock, addressing mail, writing a check, using a phone, and pretending to program a microwave. Cullen et al. (2001) found that TFLS scores in patients with Alzheimer's disease were significantly lower than that of healthy participants. Results also revealed that the scores on the TFLS were moderately to highly correlated with all participants' scores on the MMSE. In another sample of dementia sufferers, Weiner, Gehrmann, Hynan, Saine, and Cullum (2006) also identified strong correlations between performance on the TFLS and MMSE scores. A later study by Binegar, Hynan, Lcaritz, Weiner, and Cullum (2009) revealed the TFLS was also able to detect small differences between individuals with MCI and healthy participants.

The TFLS isa measure of basic skills that are representative of functional cognitive success or decline; it is not a measure of executive function. However, the fact that it is a direct functional measure, a laboratory assessment, and has demonstrated the ability to evaluate neurologically impaired populations, may make it a valuable tool in determining the nature of the relationship between global cognition, executive function and IADLs.

The Present Study

The present study was constructed with three main goals. The first was to investigate if a cognitive screening assessment that contains executive function items is more sensitive to cognitive impairment than one without. More specifically, hypothesis one is that the MoCA, with its executive function components, will be more sensitive to neurological impairment than the MMSE. In other words, it is expected that control participants will score within the normal range on both assessments, while individuals with PD will score within the normal range on the MMSE yet score within the impaired range on the MoCA.

The second goal is to investigate the relationship among the TFLS and measures of executive function. Since the TFLS is a measure of general functional ability, but not executive function, it is expected that it should be related to clinical screening measures of global cognition, clinical measures of executive function, and UTC-MET performance indicators. As such, hypothesis two is that the TFLS will be moderately to strongly correlated with clinical screening measures of global cognition, standardized neuropsychological measures of executive function and UTC-MET performance indicators.

The last goal of the study is to investigate if the TFLS, with its clinical control, is better able to identify impairment than the UTC-MET. Therefore, hypothesis three is that there will be significant differences in group performance on the TFLS total score, and the UTC-MET as measured by total error score, the number of task omissions, the number of partial task failures, frequency of inefficient behaviors, frequency of breaking rules, and the number of strategies used. Secondary to that, is that it is expected that the UTC-MET performance indicators will be better able to distinguish impaired individuals than the TFLS.

CHAPTER II

METHOD

Participants

Participants suffering from PD and healthy control participants were recruited between January 2015 and January 2016 as part of a larger ongoing study investigating the discriminate validity of the UTC-MET for various clinical populations. Participants with PD were recruited from local PD support groups in Chattanooga, Tennessee and Dalton, Georgia and healthy control participants were recruited through friends and family members of those PD participants. Demographic information was collected via phone after individuals consented to participate. The full demographic questionnaire is included in Appendix B. Individuals were excluded during recruitment if they were not fluent in both written and spoken English or had experienced bereavement within the past 6 months. Nine participants with PD (three female) and ten healthy control participants (seven female) qualified for the present study. Detailed demographic and clinical characteristics for the sample can be found in Table 3.1. All PD participants were either in stage one or stage two of the disease course. Participants were compensated $10.00 per hour for their participation and the Institutional Review Board at UTC approved the research study (Appendix A).

Measures

The data collected in the present study was taken from an ongoing larger study, and therefore, while several other assessments were administered (Appendix C), only the processes and measures that pertain to the present study will be discussed. All tests were administered by trained graduate students under the supervision of a clinical neuropsychologist.

Participant characteristic measures.

To assess the frequency of attention-related errors that participants experience in everyday life, the Attention-Related Cognitive Errors Scale (ARCES) (Cheyne, Carriere & Smilek, 2006) was administered. The ARCES is a 12 item self-report questionnaire that is a valid measure of attention-related errors in various community and clinical samples (Cheyne, Carriere, & Smilek, 2006; Smilek, Carriere, & Cheyne, 2010).

The Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A)(Roth, Isquith, & Gioia, 2013) was administered to capture participants' perception of their executive function abilities in their everyday environment. The BRIEF-A is a 75 item self-report questionnaire with nine separate scales that measure multiple aspects of executive function and self-regulation: inhibit, self-Monitor, plan/organize, shift, initiate, task monitor, emotional control, working memory, and organization of materials. The scales form two indexes, Behavioral Regulation and Metacognition as well as an overall Global Executive Composite.

The Geriatric Depression Scale (GDS) (Yesavage et al., 1982) was administered to identify if participants' were experiencing depression. The GDS is a 30 item self-report measure. Each question is worth 0 or 1 point and the total score is used to determine the level of severity. A score of less than nine is considered within the normal range, 10-19 is considered mildly depressed, and 20-30 is considered severely depressed. The GDS alone cannot be used to diagnosis depression, but has high reliability and validity (Yesavage et al., 1982).

The Test of Premorbid Functioning (TOPF) (Delis, Kaplan, & Kramer, 2009) was administered to assess individuals' premorbid verbal intelligence. It is a word reading test that can be administered to individuals ages 20-90 and consists of 70 words that are unique in their phonic pronunciation. Prior knowledge is needed to pronounce the words correctly and participants are presented with the easiest word first ("eye") and the difficulty increases to the hardest word ("ceilidh"). Participants score one point for each correct pronunciation.

