AWARENESS OF COGNITIVE ABILITIES AND MINDFULNESS IN HEALTHY OLDER ADULTS

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by

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Chapter I – Abstract

Impaired awareness of cognitive abilities, termed anosognosia, is present and well documented in dementia, but work utilizing metacognitive models to understand cognitive awareness in healthy older adults has been less conclusive. Mindfulness, involving attention to cognition and sensations, may play a role in awareness. This study examined accuracy in predicting cognitive ability in healthy older adults, and whether the link between subjective and objective cognition is strengthened by mindfulness. 59 cognitively healthy older adults completed neuropsychological testing and self-report measures of cognitive difficulty and mindfulness. Analyses revealed better objective cognition was linked to better subjective cognition. Global mindfulness did not moderate this relationship. Results indicate healthy older adults are aware of their cognitive abilities, and the anosognosia seen in dementia does not accompany normal aging. Greater mindfulness does not appear to strengthen awareness. However, further work is needed to explore awareness and mindfulness across the spectrum of normal to impaired cognition, due to potential restricted range imposed by our focus on cognitively healthy subjects.
Chapter II – Introduction

Cognitive Awareness

Insight into one’s own cognitive abilities is a mental faculty that has been well studied in the field of cognitive psychology (Vanderhill, Hultsch, Hunter, & Strauss, 2010). Termed “metacognition” in this literature, investigation of this topic is of great relevance to the field of neuropsychology as well, as many clinical populations, from psychiatric (e.g. schizophrenia) to neurologic (e.g. traumatic brain injury, Alzheimer’s disease), display impairments in awareness of their own cognitive abilities (Salmon et al., 2006). Clinicians describe this distinct clinical deficit in cognitive awareness, or metacognition as anosognosia (Salmon et al., 2006).

To study this phenomenon in patient populations, clinicians and clinical researchers have often assessed a patient’s level of anosognosia by comparing the patient’s self-report on a clinical cognitive complaint inventory to that of a caretaker reporting in reference to the patient, or relative to some objective neuropsychological measure of global cognitive skills (Michon, Deweer, Pillon, Agid, & Dubois, 1994; Salmon et al., 2006; Spitznagel & Tremont, 2005). These methods have proven valid and clinically useful due to the tendency of patients displaying anosognosia to grossly overestimate their cognitive abilities when compared to either a collateral source or performance-based measures (Michon et al., 1994; Salmon et al., 2006; Spitznagel & Tremont, 2005). However, certain additional benefits are gained through comparison to objective performance as opposed to collateral report, such as the reduction of subjective
bias that comes with the use of collateral report measures (Okonkwo et al., 2008).
Regardless, both methods have been invaluable in yielding insight regarding the neural correlates and underlying factors of this common neurologic symptom (Cosentino & Stern, 2005; Michon et al., 1994; Salmon et al., 2006).

**Neural and Cognitive Correlates of Awareness**

As early as 1994, Michon and colleagues began to tie anosognosia to specific dysfunction in the frontal lobe of the cerebral cortex. This study revealed that patients’ severity of anosognosia was negatively associated with their score on a battery of executive functioning tests shown to be highly sensitive to frontal systems dysfunction in neurodegenerative diseases (e.g. the Wisconsin Card Sorting Task) (Michon et al., 1994). Multiple accounts from clinical case studies of frontal trauma due to aneurysm, penetrating brain injury, etc. in which patients also displayed flawed awareness of cognitive deficits further supported this selective frontal deterioration hypothesis underlying anosognosia (Alexander & Stuss, 2000; McGlynn & Schacter, 1989; Michon et al., 1994).

Advances in brain imaging in the past two decades have served to refine and add to the frontal systems hypothesis of impaired awareness. Functional imaging studies have repeatedly implicated reduced perfusion in the right prefrontal and parietal cortices as key factors in anosognosia severity (Reed, Jagust, & Coulter, 1993; Starkstein et al., 1995). These findings are in line with neuroimaging research on healthy individuals indicating that the right prefrontal cortex is critical in assessing one’s own memory abilities (Kikyo, Ohki, & Miyashita, 2002; Platek, Keenan, Gallup, & Mohamed, 2004; Schnyer et al.,
In a 2006 study, Salmon and colleagues further localized the neural correlates of anosognosia to the orbitofrontal cortex and the temporoparietal junction specifically, rather than just the general prefrontal and parietal cortices. Thus, most of these neuroimaging studies converge on the idea that anosognosia severity is related specifically to the functioning of these structures rather than being related to global cortical decline or general dementia severity, although some debate still exists (Cosentino & Stern, 2005; Reed et al., 1993; Salmon et al., 2006; Starkstein et al., 1995).

