PROVERB INTERPRETATION AND THEORY OF MIND: EXPLORING FUNCTIONAL INDEPENDENCE IN A COMMUNITY-DWELLING GERIATRIC POPULATION

by

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(Under the Direction of L. Stephen Miller)

ABSTRACT

This project examined the relationship of proverb interpretation and Theory of Mind (ToM) to functional independence in a cognitively-intact older adult population. Participants were administered tests of executive function, proverb interpretation, ToM, and functional independence. Results showed that proverb interpretation and one ToM measure did account for a significant amount of unique variance in functional independence. Results of a multiple mediation model suggested that the combined indirect effects of the executive function measures accounted for the relationship between ToM and functional independence. Results of this project suggest that tests of ToM may not be beneficial in a similar functional independence measure. A test of proverb interpretation, however, may be a useful tool during a diagnostic assessment where functional independence is a concern.

INDEX WORDS: Proverbs, Theory of Mind, Neuropsychology, Functional Independence

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DEDICATION

This dissertation is dedicated to my husband and parents for their love and support. I would like to extend a special dedication to my grandparents, who inspired me to embark on a career in aging research.

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INTRODUCTION

The geriatric population is growing exponentially in the United States. By 2030, the number of older adults (i.e., age 65 and older) is estimated to jump to 20% of the total U.S. population (Federal Interagency Forum on Age-Related Statistics, 2008). As the geriatric population increases, so does the prevalence of dementia. As of 2004, 24.3 million people in the world had a diagnosis of dementia, and this number may increase by as many as 4.6 million annually (Ferri et al., 2005). In 2001, 60% of dementia occurred in developed nations. This number is expected to reach 71% by 2040 (Ferri et al., 2005). The increasing rates of dementia has a significant effect on the economy. Annual healthcare costs of Alzheimer's disease is expected to be $1.08 trillion. Individuals diagnosed at an earlier stage and subsequently prescribed cholinesterase inhibitors had annual health care costs that were $2,408 less than those at a later stage (Fillit, Hill, & Futterman, 2002). A more recent study conducted by McCarten and collegues found that early detection saved individuals $1,700 per year (Steenhuysen, 2010, July). Therefore, identifying additional methods of detecting early signs of decline is paramount.

Normal Age-Related Changes

Physiological changes. As one ages, the body experiences physiological changes. Cell death occurs, which can be related to a number of factors including the buildup of toxic metabolites, free radicals, and a decreased supply of nutrients (Taylor, 1999). Another change that occurs as one ages is the reduction of brain mass. From ages 16-80, brain volume gradually declines. The rate of decline speeds up after age 55. By ages 71-80 years, the brain voume is

26% less than that of two to three-year-olds (Courchesne et al., 2000). This is evidenced on neuroimaging by enlarged ventricles and cortical atrophy. The brain does not atrophy in an even manner. Areas that decrease to a greater extent include the precentral gyrus, superior frontal and temporal gyrus, visual cortex, locus ceruleus, cerebellar Purkinje, substantia nigra, and basal nucleus of Meynert (Flashman, Wishart, Oxman, & Saykin, 2003).

Cognitive changes. In healthy aging, there still exists some level of cognitive decline (Flahsman et al., 2003). The physiological changes as one ages affects the brain and appears to lead to cognitive decline, which can begin as early as one's 50s (Kaufman, 2007) and is linked to age-related atrophy of the brain. Normal cognitive decline affects four main areas: recent memory, executive functioning, processing speed, and working memory. Age-appropriate decrease of recent memory is defined as some difficulty recalling new information; however, this is differentiated from pathological memory impairment in that it is much less severe (Kaufman, 2007). Executive functioning refers to the cognitive processes involved in planning and executing complex behaviors. Therefore, it is common for older adults to show poorer performance in solving complex problems compared to younger adults (Sorel & Pannequin, 2008; Kaufman, 2007; see below for a more detalied review). Processing speed (i.e., the rate of speed in carrying out tasks) also slows with age. Finally, working memory refers to the ability to mentally maintain and manipulate information, and this too becomes more difficult as one gets older (Kaufman, 2007).

Cognitive Theories of Aging

Processing speed theory of aging. First introduced by Salthouse (1985), the processing speed theory of aging states that the speed in which one performs cognitive functions slows significantly with age (Salthouse, 1985, 1996). This theory is explained by two mechanisms: the

limited time mechanism and the simultaneity mechanism. The limited time mechanism posits that there is a processing speed deficit because too much of the time required to carry out the task is lost in the beginning steps of the process. Therefore, a person simply runs out of time to effectively carry out the cognitive task. This helps explain why more demanding, multi-step cognitive tasks take much longer to complete in older adults than simple ones. The simultaneity theory states that information gained in the initial processing stages is lost over time. Thus, these two theories build on one another. That is, the limited time mechanism explains that one's resources are exhausted during earlier processing and the simultaneity theory asserts that what is gained in the beginning steps of a complex time is lost over time (Salthouse, 1996).

Salthouse (1996) states that this theory alone does not account for all the cognitive decline seen in aging. For example, Salthouse and Fristoe (1995) administered measures of cognitive flexibility to older adults and young controls. As expected, older adults demonstrated lower performance that their younger counterparts. This effect was mostly, but not completely, mediated by processing speed.

Inhibition deficit theory of aging. The inhibition deficit theory of aging postulates that older adults struggle with tasks that require the inhibition of prepotent responses. First described in 1988 by Hasher and Zacks, the inhibition deficit hypothesis states that age-related cognitive change can be traced back to increased difficulties in inhibition tasks. Specifically, this refers to the ability to parse out distracting information in a goal-oriented task (Van Gerven, Boxtel, Meijer, Willems, & Jolles, 2007).

Several studies have supported the inhibition deficit model of aging. Braver et al. (2001) compared older adults with young adults on measures of cognitive control, which they defined as the ability to both keep relevant information in working memory and to inhibit attention to

distracting information. They found that older adults showed a decrease in cognitive control compared to younger adults. Paxton, Barch, Racine, and Braver (2007) found that older adults were unable to effectively use cognitive control skills compared to younger adults. Van Gerven et al. (2007) examined whether this age-related deficit in inhibition is found in both simple and complex tasks. Their results showed that older adults do not have difficulty with simple tasks but struggle in complex tasks of inhibition.

Frontal lobe hypothesis of aging. While both the processing speed and inhibition deficit theories have been supported in the literature, they only focus on singular aspects of cognitive decline. A more encompassing theory that includes inhibitory and processing speed deficits is the frontal lobe hypothesis (West, 1996). It posits that the frontal regions of the brain deteriorate first and faster than other regions (West, 2000). The frontal lobe encompasses executive functions. Therefore, the frontal lobe hypothesis of aging suggests that there is differential atrophy of the brain, affecting the frontal lobes first and thus resulting in decline of executive functions in the early stages of age-related cognitive decline (West, 1996). Age-related cognitive decline has been linked to the prefrontal cortex (Hedden & Gabrieli, 2004). The dorsolateral prefrontal cortex as well as its association cortices and subcortical neural networks have shown decline (Potter & Grealy, 2006). It has also been found to affect the orbitofrontal cortex in addition to the dorsolateral prefrontal cortex (Lamar & Resnick, 2004). It has been suggested that instead of separate cortical areas responsible for specific executive tasks, that they share regions and are dependent upon one another (Carpenter, Just, & Reichle, 2000).

Physical and chemical changes in the brain have been associated with executive dysfunction. According to Buckner (2004), frontal-striatal circuits evidence more white matter decline than the rest of the brain and are associated with executive dysfunction with normal

aging. Additionally, gray matter in the frontal regions of the brain has a faster rate of atrophy than the rest of the brain (Buckner, 2004). Compared to the temporal, occipital, and parietal lobes, the prefrontal lobe shows significantly more volume loss (Raz & Rodrigue, 2006). White matter lesions, which often result from cerebral small-vessel disease, have also been shown to affect executive function. Specifically, there is evidence of decline in processing speed and overall executive decline from white matter lesions (Buckner, 2004; Prins et al., 2005). Cerebral small-vessel disease also results in infarcts. Infarcts, white matter lesions, and generalized atrophy have all been related to the speed of cognitive decline (Prins et al., 2005). The presence of systemic hypoperfusion, which is a result of cardiovascular disease, has been linked with decline in cognitive flexibility (Jefferson, Poppas, Paul, & Cohen, 2007). Over time, the increasing presence of white matter lesions can lead to subcortical dementia (Lindeboom & Weinstein, 2004). Finally, dopamine levels decline with age and have also been associated with general cognitive decline (Bäckman, Nyberg, Lindenberger, Li, & Farde, 2006), including executive dysfunction (Buckner, 2004). As aforementioned, Paxton et al. (2007) found that older adults perform more poorly on tasks of cognitive control compared to younger adults. Not only did they find this decline in inhibitory skills, but they were also able to demonstrate, through neuroimaging, a significant change in the prefrontal cortex associated with these skills (Paxton et al., 2007).

There is a multitude of studies that have detailed deficits in executive functions in older adults (Razani et al., 2007; Wecker et al., 2000; Jefferson et al., 2006; Nutter-Upham et al., 2008 Davies, 1968; Sorel & Pannequin, 2008). Because executive functions are believed to involve the prefrontal cortex, evidence of age-related executive dysfunction supports the frontal lobe hypothesis of aging. Furthermore, both processing speed and inhibition are associated with the

frontal lobe. Therefore, the frontal lobe hypothesis of aging also helps explain processing speed and inhibitory deficits observed in aging.

Dementia

Unlike age-related declines, dementia occurs when the decreases in cognitive ability are much more severe and continue to get significantly worse. This results from a neurodegenerative disease process. According to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR), dementia is defined as "…multiple cognitive deficits (including memory impairment) that are due to the direct physiological effects of a general medical condition, to the persisting effects of a substance, or to multiple etiologies (e.g., the combined effects of cerebrovascular disease and Alzheimer's disease)" (DSM-IV-TR, 2000, p. 147). As aforementioned, a diagnosis of dementia is met when there is impairment in memory *and* another domain, such as language, motor skills, or executive functioning (DSM-IV-TR, 2000). Dementia can result from multiple neurodegenerative diseases, such as Parkinson's disease, Pick's disease, Huntington's disease, Lewy body disease, dementia of the Alzheimer type, and vascular dementia (Flashman et al., 2003).

In addition to cognitive decline, there must also be evidence of functional decline (DSM-IV). Functional ability is defined as the ability to perform self-care tasks and therefore be able to live independently. These are classified as either Activities of Daily Living (ADLs) or Instrumental Activities of Daily Living (IADLs). ADLs refer to basic living skills, such as feeding oneself, bathing, grooming, dressing, and using the toilet. IADLs are more complex skills, such as shopping, managing finances, and driving. In dementia, a person first shows decline in IADLs before ADLs (Njegovan, Hing, Mitchell, & Molnar, 2001). Additionally, there appears to be a specific pattern of functional loss within the broad areas of IADLs and ADLs.

Njegovan and colleagues (2001) administered the Modified Mini Mental State Exam (3MS), a brief cognitive screen. Scores are out of 100, and lower scores indicate cognitive decline. They found that participants with scores of 75 or higher showed declines only in IADLs, which included housework, transportation, meal preparation, and shopping. Participants who obtained scores of 70 to 75 demonstrated declines in additional IADLs, including telephone use, financial management, and medication management as well as declines in some ADLs, such as toileting and dressing. Finally, participants with scores below 70 demonstrated decline across the assessed ADLs, including feeding and grooming (Njegovan et al., 2001).

Relationship between Cognitive and Functional Assessment

As cognitive abilities decline, one can infer that the functional tasks that are dependent on those cognitive processes will decline as well. In fact, functional status has been shown to decline according to severity of cognitive deficit (Pereira et al., 2010). Planning has been shown to be associated with functional decline, as measured by a performance-based test (Lewis & Miller, 2006). In the same study, working memory, verbal fluency, and cognitive flexibility were also correlated with functional ability.

It is important to note that although there is an association between cognitive and functional decline, research shows that cognitive decline does not completely account for all of the loss in functional ability. In Lewis & Miller's (2006) study, the cognitive skills assessed did not account for total variance in functional outcome measures. Cognitive decline can also differentially predict functional decline. In a study of cognitive predictors for financial ability, Sherod et al. (2009) found that performance on the Wide Range Achievement Test- Third Edition (WRAT-3) Arithmetic subtest was the best predictor for financial ability across groups

with Mild Cognitive Impairment (MCI; individuals with more cognitive decline than their age-related peers but not dementia; for a review, see Petersen et al., 2009), Alzheimer's disease, and healthy controls. Memory for prose passages was also a significant predictor across all groups. However, processing speed significantly predicted financial ability in the Alzheimer group while a task of cognitive flexibility was a significant predictor in the group with MCI (Sherod et al., 2009). Furthermore, although cognitive and functional abilities both decline, one cannot simply infer the level of functional decline based on the level of measured cognitive decline. For example, one study (Baird, 2006) found that functional decline was much slower than cognitive decline. In fact, by the time participants were two standard deviations below the mean on the functional measure, they were already five standard deviations below the mean on the cognitive measure (Baird, 2006). Therefore, it is important to assess *both* cognitive and functional ability within the geriatric population.

Executive Function

Definition of executive function. Executive function is defined as the set of cognitive processes necessary to complete goal-oriented, complex tasks (Lezak, Howieson, & Loring, 2004; Zelzao & Frye, 1998) and has been associated with the prefrontal cortex (Buckner, 2004; Jefferson et al., 2007; Raz & Rodrigue, 2006; Paxton et al., 2007; Royall et al., 2002; Stuss et al., 2002; West, 1996). According to Lezak et al. (2004), executive function is composed of four areas. They are: (a) volition, (b) planning, (c) purposive action, and (d) effective performance. Volition refers to formulating a plan to achieve a goal. Planning requires choosing the appropriate steps to reach the goal. Purposive action is the process of carrying out the steps. Finally, effective performance refers to the ability to evaluate the performance.

However, there is still no agreement on a definitive set of executive functions (for a review, see Stuss & Knight, 2002). In fact, a test may be considered to be an executive measure by one researcher and an attentional measure by another researcher (Wecker et al., 2000). Because of this dilemma, some researchers employ a process-oriented approach. Instead of trying to differentiate distinct executive functions and measures that yield only one score, the Cognitive-Process approach assesses the different skills that one needs in order to complete skills that are affected by frontal lobe injury (Homack, Lee, & Riccio, 2005; Delis, Kaplan, & Kramer, 2001a). Even though an established set of executive functions has not been determined within the field of neuropsychology, there is agreement on the basic assumption that executive functions are the cognitive processes necessary to complete complex problems (Zelzao & Frye, 1998).

Executive dysfunction in aging. Executive function deficits have been consistently found in the normal aging process. Specifically, there is significant evidence of declines in cognitive flexibility and inhibition (Butler & Zacks, 2006; Davies, 1968; Hasher & Zacks, 1988; Uekermann, Thoma, & Daum, 2008; Von Hippel & Dunlop, 2005; Wecker, Kramer, & Delis, 2005; Wecker, Kramer, Wisniewski, Delis, & Kaplan, 2000).

Cognitive flexibility. Cognitive flexibility is the ability to both adapt and switch between new instruction or rules (Delis et al., 2001a), and this ability declines with increasing age. For example, performance on the trail making test (a gold-standard measure of cognitive flexibility) declines with age (Davies, 1968; Jefferson et al., 2007; Nutter-Upham et al., 2008; Wecker et al., 2000). The trail making test consists of two components: a sequencing measure and a cognitive flexibility measure (Army Individual Test Battery, 1944; Reitan, 1958). Older adults have a more difficult time on this test than younger adults (Davies, 1968). In a study by Sorel and Pannequin (2008), participants were placed into three groups according to age (i.e., the mean age of group

one was 22.7, the mean age of group two was 68.1, and the mean age of group 3 was 78.5). Task performance declined with age, as the older groups took longer to complete the tasks and made significantly more errors. Jefferson et al. (2007) found that it took 70 seconds longer for individuals with mild dementia to complete Condition 4 of the Trail Making Test than age- and education-matched controls. In a study examining adults with MCI, healthy controls obtained a scaled score of 12.94 while participants with MCI obtained scores of 9.76 (Nutter-Upham et al., 2008). Wecker et al. (2005) found that age influenced cognitive flexibility, as measured by the D-KEFS Trail Making Test. Specifically, increasing age caused longer completion times. Wecker, Kramer, and Delis (2005) found that age predicted decline in set shifting above and beyond demographic characteristics (i.e., education, IQ, and gender) and process skills (e.g., visual scanning, letter sequencing, number sequencing, and motor speed).

Inhibition. Inhibition refers to the ability to monitor oneself and refrain from prepotent responses (Delis et al., 2001a). Aging has also been linked with a decrease in inhibitory behavior. Butler & Zacks (2006) examined differing levels of complexity for an antisaccade task. A group of community-dwelling older adults and a group of healthy undergraduate students were given two types of antisaccade tasks: one with peripheral cues and one with a central cue (which requires less inhibitory skill). The central cue task requires less inhibitory skill, so there ought to be a difference in performance between the two. Older adults showed a larger difference between their prosaccade and antisaccade accuracy and the cue type did not significantly affect performance in the control group. The results of this study, therefore, illustrated an age-related decline in inhibitory skills (Butler & Zacks, 2006). Von Hippel and Dunlop (2005) also found a group difference between older and young adults in their ability to inhibit a response, as

measured by performance on the Stroop task and number of perseverative errors on the Wisconsin Card Sorting Test.

Proverb interpretation. Proverbs are defined as abstract expressions that convey messages about society (Uekermann, Thoma, & Daum, 2008). Successful proverb interpretation requires the ability to understand the abstract meaning instead of its concrete statement (Delis et al., 2001a). Understanding the meaning behind a proverb requires a higher-order cognitive process and can be considered an executive function. There is a proverb interpretation subtest in the Delis-Kaplan Executive Function System (D-KEFS), a battery of tests designed to assess multiple components of executive functioning (Delis et al., 2001a). Poor proverb interpretation has been found in people with schizophrenia (Brüne & Bodenstein, 2005). However, there is limited research regarding decline in understanding proverbs in aging. One study that did explore this relationship found that older adults' performance on proverb tasks were significantly lower than younger adults (Uekermann, Thoma, & Daum, 2008).

Executive function and functional independence. Executive dysfunction has been shown to be a good predictor of functional decline (Bell-McGinty, Podell, Franzen, Baird, & Williams, 2002; Cahn-Weiner, et al., 2000; Lewis & Miller, 2002; Mitchell & Miller, 2008; Sherod et al., 2009). Sherod et al. (2009) found that poor performance on a measure of cognitive flexibility was a significant predictor of decreased capacity for financial reasoning in individuals with MCI. Additionally, performance on tests of cognitive flexibility and planning have also been shown to be good predictors of functional decline in older adults who were diagnosed with dementia as well as older adults who did not have a diagnosis (Bell-McGinty et al., 2002). Razani et al. (2007) also found that a measure of cognitive flexibility (i.e., Trail Making Test) was correlated ($r = .60$) with the ability to shop independently. Cahn-Weiner, Boyle, and Malloy

(2002) found that the Trail Making Test accounted for IADL performance over other tests of executive function. Finally, the increased difficulty of inhibiting prepotent responses has been shown to be a strong predictor of functional decline. Jefferson, Paul, Ozonoff, and Cohen (2006) found that a measure of response inhibition (D-KEFS Color-Word Interference Test) was a significant predictor of IADL functioning ($\beta = -.4$). It was significantly correlated with shopping ($r = -.23$), finances ($r = -.23$), laundry ($r = -.27$), and transportation ($r = -.33$).

Proverb interpretation and functional decline. Less is known about the relationship between decline in the understanding of proverbs and functional decline in older adults. To the best of the author's knowledge, there has not been research examining the relationship between proverb interpretation and functional decline in older adults.

Theory of Mind

Definition. First introduced by Premack and Woodruff (1978), Theory of Mind (ToM) is defined as the ability to understand another's perception of a situation. Stemming from autism and developmental literature, it is one model that attempts to explain how one comes to comprehend views and beliefs of other people (Baron-Cohen, 1988). Though it is not found in traditional neurocognitive literature, the ToM literature argues that it is a cognitive process because it requires one to be able to infer both emotions and thoughts of another person (Baron-Cohen, 1988). Unlike empathy, which consists of both cognitive and affective components, researchers posit that ToM is solely based on a cognitive mechanism. Whereas empathy requires one to experience a shared emotion with another person, ToM only requires one to take the perspective of another person which may or may not lead to experiencing a shared emotion (Baron-Cohen & Wheelwright, 2004).

Difficulty with ToM can significantly impact one's life. Successful social interaction is a component in many areas of daily functioning, such as school, work, friends, family, and significant others. Because of the significant impact on daily living that deficiencies in ToM can produce, it is an important area of study. Additionally, limited ToM abilities have been found in clinical populations in which poor social interaction is often observed. These include autism spectrum disorders, attentional disorders, dementia, bipolar disorder, multiple sclerosis, and schizophrenia (Baron-Cohen, Leslie, & Frith, 1985; Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997; Brüne & Brüne-Cohrs, 2005; Bora et al., 2005; Cuerva et al, 2001; Gottlieb, 2005; Gregory et al, 2002; Happé, 1994; Hughes, Dunn, & White, 1998; Kaland et al., 2002; Kerr, Dunbar, & Benteall, 2003; Ouellet et al., 2010).

The concept of ToM stems from the developmental literature and focuses on the stages of normal ToM development from age one to eleven. In their review of ToM, Brüne and Brüne-Cohrs (2005) outlined the stages of ToM development. At age one, a child first begins to form an understanding that another person can attend to the same information that the child can. This is referred to as joint attention. By ages 14 to 18 months, children are able to extend the concept of joint attention to include mood. By age two, children begin engaging in pretend play (also known as de-coupling), an exercise which requires the child to take the perspective of another character. Between ages three and four, children begin to understand that another person's belief can be different than their own. This is referred to as understanding of false belief. By ages six to seven, children begin to understand jokes that incorporate irony. The last stage of ToM development occurs between the ages of nine and eleven, when a child understands the concept of a faux pas (Brüne and Brüne-Cohrs, 2005). The definition of a faux pas is that one person makes an offensive comment to another person without intending to offend. This requires simultaneous

ToM for both characters, the one making the faux pas and the one feeling offended (Brüne & Brüne-Cohrs, 2005; Gregory et al, 2002; Stone, Baron-Cohen, & Knight, 1998).

Similar to executive functions, engaging in ToM tasks shows activation in the prefrontal cortex. Happé et al. (1996) found that healthy ToM performance showed areas of activation in the medial left prefrontal cortex. Interestingly, an Asperger group (i.e., a clinical sample shown to have deficits in ToM) did not display the same activation and instead demonstrated greater activation in the surrounding areas (Happé et al., 1996). This suggests that deficits in ToM may be linked to a functional difference at the neuronal level, thus supporting that ToM is dependent on prefrontal brain regions.