Global cognition measures.

Global cognition was assessed using the MMSE (Folstein, Folstein & McHugh, 1975) and the MoCA (Nasreddine et al., 2005). The MMSE is an 11-item questionnaire that measures general cognitive impairment. It assesses cognition in five subtest areas: orientation, registration, recall, attention/concentration/calculation, and language. Despite not having an executive function component, the MMSE has good criterion validity and high reliability in identifying cognitive impairment across various neurologically impaired populations (Tombaugh & McIntyre, 1992). Additionally it has been found to have 80% sensitivity and specificity of 74% in a study of individuals with PD. The conventional cutoff score for identifying mild cognitive impairment for the MMSE is 23, and 18 for major cognitive impairment. The MoCA is also a brief screening measure that assesses multiple aspects of cognition, including: short-term memory, visuospatial ability, executive functioning, attention, concentration and working memory, language, and orientation to time and place. The MoCA has been found to have high reliability as well as good criterion and convergent validity with the MMSE (Lam et al., 2013). It was developed with more complex, higher-level language, and visuospatial processing items and items to assess executive abilities (Julayanont, Chertkow, & Nasreddine, 2013).

Additionally, the MoCA has been found to have 90% sensitivity and 75% specificity in detecting MCI in a PD sample (Dalrymple-Alford et al., 2010). The diagnostic cut-off for identifying mild cognitive impairment is 26, 18 for moderate cognitive impairment, and 10 for severe cognitive impairment.

Neuropsychological assessments.

The Word Choice Test (WC) (Pearson, 2008) was administered as a measure of participant effort. WC is a 50 item standardized stand-alone performance validity test (PVT), and is a subtest of the Wechsler Memory Scale, 4th edition (Pearson Education, 2008). It assesses poor effort by measuring response bias in a forced choice paradigm (Miller et al., 2011). In this assessment, participants are shown and read a series of words. Each word is displayed and read aloud at the same time and participants are instructed to say whether the word represents something that is natural or man-made. Following the presentation of the last word, participants are shown a card with 50 word-pairs, where one of the words in each pair was presented during the identification (natural or manmade) portion of the assessment. Participants are instructed to identify which word in the pair was previously shown and they score a point for each correct selection of the previously used word. A score of 48 or lower suggests that an individual may not be putting forth full effort. (Pearson Education, 2008).

The D-KEFS (Delis, Kaplan, & Kramer, 2001), a standardized clinical neuropsychological measure constructed to measure executive dysfunction, was administered to evaluate participants' executive function in a clinical context. The D-KEFS consists of nine stand-alone subtests that assess various components of executive function. For the present study, two subtests were administered to measure specific executive abilities: the Verbal Fluency and

Trail Making tests. The Verbal Fluency test assesses task initiation, processing speed and switching (Swanson, 2005). Participants are asked to say as many words as they can think of that begin with a certain letter of the alphabet. They are given 60 seconds to do this and then subsequently required to switch to a different letter for another 60 seconds, with a total of three trials. The Verbal Fluency test has high internal consistency across older adult age groups: 50-59 years of age (α = .90), 60-69 years of age (α = .85), 70-79 years of age (α = .87) (Delis, Kaplan & Kramer, 2001).

The Trail Making test includes four conditions, but only conditions three and four were used in the current study (Figure 2.1). Condition three of the Trail Making test requires examinees to connect letters A through P, in alphabetical order, while being timed, with distractor numbers present on the page. This condition measures attention and processing speed. Condition four requires participants to switch back and forth between connecting numbers and letters (i.e., 1, A, 2, B, etc., to 16, P). This task measures cognitive flexibility and motor speed.

The TFLS (Cullum et al., 2001) consists of 24 performance-based items and was administered to measure participant's functional ability in everyday life. A total performance score is given as well as scores on four subscales: time, money and calculation, communication, and memory (Figure 2.2). Example items include having the participant write a check and address an envelope to pay a utility bill, do basic arithmetic in counting money, remember to remove pretend medication from a pill bottle at a future time, execute a phone call and program a microwave. The TFLS has evidence of good reliability, internal consistency, and convergent and discriminate validity with the MSME and behavioral functioning (Cullen et al., 2001).The TFLS has shown moderate to high reliability across age groups in healthy older adults with the highest reliability occurring with individuals 60-69 years of age (α = .81). In addition, Cullum, Weiner and Saine (2009) demonstrated that the TFLS has high reliability in special groups such as individuals with probable AD ($\alpha = .95$), and individuals who have experienced a TBI ($\alpha = .88$). Moreover, previous studies using the TFLS have been successful in identifying individuals suffering from Alzheimer's disease and other dementias (Cullen et al., 2001; Weiner, Gehrmann, Hynan, Saine, &Cullum, 2006).

Naturalistic assessments.

The UTC-MET was administered to measure participant's real-world executive abilities using a naturalistic shopping task. The UTC-MET is a real-world assessment of executive function that participants complete within the main floor of the University Center at UTC. Prior to beginning this assessment participants are given a list of tasks that they must complete (e.g. buy a pack of gum, determine what time the bookstores close on Thursday) as well as a list of rules that they must follow (e.g. do not buy more than two items at one location, do not speak to the examiner unless it is part of the exercise). The full list of tasks and rules is included in Appendix D. Participant performance was video recorded by a research assistant while the experimenter takes manual notes on participant performance and interacts with the participant as needed.

Based on the findings of previous versions of the MET, there are six main performance indicators: number of task omissions(e.g. fails to attempt task at all), number of partial task failures (e.g. attempted to complete task but made error like purchasing an incorrect item or providing incomplete responses), frequency of inefficient behaviors (e.g. purchasing multiple items at separate locations when they both could be purchased at one),frequency of breaking rules (e.g. went into an area clearly marked exit even though instructed not to do so on rule sheet), the number of strategies used (e.g. asking staff for help), and total error score (calculated by adding the number of task omissions, partial task failures, and the number of rules broken). A score of 1 is given each time a participant makes a task omission, partial task failure, displays inefficient behavior, breaks a rule, or uses a strategy.

Procedure

Participation in this study took place over two sessions. Session one was completed in the Assessing Cognition Lab (ACL) and in Cognition, Aging, Learning and Memory Lab (CALM) in Holt Hall on the UTC campus. Session two took place in the ACL and the CALM as well as in the University Center on the UTC campus. Prior to each session, informed consent was obtained. During each session, participants completed a series of questionnaires and neuropsychological assessments relating to the present study as well as those that are part of a larger project.

Session one.

After providing consent, participants completed either the MMSE or MoCA, which was randomly counterbalanced across sessions. Following that, participants completed a neuropsychological testing battery lasting approximately 90 minutes, followed by the TFLS. After completion of the TFLS, individuals were generally informed what would take place during session two, invited to schedule a date and time for the next session and provided compensation for their time.

Session two.

Subsequent to providing consent, participants completed the MMSE or MoCA, whichever was not completed in session one. Next, participants completed the UTC-MET. During the MET the examiner first explained to participants that the main idea of the task is to measure things they might do in a normal day by completing everyday task in a shopping mall environment. Participants were then introduced to the tasks they needed to complete and the rules they needed to follow. To ensure that participants understood the tasks and rules, they were asked to read the list of tasks and rules to the examiner. Next, participants were given 60 seconds to study the rules, after which they were asked to tell the examiner as many rules as they could remember. For any rules they could not recall, the examiner prompted them. The objective of this rule recall was to ensure that participants understood what they had to do. Executive deficits manifest in goal directed action even when knowledge is present, thus understanding of test instructions and rules was emphasized. Following the rule recall, the examiner asked the participants if they had any questions. If not, participants were taken from the Assessing Cognition Lab to the University Center on the UTC campus where they completed the UTC-MET.

Once at the University Center, participants were provided with a binder that contained the task and rules sheets, along with $5.00 and a wristwatch if they were not already wearing one. Next, participants were told that the examiner would be following them from a distance and were reminded not speak to the examiner unless it was part of the exercise. They were then instructed to let the examiner know when they were ready to begin the exercise and to approach him/her and let him/her know when they were finished. At that point, participants were asked again if they had any questions. If the participants had no further questions, they were asked to tell the examiner in their own words what they were to do in the exercise. If the participants misinterpreted any of the tasks or rules, the examiner clarified and reinforced that participants were to carry out the lists of tasks on the tasks sheet while following the list of rules on the rules sheet.

The examiner followed participants during the exercise, observed the participants' behavior and took detailed notes about the participants' unusual behaviors, strategies, and problems observed during task performance. Additionally, the examiner tallied how many times participants checked their tasks sheet, rules sheet, and/or watch. During the exercise, an additional research assistant videotaped participant performance. Immediately after they completed the exercise, participants were asked how they felt they did on the task on a scale of 1 to 10 and then returned to the Assessing Cognition Lab with the examiner.

Once at the lab, participants were given a debriefing interview. During the interview, the examiner addressed any tasks that appeared difficult for participants and/or any rules that were neglected or broken. Additionally, any unusual behaviors and possible strategies participants were addressed. Following the debriefing, participants completed a series of computerized laboratory based prospective memory experiments that were part of the larger study, and two neuropsychological assessments, the D-KEFS Verbal Fluency and D-KEFS Trail-Making task conditions three and four. Finally, the participants were debriefed and compensated for their participation.

CHAPTER III

RESULTS

Given that clinical assessments were administered during the study, full effort from participants was imperative to the findings. Poor effort could lead to invalid results that would not accurately represent their level of cognitive function and executive ability. Results from the WC test indicated that one PD participant scored a 44 and another scored a 47 on the assessment while two control participants scored a 48. A score of 48 or lower could suggest those participants were not putting forth full effort.

To evaluate possible group differences between the participant groups independent samples *t*-tests were conducted. No significant differences were found between groups on age or level of education, (Table 3.1). However, the groups did significantly differ in sex, $t(17) = 2.21$, $p < .05$, $d = 1.02$. In terms of participant characteristics, no significant group differences were found on the Behavior Rating Index or the Global Executive Composite scores of the BRIEF-A or the TOPF. Significant group differences were found on the ARCES, $t(17) = -2.84$, $p < .05$, $d = 1.01$, the Metacognitive Index of the BRIEF-A, $t(17) = -2.16$, $p < .05$, $d = 1.01$, and the GDS, $t(17) = -2.84$, $p < .05$, $d = 1.29$.