Executive mechanisms of ToM. There is growing research in the area of executive function and ToM. While there have been some case studies that have not established a relationship between executive functions and ToM (Bach, Happé, Fleminger, & Powell, 2005; Fine, Lumsden, & Blair, 2001), there have been many more studies that have identified an association between the two. Within autism research, findings have suggested a positive relationship between inhibition, working memory and ToM (Joseph & Tager-Flusberg, 2004). Furthermore, both executive function and ToM performance is lower in individuals with autism spectrum disorders, and a review by Hughes and Graham (2002) suggest that they are related. Finally, research has examined the clinical implications of an executive function-ToM connection. One study trained children in either ToM skills or executive function skills and found that those children who were trained in executive function skills showed better ToM performance (Fisher & Happé, 2005). This not only suggests a relationship between executive function and ToM, but it provides evidence that ToM is driven by executive functions and not the other way around. Children with attentional disorders have also demonstrated poorer ToM

performance in addition to deficient executive functioning. In a sample of preschool children, researchers found a significant positive correlation between executive function and ToM (Hughes, Dunn, & White, 1998).

The executive function-ToM relationship is not specific to developmental disorders. In normally-developing preschoolers, executive function scores predicted ToM performance (Cole & Mitchell, 1998; Gordon & Olsen, 1998). This relationship has also been demonstrated in a group of Chinese preschoolers; specifically, cognitive flexibility, inhibition, and planning were significantly correlated with ToM in a positive direction (Sabbagh, Xu, Carlson, Moses, & Lee, 2006). Onset of ToM was examined by Carlson et al. (2004) and results showed that it can be found as early as 39 months of age; specifically, working memory and inhibition were associated with ToM performance. Compared to working memory and planning, this research group found that inhibition was a stronger predictor of ToM (Carlson, Moses and Breton, 2002; Carlson, Moses, & Claxton, 2004). Similar to the autism research, the relationship between executive functions and ToM suggests that executive function underlies ToM performance and not the other way around (Hughes, 1998).

Though the majority of ToM research has been with children, it is increasingly being studied in adult populations. Problem solving, design fluency, and verbal fluency were found to have a significant positive correlation with ToM in older adults (Saltzman, Strauss, Hunter, & Archibald, 2000). Poor inhibition was also associated with increased socially inappropriate behavior (Von Hippel & Dunlop, 2005). Research examining this relationship in typically-developing adults using a comprehensive measure of executive functions and three levels of ToM measures indicated executive function skills are not necessary for basic emotion recognition (Ahmed & Miller, 2010), which has been argued to be the foundation of ToM ability

(Baron-Cohen, 2001). Furthermore, Ahmed and Miller (2010) found that deductive reasoning, verbal fluency, and design fluency were significantly related with a ToM measure of second-order ToM while problem solving was associated with scores on a ToM measure of faux pas identification.

ToM and proverbs. As aforementioned, there is limited research on proverb interpretation. However, it has been conceptualized as an executive function (Delis et al., 2001a). In our previous research, we found that performance on executive domains accounted for significant levels of variance on ToM performance (Ahmed & Miller, 2010) and the ToM-executive function link has been well established by others (Bach et al., 2005; Carlson et al., 2002; Carlson et al., 2004; Fisher & Happè, 2005; Hugh et al., 1998; Joseph & Tager-Flusberg, 2004; Sabbagh et al., 2006; Saltzman et al., 2000). Given this relationship between ToM and executive functioning, it seems likely that there should be a relationship between ToM and proverb interpretation. Not only is proverb interpretation considered to be an executive function (Delis et al., 2001a), but it also requires abstract thinking similar to ToM (Uekermann et al., 2008). Therefore, it seems likely that these two constructs should be at least moderately correlated.

Though both ToM and proverb interpretation represent one's ability to generate abstract thought (Delis et al., 2001; Uekermann et al., 2008), there is limited research on proverb interpretation and ToM. One such study that did examine this relationship was with a schizophrenia population. Researchers found that performance on proverb interpretation was significantly correlated in a positive direction with a ToM task, after controlling for IQ (Brüne & Bodenstein, 2005).

ToM in aging. There is conflicting evidence regarding a decline in ToM ability in an elderly population. Happé, Winner, & Brownell (1998) found better ToM scores in an older adult group than in a college-aged group. However, this seems to be the only study that has found an increase in ToM ability with age. Other studies have revealed ToM decline in older adults. In one study, researchers found that older adults tended to ask more socially inappropriate questions and that this relationship was mediated by poor inhibitory skills (Von Hippel & Dunlop, 2005). In a study examining ToM in university controls, older adults and those with Parkinson's disease, researchers found that in general older adults had lower scores on measures of ToM. Participants with Parkinson's disease performed even more poorly on ToM measures compared to university controls and older adults without the disease (Saltzman, Strauss, Hunter, & Archibald, 2000). Individuals with frontotemporal dementia also evidence ToM deficits (Lough, Kipps, Triese, Watson, Blair, & Hodges, 2006; Schroeter, Raczka, Neumann, & von Crammon, 2008). Finally, significant age effects were found on a measure of faux pas recognition (MacPherson, Phillips, & Della Salla, 2002). Another study, however, found that the ability to detect a faux pas was more difficult for older adults than controls, but that this was the same across all ToM and non-ToM items (MacPherson, Phillis, & Sala, 2002). A possible explanation for this decline in ToM is that it is due to general cognitive factors. One study contributed ToM decline to a general decline (Slessor, Phillips, & Bull, 2007). Another study found that the ToM decline in older adults was fully mediate by executive functioning, processing speed, and intelligence (Charlton, Barrick, Markus, & Morris, 2009). Given the varying conclusions in the linited ToM/aging literature, more research into this area is warranted.

As with the literature in executive dysfunction and aging, research has emphasized that deterioration of frontal regions, such as the dorsolateral prefrontal cortex and the anterior medial

frontal cortex, are associated with ToM decline (Blakemore & Choudhury, 2006; MacPherson et al., 2002; Schroeter et al., 2008). In a meta-nalysis, it was found that the medial rostral prefrontal cortex area showed the most activation during tasks requiring ToM (Gilbert et al., 2006). The medial prefrontal lobe, temporal regions, and superior temporal sulcus have also shown to be utilized in tasks that require ToM (Singer, 2006). Similar to the imaging data detailing the widespread nature of executive function in the brain, it appears that the ToM tasks also tend to be associated with general prefrontal areas.

ToM is considered to be a cognitive construct within the developmental literature (Baron-Cohen, 1988; Baron-Cohen & Wheelwright, 2004). Therefore, the study of ToM in older adults is separate from examination of the affective components of emotional processing, which have been found not to decline with age (St. Jacques, Bessette-Symons, & Cabeza, 2009).

ToM and functional independence. To our knowledge, there has not been research examining the relationship between ToM and functional independence. However, given that there is a link between executive functions and ToM and that executive functions are significant predictors of functional decline, ToM too may be related to functional independence.

Aims

Research on proverb interpretation and ToM in a geriatric population is limited. Further, to the author's knowledge, there is no research examining their relationship to functional independence. Given the paucity of research in this area, there were four aims for this study.

The first aim was to examine whether proverb interpretation was related to independence in IADLs of older adults. If so, the next step would be to determine whether it accounts for more variance than traditional executive function measures. Because proverb interpretation is

considered an executive function (Delis et al., 2001a), executive functioning is associated with functional decline (Mitchell & Miller, 2008), and older adults demonstrated poorer proverb interpretation than younger adults (Uekermann et al., 2008), it was hypothesized that proverb interpretation would account for significant variance in IADL functioning.

The second aim of this study was to examine whether ToM was related to IADLs in older adults. If ToM accounted for significant variance in functional independence, the next step would be to determine whether it accounted for more variance than traditional executive function measures and proverb interpretation (if proverb interpretation was found to be associated). Because there is ToM decline in older adults (MacPherson et al., 2002; Saltzman et al., 2000; Schroeter et al., 2008; Von Hippel & Dunlop, 2005) and its relationship to executive function (Ahmed & Miller, 2010; Carlson et al., 2002; Carlson et al., 2004; Cole & Mitchell, 1998; Fisher & Happé, 2005; Hughes et al., 1998; Sabbagh et al., 2006), it was hypothesized that ToM would account for a significant amount of variance in IADLs.

The third aim was to examine whether proverb interpretation accounted for significant variance in ToM performance. Since proverb interpretation requires abstract thinking (Delis et al., 2001a) and ToM is conceptualized as an abstract cognitive process (Baron-Cohen, 2001), it was hypothesized that proverb interpretation would be related to ToM performance.

Finally, the fourth aim of this study was to examine if the relationship between ToM and functional ability was mediated by executive functioning (i.e., cognitive flexibility, inhibition, and proverb interpretation). Because of the relationship between executive functioning and ToM (Ahmed & Miller, 2010; Carlson et al., 2002; Carlson et al., 2004; Cole & Mitchell, 1998; Fisher

& Happé, 2005; Hughes et al., 1998; Sabbagh et al., 2006), it was hypothesized that executive functioning mediated or partially mediated the relationship between ToM and functional ability.

CHAPTER 2

METHODS

Participants

Power analysis.

A review of previous studies that have examined ToM in older adults revealed the use of 20 to 25 participants. However, these were between-group studies and did not examine functional independence (e.g., Happè et al., 1998; Maylor et al., 2002). Previous research from this laboratory examining functional independence in a community-dwelling older adult population used 45 participants. This study also used four independent variables, slightly less than the current study (Mitchell & Miller, 2008). Neither of the above-mentioned studies, however, has examined both ToM and functional independence. Therefore, an a priori power analysis was employed using G-Power (Faul, Erdfelder, Buchner, & Lang, 2009; Faul, Erdfelder, Lang, & Buchner, 2007) by entering a large effect size (.35), power of .80, five independent variables, and one dependent variable. A large effect size was entered because the only other known study examining functional independence in a sample from the same community found a very large effect (f^2= .79; Mitchell & Miller, 2008), though this was specific to executive measures. After entering the aforementioned specifications on G-Power, the calculated sample size necessary was 43 participants.

Recruitment.

Participants were recruited from the greater Athens community. The principal investigator (PI) posted fliers in public boards throughout the community. With permission from

assisted living/retirement communities, fliers were posted on common area boards and resident mailboxes. Furthermore, the PI gave presentations about ways in which older adults can keep their minds active to multiple assisted living/retirement communities in the area and the local library.

Exclusion/inclusion criteria.

Inclusion for the study involved meeting the age requirement of 65 to 89. Exclusion criteria included significantly impaired vision (to the extent that it impedes the ability to read), self-reported illiteracy, self-report of a current diagnosis of dementia/significant cognitive deficits, or performance below 23 on the Mini Mental Status Exam (MMSE), a global measure of mental status (Folstein, Folstein, & McHugh, 1975). Finally, individuals who reported significant current symptoms of depression were excluded from the study. This was determined by a cutoff score of 20 or higher on the Geriatric Depression Scale (GDS, see below for more detail). Three participants were excluded from this study for attaining an MMSE score below 23. No other exclusion criteria was met by any participant.

Measures

Brief cognitive screen.

Mini-mental status exam (MMSE). The MMSE is a 30-item brief screen of global cognitive functioning. It assesses the following areas: (a) orientation to time, (b) orientation to place, (c) registration, (d) working memory, (e) recall, (f) naming, (g) repetition, (h) auditory comprehension, (i) reading comprehension, (j) writing, and (k) construction (Folstein et al., 1975). A score below 23 excluded participants from this study. This has traditionally been used as a cutoff score indicating cognitive impairment in the literature, as it is 69% sensitive and 99% specific on dementia. Age has been shown to be a significant predictor of MMSE scores

(Tangalos et al., 1996). Test-retest reliability has been quite high, ranging between .80 and .95 (Tombaugh & McIntyre, 1992). In a sample of healthy community-dwelling older adults, the reliable change index difference score ranged from $\pm$2.94 to $\pm$4.42 across different intervals over five years between the administrations of the test, which is considered to be stable over time (Tombaugh, 2004).

Emotional functioning.

Geriatric depression scale (GDS). Depression has been associated with functional decline (Alexapoulos, 2005; Baird, 2006). Therefore, participants were administered the GDS, an orally-administered test in which participants answer yes or no questions regarding statements about feelings and behaviors over the past week. There are 30 statements, each receiving one point for an acknowledgement of a depressive item. A total score of 0-9 indicates an absence of significant depressive symptoms, 10-19 indicates mild depression, and 20-30 is indicative of current severe symptoms of depression (Brink, Yesavage, Lum, Heersema, Adey, & Rose, 1982; Sheikh et al., 1991; Sheikh & Yesavage, 1986). Individuals with a score of 20 or higher were excluded from this study. The GDS has shown very high split-half reliability (r = .94) and test-retest reliability (r = .85) (Yesavege, et al., 1983). The GDS has also been shown to be a valid measure of depression among older adults. Specifically, it was found that individuals classified as either normal, mildly depressed, or severely depressed obtained scores consistent with their classification. That is, the GDS scores became lower as the severity of depression increased (Yesavage et al., 1983).

IQ estimate.

Wechsler test of adult reading (WTAR). It was important to obtain an estimate of the participant's IQ in order to assess the effects of IQ on cognitive and functional performance. This

study employed the Wechsler Test of Adult Reading (WTAR) in order to obtain a predicted Full Scale IQ (FSIQ) score (The Psychological Corporation, 2001). Test-retest reliability has been quite high (r = .97). It has also been shown to be a valid screen for IQ, as it remains stable over time, which is characteristic of IQ (Green, Melo, Christensen, Ngo, Monette, & Bradbury, 2008).

Executive function measures.

Delis-Kaplan executive function system (D-KEFS). Select tasks from the D-KEFS were used to assess specific domains of executive function. Developers of the D-KEFS based each of the subtests on traditional measures of executive function and normed them on a sample of 1,150 adults and children ranging in age from 8-89 years. This is a paper-and pencil cognitive battery made up of nine subtests. Using a cognitive process approach, each subtest is broken down into multiple scores (Delis et al., 2001a). By breaking the test scores into multiple process scores, clinicians are able to better describe a patient's performance. It has low floors and high ceilings due to the large age range. Test-retest reliability across all subtests ranges between .06 and .90.The D-KEFS reported validity by running intercorrelations within the conditions of the D-KEFS subtests, ranging from -.94 to 0.95 (Delis et al., 2001b). Though there are other, more traditionally-utilized measures of executive function in research with older adults, this study employed measures from the D-KEFS. The D-KEFS provides the same normative sample for all of its subtests (Delis et al., 2001). Therefore, it helps streamline the interpretation of results.

There are nine subtests: (a) Trail Making, (b) Verbal Fluency, (c) Design Fluency, (d) Color-Word Interference, (e), Sorting, (f) Twenty Questions, (g) Word Context, (h) Tower, and (i) Proverb (Delis et al., 2001). However, only the Trail Making Test, Color-Word Interference Test, and Proverb Test were used in this study. Both the Trail Making and Color-Word Interference tests measure executive domains that have support in the literature regarding their

ability to predict functional ability (Butler & Zachs, 2006; Davies, 1968; Hasher & Zachs, 1988; Sorel & Pannequin, 2008; West, 1996) and were used to compare the effectiveness of the Proverb test on functional independence.

The D-KEFS tests was administered and scored according to standard protocol (Delis et al., 2001).

D-KEFS trail making test. This subtest measures cognitive flexibility which refers to the ability to quickly adapt to new rules and concepts (Delis et al., 2001a). The Trail Making Test is divided into five conditions. The first condition required participants to quickly scan the page full of numbers and identify how many three's there are on the page. The second condition asked participants to connect numbered circled dots in numerical order, while the third condition measured the ability for participants to connect lettered dots in order. The fourth condition was considered the traditional executive measure of cognitive flexibility, as it required the participants to switch between connecting numbers and letters in both numerical and alphabetical order. Finally, the fifth condition measured motor speed by having the participants connect dots along a dashed line as quickly as possible. Scaled scores for each condition were based on total completion time in seconds. The utility of having multiple conditions in addition to the traditional executive measure is that it allows one to interpret test performance by breaking down each skill necessary to complete the task. In this case, it breaks down the participant's ability of visual scanning, sequencing numbers, sequencing letters, and motor speed. If any of these areas are impaired, it will automatically affect condition four, the executive measure of cognitive flexibility (Delis et al., 2001a).

The internal consistency across individuals ages 8-89 was high (r = .57 to .81) and was also high among individuals aged 60-89 (r = .60 to .80) (Delis, Kaplan, & Kramer, 2001b;

Shunk, Davis, & Dean, 2006). Test-retest reliability was .66 across all age groups and .60 for individuals between the ages of 50 to 89. Length of retest averaged 25 $\pm$ 12.8 days. (Delis et al., 2001b). The D-KEFS Trail Making Test is frequently used in the older adult population. Differences between healthy and clinical populations of older adults have been consistently demonstrated. Specifically, older adults show poorer performance compared to younger controls (Jefferson et al., 2007; Nutter-Upham et al., 2008; Razani et al., 2007; Wecker et al., 2005).

The aim of this study was to examine if (and to what extent) measures of proverb interpretation and ToM were related to functional independence. In order for the results of this study to be relevant, the relationships of proverb interpretation and ToM on functional independence were compared to traditionally-measured executive domains. Tests of cognitive flexibility are commonly assessed in older adult populations (Davies, 1968; Sorel & Pannequin, 2008; Stuss et al., 2001; Wecker et al., 2005). The trail making test is also one of the oldest executive function measures (Army Individual Test Battery, 1944). Additionally, it has been shown to account for variance in IADL performance over other measures of executive function (Cahn-Weiner et al., 2002). Therefore, the use of the D-KEFS Trail Making test helped compare the significance (if any) of proverb interpretation and ToM on functional decline.

D-KEFS color-word interference test. This subtest measures inhibition, the ability to hold back one's automatic response for the correct one (Delis et al., 2001a). This test is divided into four conditions. The first required participants to name color patches. The second condition measured the ability to read words (i.e., red, blue, and green) written in black ink. The third condition is based on the traditional Stroop test of inhibition. In this condition, the words "red," "green," and "blue" are written in different-colored ink. Participants were asked to name the color of the ink and not read the word as quickly as possible. This test requires one to inhibit

reading the word and name the ink color instead. The last condition asked participants to switch between naming ink colors and reading words. It incorporates both cognitive switching and inhibition. As with the D-KEFS Trail Making Test, scaled scores were derived from total completion time in seconds (Delis et al., 2001a).

According to the D-KEFS Technical Manual, internal consistency was high across the ages of 8 to 89 (r = .62 to .86). It ranged from .77 to .86 in individuals aged 60-89. Test-retest reliability across all ages was .65 and .57 among the 50-89-year-old age group (Delis et al., 2001b; Shunk et al., 2006). Length of retest averaged 25 $\pm$ 12.8 days. (Delis et al., 2001b).

Regarding validity, the use of this test appears limited compared to the traditional Stroop test in the extant literature. Of the studies that were available for review and which provided detailed information about performance on this test, differences were found in the average amount of time needed to complete the inhibition condition of this test. On average, it took 84.43 seconds for a group healthy older adults to complete the inhibition condition of the Color-Word Interference Test (Razani et al., 2007). In another study, healthy older adults (ages 50-85 years) completed the same condition in 68.3 seconds (Alibhai et al., 2010). Jefferson et al. (2007) found that it took healthy older adults (mean age 69.41) an average of 66.5 seconds to complete the D-KEFS Color-Word Test. In yet another study, older adults (mean age of 69.14) completed this condition in 59.08 seconds (Deria, 2001).

Tests of inhibition are common measures in research on cognitive decline in older adults (Braver et al., 2001; Butler & Zacks, 2006; Gerven et al., 2007; Paxton et al., 2007; Von Hippel & Dunlop, 2005). The traditional Stroop paradigm is also one of the oldest executive function tests (Stroop, 1935). By using a measure of inhibition, we were able to examine whether Proverb

tests and tests of ToM were related to functional independence beyond a more traditionally-assessed domain: inhibition.

D-KEFS proverb test. Proverb understanding refers to the ability to comprehend statements beyond literal meaning (Delis et al., 2001a). In this subtest, participants were provided with different proverbs, ranging from common to less common. As with the other D-KEFS tests, there is more than one condition. In the first condition, participants were asked to explain the meaning of the proverb in their own words. Responses were scored based on two domains: (a) accuracy of the interpretation and (b) level of abstract thinking. In the second condition, participants were provided with a choice of four possible meanings for the proverbs and chose the meaning they think is most accurate (Delis et al., 2001a).

The D-KEFS Technical Manual reports high test-retest reliability across all age groups (r = .76) and even higher test-retest reliability among people between the ages of 50-89 (r = .81). Length of retest averaged 25 $\pm$ 12.8 days. Internal consistency in this age range is also good (r = .68 to .74) for individuals aged 60-89 (Delis et al., 2001b; Shunk et al., 2006). As aforementioned, there is very limited research examining proverb interpretation in older adults. To the author's knowledge, there are no validity studies on the D-KEFS Proverb Test in older adults.

ToM measures.

ToM measures were originally false belief paradigms. The traditional Sally-and-Anne test is a good example of a false belief paradigm. In this test, the examinee observes one character (Sally) hiding an object while the other character is not in the room (Anne). The examinee is asked where they think Anne will look for the object when she returns. This requires the examinee to understand that Anne does not know that the object is hidden (Brüne & Brüne-

Cohrs, 2005). However, more sophisticated ToM measures have been developed for older individuals (Brent et al., 2004; Brüne & Brüne-Cohrs, 2005; Gregory et al, 2002; Happé et al., 1998; Jolliffe & Baron-Cohen, 1999; Stone, Baron-Cohen, & Knight, 1998).

Strange stories test. This test was developed as a more complex form of ToM measurement. Instead of the traditional false belief paradigm that was used for children with autism, the Strange Stories are a series of vignettes in which the intention of the character's actions has to be deciphered by participants (Happé, 1994). Furthermore, it has been shown to be more sensitive within the Asperger population, who normally pass simple ToM tasks but still struggle with more subtle ToM skills, such as double bluffs and white lies (Happé, 1994; Jolliffe & Baron-Cohen, 1999).

Participants were given a series of vignettes and these are read to them by the examiner. They were then asked questions about the intention behind the character's action. There was no memory load, as participants could read back over the vignette when answering quesitons. Responses were rated on a two-point scale based on the accuracy of their response (Happé, 1994; Happé et al., 1998).

There are multiple versions of ths test for different populations (Happé, 1994; Jolliffe & Baron-Cohen, 1999; Happé et al., 1998; Maylor, Moulson, Muncer, & Taylor, 2002; Sullivan, & Ruffman, 2004). Permission was obtained from the test developer, and the version that this study used was a selection of stories from the version that was administered to young and older adults (Brent et al., 2004; Happé et al., 1998). It consists of six stories, four of which require the use of ToM and two control stories. However, all of the stories have been used as part of a larger set of stories (Brent et al., 2004; Happé, 1994). Therefore, specific data of the reliability and validity of this exact set are unknown. However, the Strange Stories tests in general have shown good

reliability and validity. In past studies, the Strange Stories test has been validated as a measure of ToM, was sensitive in its ability to show performance differences in Asperger's Disorder, and has shown high interrater reliability (Happé, 1994; Happé et al., 1998; Gottlieb, 2005; Kaland et al., 2002).

Administration and scoring of the Strange Stories test adhered to standard protocol (Happé, 1994).