Table 3.1

Participant Demographics and Characteristics

	PD (n = 9)	Control (n = 10)	*t* (17)	*p*	*d*
Sex	1.33 ± .50	1.80 ± .42	2.21	0.04*	1.02
Age	71.44 ± 9.40	67.20 ± 8.48	-1.34	0.32	0.47
Education	14.67 ± 1.23	15.40 ± 3.02	0.69	0.50	0.32
ARCES	35.56 ± 6.73	28.90 ± 6.59	-2.18	0.04*	1.01
GDS	8.33 ± 4.12	3.60 ± 3.13	-2.84	0.01*	1.29
BRIEF-A GEC	63.33 ± 10.84	54.60 ± 13.64	-1.53	0.14	0.71
BRIEF-A MCI	66.89 ± 11.22	54.30 ± 13.81	-2.16	0.04*	1.01
BRIEF-A BRI	56.56 ± 10.62	54.20 ± 12.08	-0.45	0.66	0.2
TOPF	40.11 ± 13.62	44.80 ± 17.66	0.64	0.53	0.3

Notes: Values are mean ± SD or as otherwise indicated. ARCES = Attention Related Cognitive Error Scale, GDS = Geriatric Depression Scale, BRIEF-A = Behavior Rating Inventory of Executive Function,BRI = Behavior Regulation Index, MCI = Metacognition Index, GEC = Global Execuitve Composite, TOPF = Test of Premorbid Functioning
*p < .05 compared to healthy participants

Executive Function in Global Cognition Assessments: Hypothesis One

MMSE vs. MoCA.

To investigate if clinical screening assessments of global cognition that contain executive function components were more sensitive in identifying neurological impairment than those without, a paired samples *t*-test was conducted. Consistent with the hypothesis, there was a significant difference between PD group mean scores on the MMSE and the MoCA,$t(8) = 4.66$, $p < .003$, $d = .839$, (Figure 2.1). However, the PD group mean score was below the age and education median norm cutoff of 28 (Crum, Anthony, Basset, & Folstein, 1993) on the MMSE ($M = 26.00$, $SD = 3.08$) and also below the cutoff of 26 on the MoCA ($M = 23.22$, $SD = 3.53$). The control group mean score was above the education median norm cutoff for the MMSE (M =

28.80, *SD* = 1.62) and also above cutoff of 26 on the MoCA (*M*= 27.20, *SD* = 1.93). Sensitivity and specificity were calculated for both assessments. The MMSE displayed 77.78% sensitivity and 80% specificity while the MoCA displayed 88.89% sensitivity and 93.33% specificity.

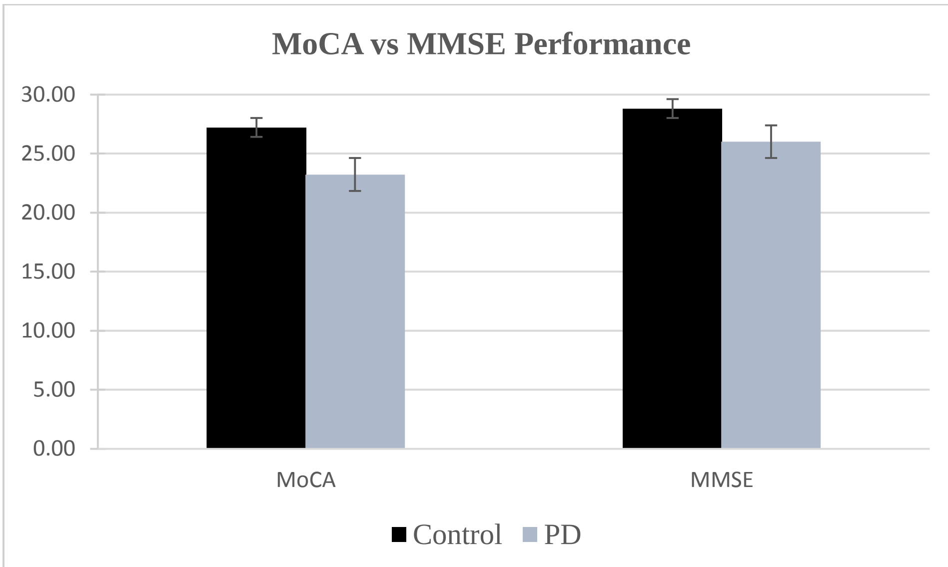

Figure 3.1

Group Performance on the MoCA vs. MMSE

TFLS Assessment with Measures of Executive Function: Hypothesis Two

To investigate the relationship between the TFLS, UTC-MET performance indicators, the MMSE and MoCA, Verbal Fluency and condition's 3 and 4 of Trail Making Test from the D-KEFS, Pearson *r* correlations were used. No participants made errors in condition 3, thus it was excluded from the matrix. As demonstrated in Table 3.2, there were no relationships between the TFLS total score and the UTC-MET performance indicators of task omissions, partial task failures, frequency of rule breaks, frequency of strategies used or total error score. There was also no relationship between TFLS total score and DKEFS Verbal Fluency performance. However, strong correlations were identified between the TFLS and the frequency of inefficient behavior on the UTC-MET, the MMSE and MoCA, and completion time on conditions 3 and 4 of Trail Making.

Table 3.2

Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. TFLS	1												
2. UTC-MET Omissions	.025	1											
3. UTC-MET Partial Task Failures	-.402	-.581**	1										
4. UTC-MET Inefficiencies	-.668**	-.373	.683**	1									
5. UTC-MET Rule Breaks	-.248	.663**	-.137	-.101	1								
6. UTC-MET Strategy Use	.112	-.243	.016	.058	-.192	1							
7. UTC-MET Total Score	-.367	.630**	.174	.118	.875**	-.313	1						
8. MMSE	.772**	.149	-.461*	-.840**	-.014	.047	-.171	1					
9. MoCA	.660**	.236	-.418	-.749**	.126	-.200	.002	.837**	1				
10. D-KEFS TMT Condition 3 Time	-.756**	.012	.132	.418	.223	-.091	.240	-.532*	-.487*	1			
11. D-KEFS TMT Condition 4 Errors	-.657**	.057	.169	.305	.219	-.207	.242	-.445	-.486*	.350	1		
12. D-KEFS TMT Condition 4 Time	-.757**	-.117	.430	.487*	.258	-.225	.118	-.556*	-.376	.712**	.416	1	
13. D-KEFS Verbal Fluency	.068	-.203	.201	-.135	.116	-.078	.087	-.051	.166	-.193	-.075	.083	1

Notes: **. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Identifying Impairment with and without Clinical Control: Hypothesis Three

TFLS vs. UTC-MET

To investigate whether the TFLS, with its clinical control, is better able to identify impairment then the naturalistic structure of the UTC-MET, independent sample *t*-tests were conducted to examine if there were group differences in performance on the TFLS and the six UTC-MET performance indicators. Due to the small sample size, Cohen's *d* effect sizes were also calculated to investigate the strength of the observed relationships (Table 3.3). No significant group differences were found with respect to the UTC-MET performance indicators of task omissions, partial task failures, frequency of breaking rules, frequency of strategies used, or total error score. However, control participants scored significantly higher on the TFLS than PD participants, $t(17) = 2.25$, $p < .05$, $d = 1.03$, and displayed significantly fewer inefficient behaviors on the UTC-MET, $t(17) = -2.59$, $p < .05$, $d = 1.19$.

Table 3.3

Participant Performance on TFLS and UTC-MET Performance Indicators

Assessment	PD (n = 9)	Control (n = 11)	*t* (17)	*p*	*d*
TFLS	42.44 ± 7.20*	47.70 ± 1.70	2.25	0.037*	1.03 (.03-1.94)
UTC-MET Omissions	2.44 ± 3.13	3.20 ± 2.20	0.61	0.547	.28 (-.63-1.18)
UTC-MET Partial Task Failures	4.33 ± 3.08	2.70 ± 1.49	-1.50	0.153	.69 (-.27-1.58)
UTC-MET Inefficiencies	8.56 ± 9.02*	1.10 ± 1.37	-2.59	0.019*	1.19 (.17-2.11)
UTC-MET Rule Breaks	4.33 ± 2.30	4.00 ± 2.26	-0.32	0.618	.15 (-.76-1.04)
UTC-MET Strategy Use	31.22 ± 12.18	32.10 ± 12.29	0.15	0.904	-0.07 (-.97-.83)
UTC-MET Total Error Score	11.56 ± 3.78	10.00 ± 4.62	-0.80	0.436	.37 (-.56-1.26)

Notes: Values are mean ± SD or as otherwise indicated. Cohen's d effect sizes are presented in column titled d with 95% confidence interval of the effect size presented in parenthesis.

*p < .05 compared to healthy participants

CHAPTER IV

DISCUSSION

The present study was developed with three main goals in mind. The first goal was to examine the sensitivity of a cognitive screening measure with executive function items, the MoCA, in comparison to one without, the MMSE. The second goal was to investigate the relationship between the TFLS, clinical neuropsychological measures and a naturalistic measure of executive function, the UTC-MET. The last goal was to compare the ability of the TFLS, with its clinical control, to the UTC-MET in detecting impairment. The overall findings of the present study stress the importance of including executive function components within cognitive screening measures, the significant role the TFLS may play when incorporated with measures of executive function, and that while the TFLS may be able to identify functional impairment and is related to measures of executive function, used alone it may not provide a full picture of what that impairment reflects in everyday life; naturalistic assessments may better be able to do so.