Faux pas test. Faux pas is defined as a socially inappropriate comment or act (resulting in hurt or upset feelings) that is unintentionally made. Detection of a faux pas requires simultaneous ToM, as one has to identify that someone was offended by a comment and that the person making the comment did so unintentionally (Brüne & Brüne-Cohrs, 2005; Gregory et al, 2002; Stone, Baron-Cohen, & Knight, 1998). Participants read a series of 20 vignettes, some that contain a faux pas and some that do not. Participants answered the following questions: (a) whether a faux pas occurred, (b) that it resulted in hurt feelings in one of the characters, (c) that the character who made the faux pas did not intend for a negative outcome, and (d) control questions that ensure the participant comprehended the reading material. There was no memory load on this test, as participants were allowed to look back at the vignettes when answering questions (Gregory et al., 2002; Stone, Baron-Cohen, & Knight, 1998).

This test has shown interrater reliability at .98 and correlated with both first-order and second-order ToM measures ($r = .76$ and 0.78) (Gregory et al., 2002).

Administration and scoring of the Faux Pas test adhered to standard protocol (Gregory et al., 2002; Stone, Baron-Cohen, & Knight, 1998).

Functional independence measure.

Independent living scales (ILS). The ILS was used as the functional independence measure for this study. Originally termed the Community Competence Scale, the ILS (Loeb, 1996) was developed to assess IADLs in a geriatric population. Test items were developed from a survey, review of the literature related to issues of guardianship, and interviewing both older adults and professional groups. The normative sample was made up of 590 healthy older adults ages 65 and up. Internal consistency is high, ranging from .72 to.92 across subtests. Test-retest reliability ranged from .81 to .94. The time between administrations ranged from 7 to 24 days with an average of 14 days. This test has been validated on a sample of adults with dementia, who obtained subtest scores that were significantly lower than controls (Loeb, 1996).The ILS has been significantly correlated with the Dementia Rating Sale, which assesses severity of cognitive decline (Baird, 2006). Additionally, its problem-solving domain has been validated on a schizophrenia population (Revheim et al., 2006).

The ILS yields an overall Full Scale score. It is also broken into five scales: (a) Memory/Orientation, (b) Managing Money, (c), Home and Transportation, (d), Health and Safety, and (e) Social Adjustment. In addition to these subtest scores, items are divided into two classes: (a) those that require basic knowledge, and (b) those that require problem-solving.

Administration and scoring of the ILS adhered to standard protocol (Loeb, 1996).

Procedure

This study was conducted in one of two places: (a) the Neuropsychology and Memory Assessment Laboratory of the Psychology building at the University of Georgia, or (b) the residence of the participant or a common room in the participant's residential building. The study

took place at the participant's residence if they were unable to come to the laboratory. Interested participants contacted the PI via telephone, and a two-hour session was scheduled.

At the beginning of the session, participants were provided with a written consent form and the principal investigator answered any questions. It was assumed that the participant has capacity to consent based on their ability to comprehend the recruitment flyer, call the researcher, and schedule a time to participate in the study. However, if the participant did not appear to comprehend the examiner, they were not included in the study because they may not have had the capacity to consent. After consenting, participants completed a demographic information form. This included items such as age, gender, years of education, and current income. Next, participants were administered the MMSE. If they performed above the cutoff as defined by the MMSE literature (i.e., below 23/30; Tangalos et al., 1996), they continued to participate in the study. If not, they were excluded from the study and provided with information about the UGA Memory Assessment Clinic. Three participants obtained scores below 23 and were excluded from the study. Next, participants were administered the GDS. Scores above 20 excluded them from the study, as this meets criteria for depression (Brink, Yesavage et al., 1982; Sheikh et al., 1991; Sheikh & Yesavage, 1986). No participant obtained a score above 20. Those participants who were not excluded were then administered the Wechsler Test of Adult Reading (WTAR) to obtain an IQ estimate (The Psychological Corporation, 2001). Next, participants were administered the D-KEFS Trail Making Test, D-KEFS Color-Word Interference Test, D-KEFS Proverb Test, Strange Stories test, Faux Pas test, and ILS. After completion of testing, participants were provided with a written debriefing form as well as an oral explanation of the study. They were then paid $20 for their participation regardless of whether they completed the

study. After payment, participants signed a form acknowledging that they received payment for this study.

Analysis

Each of the ToM tests yielded a total score. Previous research from our lab has found that the Strange Stories test and the Faux Pas test are driven by differing executive mechanisms (Ahmed & Miller, 2010). Therefore, the ToM tests were not aggregated into a composite ToM score; rather, each test was entered into separate regression analyses (see Aims section for more detail). The age-adjusted scaled score from the D-KEFS Proverb test was the other independent variable. The two additional executive function measures (D-KEFS Trail Making test and Color-Word Interference) each yielded a scaled score from the D-KEFS normative sample. These were also entered as independent variables in the regression models for two out of the four aims detailed below. Finally, the total scaled score from the ILS was the dependent variable.

First, a bivariate correlation matrix was calculated among all variables. Only the aforementioned independent variables that were significantly correlated with the dependent variable (i.e., ILS score) were entered in the following regression models. Several hierarchical multiple regression analyses were employed. First, the impact of demographic variables (i.e., age, education, gender, WTAR-predicted FSIQ) on functional independence was assessed through multiple regression. If any of these variables shared significant variance with performance on the ILS, then those variable/s were entered into the first step of each regression model.

The first aim of this study was to examine the relationship between proverb interpretation and functional independence. This was carried out by entering the scaled scores from the D-KEFS Proverb test into a regression model as the independent variable and by entering the ILS

scaled score as the dependent variable. The next step was to determine whether proverb interpretation accounted for significant variance in functional independence better than the executive functions of cognitive shifting and inhibition. To examine this, the scaled scores of the D-KEFS Trail Making Test and Color-Word Interference Test were entered into the first step of a new regression model and the Proverb test variable was entered into the second step.

The second aim of this study was to examine if ToM was related to functional independence. In order to examine this, ToM scores were entered into a regression model with the ILS score as the dependent variable. If ToM was significantly associated with ILS scores, the next step was to determine whether ToM accounted for additional variability in ILS performance above and beyond that of proverb interpretation. To examine this, the Proverb Test variable was entered into the first step of a new regression model and ToM was entered into the second step.

The third aim of this study was to explore whether proverb interpretation accounted for significant variance in ToM scores. For this aim, another regression model was utilized in which the Proverb test variable was the independent variable and the ToM was the dependent variable.

Finally, the fourth aim was to use mediation analyses to determine whether the relationship between ToM and ILS was mediated by the executive variables.

CHAPTER 3

ADEQUATE PROVERB INTERPRETATION ASSOCIATED IS WITH PERFORMANCE ON THE INDEPENDENT LIVING SCALES [1]

[1]Ahmed, F.S. & Miller, L.S. To be submitted to *Journal of Clinical and Experimental Neuropsychology*.

Abstract

The purpose of this study was to examine the association of proverb interpretation with functional independence in older adults. From the limited literature on proverb interpretation in aging and its conceptualization as an executive function, it was hypothesized that proverb interpretation would be related to functional independence similar to other executive functions. Tests of proverb interpretation, additional executive functions, and functional ability were administered to non-dementing older adults. Results showed that proverb interpretation accounted for a significant amount of unique variance of functional ability scores. This supports including a measure of proverb interpretation to the assessment of an older adults.

The geriatric population is growing rapidly in the United States. By 2030, the number of older adults (i.e., age 65 and older) is estimated to jump to 20% of the total U.S. population (Federal Interagency Forum on Age-Related Statistics, 2008). As the geriatric population increases, so does the prevalence of dementia. As of 2004, 24.3 million people in the world had a diagnosis of dementia, and this number may increase by as many as 4.6 million annually (Ferri et al., 2005). Annual healthcare costs of Alzheimer's disease is expected to be $1.08 trillion. Diagnosing at an earlier stage significantly lowers health care costs (Fillit, Hill, & Futterman, 2002). Therefore, identifying additional methods of detecting early signs of decline is paramount.

Healthy Cognitive Aging

In healthy aging, there still exists some level of cognitive decline (Flahsman et al., 2003). The physiological changes as one ages affects the brain and appears to lead to cognitive decline, which can begin as early as one's 50s (Kaufman, 2007) and is linked to age-related atrophy of the brain.

There are multiple cognitive theories of aging. The processing speed theory, first introduced by Salthouse (1985), states that the speed in which one performs cognitive functions slows significantly with age (Salthouse, 1985, 1996). The inhibition deficit theory of aging postulates that older adults struggle with tasks that require the inhibition of prepotent responses. (Hasher & Zacks, 1988; Van Gerven, Boxtel, Meijer, Willems, & Jolles, 2007). While both the processing speed and inhibition deficit theories have been supported in the literature, they only focus on singular aspects of cognitive decline. A more encompassing theory that includes inhibitory and processing speed deficits is the frontal lobe hypothesis (West, 1996). It posits that the frontal regions of the brain deteriorate first and faster than other regions (West, 2000). The

frontal lobe encompasses executive functions, which are the cognitive processes necessary to complete goal-oriented, complex tasks (Buckner, 2004; Jefferson et al., 2007; Lezak, Howieson, & Loring, 2004; Zelzao & Frye, 1998; Raz & Rodrigue, 2006; Paxton et al., 2007; Royall et al., 2002; Stuss et al., 2002; West, 1996). Executive function deficits have been consistently found in the normal aging process (Razani et al., 2007; Wecker et al., 2000; Jefferson et al., 2006; Nutter-Upham et al., 2008 Davies, 1968; Sorel & Pannequin, 2008). Therefore, the frontal lobe hypothesis of aging suggests that there is differential atrophy of the brain, affecting the frontal lobe first and thus resulting in decline of executive functions in the early stages of age-related cognitive decline (West, 1996).

Specifically, there is significant evidence of declines in cognitive flexibility and inhibition with aging (Butler & Zacks, 2006; Davies, 1968; Hasher & Zacks, 1988; Uekermann, Thoma, & Daum, 2008; Von Hippel & Dunlop, 2005; Wecker, Kramer, & Delis, 2005; Wecker, Kramer, Wisniewski, Delis, & Kaplan, 2000). Cognitive flexibility is the ability to both adapt and switch between new instruction or rules (Delis et al., 2001a), and this ability declines with increasing age. For example, performance on the trail making test (a gold-standard measure of cognitive flexibility) declines with age (Davies, 1968; Nutter-Upham et al., 2008; Wecker et al., 2000). The trail making test consists of two components: a sequencing measure and a cognitive flexibility measure (Army Individual Test Battery, 1944; Reitan, 1958). Older adults have a more difficult time on this test than younger adults (Davies, 1968; Jefferson et al., 2007; Nutter-Upham et al., 2008; Sorel & Pannequin, 2008; Wecker et al., 2005). Inhibition refers to the ability to monitor oneself and refrain from prepotent responses (Delis et al., 2001a). Aging has also been linked with a decrease in inhibitory behavior (Butler & Zacks, 2006; Von Hippel & Dunlop, 2005).

Abnormal Cognitive Aging

Unlike age-related declines, dementia occurs when the decreases in cognitive ability are much more severe and continue to get significantly worse. To be classified as dementia, the impairment occurs in memory and at least one other domain, as well as an impairment in functional ability (DSM-IV-TR, 2000).

Functional ability is defined as the ability to perform self-care tasks and therefore be able to live independently. These are classified as either Activities of Daily Living (ADLs) or Instrumental Activities of Daily Living (IADLs). ADLs refer to basic living skills, such as feeding oneself, bathing, grooming, dressing, and using the toilet. IADLs are more complex skills, such as shopping, managing finances, and driving. In dementia, a person first shows decline in IADLs before ADLs (Njegovan, Hing, Mitchell, & Molnar, 2001). Additionally, there appears to be a specific pattern of functional loss within the broad areas of IADLs and ADLs (Njegovan et al., 2001).

Relationship between Cognitive and Functional Assessment

As cognitive abilities decline, one can infer that the functional tasks dependent on those cognitive processes will decline as well. In fact, functional status has been shown to decline according to severity of cognitive deficit (Pereira et al., 2010). It is important to note, although there is an association between cognitive and functional decline, research shows that cognitive decline does not completely account for all of the loss in functional ability (Baird, 2006; Lewis & Miller, 2006; Sherod et al., 2009). Therefore, it is important to assess *both* cognitive and functional ability within the geriatric population. Nevertheless, executive dysfunction has been shown to be the best predictor of functional decline (Bell-McGinty, Podell, Franzen, Baird, &

Williams, 2002; Cahn-Weiner, et al., 2000; Lewis & Miller, 2002; Mitchell & Miller, 2008; Sherod et al., 2009).

New potential executive function domain to assess

Proverbs are defined as abstract expressions that convey messages about society (Uekermann, Thoma, & Daum, 2008). Successful proverb interpretation requires the ability to understand the abstract meaning instead of its concrete statement, and is therefore considered an executive function (Delis et al., 2001a). Poor proverb interpretation has been found in people with schizophrenia (Brüne & Bodenstein, 2005). However, there is limited research regarding decline in understanding proverbs in aging. One study that did explore this relationship found that older adults' performance on proverb tasks were significantly lower than younger adults (Uekermann, Thoma, & Daum, 2008).

Less is known about the relationship between decline in the understanding of proverbs and functional decline in older adults. To the best of our knowledge, there has not been research examining the association of proverb interpretation with functional decline in older adults.

Aims

The aims of this study were to examine whether proverb interpretation is significantly related to independence in IADLs and to determine whether it accounted for more variance above and beyond that of other executive function measures. Based on proverb interpretation's role as an executive function (Delis et al., 2001a), executive functioning's role in functional decline (Mitchell & Miller, 2008) and older adults' poorer proverb interpretation compared to younger adults (Uekermann et al., 2008), we hypothesized that proverb interpretation would account for significant variance in IADL functioning.

Method

Participants

Participants were recruited from the local community. The principal investigator (PI) posted fliers in public boards throughout the community. With permission from assisted living/retirement communities, the fliers were posted on common area boards and resident mailboxes. Furthermore, the PI gave presentations about ways in which older adults can keep their minds active to multiple assisted living/retirement communities and the local library.

Exclusion/inclusion criteria.

Inclusion for the study involved meeting the age requirement of 65 to 89. Exclusion criteria included significantly impaired vision (to the extent that it impedes the ability to read), self-reported illiteracy, self-report of a current diagnosis of dementia/significant cognitive deficits, or performance below 23 on the Mini Mental Status Exam (MMSE), a global measure of mental status (Folstein, Folstein, & McHugh, 1975). Finally, individuals who reported significant current symptoms of depression were excluded from the study (Cutoff score $\geq$ 20 or higher on the Geriatric Depression Scale; GDS).

Measures

Brief cognitive screen.

Mini-mental status exam (MMSE). The MMSE is a 30-item brief screen of global cognitive functioning (Folstein et al., 1975). A score below 23 excluded participants from this study (Tangalos et al., 1996). Age has been shown to be a significant predictor of MMSE scores (Tangalos et al., 1996) and reliability has been high (Tombaugh & McIntyre, 1992; Tombaugh, 2004).

Emotional functioning.

Geriatric depression scale (GDS). Depression has been associated with functional decline (Alexapoulos, 2005; Baird, 2006). Therefore, participants were administered the GDS, an orally-administered set of questions regarding the participant's feelings over the past week. (Brink, Yesavage, Lum, Heersema, Adey, & Rose, 1982; Sheikh et al., 1991; Sheikh & Yesavage, 1986). Individuals with a score of 20 or higher were excluded from this study, as it indicates a severe level of current depressive symptoms (Yesavege, et al., 1983). Reliability and validity have been supported (Yesavege, et al., 1983).

IQ estimate.

Wechsler test of adult reading (WTAR). It is important to obtain an estimate of the participant's IQ in order to assess the effects of IQ on cognitive and functional performance. This study employed the Wechsler Test of Adult Reading (WTAR) in order to obtain a predicted Full Scale IQ (FSIQ) score (The Psychological Corporation, 2001). This measure has also shown to have high reliability and validity (Green, Melo, Christensen, Ngo, Monette, & Bradbury, 2008).

Executive function measures.

Delis-Kaplan executive function system (D-KEFS). Select tasks from the Delis-Kaplan Executive Function System (D-KEFS) were employed to assess specific domains of executive function. (Delis et al., 2001a). It has low floors and high ceilings due to the large age range. Test-retest reliability has varied from moderate to strong (Delis et al., 2001b). Though there are other, more traditionally-utilized measures of executive function in research with older adults, this study will employ measures from the D-KEFS. The D-KEFS provides the same normative sample for all of its subtests (Delis et al., 2001), streamlining the interpretation of results.

This study used the Trail Making Test, Color-Word Interference Test, and Proverb Test. Traditional trail making (Army Individual Test Battery, 1944) and Stroop (1935) tests measure executive domains that have support in the literature regarding their ability to predict functional ability (Butler & Zachs, 2006; Davies, 1968; Hasher & Zachs, 1988; Sorel & Pannequin, 2008; West, 1996) and were used to compare the effectiveness of the Proverb test on functional independence.

D-KEFS trail making test. This subtest measures cognitive flexibility, the ability to quickly adapt to new rules and concepts (Delis et al., 2001a), and is divided into five conditions. The fourth is considered the traditional executive measure of cognitive flexibility, as it requires the participants to switch between connecting numbers and letters in both numerical and alphabetical order. Scaled scores are based on total completion time in seconds (Delis et al., 2001a).

The D-KEFS Trail Making Test is frequently used in the older adult population. Older adults have consistently demonstrated poorer performance compared to younger controls (Jefferson et al., 2007; Nutter-Upham et al., 2008; Razani et al., 2007; Wecker et al., 2005).

The aim of this study was to examine if (and to what extent) of proverb interpretation was related to functional independence. We compared the relationship between proverb interpretation and functional independence to the relationship between functional independence and traditionally-measured executive domains. Tests of cognitive flexibility are commonly assessed in older adult populations (Davies, 1968; Sorel & Pannequin, 2008; Stuss et al., 2001; Wecker et al., 2005). The trail making test is also one of the oldest executive function measures (Army Individual Test Battery, 1944). Therefore, the use of the D-KEFS Trail Making test helped us compare the significance of proverb interpretation on functional decline.

D-KEFS color-word interference test. This subtest measures inhibition, the ability to hold back one's automatic response for the correct one. This test is divided into four conditions. The third is based on the traditional Stroop test of inhibition. In this condition, the words "red," "green," and "blue" are written in different-colored ink. This test requires one to inhibit reading the word and name the ink color instead. Psychometric properties of this test are good (Delis et al., 2001b).

This particular test has been used less frequently with older adults compared to the Stroop test. However, tests of inhibition are common measures in research on cognitive decline in older adults (Braver et al., 2001; Butler & Zacks, 2006; Gerven et al., 2007; Paxton et al., 2007; Von Hippel & Dunlop, 2005). The traditional Stroop paradigm is also one of the oldest executive function tests (Stroop, 1935). By using a measure of inhibition, we were able to examine whether the Proverb test was related to functional independence beyond a more traditionally-assessed domain.

D-KEFS proverb test. Proverb understanding refers to the ability to comprehend statements beyond literal meaning. Participants were provided with common and uncommon proverbs (Delis et al., 2001a). Psychometric properties are good (Delis et al., 2001b; Shunk et al., 2006). Research is very limited, with none examining older adults with this particular test.

Functional independence measure.

Independent living scales (ILS). The ILS was used as the funcitonal independence measure for this study. It is an objective measure of Instrumental Activities of Daily Living (IADLs) (Loeb, 1996). Psychometric properties are good (Baird, 2006; Loeb, 1996; Revheimet al., 2006).

The ILS yields an overall Full Scale score. It is also broken into five scales: (a) Memory/Orientation, (b) Managing Money, (c), Home and Transportation, (d), Health and Safety, and (e) Social Adjustment. In addition to these subtest scores, items are divided into two classes: (a) those that require basic knowledge and (b) those that require problem-solving (Loeb, 1996).

Procedure

This study was approved by the home institution's Institutional Review Board. Interested participants contacted the PI via telephone, and a two-hour session was scheduled. This study was conducted in either the Neuropsychology and Memory Assessment Laboratory at the University of Georgia, or the residence of the participant/common room in the participant's residential building if they were unable to come to the laboratory. Participants completed a written consent form and the PI answered any questions. It was assumed that the participant had capacity to consent based on their ability to comprehend the recruitment flyer, call the researcher, and schedule a time to participate in the study. However, if the participant appeared to have significant difficulty comprehending the examiner, they were not included in the study. After consenting, participants completed a demographic information form including age, gender, years of education, and current income. Participants were administered the MMSE. If they performed below the cutoff as defined by MMSE literature (i.e., < 23/30; Tangalos et al., 1996), they were excluded from further participation and provided with information about the UGA Memory Assessment Clinic. Three participants were excluded per above. Next, participants were administered the GDS. Scores above 20 would have excluded them from the study (Brink, Yesavage et al., 1982; Sheikh et al., 1991; Sheikh & Yesavage, 1986); however, no participant obtained a score above 20. Participants were then administered the Wechsler Test of Adult

Reading (WTAR) to obtain an IQ estimate (The Psychological Corporation, 2001) followed by the D-KEFS Trail Making Test, D-KEFS Color-Word Interference Test, D-KEFS Proverb Test, and ILS. After completion of testing, participants were provided with a written debriefing as well as an oral explanation of the study. Participants were paid $20 regardless of whether they completed the study.

Results

Forty-six participants were recruited for the study. Three were excluded due to an MMSE score ≤ 23, resulting in a total N of 43. No other exclusion criteria were met by any participant. Demographic information and descriptive data for the variables are detailed in Tables 1.1 and 2.1. A Wilk W Test was used to check for normality of the distribution of the independent and dependent variables. With the exception of the Strange Stories test, all variables were non-normally distributed. We therefore mean-centered the data.

One participant was unable to complete the D-KEFS Color-Word Interference Test due to color-blindness and was not counted for analyses that included that measure. The P-P and residual plots appeared within normal limits for every regression analysis. Additionally, VIF and tolerance scores were also within normal limits.

Next, we ran correlational analyses among the independent and dependent variables. Because the data were not normally distributed, a Spearman's rank-order correlation was employed. All of the independent variables were correlated with the dependent variable, the Full Scale ILS score (see Table 3.1) supporting further examination of relationships of all independent variables in regression models.

Before a regression analysis was employed, we examined the effect of demographic information (i.e., age, gender, ethnicity, education, and income, and WTAR-predicted IQ) on the ILS Full Scale score. Only age (β = - .61, t (42) = -2.54, $p < .05$) was significant.

Hierarchical regression was utilized. Age was entered into the first step of the model. Next, the traditional domains of cognitive flexibility and inhibition were entered into the second step, as operationalized by the Trail Making Test Condition 4 (cognitive flexibility) and Color-Word Interference Test Condition 3 (inhibition) variables from the D-KEFS. The D-KEFS Proverb Test Achievement (proverb interpretation) variable was entered into the third step. The Full Scale ILS standard score (functional independence) was entered as the dependent variable.