Importance of Executive Function in Global Cognition Screening Assessments

The present study lends support to the importance of including executive function components in screening measures of global cognition. Eight PD participants were correctly classified by their performance on the MoCA, but of those eight, only one was correctly classified based on performance on the MMSE. Given the subtle nature of executive deficits, the executive function components of the MoCA may have been better suited to detect mild impairments that the MMSE was unable to detect. However, it is important to note that the MoCA and MMSE weigh items differently as well. The MoCA puts less weight on items regarding orientation to time and place than the MMSE, while giving more weight to items of recall and attention\calculation performance. Also important to consider is that the control group mean was below the cutoff on the MoCA. Therefore, there is a possibility that there was cognitive impairment within the control group, but that could also be the result of a small sample size.

Clinical and Naturalistic Measures of Everyday Ability

TFLS.

The TFLS, as a basic measure of functional success or decline, overlaps clinical and naturalistic measures of executive function in several characteristics, but does not require the initiation and completion of more complicated goal directed behavior or adaptation when presented with a novel task. However, consistent with previous research with Alzheimer's disease groups (Cullen et al., 2001; Weiner, Gehrmann, Hynan, Saine, &Cullum, 2006), PD participants in this study also scored significantly lower than control participants. This suggests that while clinical assessments of functional ability, like the TFLS, may not specifically measure executive deficits, they are important in the identification and measurement of basic functional decline.

UTC-MET.

Surprisingly, only one of the UTC-MET performance indicators identified significant group differences. Specifically, the present study revealed that PD participants displayed significantly more inefficient behaviors than control participants. The performance indicators of task omissions, partial task failures, frequency of inefficiencies, frequency of rule breaks, frequency of strategy use, and total error score were selected based on the literature of previous site specific versions of the MET (Dawson et al., 2009;Cuberos-Urbano 2013; Clark, Anderson, Nalder, Arshad & Dawson, 2015) as they had successfully identified impaired stroke and TBI groups. However, the UTC-MET is the first site-specific version of the MET to examine a PD group. Therefore, the lack of group differences for the other performance indicators could suggest that in individuals suffering from PD, executive deficits may present in a more isolated or more diffuse manner.

An alternate explanation to the lack of differences in group performance is that control participants may not have put forth full effort. Results from the WC test indicated that two control participants scored a 48, and may not have been putting forth full effort, however the remaining nine scored 50. Given this, lack of effort cannot be suggested from this assessment alone. However, within the MET literature there is support for possible embedded measures of effort within versions of the MET. A previous study involving simulating malingerers and a simplified version of the MET (Castiel, Alderman, Jenkins, Knight & Burgess, 2012) identified a specific strategy that distinguished simulating malingerer's performance on the assessment from individuals with acquired brain injury (ABI) and healthy control participants. In their study, only 4% of the 47 simulating malingerers sought assistance (e.g. ask staff for help) while the ABI group sought assistance four times as much as the control group. Though simulating malingerers were instructed to feign a brain injury, the findings suggest that assessing the strategy of asking for assistance may be beneficial as an embedded measure of effort in healthy control participants as well. In the present study, 45% of the 10 control participants did not seek assistance.

Many factors can contribute to poor effort in psychological assessments outside of malingering. These include energy level, time of day of administration, and difficulty and duration of assessment batteries as well as many others. The present study attempted to control for such factors by scheduling the UTC-MET for the time of day participants indicated they were the most active and by administering the test roughly 30 minutes into session two. Regardless, the present findings stress the importance of developing measures of effort in naturalistic contexts.

Participant Characteristics

Sex.

In terms of participant characteristics, there were group differences between the control and PD group. The PD group consisted of six males and three females while the control group consisted of two males and nine females. Most healthy control participant that were recruited were spouses of the PD participants, thus the uneven distribution of sex between groups. Beyond that, literature has revealed that male sex has been implicated as an important risk factor in developing PD at all ages (Baldereschi et al., 2000, Gillies, Pienaar, Vohra & Qamhawi, 2014), and twice as many men suffer from PD as women (Elbaz et al., 2002). This is reflective in the PD group of the present study.

Self-Report Measures.

Significant group differences were also found on the ARCES, BRIEF-A Metacognitive Index and GDS self-report measures. The ARCES measures the frequency with which one experiences everyday cognitive failures, usually the result of a lapse of attention. Additionally, PD participants scored significantly higher on the Metacognitive Index of the BRIEF-A. The Metacognitive Index combines self-report scores from the BRIEF-A on statements that measure initiation, organization of materials, monitoring, working memory and planning. The fact that PD participants experienced more lapses in attention is not surprising given that attention is not only an important individual executive function, but is important to the successful execution of other types of executive abilities such as working memory, prospective memory, inhibition, planning, and multi-tasking. Thus, at a minimum, attention appears to be a needed factor in efficient everyday behaviors. However, the degree to which attention impairment affects other executive functions could fluctuate in individuals suffering from PD depending on a number of factors such as length of time since diagnosis, degree of enrichment in one's lifestyle, and number and effectiveness of compensatory strategies.

Significant group differences were also found on GDS scores. Although, the PD group mean score was higher than the control group, it is important to note that all PD participants still scored within the normal range, and their scores are not suggestive of possible depression.

Limitations

Though the findings of the present study stress the important role of executive function in clinical screening tools and neuropsychological assessments, there are many limitations. The most important to note would be sample size. A larger sample size of 16 PD participants and 16 control participants would yield an ideal power of .8 and strengthen the likelihood of producing important findings. A larger sample size would also allow for more complex statistical analyses such as linear and logistic regression and may have led to more significant group differences within the UTC-MET performance indicators. Despite this, the strong correlations between the TFLS and clinical and naturalistic assessments taken with significant group differences suggest that the findings with respect to the relationship among measures of global cognition, executive function, and IADLs are informative.

A second possible limitation was the inability to control for date of onset for PD participants as well as their medication schedule. Participants ranged from two years post diagnosis to 26 years post diagnosis. Additionally, participants were on various types of synthetic dopamine medication and on various schedules of administration. Therefore, the amount of time since the participant's last medication dose could have affected their performance. There was a noted increase in energy level of the few PD participants who needed to take their medication during the testing. This shift usually occurred 15 to 30 minutes after taking medication. The present study could not control for the need to take medication (e.g. – asking participants to restrict taking medication until later) but the experimenter did make note of the last time the participant took his/her medication. In future research, it may be more beneficial to schedule PD participant testing times based on the medication schedule. However, this would still not be able to account for the various ways medication can help or hinder performance from one individual to another.

Lastly, an important consideration in the findings of the study is fatigue. The present study was part of a larger experiment that took place over two testing days with each day ranging from 3 to 3.5 hours of testing. The demands of neuropsychological assessments can be draining on both impaired and healthy individuals. Since the TFLS was the last assessment administered in session one, and the UTC-MET was the second assessment administered in session two, testing order could have had an impact on the PD group performance. This might have been better controlled by reducing the number of assessments and counterbalancing assessment order within each session.

Future Directions

Historically, clinical and naturalistic assessments have not been utilized together in a typical testing battery. Future studies may benefit from further investigation of this relationship. Integrating naturalistic measures of executive function into existing clinical batteries may prove useful. Doing so may assist clinicians in identifying the real-world impact of executive deficits in their patients and allow for better treatment plans in coordination with rehabilitative specialists.

It is also important to note that the UTC-MET was the first version of the MET to be administered on a college campus. Previous versions of the MET (Clark, Anderson, Nalder, Arshad & Dawson, 2015; Cuberos-Urbano 2013; Dawson et al., 2009) have typically been administered in hospital atriums that participants may have previously visited. In the present study, with the exception of one control participant, participants had not visited the main floor of the University Center on campus at all. While the impact of familiarity is unknown, future administration of the test may want to investigate the impact of familiarity with the site on UTC-MET test performance.

Additionally, the UTC-MET may benefit from administering the test to groups of individuals who have suffered a stroke or experienced a TBI. These groups have been utilized in previous versions of the MET (Clark, Anderson, Nalder, Arshad & Dawson, 2015; Cuberos-Urbano 2013; Dawson et al., 2009) and significant group differences were identified on a number of performance indicators. UTC-MET administration involving these groups may help measure the validity and reliability of it with the previous versions and identify possible modifications that may need to be made to the current design of the test.

Finally, the UTC-MET was the first version to be administered to individuals with PD. The PD participants in the present study were in the early stages of the disease course and thus may have impacted the findings. The TFLS may be more sensitive than the UTC-MET in the early stages of PD impairment. It may be important to conduct future MET studies with this group at various stages to help identify patterns of MET performance and determine if that pattern is consistent with that seen for stroke and TBI groups. If an overlap in pattern of performance is not found, it will add important information to the existing literature in noting that the MET might be designed to identify executive deficits in some groups with neurological impairment and not in others.

Conclusions

The overall findings of the present study indicate an interdependent relationship among clinical and naturalistic measures of executive function and everyday functional ability. While measures of executive function and general functional abilities share basic common characteristics, the more complex and subtle nature of executive deficits makes inclusion of executive function components in global screening measures critical, especially in identifying mild cognitive decline.

The findings also stress the importance of including both clinical and naturalistic assessments of executive function when everyday impairment is suspected. Utilizing assessments in both clinical and naturalistic contexts may allow for more accurate diagnosis and thorough rehabilitative treatment plans to assist impaired individuals successfully complete IADLs and living more independent lives.

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APPENDIX A

IRB APPROVAL

THE UNIVERSITY of TENNESSEE UT CHATTANOOGA

Institutional Review Board
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MEMORANDUM

TO:	Dr. Amanda Clark Dr. Chris Young	**IRB # 13-163**
FROM:	Lindsay Pardue, Director of Research Integrity Dr. Bart Weathington, IRB Committee Chair	
DATE:	11/20/2015	
SUBJECT:	IRB #:**13-163**: Functional Impact of Executive Dysfunction	

The Institutional Review Board has reviewed and approved the following changes for the IRB project listed below:

- Changes in recruitment strategies. Recruit at organizations and events that are take place within the Chattanooga community with the expressed consent of the organization to recruit. Examples of such established organizations are: the Chattanooga Stroke Camp (affiliated with Erlanger Hospital), the Eastgate Senior Center, Chattanooga YMCAs, Alexian Village, the Northgate Shopping center and other similar venues.

You must include the following approval statement on research materials seen by participants and used in research reports:

The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project # 13-163.