The first step of the model was significantly associated with functional independence (R^2 = .13, F (1, 40) = 5.82, $p < .05$), and age accounted for a significant portion of variance in ILS performance (β = -.60, t (40) = -2.41, $p < .05$). The second step of the model was also significant (R^2 = .30, R^2 change = .17, F (3, 38) = 5.45, $p < .01$, significant F change $p < .05$). Age was no longer significant and inhibition did not account for significant variance. Cognitive flexibility was significantly associated with the ILS (β = 1.32, t (38) = 2.65, $p < .05$). The third step of the model was again significant (R^2 = .45, R^2 change = .15, F (4, 37) = 7.52, $p < .01$, significant F change $p < .01$). Both cognitive flexibility (β = 1.26, t (37) = 2.81, $p < .01$) and proverb interpretation (β = 1.47, t (37) = 3.15, $p < .01$) were significant. See Table 4.1.

Discussion

Since executive functioning is the single best predictor of functional independence (Bell-McGinty et al., 2002; Cahn-Weiner, et al., 2000; Lewis & Miller, 2002; Mitchell & Miller, 2008; Sherod et al., 2009) and proverb interpretation has been conceptualized as an executive function (Delis et al., 2001a), examining the relationship between proverb interpretation and functional

independence seemed warranted. Results indicated that after controlling for age, proverb interpretation and cognitive flexibility were significantly associated with performance on the ILS. This suggests that the ability to comprehend/correctly verbalize an abstract concept and think flexibly may be related to one's ability to live independently as measured by the ILS. It is surprising that the inhibition test did not account for significant and unique variance on functional ability given that it was significantly correlated with the ILS (D-KEFS Color-Word Interference Test, Condition 3 r = .33, $p < .05$). Furthermore, this task is one of the oldest executive function measures (Stroop, 1935) and has in the past been shown to predict functional ability (Jefferson et al., 2006).

To examine the possible reasons why inhibition was not associated with functional ability, a review of the functional ability measure used in this study is necessary. The ILS is a measure of IADLs (Loeb, 1996). IADLs are the more complex daily living tasks, such as shopping and paying bills (Njegovan et al., 2001). Test items consisted of the examiner asking participants to answer how they would solve real-life problems, demonstrate the ability to carry out specific tasks, and correctly identify general knowledge questions related to independence (Loeb, 1996). It is possible that successful performance on the ILS does not rely heavily upon inhibition. While the ILS requires one to think flexibly when answering various questions about different scenarios (perhaps utilizing cognitive flexibility), it does not appear sensitive to variation in inhibitory processes, at least those associated with the Stroop.

It may be argued that the ILS measures basic verbal ability. However, if this was the case, it would be expected that the WTAR-predicted FSIQ, which is a measure of word-reading ability (The Psychological Corporation, 2001), would also be significantly associated with ILS performance. These scores did not significantly correlate with the ILS, suggesting that the ILS is

not simply dependent on basic verbalization. It is possible that the ILS relies more on complex, abstract reasoning and verbalization. This may be a reason why proverb interpretation was strongly associated with its performance.

To our knowledge, these research questions have not been examined in an older adult population. A strength of this study is that we were able to examine these variables in a healthy community-dwelling population. The benefit of studying a healthy population is that it limits the chance that variance in scores is due to cognitive disorders, such as MCI or dementia.

The population used in this study can also be viewed as a limitation, however, as this was a somewhat high-functioning sample. Further, this sample consisted of mostly women who had a high level of education and a higher income than the general population. Given this sample, the scores were in a limited range, which may have limited the sensitivity of the measures to find results of statistical significance. A caveat to this study is that the conclusions regarding functional independence have been made in the context of functional independence *as measured by the ILS.* It is possible that given a different measure of functional independence, the results may vary. Therefore, conclusions regarding the apparent lack of utility of ToM assessment for functional independence refer only to the ILS.

For future studies, the population could be broader, both demographically and in terms of cognitive functioning. It may be beneficial to collect data from multiple groups, including healthy adults, those with MCI, and those with mild dementia. This way, group effects could be directly compared. Additionally, collecting data from a collateral source, such as a spouse or adult child, may likely provide additional data regarding the participant's functional ability. Recent research from our laboratory has indicated that participant and collateral report of functional ability increasingly differ with increasing cognitive impairment (Miller, Brown,

Mitchell, & Williamson, In Press). Therefore, gathering data from a collateral source may prove beneficial. Finally, additional measures of functional independence would help clarify whether the results obtained in this study generalize to other functional ability measures. This would strengthen the argument that assessing for ToM does not add additional information not already obtained through measuring executive function.

In sum, the results of this study suggest that a proverb interpretation task (i.e., measure of verbal abstraction), explains additional variance in functional independence. During a neuropsychological evaluation of an older adult, adding the D-KEFS Proverb Test or similar measure may be beneficial in adding to a more complete neurocognitive profile.

References

Alexopaulos, G.S. (2005). Depression in the elderly. *The Lancet, 365,* 1961-1970.

Alibhai, S.M.H., Mahmoud, S., Hussain, F., Naglie, G., Tannock, I., Tomlinson, G., Fleshner, N., Krahn, M., Warde, P., Klotz, L., Breunis, H., Leach, M., & Duff Canning, S. (2010). Levels of sex hormones have limited effect on cognition in older men with or without prostate cancer. *Critical Reviews in Oncology/Hematology, 73,* 167-175.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (Revised 4th ed.). Washington, DC: Author.

Army Individual Test Battery. (1944). *Manual of Directions and Scoring*. Washington, DC: War Department, Adjutant General's Office.

Baird, A. (2006). Fine tuning recommendations for older adults with memory complaints: Using the independent living scales with the dementia rating scale. *The Clinical Neuropsychologist, 20,* 649-661.

Bell-McGinty, A., Podell, K., Franzen, M., Baird, A., & Williams, M.J. (2002). Standard measures of executive function in predicting instrumental activities of daily living in older adults. *International Journal of Geriatric Psychiatry, 17,* 828-834.

Bollen, K., A. & Jackman, R., W. (1990) Regression Diagnostics: an Expository treatment of Outliers and Influential cases In J. Fox & S. Long (Eds) *Modern Methods of Data Analysis* Newbury Park CA: Sage.

Brink T.L., Yesavage J.A., Lum O., Heersema P., Adey M.B.,& Rose T.L. (1982)Screening tests for geriatric depression. *Clinical Gerontologist, 1,* 37-44.

Brüne, M., & Bodenstein, L. (2005). Proverb comprehension reconsidered – 'Theory of mind' and the pragmatic use of language in schizophrenia. *Schizophrenia Research, 75,* 233-239.

Buckner, R.L. (2004). Memory and executive function in aging and ad: Multiple factors that cause decline and reserve factors that compensate. *Neuron, 44,* 195-208.

Butler, K.M., & Zacks, R.T. (2006). Age deficits in control of prepotent responses: Evidence for an inhibitory decline. *Psychology and Aging,21,* 638-643.

Cahn-Weiner, D.A., Malloy, P.F., Boyle, P.A., Marran, M., & Salloway, S. (2000). Prediction of functional status from neuropsychological tests in community-dwelling elderly individuals. *The Clinical Neuropsychologist, 14,* 187-195.

Davies, A.D. (1968). The influence of age on trail making test performance. *Journal of clinical Psychology, 24,* 96-98.

Delis, D.C., Kaplan, E., & Kramer, J.H. (2001a). Delis Kaplan Executive Function System Examiner's Manual. San Antonio, TX: The Psychological Corporation.

Delis, D., Kaplan, E., & Kramer, J.H. (2001b). Delis Kaplan Executive Function System Technical Manual. San Antonio, TX: The Psychological Corporation.

Delis, D.C., Kramer, J.H., Kaplan, E., & Holdnack, J. (2004). Reliability and validity of the Delis-Kaplan Executive Function System: An update. *Journal of the International Neuropsychological Society, 10,* 301-303.

Federal Interagency Forum on Aging-Related Statistics. Older Americans 2008: Key Indicators of Well-Being. Federal Interagency Forum on Aging-Related Statistics, Washington, DC: U.S. Government Printing Office.

Ferri, C.P., Prince, M., Brayne, C., Brodaty, H., Fratiglioni, L., ganguli, M., Hall, K., Hasegawa, K., Hendrie, H., Huang, Y., Jorm, A., Mathers, C., Menezes, P.R., Rimmer, E.,& Scazufca, M. (2005). Global prevalence of dementia: A Delphi consensus study. *The Lancet, 366,* 2112-2117.

Fillit, H., Hill, J.W., & Futterman, R. (2002). Health care utilization and costs of Alzheimer's disease: The role of co-morbid conditions, disease stage, and pharmacotherapy. *Family Medicine, 34,* 528-535.

Flashman, L.A., Wishart, H.A., Oxman, T.E., & Saykin, A.J. (2003). Boundaries between normal aging and dementia: Perspectives from neuropsychological and neuroimaging investigations. In V.O.B. Emery & T.E. Oxman (Eds.) *Dementia: Presentations, Differential Diagnosis, and Nosology (2nd edition)*. Johns Hopkins University Press. Baltimore, 3-30.

Folstein, M.F., Folstein, S.E., & McHugh, P.R. (1975). "Mini-mental state" : A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12,* 189-198.

Green, R.E.A., Melo, B., Christensen, B., Ngo, L., Monette, G., & Bradbury, C. (2008). Measuring premorbid IQ in traumatic brain injury: An examination of the validity of the Wechsler Test of Adult Reading (WTAR). *Journal of Clinical and Experimental Neuropsychology, 30,* 163-172.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. H. Bower (Ed.). *The psychology of learning and motivation: Vol. 22* (pp. 193-225). San Diego, CA: Academic Press.

Homack, S., Lee, D., & Riccio, C.A. (2005). Test review: Delis-Kaplan Executive Function System. *Journal of Clinical and Experimental Neuropsychology, 27,* 599-609.

Jefferson, A.L., Paul, R.H., Ozonoff, A., & Cohen, R.A. (2006). Evaluating elements of executive functioning as predictors of instrumental activities of daily living (IADLs). *Archives of Clinical Neuropsychology, 21,* 311-320.

Kaufman, D.M. (2007). *Clinical Neurology for Psychiatrists (6th Edition).* Philadelphia: Elsevier.

Lewis, M.S., & Miller, L.S. (2007). Executive control functioning and functional ability in older adults. *The Clinical Neuropsychologist, 21,* 274-285.

Lezak, M.D., Howieson, D.B., & Loring, D.W. (2004). Neuropsychological Assessment (4th edition). New York, NY: Oxford University Press.

Loeb, P.A. (1996). ILS: Independent Living Scales Manual. The Psychological Corporation, San Antonio.

Miller, L.S., Brown, C., Mitchell, M., & Williamson, G. (In press). Activities of Daily Living are Associated with Older Adult Cognitive Status: Caregiver versus Self Reports. *Journal of Applied Gerontology*.

Mitchell, M., & Miller, L.S. (2008). Prediction of functional status in older adults: the ecological validity of four Delis-Kaplan Executive Function System tests. *Journal of clinical and Experimental Neuropsychology, 30,* 683-690.

Njegovan, V., Man-Son-Hing, M., Mitchell, S.L., & Molnar, F.J. (2001). The hierarchy of functional loss associated with cognitive decline in older persons. *Journal of Gerontology, 56,* M638-M643.

Nutter-Upham, K.E., Saykin, A.J., Rabin, L.A., Roth, R.M., Wishart, H.A., Pare, N., & Flashman, L.A. (2008). Verbal fluency performance in amnestic MCI and older adults with cognitive complaints. *Archives of Clinical Neuropsychology, 23,* 229-241.

Paxton, J.L., Barch, D.M., Racine, C.A., & Braver, T.S. (2007). Cognitive control, goal maintenance, and prefrontal function in healthy aging. *Cerebral Cortex*, *18,* 1010–1028.

Pereira, F.S., Yassuda, M.S., Oliveira, A.M., Diniz, B.S., Radanovic, M., Talib, L.L., Gattaz, W.F., & Forlenza, O.V. (2010). Profiles of functional deficits in mild cognitive impairment and dementia: Benefits from objective measurement. *Journal of the International Neuropsychological Society*, *16,* 297-305.

Potter, L.M., & Grealy, M.A. (2008). Aging and inhibition of a prepotent motor response during an ongoing action. *Aging, Neuropsychology, and Cognition, 15,* 232-255.

Raz, N., & Rodrigue, K.M. (2006). Differential aging of the brain: Patterns, cognitive correlates, and modifiers. *Neurosciences and Biobehavioral Reviews, 30,* 730-748.

Razani, J., Casas, R., Wong, J.T., Lu, P., Alessi, C., & Josephson, K. (2007). Relationship between executive functioning and activities of daily living in patients with relatively mild dementia. *Applied Neuropsychology, 14,* 208-214.

Reitan, R.M. (1958). Validity of the trail making test as an indicator of organic brain damage. *Perceptual and Motor Skills,8, 271-276.*

Revheim, N., Schechter, I., Kim, D., Silpo, G., Allingham, B., Butler, P., & Javitt, D.C. (2006). Neurocognitive and symptom correlates of daily problem-solving skills in schizophrenia. *Schizophrenia Research, 83,* 237-245.

Royall, D.R., Lauterbach, E.C., Cummings, J.L., Reeve, A., Rummans, T.A., Kaufer, D.I., LaFrance, W.C., & Coffey, C.E. (2002). Executive control function: A review of its promise and challenges for clinical research. *Journal of Neuropsychiatry and Clinical Neurosciences, 14,* 377-405.

Salthouse, T.A. (1985). *A theory of cognitive aging.* Amsterdam: North-Holland.

Salthouse, T.A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103,* 403-428.

Salthouse, T.A., & Fristoe, N.M. (1995). Process analysis of adult age effects on a computer-administered trail making test. *Neuropsychology, 9,* 518-528.

Salthouse, T.A., Toth, J., Daniels, K., Parks, C., Pak, R., Wolbrette, M., Hocking, K.J. (2000). Effects of aging on efficiency of task switching in a variant of the trail making test. *Neuropsychology, 14,* 102-111.

Sheikh, J.I., Yesavage, J.A. (1986). Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. Clinical Gerontology : A Guide to Assessment and Intervention 165-173, NY: The Haworth Press.

Sheikh, J.I., Yesavage, J.A., Brooks, J.O., III, Friedman, L.F., Gratzinger ,P., Hill, R.D, Zadeik A., & Crook, T. (1991). Proposed factor structure of the Geriatric Depression Scale. *International Psychogeriatrics 3:* 23-28.

Sherod, M.G., Griffith, H.R., Copeland, J., Belue, K., Krzywanski, S., Zamrini, E.Y., Harrell, L.E., Clark, D.G., Brockington, J.C., Powers, R.E., & Marson, D.C. (2009). Neurocognitive predictors of financial capacity across the dementia spectrum: Normal aging, mild cognitive impairment, and Alzheimer's disease. *Journal of the International Neuropsychological Society, 15,* 258-267.

Shunk, A.W., Davis, A.S., & Dean, R.S. (2006). Test review of the Delis-Kaplan Executive Function System. *Applied Neuropsychology, 14,* 275-279.

Steenhuysen, J. (2010, July). Early diagnosis can cut Alzheimer's costs: Study. *Reuters.* Retrieved from http://www.reuters.com

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psycholology, **18,*** 643–662.

Stuss, D.T., Alexander, M.P., Floden, D., Binns, M.A., Levine, B., McIntosh, N., Rajah, N., & Hevenor, S.J. (2002). Fractionation and localization of distinct frontal lobe processes: Evidence from focal lesions in humans. In R.T. Knight & Studd, D.T. (Eds.) *Principles of Frontal Lobe Function*. Oxford University Press. New York, 392-407.

Sorel, O., & Pannequin, V. (2008). Aging of the planning process: The role of executive functioning. *Brain and Cognition, 66,* 196-201.

Tangalos, E.G., Smith, G. E., Ivnik, R.J., Petersen, R.C., Kokmen, E., Kurland, L.T., Offord, K.P., & Parisi, J.E. (1996). The Mini-Mental State Examination in general medical practice: Clinical utility and acceptance. *Mayo Clinic Proceedings, 71,* 829-837.

Taylor, M.A. (1999). *The Fundamentals of Clinical Neuropsychiatry*. New York: Oxford University Press.

The Psychological Corporation (2001). *Wechsler Test of Adult Reading*. San Antonio, TX: Harcourt Brace & Company.

Tombaugh, T.N. (2005). Test-retest reliable coefficients and 5-year change scores for the MMSE and 3MS. *Archives of Clinical Neuropsychology, 20,* 485-503.

Uekermann, J., Thoma, P., & Daum, I. (2008). Proverb interpretation changes in aging. *Brain and cognition, 67,* 51-57.

Van Gerven, P.W.M., Van Boxtel, M.P.J., Meijer, W.M., Willems, D., & Jolles, J. (2007). On the relative role of inhibition in age-related working memory decline. *Aging, Neuropsychology, and Cognition, 14,* 95-107.

Von Hippel, W., & Dunlop, S.M. (2005). Aging, inhibition, and social inappropriateness. *Psychology and Aging, 20,* 519-523.

Wecker, N.S., Kramer, J.H., Hallam, B.J., & Delis, D.C. (2005). Mental flexibility: Age effects on switching. *Neuropsychology, 19,* 345-352.

Wecker, N.S., Kramer, J.H., Wisniewski, A., Delis, D.C., & Kaplan, E. (2000). Age effects on executive ability. *Neuropsychology, 14,* 409-414.

West, R.L. (1996). An application of prefrontal cortex function theory to cognitive aging. *Psychological Bulletin, 120,* 272-292.

West, R.L. (2000). In defense of the frontal lobe hypothesis of cognitive aging. *Journal of the International Neuropsychological Society, 6,* 727-729.

Wimo, A.,& Winblad, B. (2008). Economical aspects of dementia. In C. Duyckaerts & I. Litvan (Eds.) *Handbook of Clinical Neurology (volume 89; 3rd series).* Elsevier. Amsterdam: 137-146.

Yesavage, J., A., Brink, T.L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V.O. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research, 17,* 37-49.

Zelazo, P.D., & Frye, D. (1998). Cognitive complexity and control ii. The development of executive function in childhood. *American Psychological Society, 7,* 121-125.

Table 1.1

Demographic Information

	Frequency	Minimum	Maximum	Mean	Standard Deviation
Age (in years)		65	89	77	7.10
Gender					
Male	6				
Female	37				
Ethnicity					
White/ Non Hispanic	40				
African American/Black	2				
Hispanic/Latino	0				
Asian/Pacific Islander	1				
Other	0				
Education (in years)		9	22	15.07	3.65
Family Income					
Below $10,000	5				
$10,001-$30,000	26				
$30,001-$60,000	4				
$60,001-$90,000	4				
$90,001 and Above	4				
Geographical Region Raised					
South	23				
North Central	9				
West	1				
Northeast	6				
Other	4				
WTAR-Predicted FSIQ[b]		78	129	108.28	15.35

Note. N = 43.

[a] WTAR-Predicted FSIQ = Wechsler Test of Adult Reading-Predicted Full Scale IQ. Scores based on mean of 100 and standard deviation of 15.

Table 2.1

Descriptive Information for all Independent and Dependent Variables

	Minimum	Maximum	Mean	Standard Deviation
D-KEFS[a] TMT-4[b]	2	16	9.46	3.99
D-KEFS C-W-3[c, d]	1	15	9.95	3.40
D-KEFS Proverb[e]	3	16	11.07	3.24
ILS[f]	65	118	102.19	11.70

Note. N = 43 for all variables except the D-KEFS Color-Word Interference test, Condition 3
[a] Delis-Kaplan Executive Function System
[b] D-KEFS Trail Making Test Condition 4. Scaled score based on mean of 10 and standard deviation of 3
[c] D-KEFS Color-Word Interference Test Condition 3. Scaled score based on mean of 10 and standard deviation of 3
[d] N = 42
[e] D-KEFS Proverb Test Achievement Score. Scaled score based on mean of 10 and standard deviation of 3
[d] Independent Living Scales Full Scale Standard Score. Standard score based on mean of 100 and standard deviation of 15

Table 3.1

Correlation[a] Matrix of Independent and Dependent Variables[b]

	D-KEFS[c] TMT-4	D-KEFS C-W-3	D-KEFs Proverb Test, Achievement	ILS[g] Full Scale SS[h]
D-KEFS[c] TMT-4[d]		.60**	.17	.47**
D-KEFS C-W[e]			.28	.33*
D-KEFS Proverb[f]				.44**
ILS[g]				

Note. N = 43 for all variables except for correlations with the D-KEFs Color-Word Interference Test (N = 42)
[a] Spearman's correlation was used due to the non-normal distributions of the variables
[b] All variables have been mean-centered
[c] Delis-Kaplan Executive Function System
[d] D-KEFSTrail Making Test Condition 4. Scaled score based on mean of 10 and standard deviation of 3
[e] D-KEFS Color-Word Interference Test Condition 3. Scaled score based on mean of 10 and standard deviation of 3
[f] D-KEFS Proverb Test Achievement Score. Scaled score based on mean of 10 and standard deviation of 3
[g] Independent Living Scales Full Scale Standard Score. Standard score based on mean of 100 and standard deviation of 15
* $p < .05$ ** $p < .01$

Table 4.1

Multiple Regression Analysis of ILS[a] by D-KEFS[b] Proverb Test

Step 1: R = .36 R^2 = .13 Adj. R^2 = .11 Standard. Error of Estimate = 11.14F (1, 40) = 5.82, $p < .05$
Step 2: R = .55 R^2 = .30 Adj. R^2 = .25 R^2 change = .17 Standard. Error of Estimate 10.22 F (3, 38) = 5.45, $p < .01$ F change = 4.73, $p < .05$
Step 3: R = .67 R^2 = .45 Adj. R^2 = .39 R^2 change = .15 Standard. Error of Estimate = 9.21 F (4, 37) = 7.52, $p < .01$ F change = 9.89, $p < .01$

					Correlations		
Step		Beta	t	Sig.	Zero-order	Partial	Part
1	Age	-.60	-2.41	$p < .05$	-.36	-.36	-.36
2	Age	-.42	1.80	*ns*	-.36	-.28	-.24
	D-KEFS TMT-4[c]	1.32	2.65	$p < .05$	.49	.39	.36
	D-KEFS C-W-3[d]	-.13	-.22	*ns*	.28	-.04	-.03
3	Age	-.30	-1.38	*ns*	-.36	-.22	-.17
	D-KEFS TMT-4	1.26	2.81	$p < .01$	.49	.42	.34
	D-KEFS C-W-3	-.45	-.84	*ns*	.28	-.14	-.10
	D-KEFS Proverb[e]	1.47	3.15	$p < .01$	.51	.46	.38

Note. N = 42
[a] Independent Living Scales Full Scale Standard Score. Standard Scores based on mean of 100 and standard deviation of 15
[b] Delis-Kaplan Executive Function System
[c] D-KEFS Trail Making Test Condition 4. Scaled score based on mean of 10 and standard deviation of 3
[d] D-KEFS Color-Word Interference Test Condition 3. Scaled score based on mean of 10 and standard deviation of 3
[e] D-KEFS Proverb Test Achievement Score. Scaled score based on mean of 10 and standard deviation of 3

CHAPTER 4

RELATIONSHIP BETWEEN THEORY OF MIND AND FUNCTIONAL INDEPENDENCE IS MEDIATED BY EXECUTIVE FUNCTION[1]

[1]Ahmed, F.S. & Miller, L.S. To be submitted to *Psychology and Aging*.

Abstract

Theory of Mind (ToM) is the ability to comprehend another person's perspective. Though there is much literature of ToM in children, there is a limited and somewhat inconclusive amount of studies examining ToM in a geriatric population. This study examined ToM's relationship to functional independence. Two tests of ToM, executive function, and functional ability were administered to cognitively-intact older adults. Results showed that one test of ToM (Strange Stories test) significantly accounted for variance in functional ability, while the other did not (Faux Pas test). Additionally, the Strange Stories test performance was partially driven by a verbal abstraction-based executive function: proverb interpretation. A multiple mediation model was employed to examine whether executive functions explained the relationship between the Strange Stories test and functional ability. Results showed that both the combined and individual indirect effects of the executive function measures mediated the relationship. This study suggests that assessment of ToM does not appear to add unique additional variance in to a functional independence measure.

There has been a significant amount of research examining the best methods to predict functional decline in older adults. Functional ability is defined as the ability to perform self-care tasks and therefore live independently. In dementia, a person first shows decline in Instrumental Activities of Daily Living (complex self-care; IADLs) before Activities of Daily Living (basic self care; ADLs) (Njegovan, Hing, Mitchell, & Molnar, 2001). As cognitive abilities decline, one can infer that the functional tasks that are dependent on those cognitive processes will decline as well. In fact, functional status has been shown to decline according to severity of cognitive deficit (Pereira et al., 2010).

Specifically, executive dysfunction has been shown to be the best predictor of functional decline (Bell-McGinty, Podell, Franzen, Baird, & Williams, 2002; Cahn-Weiner, et al., 2000; Lewis & Miller, 2002; Mitchell & Miller, 2008; Sherod et al., 2009). Executive function is defined as the set of cognitive processes necessary to complete goal-oriented, complex tasks (Lezak, Howieson, & Loring, 2004; Zelzao & Frye, 1998) and has been associated with the prefrontal cortex (Buckner, 2004; Jefferson et al., 2007; Raz & Rodrigue, 2006; Paxton et al., 2007; Royall et al., 2002; Stuss et al., 2002; West, 1996). Executive function deficits have been consistently found in the normal aging process. Specifically, there is evidence of declines in cognitive flexibility and inhibition (Butler & Zacks, 2006; Davies, 1968; Hasher & Zacks, 1988; Uekermann, Thoma, & Daum, 2008; Von Hippel & Dunlop, 2005; Wecker, Kramer, & Delis, 2005; Wecker, Kramer, Wisniewski, Delis, & Kaplan, 2000). Cognitive flexibility is the ability to both adapt and switch between new instruction or rules (Delis et al., 2001a), and this ability declines with increasing age (Davies, 1968; Jefferson et al., 2007; Nutter-Upham et al., 2008; Wecker et al., 2000). Inhibition refers to the ability to monitor oneself and refrain from prepotent responses (Delis et al., 2001a). Aging has also been linked with a decrease in inhibitory behavior

(Butler & Zacks, 2006, Von Hippel & Dunlop, 2005). Lastly, research from our laboratory (see chapter 3) examined the relationship between proverb interpretation and functional independence. Proverbs are defined as abstract expressions that convey messages about society (Uekermann, Thoma, & Daum, 2008). Successful proverb interpretation requires the ability to understand the abstract meaning instead of its concrete statement (Delis et al., 2001a).

There is no universally specified set of executive functions (for a review, see Stuss & Knight, 2002). An emerging area of research has been on Theory of Mind and its relationship to executive function. First introduced by Premack and Woodruff (1978), Theory of Mind (ToM) is defined as the ability to understand another's perception of a situation. Stemming from autism and developmental literature, it is one model that attempts to explain how one comes to comprehend views and beliefs of other people (Baron-Cohen, 1988). Though it is not found in traditional neurocognitive literature, the ToM literature argues that it is a cognitive process because it requires one to infer both emotions and thoughts of another person (Baron-Cohen, 1988). Similar to executive functions, engaging in ToM tasks shows activation in the prefrontal cortex. Happé et al. (1996) found that healthy ToM performance showed areas of activation in the medial left prefrontal cortex. Interestingly, an Asperger group (i.e., a clinical sample shown to have deficits in ToM) did not display the same activation and instead demonstrated greater activation in the surrounding areas (Happé et al., 1996). This suggests that deficits in ToM may be linked to a functional difference at the neuronal level, thus supporting ToM's dependence on prefrontal brain regions.

While there have been some case studies that have not established a relationship between executive functions and ToM (Bach, Happé, Fleminger, & Powell, 2005; Fine, Lumsden, & Blair, 2001), there have been many more that have identified an association between the two in

the developmental literature (Carlson, Moses and Breton, 2002; Carlson, Moses, & Claxton, 2004; Cole & Mitchell, 1998; Fisher & Happé, 2005; Gordon & Olsen, 1998; Hughes, 1998; Hughes, Dunn, & White, 1998; Hughes & Graham, 2002; Joseph & Tager-Flusberg, 2004; Sabbagh, Xu, Carlson, Moses, & Lee, 2006). The association between ToM and executive functioning has also been shown in adults (Ahmed & Miller, 2010; Saltzman, Strauss, Hunter, & Archibald, 2000; Von Hippel & Dunlop, 2005).

Given the research supporting an executive function component ToM, it is possible that ToM may be affected with aging. There is conflicting evidence regarding a decline in ToM ability in a geriatric population. Happé, Winner, & Brownell (1998) found better ToM scores in an older adult group than in a college-aged group. However, this seems to be the only study that has found an increase in ToM ability with age. Other studies have revealed ToM decline in older adults. The ability to detect a faux pas was more difficult for older adults than controls. (MacPherson, Phillios, & Sala, 2002). In one study, researchers found that older adults tended to ask more socially inappropriate questions and that this relationship was mediated by poor inhibitory skills (Von Hippel & Dunlop, 2005). In a study examining ToM in university controls, older adults and those with Parkinson's disease, researchers found that in general older adults had lower scores on measures of ToM. Participants with Parkinson's disease performed even more poorly on ToM measures compared to university controls and older adults without the disease (Saltzman, Strauss, Hunter, & Archibald, 2000). Individuals with frontotemporal dementia also evidence ToM deficits (Schroeter, Raczka, Neumann, & von Crammon, 2008). Finally, significant age effects were found on a measure of faux pas recognition (MacPherson, Phillips, & Della Salla, 2002).

As with the literature in executive dysfunction and aging, research has emphasized that deterioration of frontal regions, such as the dorsolateral prefrontal cortex and the anterior medial frontal cortex, are associated with ToM decline (MacPherson et al., 2002; Schroeter et al., 2008). ToM is considered to be a cognitive construct within the developmental literature (Baron-Cohen, 1988; Baron-Cohen & Wheelwright, 2004). Therefore, the study of ToM in older adults is separate from examination of the affective components of emotional processing, which have been found not to decline with age (St. Jacques, Bessette-Symons, & Cabeza, 2009).

To our knowledge, there has not been research examining the relationship between ToM and functional independence. However, given that there is a link between executive functions and ToM and that executive functions are significant predictors of functional decline, ToM too may be significantly associated with it.

Aims

The primary aim of this study was to examine the association of ToM to functional independence. A second aim was to evaluate the relationship of proverb interpretation to ToM. Research from our laboratory (see Chapter 3) found that proverb interpretation accounts for significant variance in measures of functional independence. Given the abstract nature of both proverb and ToM, it was hypothesized that proverb interpretation will also be associated with ToM. Finally, given a relationship between ToM and functional independence, analysis of potential indirect effects from executive functioning were conducted. Specifically, multiple mediation models were utilized to examine if the association of ToM to functional was mediated by executive functioning (i.e., cognitive flexibility, inhibition, and proverb interpretation).

Method

Participants

Participants were recruited from the local community. The principal investigator (PI) posted fliers in public boards throughout the community. With permission from assisted living/retirement communities, the fliers were posted on common area boards and resident mailboxes. Furthermore, the PI gave presentations about ways in which older adults can keep their minds active to multiple assisted living/retirement communities and the local library.

Exclusion/inclusion criteria.

Inclusion for the study involved meeting the age requirement of 65 to 89. Exclusion criteria included significantly impaired vision (to the extent that it impedes the ability to read), self-reported illiteracy, self-report of a current diagnosis of dementia/significant cognitive deficits, or performance below 23 on the Mini Mental Status Exam (MMSE), a global measure of mental status (Folstein, Folstein, & McHugh, 1975). Finally, individuals who reported significant current symptoms of depression were excluded from the study (Cutoff score $\geq$ 20 or higher on the Geriatric Depression Scale; GDS).

Measures

Brief cognitive screen.

Mini-mental status exam (MMSE). The MMSE is a 30-item brief screen of global cognitive functioning (Folstein et al., 1975). A score below 23 excluded participants from this study (Tangalos et al., 1996).

Emotional functioning.

Geriatric depression scale (GDS). Depression has been associated with functional decline (Alexapoulos, 2005; Baird, 2006). Therefore, participants were administered the GDS, an

orally-administered set of questions regarding the participant's feelings over the past week. (Brink, Yesavage, Lum, Heersema, Adey, & Rose, 1982; Sheikh et al., 1991; Sheikh & Yesavage, 1986). Individuals with a score of 20 or higher were to be excluded from this study (Yesavege, et al., 1983).

IQ estimate.

Wechsler test of adult reading (WTAR). This study employed the Wechsler Test of Adult Reading (WTAR) in order to obtain a predicted Full Scale IQ (FSIQ) score (The Psychological Corporation, 2001).

ToM measures.

Strange stories test. This Strange Stories are a series of vignettes in which the intention of the character's actions has to be deciphered by participants (Happé, 1994). Furthermore, it has been shown to be more sensitive within the Asperger population, who normally pass simple ToM tasks but still struggle with more subtle ToM skills, such as double bluffs and white lies (Happé, 1994; Jolliffe & Baron-Cohen, 1999).

There are multiple versions of this test for different populations (Happé, 1994; Jolliffe & Baron-Cohen, 1999; Happé et al., 1998; Maylor, Moulson, Muncer, & Taylor, 2002; Sullivan, & Ruffman, 2004). Permission was obtained from the test developer, and the version that this study used was a selection of stories from the version that was administered to young and older adults (Brent et al., 2004; Happé et al., 1998). It consists of six stories, four of which require the use of ToM and two control stories. However, all of the stories have been used as part of a larger set of stories (Brent et al., 2004; Happé, 1994). Therefore, specific data of the reliability and validity of this exact set are unknown, though the Strange Stories in general has shown good reliability and validity (Happé, 1994; Happé et al., 1998; Gottlieb, 2005; Kaland et al., 2002).

Faux pas test. Faux pas is defined as a socially inappropriate comment or act (resulting in hurt or upset feelings) that is unintentionally made (Brüne & Brüne-Cohrs, 2005; Gregory et al, 2002; Stone, Baron-Cohen, & Knight, 1998). Participants read a series of 20 vignettes, and asked to identify whether a faux pas occurred, the intention of the person committing the faux pas, and the emotional reaction of the other person (Gregory et al., 2002; Stone, Baron-Cohen, & Knight, 1998). This test has shown interrater reliability at .98 and correlated with both first-order and second-order ToM measures (r = .76 and 0.78) (Gregory et al., 2002).

Functional independence measure.

Independent living scales (ILS). The ILS was used as an objective measure of IADLs (Loeb, 1996). Psychometric properties are good (Baird, 2006; Loeb, 1996; Revheimet al., 2006). It assesses areas related to memory/orientation, financial management, caring for the home and travelling, safety and health awareness, and socialization (Loeb, 1996).

Executive function measures.

Delis-Kaplan executive function system (D-KEFS). Select tasks from the D-KEFS were employed to assess specific domains of executive function. (Delis et al., 2001a). Though there are other, more traditionally-utilized measures of executive function in research with older adults, this study employed measures from the D-KEFS. The D-KEFS provides the same normative sample for all of its subtests (Delis et al., 2001), streamlining the interpretation of results.

This study used the Trail Making Test, Color-Word Interference Test, and Proverb Test. Traditional trail making (Army Individual Test Battery, 1944) and Stroop (1935) tests measure executive domains that have support in the literature regarding their ability to predict functional ability (Butler & Zachs, 2006; Davies, 1968; Hasher & Zachs, 1988; Sorel & Pannequin, 2008;

West, 1996) and were therefore used to compare the effectiveness of ToM on functional independence.

D-KEFS trail making test. This subtest measures cognitive flexibility which refers to the ability to quickly adapt to new rules and concepts (Delis et al., 2001a). The Trail Making Test is divided into five conditions. The fourth is considered the traditional executive measure of cognitive flexibility, as it requires the participants to switch between connecting numbers and letters in both numerical and alphabetical order (Delis et al., 2001a).

The D-KEFS Trail Making Test is frequently used in the older adult population, with older adults showing poorer performance (Jefferson et al., 2007; Nutter-Upham et al., 2008; Razani et al., 2007; Wecker et al., 2005).

The aim of this study was to examine the relationship between ToM and functional independence. Tests of cognitive flexibility are commonly assessed in older adult populations (Davies, 1968; Sorel & Pannequin, 2008; Stuss et al., 2001; Wecker et al., 2005), and the trail making test is also one of the oldest executive function measures (Army Individual Test Battery, 1944). Therefore, the use of the D-KEFS Trail Making test helped us compare the significance (if any) of ToM on functional decline.

D-KEFS color-word interference test. This subtest measures inhibition, the ability to hold back one's automatic response for the correct one. This test is divided into four conditions. The third is based on the traditional Stroop test. The words "red," "green," and "blue" are written in different-colored ink. This test requires one to inhibit reading the word and name the ink color instead. Scaled scores are derived from completion time in seconds (Delis et al., 2001a). Psychometric properties of this test are good (Delis et al., 2001b).

This particular test has been used less frequently with older adults compared to the Stroop test. Tests of inhibition are common measures in research on cognitive decline in older adults (Braver et al., 2001; Butler & Zacks, 2006; Gerven et al., 2007; Paxton et al., 2007; Von Hippel & Dunlop, 2005). The traditional Stroop paradigm is also one of the oldest executive function tests (Stroop, 1935). By using a measure of inhibition, we were able to examine whether the ToM was related to functional independence beyond inhibition.

D-KEFS proverb test. Participants were provided with common and uncommon proverbs and asked to describe their meanings (Delis et al., 2001a). Psychometric properties are good (Delis et al., 2001b; Shunk et al., 2006). There is very limited research examining proverb interpretation in older adults. Previous research in our lab (chapter 3) found that the D-KEFS Proverb Test accounted for a significant amount of unique variance in functional independence. To our knowledge, there are no other studies using the D-KEFS Proverb Test in older adults. Given the abstract nature of interpreting proverbs, we examined its contribution of proverb ability on ToM.

Procedure

This study was approved by the home institution's Institutional Review Board. Interested participants contacted the PI via telephone, and a two-hour session was scheduled. This study was conducted in either the Neuropsychology and Memory Assessment Laboratory at the University of Georgia, or the residence of the participant/common room in the participant's residential building if they were unable to come to the laboratory. Participants completed a written consent form and the PI answered any questions. It was assumed that the participant had capacity to consent based on their ability to comprehend the recruitment flyer, call the researcher, and schedule a time to participate in the study. However, if the participant appeared

to have significant difficulty comprehending the examiner, they were not included in the study. After consenting, participants completed a demographic information form including age, gender, years of education, and current income. Participants were administered the MMSE. If they performed below the cutoff as defined by MMSE literature (i.e., < 23/30; Tangalos et al., 1996), they were excluded from further participation and provided with information about the UGA Memory Assessment Clinic. Three participants were excluded per above. Next, participants were administered the GDS. Scores above 20 would have excluded them from the study (Brink, Yesavage et al., 1982; Sheikh et al., 1991; Sheikh & Yesavage, 1986), however, no participant obtained a score above 20. Participants were then administered the Wechsler Test of Adult Reading (WTAR) to obtain an IQ estimate (The Psychological Corporation, 2001) followed by the D-KEFS Trail Making Test, D-KEFS Color-Word Interference Test, D-KEFS Proverb Test, Strange Stories test, Faux Pas test, and ILS. After completion of testing, participants were provided with a written debriefing as well as an oral explanation of the study. Participants were paid $20 regardless of whether they completed the study.

Results

Forty-six participants were recruited for the study. Three were excluded due to an MMSE score $\leq$ 23, resulting in a total N of 43. No other exclusion criteria were met by any participant. Demographic information and descriptive data for the variables are detailed in Tables 1.2 and 2.2. A Wilk W Test was used to check for normality of the distribution of all the independent and dependent variables. With the exception of the Strange Stories test, all variables were non-normally distributed. We therefore mean-centered the data.

One participant was unable to complete the D-KEFS Color-Word Interference Test due to color-blindness and was not included in any analysis that included that measure. The P-P and

residual plots appeared within normal limits for every regression analysis. Additionally, VIF and tolerance scores were also within normal limits.

Next, we ran correlational analyses among the independent and dependent variables. Because the data were not normally distributed, a Spearman's rank-order correlation was employed. All of the independent variables were correlated with the dependent variable, the Full Scale ILS score (see Table 3.2), supporting further examination of relationships of all independent variables in regression models.

Primary Aim: ToM and Functional Independence

Previous research from our lab found that the Strange Stories Test and the Faux Pas test did not utilize the same executive mechanisms (Ahmed & Miller, 2010). Therefore, separate regression analyses were employed with each ToM test an independent variable.

Strange stories test. Interrater reliability of the Strange Stories test was very good ($r = .94$, $p < .01$). A hierarchical regression model was used to examine the effect of performance on the Strange Stories test on the ILS Full Scale score. Age was entered into the first step of the overall model. The Strange Stories test total composite score was entered into the second step. The Full Scale ILS standard score was entered as the dependent variable. The first step accounted for significant variance ($R^2 = .14$, $F (1, 41) = 6.45$, $p < .05$), and age was significantly associated with functional independence ($\beta = -.61$, $t (41) = -2.54$, $p < .05$). The second step of the model was significant, accounting for additional variance beyond the first model ($R^2 = .31$, R^2 change $= .17$, $F (2, 40) = 8.78$, $p < .01$, significant F change $p < .01$). Both age ($\beta = -.54$, $t (40) = -2.48$, $p < .05$) and Strange Stories performance ($\beta = 2.07$, $t (40) = 3.12$, $p < .01$) accounted for significant variance (Table 4.2).

Faux pas test. Strong interrater reliability was found (r = .98, $p < .01$). This hierarchical regression consisted of entering age into the first step and scores from the Faux Pas test total composite score into the second step. The Full Scale ILS standard score was entered as the dependent variable. The first step of the model was significant ($R^2 = .15$, F (1, 41) = 6.45, $p < .05$) and age was significantly associated with functional independence ($\beta = -.61$, t (41) = -2.54, $p < .05$). The second step of the model was also significant ($R^2 = .19$, R^2 change = .05, F (2, 40) = 4.61, $p < .05$); however, the change in the F statistic was not significant ($p > .05$ and the Faux Pas test did not account for a significant amount of additional variance in functional independence ($p > .05$; Table 5.2).

Secondary Aim: Proverb and ToM

The next aim of the present study was to examine whether proverb interpretation was associated with ToM performance. Two separate regression analyses were employed, with either the Strange Stories or the Faux Pas tests as the dependent variable.

Strange stories test. There was a significant correlation (Spearman rho = .40, $p < .01$) between proverb interpretation and Strange Stories. Next, we examined the effect of demographic information (i.e., age, gender, ethnicity, education, income, and WTAR-predicted IQ) on the Strange Stories test. Education ($\beta = .20$, t (41) = 2.14, $p < .05$), income ($\beta = .69$, t (41) = 2.24, $p < .05$), and WTAR-predicted IQ ($\beta = .06$, t (41) = 2.97, $p < .01$) were significant. Therefore, they were simultaneously entered into the first step of the model. The D-KEFS Proverb Test Achievement score was entered into the second step, and the Strange Stories total composite score was entered as the dependent variable. The first step of the model was significant ($R^2 = .20$, F (3, 39) = 3.33, $p < .05$), and this time none of the demographic variables were significantly associated with the Strange Stories test ($p > .05$). The second step of the model

was also significant (R^2 = .28, R^2 change = .08, F (4, 38) = 3.79, $p < .05$, significant F change $p <$ .05) with proverb interpretation being significantly associated with the Strange Stories test (β = .23, t (380 = 2.08, $p < .05$) (Table 6.2).

Faux pas test. The correlation between proverb interpretation and Faux Pas performance was examined. They were not found to be significantly correlated ($p > .05$), and therefore no further analyses were conducted.

Mediation Analyses

Since the Strange Stories test accounted for significant variance in ILS performance, the next step was to examine the indirect effects of executive function. Because executive function has been shown to account for some variance in the ToM (Ahmed & Miller, 2010), it seems likely that they would at least partially mediate the relationship between ToM and functional independence. We examined the indirect effects of cognitive flexibility, inhibition, and proverb interpretation. As aforementioned, both cognitive flexibility and inhibition have traditionally predicted performance in functional independence (Bell-McGinty et al., 2002; Cahn-Weiner, et al., 2000; Lewis & Miller, 2002; Mitchell & Miller, 2008; Sherod et al., 2009). The association between proverb interpretation and functional independence does not appear to have been examined by other researchers. Previous research from our laboratory, however, found that it accounted for significant variance in ILS performance (Ahmed & Miller, unpublished, see chapter 3).

Mediation analyses have been outlined by Baron & Kenny (1986). However, their causal steps approach has been argued to be problematic in social science research (Preacher & Hayes, 2008). The causal steps approach assumes a normal distribution and a very large sample size, which Preacher and Hayes (2008) note is not always possible in social science research.

Furthermore, the distribution of indirect relationships is nearly always non-normal (Mallinckrodt, Abraham, Wei, & Russell, 2006; Preacher & Hayes, 2008). A mediation model that utilizes bootstrapping and the ability to examine multiple mediating variables has been argued to be the best way to examine multiple mediation. It reduces both Type I error and allows for comparisons among the magnitude of the effect of all mediating variables (Preacher & Hayes, 2008). Therefore, the multiple mediation technique outlined by Preacher and Hayes (2008) was used.

Strange stories test. Using an algorithm provided by Preacher and Hayes (2008), the Full Scale ILS score was entered as the dependent variable. Next, the Strange Stories total composite score was entered as an independent variable. The D-KEFS Trail Making Test Condition 4, Color-Word Interference Test Condition 3, and Proverb Test Achievement scores were entered as mediating variables. Age was entered as a covariate since it was significantly associated with the ILS.

The total effect was significant (total effect = 3.19, $p < .01$). Age did not display a significant partial effect ($p > .05$). The direct effect was non-significant (direct effect = 1.03, $p > .05$). Examination of the bootstrap results indicated that the total indirect effect was significant, as its 95% bias corrected and accelerated confidence interval was between .28 and 3.68 (Preacher and Hayes, 2008). Both cognitive flexibility (.13 to 2.85) and proverb interpretation (.13 to 2.41) had significant individual indirect effects.