Please remember that you must complete a Certification for Changes, Annual Review, or Project Termination/Completion Form when the project is completed or provide an annual report if the project takes over one year to complete. The IRB Committee will make every effort to remind you prior to your anniversary date; however, it is your responsibility to ensure that this additional step is satisfied.

Please remember to contact the IRB Committee immediately and submit a new project proposal for review if significant changes occur in your research design or in any instruments used in conducting the study. You should also contact the IRB Committee immediately if you encounter any adverse effects during your project that pose a risk to your subjects.

For any additional information, please consult our web page http://www.utc.edu/irb or email instrb@utc.edu

Best wishes for a successful research project.

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APPENDIX B

FULL DEMOGRAPHIC QUESTIONNAIRE

General Demographic Questionnaire: Participant ID: ___________________

Age: _______________________

Sex: _______________________

Race: ______________________

Years of Education: ___________________________

Current / Past Occupation: __________________________________

Hand Dominance (circle):	Right	Left	
Do you wear glasses?	Yes	No	
Do you have hearing aids?	Yes	No	
Do you use (circle):	Cane	Wheelchair	Walker

Medical History:

Please list any medications that you currently take:

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

Do you current use:

__ Tobacco: If so, how often: ___________________

How much: ___________________

__ Alcohol: If so, how often: ___________________

How much: ___________________

Have you experienced any of the following medical conditions in the past? If so, please indicate.

__ Head injuryor concussion If yes, please indicate when this injury occurred:______________

__Seizure

__ Stroke

__ Parkinson's disease / Lewy Body disease

__ Multiple Sclerosis

__ Alzheimer's disease

__ Mild Cognitive Impairment

__Hypoxic event

__Toxin overexposure / poisoning

__ Meningitis

__ Heart Attack

__ Attention Deficit Hyperactivity Disorder

__ Substance dependence   If yes, please indicate type of dependence: ___________________

__ Family history of dementia or "memory problems"

__ Depression / Anxiety

Do you currently experience any of the following medical conditions?

__ Heart disease / High blood pressure

__Diabetes

__ High cholesterol

__ COPD/Emphysema:

__Acute illness/infection:

__Recent surgery with general anesthesia

__Thyroid disease:

__ Recent UTI:

__ Sleep Apnea

__ Insomnia

APPENDIX C

FULL TESTING BATTERY OF OVERALL STUDY

Session One Testing Plan:

Test Order
1. Informed Consent
2. Demographics Questionnaire
3. MMSE / MoCA
4. Geriatric Depression Scale
5. BRIEF-A
6. Attention Related Cognitive Errors Scale
7. Test of Premorbid Intelligence 8. Pearson Word Choice Test
9. Wechsler Abbreviated Scale of Intelligence
10. Texas Functional Living Scale
11. Slip Induction Task
12. Y Balance Test

Session Two Testing Plan:

Test Order
1. Informed Consent
2. MMSE / MoCA
3. Multiple Errands Test Multiple Errands Test Debrief
4. Instructions for Visual Prospective Memory Task 5. DKEFS Letter Fluency 6. Visual Prospective Memory Task
7. Instructions for Non-Focal Prospective Memory Task 8. DKEFS Trail Making 9. Non-Focal Prospective Memory Task
10. Debriefing

APPENDIX D

LIST OF TASKS AND RULES

Tasks

In this exercise you should complete the following tasks:

1. Do the following 4 things:

- Buy a birthday card
- Buy a package of chewing gum
- Telephone Amanda at 425-5851 and say who you are, what time it is & the day of the week.
- Leave something at the University Center Offices to be mailed to Dr. Shelton* at the University of Tennessee.

2. Meet me at the University Center piano at ______ and tell me what the weather is like today.

3. Get the following information and write it down in the spaces below:

- What time does the Financial Aid & Scholarships office close on a Thursday?

  ____

- What times does the UTC Bookstore open on a Friday?

  ____

- What is the price of a box of a box of Nilla Wafers?

  ____

- What is the name of the meeting/conference room closest to the Information office?

  ____

4. *Tell me when you have completed the exercise.*

** Dr. Shelton – ID________
Department of Psychology
615 McCallie Ave.
Chattanooga, TN 37403

Rules

While carrying out this exercise you must obey the following rules:

- You should carry out all these tasks but may do so in any order.
- You should spend no more than $5.00.
- You should stay within the limits of the main floor of the University Center.
- You should not enter any of the "staff only" university areas
- You should not go back into an area you have already been in (not including hallways)
- You should buy no more than 2 items at any one location
- Be as efficient and timely as possible without rushing excessively
- Do not speak to the experimenters *unless* it is part of the exercise

VITA

R. Christopher Branson became interested in clinical neuropsychology while attending the University of Tennessee at Chattanooga and began conducting research with Dr. Amanda Clark. He graduated summa cum laude with a bachelor's degree in Psychology from the University of Tennessee at Chattanooga in May 2014. The following fall he accepted a graduate assistantship and continued to work with Dr. Amanda Clark while enrolled in the Master's of Science in Psychology program. R. Christopher graduated with a Master's of Science in Psychology degree in May 2016. He hopes to continue his education in Psychology by pursuing a Ph.D. in clinical psychology with a neuropsychology concentration.