Although the inhibition variable showed a significant bivariate correlation with the ILS (r = .33, $p < .05$), previous research from our laboratory found that it was not a significantly related to ILS performance (Ahmed & Miller, unpublished, see chapter 3). Therefore, we re-ran the multiple mediation model after removing the inhibition variable, leaving the cognitive flexibility and proverb interpretation variables as the only mediating variables. The conclusions remained

the same. The total direct effect was significant (total effect = 3.12, $p < .01$). Age did not have an effect ($p > .05$). The direct effect was not significant (direct effect = 1.09, $p > .05$). Bootstrap results indicated that the total indirect effect was significant, as its 95% bias corrected and accelerated confidence interval was between .33 and 3.14. Cognitive flexibility (.01 to 2.06) and proverb interpretation (.10 to 2.01) had significant individual indirect effects. The direct and indirect relationships of this second mediation model are detailed in Figure 1.2.

Faux pas test. Since the Faux Pas test was not associated with ILS performance, no further analysis was conducted.

Discussion

The primary aim of this study was to examine whether ToM was associated with functional independence. Since previous research suggests that the Strange Stories and Faux Pas tests may be driven by differing cognitive mechanisms, the impact of each ToM test on functional independence was explored separately. Results indicated that performance on the Strange Stories test accounted for significant variance in functional independence while the Faux Pas test did not.

There are two possible explanations for why one ToM test accounted for significant variance in functional independence while the other did not. Previous research from our laboratory indicated that these two tests may be measuring differing cognitive mechanisms, as they each had different numbers and types of executive functions accounting for variance in their scores (Ahmed & Miller, 2010). In our previous work, verbal fluency and deductive reasoning were associated with the Strange Stories test, while gender, verbal fluency, and problem solving were associated with performance on the Faux Pas test. Further, gender accounted for the most variance in Faux Pas test scores (Ahmed & Miller, 2010). Therefore, if the Faux Pas test relied

so heavily on gender compared to executive functions, then perhaps executive functions are comparatively weak components in the ability to detect a faux pas. In the present study, the population was primarily female and therefore gender differences were not found. The main reason why the ToM-functional independence relationship was explored was due to the executive function aspects of successful ToM performance. Our findings may be the result of the Faux Pas test having weak executive function mechanisms, and perhaps this is the reason why it was not significantly associated with the ILS. The second reason why the Faux Pas test may not have accounted for significant variance on the ILS may be due to a relatively more limited variance in scores compared to a wider distribution of Strange Stories test scores.

The second aim of this study was to examine the relationship between proverb interpretation and ToM. Proverb interpretation has been conceptualized as an executive function (Delis et al., 2001a) and previous research has determined a relationship between executive functioning and ToM (Ahmed & Miller, 2010; Cole & Mitchell, 1998; Gordon & Olsen, 1998; Joseph & Tager-Flusberg, 2004). Finally, both proverb interpretation and ToM tests require the participant to be able to think abstractly and correctly verbalize their responses (Delis et al., 2001a; Happé, 1994; Jolliffe & Baron-Cohen, 1999; Happé et al., 1998; Maylor, Moulson, Muncer, & Taylor, 2002; Sullivan, & Ruffman, 2004). Therefore, it would seem plausible that proverb interpretation would be associated with ToM performance. After analyzing the variance accounted for by proverb interpretation on each of the ToM tests separately, it was found that proverb interpretation was significantly related to the Strange Stories test but not the Faux Pas test. The reasons for the lack of a relationship between proverb interpretation and the Faux Pas test may be the same reasons described in the previous paragraph; namely, that the Faux Pas test

may be less driven by executive function and its somewhat restricted range of scores further limits the ability to identify any associative relationship with another variable.

The final aim was to examine whether the ToM-functional independence relationship was mediated by the executive functions of cognitive flexibility, inhibition, and proverb interpretation. Using a multiple mediation model, the indirect effects of executive function were evaluated. Results indicated that while the total effect was significant, the direct effect was non-significant, and the total indirect effect was significant. This suggests that while the Strange Stories test appeared to be related to functional independence, this effect was actually mediated by executive functioning. Inspection of the magnitude of effect from the individual mediating variables yielded significant indirect effects from cognitive flexibility and proverb interpretation. The inhibition variable, though correlated with the ILS, did not have a significant mediating effect. This is supported by previous research which found no significant variance accounted for through regression analysis between inhibition and the ILS (Ahmed & Miller, unpublished, see chapter 3). This may be due to the nature of the ILS itself and not a reflection on functional independence in general. The ILS, which requires participants to respond to real-life potential scenarios and answer general knowledge questions (Loeb, 1996), may rely more heavily in thinking flexibly when shifting from question to question (cognitive flexibility) and the ability to think abstractly about future events and successfully verbalize their answers (similar to a proverb interpretation skill). Mediation analyses after removing the inhibition variable yielded the same conclusions as the previous model. As described earlier, examination of ToM's relationship with functional independence was conducted in order to ascertain whether adding another test would explain additional unique variance in functional ability, thus adding incremental validity and a possible addition to a neuropsychological assessment. Results from the mediation analysis,

however, suggest that assessment of ToM in a healthy older adult population may not add additional useful information regarding functional independence, above and beyond that of measurement of executive function.

To our knowledge, these research questions have not been examined in an older adult population. A strength of this study is that we were able to examine these variables in a healthy community-dwelling population. The benefit of studying a healthy population is that it limits the chance that variance in scores is due to cognitive disorders, such as MCI or dementia.

The population used in this study can also be viewed as a limitation, however, as this was a high-functioning sample. Furthermore, this sample consisted of mostly women who had a high level of education and a higher income than the general population. Given this sample, the scores were in a limited range, which may have limited the sensitivity of the measures to find results of statistical significance. A caveat to this study is that the conclusions regarding functional independence have been made in the context of functional independence *as measured by the ILS.* It is possible that given a different measure of functional independence, the results may vary, Therefore, conclusions regarding the apparent lack of utility of ToM assessment for functional independence refers only to the ILS.

For future studies, the population could be broader, both demographically and in terms of cognitive functioning. It may be beneficial to collect data from multiple groups, including healthy adults, those with MCI, and those with mild dementia. This way, group effects could be compared. Additionally, collecting data from a collateral source, such as a spouse or adult child, may provide helpful data regarding the participant's functional ability as recent research from our laboratory has indicated that participant and collateral report of functional ability increasingly differ with increasing cognitive impairment (Miller, Brown, Mitchell, &

Williamson, In Press). Finally, additional measures of functional independence would help clarify whether the results obtained in this study generalize to other functional ability measures. This would therefore strengthen the argument that assessing for ToM does not add additional information not already obtained through measuring executive function.

These results suggest that in a healthy older adult population, assessment of ToM does not appear to be significantly associated with ILS performance. Given the literature regarding the relationship of executive functioning on functional ability, these preliminary results indicate that assessment of ToM may be an unnecessary addition to a neuropsychological battery.

References

Ahmed, F.S., & Miller, L.S. (2010). Executive function predictors of theory of mind. *Journal of Autism and Developmental Disorders,* DOI: 10.1007/s10803-010-1087-7.

Alexopaulos, G.S. (2005). Depression in the elderly. *The Lancet, 365,* 1961-1970.

Army Individual Test Battery. (1944). *Manual of Directions and Scoring*. Washington, DC: War Department, Adjutant General's Office.

Bach, L.J., Happé, F., Fleminger, S., & Powell, J. (2005). Theory of mind: Independence of executive function and the role of the frontal cortex in acquired brain injury. *Cognitive Neuropsychiatry, 5,* 175-192.

Baird, A. (2006). Fine tuning recommendations for older adults with memory complaints: Using the independent living scales with the dementia rating scale. *The Clinical Neuropsychologist, 20,* 649-661.

Baron-Cohen, S. (1988). Social and pragmatic deficits in autism: Cognitive or affective? *Journal of Autism and Developmental Disorders, 18,* 379-402.

Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: Evidence from very high functioning adults with autism or asperger syndrome. *Journal of Child Psychology and Psychiatry, 38,* 813-822.

Baron-Cohen, S., Leslie, A.M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21,* 37-46.

Baron-Cohen, S., & Wheelwright, S. (2004). The Empathy Quotient: An investigation of adults with asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34,* 163-175.

Bell-McGinty, A., Podell, K., Franzen, M., Baird, A., & Williams, M.J. (2002). Standard measures of executive function in predicting instrumental activities of daily living in older adults. *International Journal of Geriatric Psychiatry, 17,* 828-834.

Bollen, K., A. & Jackman, R., W. (1990) Regression Diagnostics: an Expository treatment of Outliers and Influential cases In J. Fox & S. Long (Eds) *Modern Methods of Data Analysis* Newbury Park CA: Sage.

Bora, E., Vahip, S., Gonul, A.S., Akdeniz, F., Alkan, M., Ogut, M., & Eryavuz, A. (2005). Evidence for theory of mind deficits in euthymic patients with bipolar disorder. *ACTA Psychiatrica Scandinavica, 112,* 110-116.

Braver, T.S., Barch, D.M., Keys, B.A., Carter, C.S., Cohen, J.D., Kaye, J.A., Janowsky, J.S., Taylor, S.F., Yesavage, J.A., Mumenthaler, M.A., Jagust, W.J., & Reed, B.R. (2001). Context processing in older adults: Evidence for a theory relating cognitive control to neurobiology in healthy aging. *Journal of Experimental Psychology, 130,* 746-763.

Brent, E., Rios, P., Happé, F., & Charman, T. (2004). Performance of children with autism spectrum disorder on advanced theory of mind tasks. *Autism*, 8, 283-299.

Brink T.L., Yesavage J.A., Lum O., Heersema P., Adey M.B.,& Rose T.L. (1982). Screening tests for geriatric depression. *Clinical Gerontologist, 1,* 37-44.

Brüne, M., & Bodenstein, L. (2005). Proverb comprehension reconsidered – 'Theory of mind' and the pragmatic use of language in schizophrenia. *Schizophrenia Research, 75,* 233-239.

Brüne, M., & Brüne-Cohrs (2005). Theory of mind- evolution, ontogeny, brain mechanisms and psychopathology. *Neuroscience and Behavioral Reviews, xx,* 1-19.

Butler, K.M., & Zacks, R.T. (2006). Age deficits in control of prepotent responses: Evidence for an inhibitory decline. *Psychology and Aging, 21,* 638-643.

Cahn-Weiner, D.A., Malloy, P.F., Boyle, P.A., Marran, M., & Salloway, S. (2000). Prediction of functional status from neuropsychological tests in community-dwelling elderly individuals. *The Clinical Neuropsychologist, 14,* 187-195.

Carlson, S.M., Mandell, D.J., & Williams, L. (2004). Execitive function and theory of mind: Stability and prediction from ages 2 to 3. *Developmental Psychology, 40*, 1105-1122.

Carlson, S.M., Moses, L.J., & Breton, C. (2002). How specific is the relation between executive function amd theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development, 11*, 73-92.

Carlson, S.M., Moses, L.J., & Claxton, L.J. (2004). Individual differences in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology, 87*, 299-319.

Cole, K. & Mitchell, P. (2000). Siblings in the development of executive control and a theory of mind. *British Journal of Developmental Psychology, 18,* 279-295.

Cuerva, A.G., Sabe, L., Kuzis, G., Tiberti, C., Dorrego, F., & Starkstein, S.E. (2001). Theory of mind and pragmatic abilities in dementia. *Neuropsychiatry, Neuropsychology, & Behavioral Neurology, 14,* 153-158.

Davies, A.D. (1968). The influence of age on trail making test performance. *Journal of clinical Psychology, 24,* 96-98.

Delis, D.C., Kaplan, E., & Kramer, J.H. (2001a). Delis Kaplan Executive Function System Examiner's Manual. San Antonio, TX: The Psychological Corporation.

Delis, D., Kaplan, E., & Kramer, J.H. (2001b). Delis Kaplan Executive Function System Technical Manual. San Antonio, TX: The Psychological Corporation.

Delis, D.C., Kramer, J.H., Kaplan, E., & Holdnack, J. (2004). Reliability and validity of the Delis-Kaplan Executive Function System: An update. *Journal of the International Neuropsychological Society, 10,* 301-303.

Dubois, B., Andrade, K., & Levy, R. (2008). Executive dysfunction and neuropsychological testing. In C. Duyckaerts & I. Litvan (Eds.) *Handbook of Clinical Neurology (volume 89; 3rd series).* Elsevier. Amsterdam: 35-52.

Fine, C., Lumsden, J., & Blair, R.J.R. (2001). Dissociation between 'theory of mind' and executive functions in a patient with early left amygdala damage. *Brain, 124,* 287-298.

Fisher, N., & Happé, F. (2005). A training study of theory of mind and executive function in children with autistic spectrum disorders. *Journal of Autism and Developmental Disorders, 35,* 757-771.

Folstein, M.F., Folstein, S.E., & McHugh, P.R. (1975). "Mini-mental state" : A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12,* 189-198.

Gordon, A.C.L., & Olson, D.R. (1998). The relation between acquisition of a theory of mind and the capacity to hold in mind. *Journal of Experimental Child Psychology, 68,* 70-83.

Gottlieb, D. (2005). The strange stories test: A replication of children and adolescents with asperger syndrome. *European Child Adolescent Psychiatry, 14,* 73-82.

Green, R.E.A., Melo, B., Christensen, B., Ngo, L., Monette, G., & Bradbury, C. (2008). Measuring premorbid IQ in traumatic brain injury: An examination of the validity of the

Wechsler Test of Adult Reading (WTAR). *Journal of Clinical and Experimental Neuropsychology, 30,* 163-172.

Gregory, C., Lough, S., Stone, V., Erzinclioglu, S., Martin, L, Baron-Cohen, S., & Hodges, J.R. (2002). Theory of mind in patients with frontal variant frontotemporal dementia and alzheimer's disease: Theoretical and practical implications. *Brain, 125,* 752-764.

Happé, F.G. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of Autism and Developmental Disorders, 24,* 129-154.

Happé, F., Ehlers, S., Fletcher, P., Frith, U., Johansson, M., Gillberg, C., Dolan, R., & Frith, C. (1996). 'Theory of mind' in the brain. Evidence from a PET scan study of asperger syndrome. *Clinical Neuroscience and Neuropathology, 8,* 197-201.

Happé, F., Winner, E., & Brownell, H. (1998). The getting of wisdom: Theory of mind in old age. *Developmental Psychology, 34,* 358-362.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. H. Bower (Ed.). *The psychology of learning and motivation: Vol. 22* (pp. 193-225). San Diego, CA: Academic Press.

Homack, S., Lee, D., & Riccio, C.A. (2005). Test review: Delis-Kaplan Executive Function System. *Journal of Clinical and Experimental Neuropsychology, 27,* 599-609.

Hughes, C. (1998). Finding your marbles: Does preschoolers' strategic behavior predict later understanding of mind? *Developmental Psychology, 34,* 1326-1339.

Hughes, C., Dunn, J., & White, A. (1998). Trick or treat?: Uneven understanding of mind and emotion and executive dysfunction in "hard to manage" preschoolers. *Journal of Child Psychology and Psychiatry, 39,* 981-994.

Hughes, C., & Graham, A. (2002). Measuring executive functions in childhood: Problems and solutions? *Child and Adolescent Mental Health, 7,* 131-142.

Jefferson, A.L., Paul, R.H., Ozonoff, A., & Cohen, R.A. (2006). Evaluating elements of executive functioning as predictors of instrumental activities of daily living (IADLs). *Archives of Clinical Neuropsychology, 21,* 311-320.

Jolliffe, T. & Baron-Cohen, S. (1999). The strange stories test: A replication with high-functioning adults with autism or asperger syndrome. *Journal of Autism and Developmental Disorders, 29,* 395-404.

Joseph, R.M., & Tager-Flusberg, H. (2004). The relationship of theory of mind and executive functions to symptom type and severity in children with autism. *Development and Psychopathology, 16,* 137-155.

Kaland, N., Moller-Nielsen, A., Callesen, K., Mortensen, E.L., Gottlieb, D., & Smith, L. (2002). A new 'advanced' test of theory of mind: Evidence from children and adolescents with asperger syndrome. *Journal of Child Psychology and Psychiatry, 43,* 517-528.

Kerr, N., Dunbar, R.I.M., & Bentall, R.P. (2003). Theory of mind deficits in bipolar affective disorder. *Journal of Affective Disorders, 73,* 253-259.

Lewis, M.S., & Miller, L.S. (2007). Executive control functioning and functional ability in older adults. *The Clinical Neuropsychologist, 21,* 274-285.

Lezak, M.D., Howieson, D.B., & Loring, D.W. (2004). Neuropsychological Assessment (4th edition). New York, NY: Oxford University Press.

Loeb, P.A. (1996). ILS: Independent Living Scales Manual. The Psychological Corporation, San Antonio.

MacPherson, S.E., Phillips, L.H., & Della Sala, S. (2002). Age, executive function, and social decision making: A dorsolateral prefrontal theory of cognitive aging. *Psychology and Aging, 17,* 598-609.

Maylor, E., Moulson, J.M., Muncer, A., & Taylor, L.A. (2002). Does performance of theory of mind tasks decline in old age? *British Journal of Psychology, 93,* 465-485.

Miller, L.S., Brown, C., Mitchell, M., & Williamson, G. (In press). Activities of Daily Living are Associated with Older Adult Cognitive Status: Caregiver versus Self Reports. *Journal of Applied Gerontology*.

Mitchell, M., & Miller, L.S. (2008). Prediction of functional status in older adults: the ecological validity of four Delis-Kaplan Executive Function System tests. *Journal of clinical and Experimental Neuropsychology, 30,* 683-690.

Njegovan, V., Man-Son-Hing, M., Mitchell, S.L., & Molnar, F.J. (2001). The hierarchy of functional loss associated with cognitive decline in older persons. *Journal of Gerontology, 56,* M638-M643.

Nutter-Upham, K.E., Saykin, A.J., Rabin, L.A., Roth, R.M., Wishart, H.A., Pare, N., & Flashman, L.A. (2008). Verbal fluency performance in amnestic MCI and older adults with cognitive complaints. *Archives of Clinical Neuropsychology, 23,* 229-241.

Ouelett, J., Scherzer, P.B., Rouleau, I., Métras, P., Bertrand-Gauvin, C., Djerroud, N., Boisseau, E., & Duquette, P. Assessment of social cognition in patients with multiple sclerosis. *Journal of the International Neuropsychological Society, 16,* 287-296.

Paxton, J.L., Barch, D.M., Racine, C.A., & Braver, T.S. (2007). Cognitive control, goal maintenance, and prefrontal function in healthy aging. *Cerebral Cortex, 18,* 1010–1028.

Pereira, F.S., Yassuda, M.S., Oliveira, A.M., Diniz, B.S., Radanovic, M., Talib, L.L., Gattaz, W.F., & Forlenza, O.V. (2010). Profiles of functional deficits in mild cognitive impairment and dementia: Benefits from objective measurement. *Journal of the International Neuropsychological Society, 16,* 297-305.

Potter, L.M., & Grealy, M.A. (2008). Aging and inhibition of a prepotent motor response during an ongoing action. *Aging, Neuropsychology, and Cognition, 15,* 232-255.

Preacher, K.J., & Hayes, A.F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40,* 879-891.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *The Behavioral and Brain Sciences, 4,* 515-526.

Raz, N., & Rodrigue, K.M. (2006). Differential aging of the brain: Patterns, cognitive correlates, and modifiers. *Neurosciences and Biobehavioral Reviews, 30,* 730-748.

Razani, J., Casas, R., Wong, J.T., Lu, P., Alessi, C., & Josephson, K. (2007). Relationship between executive functioning and activities of daily living in patients with relatively mild dementia. *Applied Neuropsychology, 14,* 208-214.

Reitan, R.M. (1958). Validity of the trail making test as an indicator of organic brain damage. *Perceptual and Motor Skills,8, 271-276.*

Revheim, N., Schechter, I., Kim, D., Silpo, G., Allingham, B., Butler, P., & Javitt, D.C. (2006). Neurocognitive and symptom correlates of daily problem-solving skills in schizophrenia. *Schizophrenia Research, 83,* 237-245.

Royall, D.R., Lauterbach, E.C., Cummings, J.L., Reeve, A., Rummans, T.A., Kaufer, D.I., LaFrance, W.C., & Coffey, C.E. (2002). Executive control function: A review of its

promise and challenges for clinical research. *Journal of Neuropsychiatry and Clinical Neurosciences, 14,* 377-405.

Sabbagh, M.A., Xu, F., Carlson, S.M., Moses, L.J., & Lee, K. (2006). The development of executive functioning and theory of mind: A comparison of chinese and u.s. preschoolers. *Psychological Science, 17,* 74-81.

Saltzman, J., Strauss, E., Hunter, M., & Archibald, S. (2000). Theory of mind and executive functions in normal aging and parkinson's disease. *Journal of the International Neuropsychological Society, 6,* 781-788.

Sheikh, J.I., Yesavage, J.A. (1986). Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. Clinical Gerontology : A Guide to Assessment and Intervention 165-173, NY: The Haworth Press.

Sheikh, J.I., Yesavage, J.A., Brooks, J.O., III, Friedman, L.F., Gratzinger, P., Hill, R.D, Zadeik A., & Crook, T. (1991). Proposed factor structure of the Geriatric Depression Scale. *International Psychogeriatrics 3:* 23-28.

Sherod, M.G., Griffith, H.R., Copeland, J., Belue, K., Krzywanski, S., Zamrini, E.Y., Harrell, L.E., Clark, D.G., Brockington, J.C., Powers, R.E., & Marson, D.C. (2009). Neurocognitive predictors of financial capacity across the dementia spectrum: Normal aging, mild cognitive impairment, and Alzheimer's disease. *Journal of the International Neuropsychological Society,15,* 258-267.

Schroeter, M., Raczka, K., Neumann, J., & von Cramon, D.Y. (2008). Neural networks in frontotemporal dementia – A meta-analysis. *Neurobiology of Aging, 29,* 418-426.

Shunk, A.W., Davis, A.S., & Dean, R.S. (2006). Test review of the Delis-Kaplan Executive Function System. *Applied Neuropsychology, 14,* 275-279.

Steenhuysen, J. (2010, July). Early diagnosis can cut Alzheimer's costs: Study. *Reuters.* Retrieved from http://www.reuters.com

Stone, V.E., Baron-Cohen, S., & Knight, R.T. (1998). Frontal lobe contributions to theory of mind. *Journal of Cognitive Neuroscience, 10,* 640-656.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psycholology, 18,* 643–662.

Stuss, D.T., Alexander, M.P., Floden, D., Binns, M.A., Levine, B., McIntosh, N., Rajah, N., & Hevenor, S.J.. (2002). Fractionation and localization of distinct frontal lobe processes: Evidence from focal lesions in humans. In R.T. Knight & Studd, D.T. (Eds.) *Principles of Frontal Lobe Function*. Oxford University Press. New York, 392-407.

Sorel, O., & Pannequin, V. (2008). Aging of the planning process: The role of executive functioning. *Brain and Cognition, 66,* 196-201.

Sullivan, S. & Ruffman, T. (2004). Social understanding: How does it fare with advancing years? *British Journal of Psychology, 95,* 1-18.

Tangalos, E.G., Smith, G. E., Ivnik, R.J., Petersen, R.C., Kokmen, E., Kurland, L.T., Offord, K.P., & Parisi, J.E. (1996). The Mini-Mental State Examination in general medical practice: Clinical utility and acceptance. *Mayo Clinic Proceedings, 71,* 829-837.

The Psychological Corporation (2001). *Wechsler Test of Adult Reading*. San Antonio, TX: Harcourt Brace & Company.

Tombaugh, T.N. (2005). Test-retest reliable coefficients and 5-year change scores for the MMSE and 3MS. *Archives of Clinical Neuropsychology, 20,* 485-503.

Uekermann, J., Thoma, P., & Daum, I. (2008). Proverb interpretation changes in aging. *Brain and cognition, 67,* 51-57.

Von Hippel, W., & Dunlop, S.M. (2005). Aging, inhibition, and social inappropriateness. *Psychology and Aging, 20,* 519-523.

Wecker, N.S., Kramer, J.H., Hallam, B.J., & Delis, D.C. (2005). Mental flexibility: Age effects on switching. *Neuropsychology, 19*, 345-352.

Wecker, N.S., Kramer, J.H., Wisniewski, A., Delis, D.C., & Kaplan, E. (2000). Age effects on executive ability. *Neuropsychology, 14,* 409-414.

West, R.L. (1996). An application of prefrontal cortex function theory to cognitive aging. *Psychological Bulletin, 120*, 272-292.

West, R.L. (2000). In defense of the frontal lobe hypothesis of cognitive aging. *Journal of the International Neuropsychological Society, 6,* 727-729.

Yesavage, J., A., Brink, T.L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V.O. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research, 17,* 37-49.

Zelazo, P.D., & Frye, D. (1998). Cognitive complexity and control ii. The development of executive function in childhood. *American Psychological Society, 7,* 121-125.

Table 1.2

Demographic Information

	Frequency	Minimum	Maximum	Mean	Standard Deviation
Age (in years)		65	89	77	7.10
Gender					
Male	6				
Female	37				
Ethnicity					
White/ Non Hispanic	40				
African American/Black	2				
Hispanic/Latino	0				
Asian/Pacific Islander	1				
Other	0				
Education (in years)		9	22	15.07	3.65
Family Income					
Below $10,000	5				
$10,001-$30,000	26				
$30,001-$60,000	4				
$60,001-$90,000	4				
$90,001 and Above	4				
Geographical Region Raised					
South	23				
North Central	9				
West	1				
Northeast	6				
Other	4				
WTAR-Predicted FSIQ[b]		78	129	108.28	15.35

Note. N = 43.

[a] WTAR-Predicted FSIQ = Wechsler Test of Adult Reading-Predicted Full Scale IQ. Scores based on mean of 100 and standard deviation of 15.

Table 2.2

Descriptive Information for all Independent and Dependent Variables

	Minimum	Maximum	Mean	Standard Deviation
D-KEFS[a] TMT-4[b]	2	16	9.46	3.99
D-KEFS C-W-3[c, d]	1	15	9.95	3.40
D-KEFS Proverb Test, Achievement scaled score	3	16	11.07	3.24
Strange Stories Test[d]	2.50	12	8.12	2.34
Faux Pas Test[e]	68.50	121	110.09	9.80
ILS[f] Full Scale	65	118	102.19	11.70

Note. N = 43 for all variables except the D-KEFS Color-Word Interference test, Condition 3
[a] Delis-Kaplan Executive Function System
[b] D-KEFS Trail Making Test Condition 4 Scaled Score. Scores based on mean of 10 and standard deviation of 3.
[c] D-KEFS Color Word Interference Test Condition 3 Scaled Score. Scores based on mean of 10 and standard deviation of 3
[d] N = 42
[d] Total composite score. Score ranged from 0 – 12
[e] Total composite score. Score ranged from 0 – 121
[f] Independent Living Scales. Standard score based on mean of 100 and standard deviation of 15

Table 3.2

Correlation[a] Matrix of Independent and Dependent Variables[b]

	D-KEFS TMT-4	D-KEFS C-W-3	D-KEFs Proverb	Strange Stories Test	Faux Pas Test	ILS Full Scale
D-KEFS[c] TMT-4[d]		.60**	.17	.47**	.37*	.47**
D-KEFS C-W-3[e]			.28	.38*	.25	.33*
D-KEFs Proverb[f]				.40**	.12	.44**
Strange Stories Test[g]					.12	.51**
Faux Pas Test[h]						.33*
ILS[i] Full Scale						

Note. N = 43 for all variables except for correlations with the D-KEFs Color-Word Interference Test (N = 42)
[a] Spearman's correlation was used due to the non-normal distributions of the variables
[b] All variables have been mean-centered
[c] Delis-Kaplan Executive Function System
[d] D-KEFS Trail Making Test Condition 4 Scaled Score. Scores based on mean of 10 and standard deviation of 3.
[e] D-KEFS Color Word Interference Test Condition 3 Scaled Score. Scores based on mean of 10 and standard deviation of 3
[f] D-KEFS Proverb Test Achievement Scaled Score. Scores based on mean of 10 and standard deviation of 3.
[g] Score ranged from 0-12
[h] Score ranged from 0-121
[i] Independent Living Scales. Standard score based on mean of 100 and standard deviation of 15
* $p < .05$ ** $p < .01$

Table 4.2

Multiple Regression Analysis of ILS[a] *by Strange Stories Test*[b]

Step 1: R = .37 R^2 = .14 Adj. R^2 = .12 Standard. Error of Estimate = 11.01 F (1, 41) = 6.45, $p <$ .05
Step 2: R = .55 R^2 = .31 Adj. R^2 = .27 R^2 change = .17 Standard. Error of Estimate = 10.00 F (2, 40) = 8.78, $p <$ .01 F change = 9.74, $p <$ .01

					Correlations		
Step		Beta	t	Sig.	Zero-order	Partial	Part
1	Age	-.61	-2.54	$p < .05$	-.37	-.37	-.37
2	Age	-.54	-2.48	$p < .05$	-.37	-.37	-.33
	Strange Stories	2.07	3.12	$p < .01$	.45	.44	.41

Note. N = 43
[a] Independent Living Scales full scale standard score. Standard scores based on mean of 100 and standard deviation of 15.
[b] Strange Stories total composite score. Scores ranged from 0-12.

Table 5.2

Multiple Regression Analysis of ILS[a] *by Faux Pas Test*[b]

Step 1: R = .37 R^2 = .14 Adj. R^2 = .12 Standard. Error of Estimate = 11.01 F (1, 41) = 6.45, $p < .05$
Step 2: R = .43 R^2 = .19 Adj. R^2 = .15 R^2 change = .05 Standard. Error of Estimate = 10.81 F (2, 40) = 4.61, $p < .05$ F change = 2.53, $p > .05$

					Correlations		
Step		Beta	t	Sig.	Zero-order	Partial	Part
1	Age	-.61	-2.54	$p < .05$	-.37	-.37	-.37
2	Age	-.61	-2.61	$p < .05$	-.37	-.38	-.37
	Faux Pas	.27	1.59	*ns*	.22	.24	.23

Note. N = 43
[a] Independent Living Scales full scale standard score. Scores based on mean of 100 and standard deviation of 15.
[b] Faux Pas Test total composite score. Scores ranged from 0-121.

Table 6.2

Multiple Regression Analysis of Strange Stories Test[a] *by D-KEFS Proverb Test*[b]

Step 1: R = .45 R^2 = .20 Adj. R^2 = .14 Standard. Error of Estimate = 2.17 F (3,39) = 3.33, $p < .05$
Step 2: R = .53 R^2 = .28 Adj. R^2= .21 R^2 change = .08 Standard. Error of Estimate = 2.08 F (4, 38) = 3.79, $p < .05$ F change = 4.31, $p < .05$

					Correlations		
Step		Beta	t	Sig.	Zero-order	Partial	Part
1	Education	-.01	-.04	*ns*	.32	-.01	-.01
	Income	.39	.98	*ns*	.33	.15	.14
	WTAR[c]-predicted IQ	.05	1.94	*ns*	.42	.30	.28
2	Education	.06	.44	*ns*	.32	.07	.06
	Income	.27	.71	*ns*	.33	.12	.10
	WTAR-predicted IQ	.03	1.05	*ns*	.42	.17	.15
	D-KEFS Proverb	.23	2.08	$p < .05$	.42	.32	.29

Note. N = 43
[a] Strange Stories total composite score
[b] Delis-Kaplan Executive Function System Proverb test achievement scaled score. Scores based on mean of 10 and standard deviation of 3.
[c] Wechsler Test of Adult Reading predicted Full Scale IQ. Scores based on mean of 100 and standard deviation of 15.

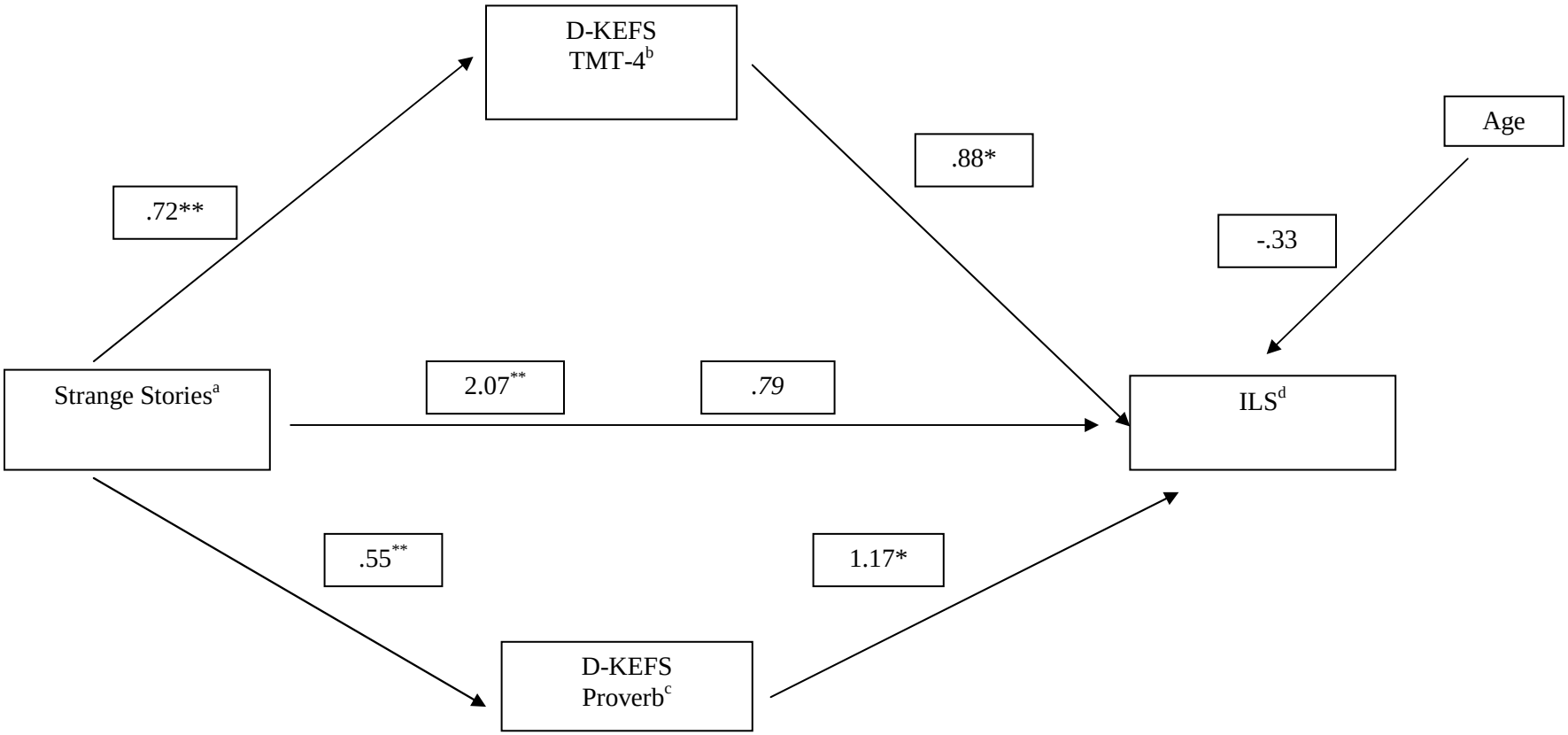

Figure 1.2. Executive Function Mediators of the Strange Stories – ILS relationship

Note: The values for each path are the unstandardized regression coefficient. The italicized number is the direct effect and the un-italicized number is the total effect. * $p < .05$. ** $p < .01$

[a] Strange Stories total composite score. Scores ranged from 0-12

[b] D-KEFS Trail Making Test Condition 4 Scaled Score. Scores based on mean of 10 and standard deviation of 3

[c] D-KEFS Proverb Test Achievement Scaled Score. Scores based on mean of 10 and standard deviation of 3

[d] Independent Living Scales Full Scale Standard Score. Scores based on mean of 100 and standard deviation of 15.

CHAPTER 5

DISCUSSION

The first aim of this study was to examine whether proverb interpretation was significantly associated with functional independence above and beyond that of cognitive flexibility and inhibition. Since executive functioning is one of the best predictors of functional independence (Bell-McGinty et al., 2002; Cahn-Weiner, et al., 2000; Lewis & Miller, 2002; Mitchell & Miller, 2008; Sherod et al., 2009) and proverb interpretation has been conceptualized as an executive function (Delis et al., 2001a), the relationship between proverb interpretation and functional independence was examined. Results indicated that after controlling for age, out of the executive tasks evaluated, proverb interpretation and cognitive flexibility were significantly associated with ILS performance. This suggests that the ability to comprehend/correctly verbalize an abstract concept and think flexibly may be related to one's ability to live independently as measured by the ILS. It is surprising that the inhibition test did not account for significant and unique variance on functional ability given that it was significantly correlated with the ILS (D-KEFS Color-Word Interference Test, Condition 3 r = .33, $p < .05$). Furthermore, this task is one of the oldest executive function measures (Stroop, 1935) and has in the past been shown to predict functional ability (Jefferson et al., 2006).

To examine the possible reasons why inhibition was not associated with functional ability, a review of the functional ability measure used in this study is necessary. The ILS is a measure of IADLs (Loeb, 1996). IADLs are the more complex daily living tasks, such as shopping and paying bills (Njegovan et al., 2001). Test items consisted of the examiner asking

participants to answer how they would solve real-life problems, demonstrate the ability to carry out specific tasks, and correctly identify general knowledge questions related to independence (Loeb, 1996). It is possible that successful performance on the ILS does not rely heavily upon inhibition. While the ILS requires one to think flexibly when answering various questions about different scenarios (perhaps utilizing cognitive flexibility), it does not appear to need inhibitory skills. Thus, at least on the ILS, it appears that inhibitory skills are not necessary for successful performance.

It may be argued that the ILS measures basic verbal ability. However, if this was the case, it would be expected that the WTAR-predicted FSIQ, which is a measure of word-reading ability (The Psychological Corporation, 2001), would also be associated with ILS performance. These scores did not even correlate with the ILS, suggesting that the ILS is not simply dependent on basic verbalization. It is possible that the ILS relies more on complex, abstract reasoning and verbalization, but less so on flexibility of thinking and intact inhibitory ability. This may be a reason why proverb interpretation was associated with ILS performance.

The second aim of this study was to examine whether ToM was associated with functional independence. Results indicated that performance on the Strange Stories test accounted for significant variance in functional independence while the Faux Pas test did not.

There are two possible explanations for why one ToM test accounted for significant variance in functional independence while the other did not. Previous research from our laboratory indicated that these two tests may be measuring differing cognitive mechanisms, as they each had different numbers and types of executive functions accounting for variance in their scores. Specifically, verbal fluency and deductive reasoning were associated with the Strange Stories test, while gender, verbal fluency, and problem solving were associated with performance

on the Faux Pas test. Furthermore, gender accounted for the most variance in Faux Pas test scores (Ahmed & Miller, 2010). Therefore, if the Faux Pas test relied so heavily on gender compared to executive functions, then perhaps executive functions are not a strong description of the ability to detect a faux pas. Instead, there may be a sociocultural explanation why females performed better on this test. In the present study, the population was primarily female and therefore gender differences were not found. The main reason why the ToM-functional independence relationship was explored was due to the executive aspects of successful ToM performance. If the Faux Pas test is weak in this regard, then it may be an inadequate associated variable with functional independence. It is also possible that the Faux Pas test was relatively more limited in variance of scores compared to the wider distribution of Strange Stories test scores, reducing its ability to elicit a relationship.

The third aim of this study was to examine the relationship between proverb interpretation and ToM. As aforementioned, proverb interpretation has been conceptualized as an executive function (Delis et al., 2001a) and previous research has determined a relationship between executive functioning and ToM (Ahmed & Miller, 2010; Cole & Mitchell, 1998; Gordon & Olsen, 1998; Joseph & Tager-Flusberg, 2004). Finally, both proverb interpretation and ToM tests require the participant to be able to think abstractly and correctly verbalize their responses (Delis et al., 2001a; Happé, 1994; Jolliffe & Baron-Cohen, 1999; Happé et al., 1998; Maylor, Moulson, Muncer, & Taylor, 2002; Sullivan, & Ruffman, 2004). Therefore, it would seem likely that proverb interpretation would be associated with ToM performance. After analyzing the variance accounted for by proverb interpretation on each of the ToM tests separately, it was found that proverb interpretation was significantly related to the Strange Stories test but not the Faux Pas test. The reasons for the lack of a relationship between proverb

interpretation and the Faux Pas test may be related to the aforementioned points. The results suggest that the ability to clearly express abstract concepts was more relevant in the Strange Stories test than the Faux Pas test. However, the small range of Faux Pas test scores limits this conclusion, as a larger score range may have resulted in a significant relationship.

The final aim was to examine whether the ToM-functional independence relationship was mediated by the executive functions of cognitive flexibility, inhibition, and proverb interpretation. Using a multiple mediation model, the indirect effects of executive function were evaluated. Overall results indicated that the total effect was significant, the direct effect was non-significant, and the total indirect effect was significant. This suggests that while the Strange Stories test appeared to be related to functional independence, this effect was actually mediated by executive functioning. Inspection of the magnitude of effect from the individual mediating variables yielded significant indirect effects from cognitive flexibility and proverb interpretation. The inhibition variable, though correlated with the ILS, did not have a significant mediating effect. This is supported by previous research which found no significant variance accounted for through regression analysis between inhibition and the ILS (Ahmed & Miller, unpublished, see chapter 3). This may be due to the nature of the ILS itself and not a reflection on functional independence in general. The ILS, which requires participants to respond to real-life potential scenarios and answer general knowledge questions (Loeb, 1996), may rely more heavily in thinking flexibly when shifting from question to question (cognitive flexibility) and the ability to think abstractly about future events and successfully verbalize their answers (similar to a proverb interpretation skill). Mediation analyses after removing the inhibition variable yielded the same conclusions as the previous model. As described earlier, examination of ToM's relationship with functional independence was conducted in order to ascertain whether adding another test would

explain additional unique variance in functional ability, thus adding incremental validity and a possible addition to a neuropsychological assessment. Results from the mediation analysis, however, suggest that assessment of ToM in a healthy older adult population may not add additional useful information regarding functional independence, above and beyond that of measurement of executive function.

To our knowledge, these research questions have not been examined in an older adult population. A strength of this study is that we were able to examine these variables in a healthy community-dwelling population. The benefit of studying a healthy population is that it limits the chance that variance in scores is due to cognitive disorders, such as MCI or dementia.

The population used in this study can also be viewed as a limitation, as this was a high-functioning sample. Furthermore, this sample consisted of mostly women who had a high level of education and a higher income than the general population. Given this sample, the scores were in a limited range, which constricts the ability to find results of statistical significance. A caveat to this study is that the conclusions regarding functional independence have been made in the context of functional independence *as measured by the ILS.* It is possible that given a different measure of functional independence, the results may vary. Therefore, conclusions regarding the apparent lack of utility of ToM assessment for functional independence refer only to the ILS.

For future studies, the population could be broader, both demographically and in terms of cognitive functioning. It might be beneficial to collect data from not only healthy adults, but those with MCI and those with dementia. This way, group effects could be compared. Additionally, collecting data from a collateral source, such as a spouse or adult child, would likely provide helpful data regarding the participant's functional ability as recent research has indicated that participant and collateral report of functional ability increasingly differ with

increasing cognitive impairment (Miller, Brown, Mitchell, & Williamson, In Press). Finally, additional measures of functional independence would help clarify whether the results obtained in this study generalize to other functional ability measures. This would strengthen the argument that assessing for ToM does not add additional information not already obtained through measuring executive function.

In sum, our findings suggested that proverb interpretation accounted for unique variance in functional independence. It also accounted for unique variance in the Strange Stories test. Proverb interpretation was unrelated to the Faux Pas test, and the Faux Pas test did not explain any variance in functional independence. The Strange Stories test did account for a significant amount of variance in functional independence, but further analysis via a multiple mediation model revealed that this relationship was removed after accounting for the total indirect effects of cognitive flexibility, inhibition, and proverb interpretation. Implications of this study suggest that adding a proverb interpretation test as a measure of verbal abstraction ability may be beneficial in accounting for additional unique variance in functional ability. Additionally, these results suggest that in a healthy older adult population, assessment of ToM in and of itself does not appear to be significantly associated with ILS performance. Given the literature regarding the relationship of executive functioning to functional ability, these preliminary results indicate that assessment of ToM may be an unnecessary addition to a neuropsychological battery.

REFERENCES

Ahmed, F.S., & Miller, L.S. (2010). Executive function predictors of theory of mind. *Journal of Autism and Developmental Disorders*, DOI: 10.1007/s10803-010-1087-7.

Alexopaulos, G.S. (2005). Depression in the elderly. *The Lancet, 365,* 1961-1970.

Alibhai, S.M.H., Mahmoud, S., Hussain, F., Naglie, G., Tannock, I., Tomlinson, G., Fleshner, N., Krahn, M., Warde, P., Klotz, L., Breunis, H., Leach, M., & Duff Canning, S. (2010). Levels of sex hormones have limited effect on cognition in older men with or without prostate cancer. *Critical Reviews in Oncology/Hematology, 73,* 167-175.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (Revised 4th ed.). Washington, DC: Author.

Army Individual Test Battery. (1944). *Manual of Directions and Scoring*. Washington, DC: War Department, Adjutant General's Office.

Bach, L.J., Happé, F., Fleminger, S., & Powell, J. (2005). Theory of mind: Independence of executive function and the role of the frontal cortex in acquired brain injury. *Cognitive Neuropsychiatry, 5,* 175-192.

Bäckman, L., Nyberg, L., Lindenberger, U., Li, S., & Farde, L. (2006). The correlative triad among aging, dopamine, and cognition: Current status and future prospects. *Neuroscience and Behavioral Reviews, 30,* 791-807.

Baird, A. (2006). Fine tuning recommendations for older adults with memory complaints: Using the independent living scales with the dementia rating scale. *The Clinical Neuropsychologist, 20,* 649-661.

Baron-Cohen, S. (1988). Social and pragmatic deficits in autism: Cognitive or affective? *Journal of Autism and Developmental Disorders, 18,* 379-402.

Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: Evidence from very high functioning adults with autism or asperger syndrome. *Journal of Child Psychology and Psychiatry, 38,* 813-822.

Baron-Cohen, S., Leslie, A.M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21,* 37-46.

Baron-Cohen, S., & Wheelwright, S. (2004). The Empathy Quotient: An investigation of adults with asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34,* 163-175.

Bell-McGinty, A., Podell, K., Franzen, M., Baird, A., & Williams, M.J. (2002). Standard measures of executive function in predicting instrumental activities of daily living in older adults. *International Journal of Geriatric Psychiatry, 17,* 828-834.

Blakemore, S.J., & Choudhury, S. (2006). Development of the adolescent brain: Implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry, 47,* 296-312.

Bollen, K., A. & Jackman, R., W. (1990) Regression Diagnostics: an Expository treatment of Outliers and Influential cases In J. Fox & S. Long (Eds) *Modern Methods of Data Analysis* Newbury Park CA: Sage.

Bora, E., Vahip, S., Gonul, A.S., Akdeniz, F., Alkan, M., Ogut, M., & Eryavuz, A. (2005). Evidence for theory of mind deficits in euthymic patients with bipolar disorder. *ACTA Psychiatrica Scandinavica, 112,* 110-116.

Braver, T.S., Barch, D.M., Keys, B.A., Carter, C.S., Cohen, J.D., Kaye, J.A., Janowsky, J.S., Taylor, S.F., Yesavage, J.A., Mumenthaler, M.A., Jagust, W.J., & Reed, B.R. (2001). Context processing in older adults: Evidence for a theory relating cognitive control to neurobiology in healthy aging. *Journal of Experimental Psychology, 130,* 746-763.

Brent, E., Rios, P., Happé, F., & Charman, T. (2004). Performance of children with autism spectrum disorder on advanced theory of mind tasks. *Autism*, 8, 283-299.

Brink T.L., Yesavage J.A., Lum O., Heersema P., Adey M.B.,& Rose T.L. (1982)Screening tests for geriatric depression. *Clinical Gerontologist, 1*, 37-44.

Brüne, M., & Bodenstein, L. (2005). Proverb comprehension reconsidered – 'Theory of mind' and the pragmatic use of language in schizophrenia. *Schizophrenia Research, 75,* 233-239.

Brüne, M., & Brüne-Cohrs (2005). Theory of mind- evolution, ontogeny, brain mechanisms and psychopathology. *Neuroscience and Behavioral Reviews, xx,* 1-19.

Buckner, R.L. (2004). Memory and executive function in aging and ad: Multiple factors that cause decline and reserve factors that compensate. *Neuron, 44,* 195-208.

Butler, K.M., & Zacks, R.T. (2006). Age deficits in control of prepotent responses: Evidence for an inhibitory decline. *Psychology and Aging,21,* 638-643.

Cahn-Weiner, D.A., Malloy, P.F., Boyle, P.A., Marran, M., & Salloway, S. (2000). Prediction of functional status from neuropsychological tests in community-dwelling elderly individuals. *The Clinical Neuropsychologist, 14,* 187-195.

Cahn-Weiner, D.A., Boyle, P.A., & Malloy, P.F. (2002). Tests of executive function predict instrumental activities of daily living in community-dwelling older individuals. *Applied Neuropsychology, 9,* 187-191.

Carlson, S.M., Mandell, D.J., & Williams, L. (2004). Execitive function and theory of mind: Stability and prediction from ages 2 to 3. *Developmental Psychology, 40,* 1105-1122.

Carlson, S.M., Moses, L.J., & Breton, C. (2002). How specific is the relation between executive function amd theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development, 11,* 73-92.

Carlson, S.M., Moses, L.J., & Claxton, L.J. (2004). Individual differences in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology, 87,* 299-319.

Carpenter, P.A., Just, M.A., & Reichle, E.D. (2000). Working memory and executive function: evidence from neuroimaging. *Current opinion in Neurobiology, 10,* 195-199.

Charlton, R.A., Barrick, T.R., Markus, H.S., & Morris, R.G. (2009). Theory of mind associations with other cognitive functions and brain imaging in normal aging. *Psychology and Aging, 24,* 338-348.

Cole, K. & Mitchell, P. (2000). Siblings in the development of executive control and a theory of mind. *British Journal of Developmental Psychology, 18,* 279-295.

Courchesne, E., Chisum, H.J., Townsend, J., Cowles, A., Covington, J., Egaas, B., Harwood, M., Hinds, S., & Press, G.A. (2000). Normal brain development and aging: Quantitative analysis at in vivo MR imaging in healthy volunteers. *Radiology, 216,* 672-682.

Cuerva, A.G., Sabe, L., Kuzis, G., Tiberti, C., Dorrego, F., & Starkstein, S.E. (2001). Theory of mind and pragmatic abilities in dementia. *Neuropsychiatry, Neuropsychology, & Behavioral Neurology, 14,* 153-158.

Davies, A.D. (1968). The influence of age on trail making test performance. *Journal of clinical Psychology, 24,* 96-98.

Delis, D.C., Kaplan, E., & Kramer, J.H. (2001a). Delis Kaplan Executive Function System Examiner's Manual. San Antonio, TX: The Psychological Corporation.

Delis, D., Kaplan, E., & Kramer, J.H. (2001b). Delis Kaplan Executive Function System Technical Manual. San Antonio, TX: The Psychological Corporation.

Delis, D.C., Kramer, J.H., Kaplan, E., & Holdnack, J. (2004). Reliability and validity of the Delis-Kaplan Executive Function System: An update. *Journal of the International Neuropsychological Society, 10,* 301-303.

Dubois, B., Andrade, K., & Levy, R. (2008). Executive dysfunction and neuropsychological testing. In C. Duyckaerts & I. Litvan (Eds.) *Handbook of Clinical Neurology (volume 89; 3rd series).* Elsevier. Amsterdam: 35-52.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*, 1149-1160.

Faul, F., Erdfelder, E., Lang, A.G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175-191.

Federal Interagency Forum on Aging-Related Statistics. Older Americans 2008: Key Indicators of Well-Being. Federal Interagency Forum on Aging-Related Statistics, Washington, DC: U.S. Government Printing Office.

Ferri, C.P., Prince, M., Brayne, C., Brodaty, H., Fratiglioni, L., Ganguli, M., Hall, K., Hasegawa, K., Hendrie, H., Huang, Y., Jorm, A., Mathers, C., Menezes, P.R., Rimmer, E.,& Scazufca, M. (2005). Global prevalence of dementia: A Delphi consensus study. *The Lancet, 366,* 2112-2117.

Fillit, H., Hill, J.W., & Futterman, R. (2002). Health care utilization and costs of Alzheimer's disease: The role of co-morbid conditions, disease stage, and pharmacotherapy. *Family Medicine, 34,* 528-535.

Fine, C., Lumsden, J., & Blair, R.J.R. (2001). Dissociation between 'theory of mind' and executive functions in a patient with early left amygdala damage. *Brain, 124,* 287-298.

Fisher, N., & Happé, F. (2005). A training study of theory of mind and executive function in children with autistic spectrum disorders. *Journal of Autism and Developmental Disorders, 35,* 757-771.

Flashman, L.A., Wishart, H.A., Oxman, T.E., & Saykin, A.J. (2003). Boundaries between normal aging and dementia: Perspectives from neuropsychological and neuroimaging investigations. In V.O.B. Emery & T.E. Oxman (Eds.) *Dementia: Presentations, Differential Diagnosis, and Nosology (2nd edition)*. Johns Hopkins University Press. Baltimore, 3-30.

Folstein, M.F., Folstein, S.E., & McHugh, P.R. (1975). "Mini-mental state" : A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12,* 189-198.

Gilbert, S.J., Spengler, S., Simons, J.S., Steele, J.D., Lawrie, S.M., Frith, C.D., & Burgess, P.W. (2006). Functional specialization within rostral prefrontal cortex (area 10): A meta-analysis. *Journal of Cognitive Neuroscience, 18,* 932-948.

Gordon, A.C.L., & Olson, D.R. (1998). The relation between acquisition of a theory of mind and the capacity to hold in mind. *Journal of Experimental Child Psychology, 68,* 70-83.

Gottlieb, D. (2005). The strange stories test: A replication of children and adolescents with asperger syndrome. *European Child Adolescent Psychiatry, 14,* 73-82.

Green, R.E.A., Melo, B., Christensen, B., Ngo, L., Monette, G., & Bradbury, C. (2008). Measuring premorbid IQ in traumatic brain injury: An examination of the validity of the Wechsler Test of Adult Reading (WTAR). *Journal of Clinical and Experimental Neuropsychology, 30,* 163-172.

Gregory, C., Lough, S., Stone, V., Erzinclioglu, S., Martin, L, Baron-Cohen, S., & Hodges, J.R. (2002). Theory of mind in patients with frontal variant frontotemporal dementia and alzheimer's disease: Theoretical and practical implications. *Brain, 125,* 752-764.

Happé, F.G. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of Autism and Developmental Disorders, 24,* 129-154.

Happé, F., Ehlers, S., Fletcher, P., Frith, U., Johansson, M., Gillberg, C., Dolan, R., & Frith, C. (1996). 'Theory of mind' in the brain. Evidence from a PET scan study of asperger syndrome. *Clinical Neuroscience and Neuropathology, 8,* 197-201.

Happé, F., Winner, E., & Brownell, H. (1998). The getting of wisdom: Theory of mind in old age. *Developmental Psychology, 34,* 358-362.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. H. Bower (Ed.). *The psychology of learning and motivation: Vol. 22* (pp. 193-225). San Diego, CA: Academic Press.

Hedden, T., & Gabrieli, J.D.E. (2004). Insights into the ageing mind: A view from cognitive neuroscience. *Nature Reviews, 5,* 87-96.

Homack, S., Lee, D., & Riccio, C.A. (2005). Test review: Delis-Kaplan Executive Function System. *Journal of Clinical and Experimental Neuropsychology, 27,* 599-609.

Hughes, C. (1998). Finding your marbles: Does preschoolers' strategic behavior predict later understanding of mind? *Developmental Psychology, 34,* 1326-1339.

Hughes, C., Dunn, J., & White, A. (1998). Trick or treat?: Uneven understanding of mind and emotion and executive dysfunction in "hard to manage" preschoolers. *Journal of Child Psychology and Psychiatry, 39,* 981-994.

Hughes, C., & Graham, A. (2002). Measuring executive functions in childhood: Problems and solutions? *Child and Adolescent Mental Health, 7,* 131-142.

Jefferson, A.L., Paul, R.H., Ozonoff, A., & Cohen, R.A. (2006). Evaluating elements of executive functioning as predictors of instrumental activities of daily living (IADLs). *Archives of Clinical Neuropsychology, 21,* 311-320.

Jefferson, A.L., Poppas, A., Paul , R.H., & Cohen, R.A. (2007). Systemic hyperfusion is associated with executive dysfunction in geriatric cardiac patients. *Neurobiology of Aging, 28,* 477-483.

Jolliffe, T. & Baron-Cohen, S. (1999). The strange stories test: A replication with high-functioning adults with autism or asperger syndrome. *Journal of Autism and Developmental Disorders, 29,* 395-404.

Joseph, R.M., & Tager-Flusberg, H. (2004). The relationship of theory of mind and executive functions to symptom type and severity in children with autism. *Development and Psychopathology, 16,* 137-155.

Kaland, N., Moller-Nielsen, A., Callesen, K., Mortensen, E.L., Gottlieb, D., & Smith, L. (2002). A new 'advanced' test of theory of mind: Evidence from children and adolescents with asperger syndrome. *Journal of Child Psychology and Psychiatry, 43,* 517-528.

Katz, S., Ford, A.B., Moskowitz, R.W., Jackson, B.A., & Jaffe, M.W. (1963). The index of ADL: A standardized measure of biological and psychosocial function. *The Journal of the American Medical Association, 185,* 914-919.

Kaufman, D.M. (2007). *Clinical Neurology for Psychiatrists (6th Edition).* Philadelphia: Elsevier.

Kerr, N., Dunbar, R.I.M., & Bentall, R.P. (2003). Theory of mind deficits in bipolar affective disorder. *Journal of Affective Disorders, 73,* 253-259.

Lamar, M., & Resnick, S.M. (2004). Aging and prefrontal functions: Dissociating orbitofrontal and dorsolateral abilities. *Neurobiology of Aging, 25,* 553-538.

Lawton, M.P., Brody, E.M. (1969). Assessment of older people: Self-maintaining and instrumental activities of daily living. *Gerontologist, 9,* 179-186.

Lewis, M.S., & Miller, L.S. (2007). Executive control functioning and functional ability in older adults. *The Clinical Neuropsychologist, 21,* 274-285.

Lezak, M.D., Howieson, D.B., & Loring, D.W. (2004). Neuropsychological Assessment (4th edition). New York, NY: Oxford University Press.

Lindeboom, J., & Weinstein, H. (2004). Neuropsychology of cognitive ageing, minimal cognitive impairment, Alzheimer's disease, and vascular cognitive impairment. *European Journal of Pharmacology, 490,* 83-86.

Loeb, P.A. (1996). ILS: Independent Living Scales Manual. The Psychological Corporation, San Antonio.

Lough, S., Kipps, C.M., Treise, C., Watson, P., Blair, J.R., & Hodges, J.R. (2006). Social reasoning, emotion and empathy in frontotemporal dementia. *Neuropsychologia, 44,* 950-958.

MacPherson, S.E., Phillips, L.H., & Della Sala, S. (2002). Age, executive function, and social decision making: A dorsolateral prefrontal theory of cognitive aging. *Psychology and Aging, 17,* 598-609.

Maylor, E., Moulson, J.M., Muncer, A., & Taylor, L.A. (2002). Does performance of theory of mind tasks decline in old age? *British Journal of Psychology, 93,* 465-485.

Miller, L.S., Brown, C., Mitchell, M., & Williamson, G. (In press). Activities of Daily Living are Associated with Older Adult Cognitive Status: Caregiver versus Self Reports. *Journal of Applied Gerontology*.

Mitchell, M., & Miller, L.S. (2008). Prediction of functional status in older adults: the ecological validity of four Delis-Kaplan Executive Function System tests. *Journal of clinical and Experimental Neuropsychology, 30,* 683-690.

Njegovan, V., Man-Son-Hing, M., Mitchell, S.L., & Molnar, F.J. (2001). The hierarchy of functional loss associated with cognitive decline in older persons. *Journal of Gerontology, 56,* M638-M643.

Nutter-Upham, K.E., Saykin, A.J., Rabin, L.A., Roth, R.M., Wishart, H.A., Pare, N., & Flashman, L.A. (2008). Verbal fluency performance in amnestic MCI and older adults with cognitive complaints. *Archives of Clinical Neuropsychology, 23,* 229-241.

Ouelett, J., Scherzer, P.B., Rouleau, I., Métras, P., Bertrand-Gauvin, C., Djerroud, N., Boisseau, E., & Duquette, P. Assessment of social cognition in patients with multiple sclerosis. *Journal of the International Neuropsychological Society, 16,* 287-296.

Paxton, J.L., Barch, D.M., Racine, C.A., & Braver, T.S. (2007). Cognitive control, goal maintenance, and prefrontal function in healthy aging. *Cerebral Cortex, 18,* 1010–1028.

Pereira, F.S., Yassuda, M.S., Oliveira, A.M., Diniz, B.S., Radanovic, M., Talib, L.L., Gattaz, W.F., & Forlenza, O.V. (2010). Profiles of functional deficits in mild cognitive impairment and dementia: Benefits from objective measurement. *Journal of the International Neuropsychological Society, 16,* 297-305.

Petersen, R.C., Roberts, R.O., Knopman, D.S., Boeve, B.F., Geda, Y.E., Ivnik, R.J., Smith G.E., & Jack Jr., C.R. (2009). Mild cognitive impairment: Ten years later. *Neurological Review, 66,* 1447-1455.

Potter, L.M., & Grealy, M.A. (2008). Aging and inhibition of a prepotent motor response during an ongoing action. *Aging, Neuropsychology, and Cognition, 15,* 232-255.

Preacher, K.J., & Hayes, A.F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40,* 879-891.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *The Behavioral and Brain Sciences, 4,* 515-526.

Prins, N. D., Van Dijk, E.J., Den Heijer, T., Vermeer, S.E., Jolles, J., Koudstani, P.J., Hofman, A., & Breteler, M.M. (2005). Cerebral small-vessel disease and decline in information processing speed, executive function, and memory. *Brain, 128,* 2034-2041.

Raz, N., & Rodrigue, K.M. (2006). Differential aging of the brain: Patterns, cognitive correlates, and modifiers. *Neurosciences and Biobehavioral Reviews, 30,* 730-748.

Razani, J., Casas, R., Wong, J.T., Lu, P., Alessi, C., & Josephson, K. (2007). Relationship between executive functioning and activities of daily living in patients with relatively mild dementia. *Applied Neuropsychology, 14,* 208-214.

Reitan, R.M. (1958). Validity of the trail making test as an indicator of organic brain damage. *Perceptual and Motor Skills,8, 271-276.*

Revheim, N., Schechter, I., Kim, D., Silpo, G., Allingham, B., Butler, P., & Javitt, D.C. (2006). Neurocognitive and symptom correlates of daily problem-solving skills in schizophrenia. *Schizophrenia Research, 83,* 237-245.

Royall, D.R., Lauterbach, E.C., Cummings, J.L., Reeve, A., Rummans, T.A., Kaufer, D.I., LaFrance, W.C., & Coffey, C.E. (2002). Executive control function: A review of its promise and challenges for clinical research. *Journal of Neuropsychiatry and Clinical Neurosciences, 14,* 377-405.

Sabbagh, M.A., Xu, F., Carlson, S.M., Moses, L.J., & Lee, K. (2006). The development of executive functioning and theory of mind: A comparison of chinese and u.s. preschoolers. *Psychological Science, 17,* 74-81.

Salthouse, T.A. (1985). *A theory of cognitive aging.* Amsterdam: North-Holland.

Salthouse, T.A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103,* 403-428.

Salthouse, T.A., & Fristoe, N.M. (1995). Process analysis of adult age effects on a computer-administered trail making test. *Neuropsychology, 9,* 518-528.

Salthouse, T.A., Toth, J., Daniels, K., Parks, C., Pak, R., Wolbrette, M., Hocking, K.J. (2000). Effects of aging on efficiency of task switching in a variant of the trail making test. *Neuropsychology, 14,* 102-111.

Saltzman, J., Strauss, E., Hunter, M., & Archibald, S. (2000). Theory of mind and executive functions in normal aging and parkinson's disease. *Journal of the International Neuropsychological Society, 6,* 781-788.

Schroeter, M., Raczka, K., Neumann, J., & von Cramon, D.Y. (2008). Neural networks in frontotemporal dementia – A meta-analysis. *Neurobiology of Aging, 29,* 418-426.

Sheikh, J.I., Yesavage, J.A. (1986). Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. Clinical Gerontology : A Guide to Assessment and Intervention 165-173, NY: The Haworth Press.

Sheikh, J.I., Yesavage, J.A., Brooks, J.O., III, Friedman, L.F., Gratzinger ,P., Hill, R.D, Zadeik A., & Crook, T. (1991). Proposed factor structure of the Geriatric Depression Scale. *International Psychogeriatrics 3:* 23-28.

Sherod, M.G., Griffith, H.R., Copeland, J., Belue, K., Krzywanski, S., Zamrini, E.Y., Harrell, L.E., Clark, D.G., Brockington, J.C., Powers, R.E., & Marson, D.C. (2009). Neurocognitive predictors of financial capacity across the dementia spectrum: Normal aging, mild cognitive impairment, and Alzheimer's disease. *Journal of the International Neuropsychological Society,15,* 258-267.

Shunk, A.W., Davis, A.S., & Dean, R.S. (2006). Test review of the Delis-Kaplan Executive Function System. *Applied Neuropsychology, 14,* 275-279.

Singer, T. (2006). The neuronal basis and ontogeny of empathy and mind reading: Review of literature and implications for future research. *Neuroscience and Behavioral Reviews, 30,* 855-863.

Slessor, G., Phillips, L.H., & Bull. (2007). Exploring the specificity of age-related differences in theory of mind tasks. *Psychology and Aging, 22,* 639-643.

Steenhuysen, J. (2010, July). Early diagnosis can cut Alzheimer's costs: Study. *Reuters.* Retrieved from http://www.reuters.com

Stone, V.E., Baron-Cohen, S., & Knight, R.T. (1998). Frontal lobe contributions to theory of mind. *Journal of Cognitive Neuroscience, 10,* 640-656.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psycholology, 18,* 643–662.

Stuss, D.T., Alexander, M.P., Floden, D., Binns, M.A., Levine, B., McIntosh, N., Rajah, N., & Hevenor, S.J.. (2002). Fractionation and localization of distinct frontal lobe processes: Evidence from focal lesions in humans. In R.T. Knight & Studd, D.T. (Eds.) *Principles of Frontal Lobe Function*. Oxford University Press. New York, 392-407.

Sorel, O., & Pannequin, V. (2008). Aging of the planning process: The role of executive functioning. *Brain and Cognition, 66,* 196-201.

Sullivan, S. & Ruffman, T. (2004). Social understanding: How does it fare with advancing years? *British Journal of Psychology, 95,* 1-18.

Tangalos, E.G., Smith, G. E., Ivnik, R.J., Petersen, R.C., Kokmen, E., Kurland, L.T., Offord, K.P., & Parisi, J.E. (1996). The Mini-Mental State Examination in general medical practice: Clinical utility and acceptance. *Mayo Clinic Proceedings, 71,* 829-837.

Taylor, M.A. (1999). *The Fundamentals of Clinical Neuropsychiatry*. New York: Oxford University Press.

The Psychological Corporation (2001). *Wechsler Test of Adult Reading*. San Antonio, TX: Harcourt Brace & Company.

Tombaugh, T.N. (2005). Test-retest reliable coefficients and 5-year change scores for the MMSE and 3MS. *Archives of Clinical Neuropsychology, 20,* 485-503.

Uekermann, J., Thoma, P., & Daum, I. (2008). Proverb interpretation changes in aging. *Brain and cognition, 67,* 51-57.

Van Gerven, P.W.M., Van Boxtel, M.P.J., Meijer, W.M., Willems, D., & Jolles, J. (2007). On the relative role of inhibition in age-related working memory decline. *Aging, Neuropsychology, and Cognition, 14,* 95-107.

Von Hippel, W., & Dunlop, S.M. (2005). Aging, inhibition, and social inappropriateness. *Psychology and Aging, 20,* 519-523.

Wecker, N.S., Kramer, J.H., Hallam, B.J., & Delis, D.C. (2005). Mental flexibility: Age effects on switching. *Neuropsychology, 19,* 345-352.

Wecker, N.S., Kramer, J.H., Wisniewski, A., Delis, D.C., & Kaplan, E. (2000). Age effects on executive ability. *Neuropsychology, 14,* 409-414.

West, R.L. (1996). An application of prefrontal cortex function theory to cognitive aging. *Psychological Bulletin, 120,* 272-292.

West, R.L. (2000). In defense of the frontal lobe hypothesis of cognitive aging. *Journal of the International Neuropsychological Society, 6,* 727-729.

Wimo, A.,& Winblad, B. (2008). Economical aspects of dementia. In C. Duyckaerts & I. Litvan (Eds.) *Handbook of Clinical Neurology (volume 89; 3rd series).* Elsevier. Amsterdam: 137-146.

Yesavage, J., A., Brink, T.L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V.O. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research, 17,* 37-49.

Zelazo, P.D., & Frye, D. (1998). Cognitive complexity and control ii. The development of executive function in childhood. *American Psychological Society, 7,* 121-125.