The Problem and Prevalence of Anosognosia

The prevalence of anosognosia in psychiatric and neurologic disorders is of concern given the many associated difficulties for patients and caregivers alike. For example, presence of anosognosia may delay medical professionals’ ability to treat and diagnose a disorder, as patients who display it are less likely to self-report problems and seek assistance (Derouesné et al., 1999). Anosognosia can also be dangerous after diagnosis, as it may interfere with patient adherence to doctor’s orders; similarly, patients who do not understand their cognitive impairment will often continue to do tasks that have been deemed dangerous (e.g. driving) (Cotrell & Wild, 1999). In addition, anosognosia has been shown to exacerbate caregiver burden and make treatment more difficult for both the patient and the medical professionals involved (DeBettignies, Mahurin, & Pirozzolo, 1990).

However, converging evidence suggests that anosognosia is present not only in severe psychiatric and neurologic disorders, but may also be present in very early stages of cognitive decline (Derouesné et al., 1999; Michon et al., 1994; Vogel et al., 2004). For
example, in studying patients with dementia, Michon found no relationship between patients’ level of anosognosia and the severity of their dementia (Michon et al., 1994). This aligns with the above neuroimaging studies, in which anosognosia severity was unrelated to global cortical decline (Reed et al., 1993; Salmon et al., 2006; Starkstein et al., 1995). In addition, multiple studies have since supported the idea that anosognosia is present even in mild cognitive impairment (MCI) or questionable dementia, the precursor to Alzheimer’s disease (AD) in which daily living has not yet been significantly impaired (Derouesné et al., 1999; Vogel et al., 2004). Estimates of anosognosia prevalence are extremely high in patients with AD (81%), but also noted in up to 60% of patients with MCI (Vogel et al., 2004).

These findings raise the question of what exactly constitutes “normal” lack of awareness for cognitive abilities in older age; in other words, to what extent might reduced insight be associated with normal deficits that accompany aging, and at what point does it become a clinical symptom? Even in apparently healthy older adults, literature on metacognitive abilities has been mixed, with reports of some task and domain-specific lack of awareness appearing throughout the last few decades.

**Metacognitive Approaches to Studying Awareness**

Cognitive psychologists have typically employed two tasks, known as judgment-of-learning (JOL) and feeling-of-knowing (FOK), to assess metacognition of memory in healthy older individuals (Souchay, Isingrini, & Espagnet, 2000). The two tasks differ primarily in that JOL asks the participant to assess the likelihood of recalling recently learned information, whereas FOK asks the participant to assess the likelihood of later
recognizing information they have already failed to recall (Souchay et al., 2000). The effects of aging on metamnemonic functioning appear to be specific to which of the above tasks is employed, as well as which domain of memory the task is assessing. For instance, multiple experiments examining the effects of aging on item-by-item JOL scores have indicated that there are no differences between younger and older adults in metamemory (Bieman-Copland & Charness, 1994; Connor, Dunlosky, & Hertzog, 1997; Rabinowitz, Ackerman, Craik, & Hinchley, 1982; Walheim, Dunlosky, & Jacoby, 2011). However, experiments on FOK tasks, especially those looking at episodic, or autobiographical, FOK tasks have indicated a deficit in episodic metamemory in older adults not seen in younger individuals (Souchay et al., 2000). In addition to the mixed evidence provided from these two tasks, experiments that compare subjective reports of mnemonic or attentive ability to actual performance on traditional cognitive tasks have elicited a mix of moderate, weak, or absent correlations, further implying a potential deficit in global cognitive awareness in healthy older adults (Salthouse & Siedlecki, 2005; Zelinski, Gilewski, & Anthony-Bergstone, 1990).

While this information provides some insight into the metacognitive abilities of healthy older adults, it does not reach a clear consensus, and does not inform the clinician with a baseline of cognitive awareness that accompanies regular aging. In order to provide such a baseline, studies are necessary that assess cognitive awareness in healthy older adults via use of the same global neuropsychological measures used by clinicians when assessing anosognosia in patient populations. This information would provide key insight for clinicians hoping to better understand the extent to which the anosognosia
observed in a patient might reflect a deviation from normative awareness or a decline from premorbid awareness. In addition to the need for better appreciation of the nature of baseline awareness in healthy individuals, an understanding of mechanisms underlying awareness may be of benefit in effort to ameliorate anosognosia when it is identified. One such mechanism may be mindfulness.

**Mindfulness**

Mindfulness is a construct originating in Eastern spiritual tradition that has been receiving increasing attention in psychology literature due to its reported therapeutic benefits for a variety of psychiatric disorders (Baer, 2003). Although the conceptualization of mindfulness varies, it often takes on a multifaceted description with at least two primary aspects in common– cognitive attention to all present-moment exogenous and endogenous sensory experience, as well as a non-judgmental and non-reactive emotional state in reference to this incoming information (Chiesa, Calati, & Serretti, 2011; Kabat-Zinn, 1994).

Mindfulness is often studied through the use of self-report questionnaires that assess the level of trait mindfulness of the rater (i.e. dispositional mindfulness) (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). Most of these questionnaires further imply the idea of mindfulness being multidimensional in nature by having distinct subscales with their own independent scores, and psychometric evidence continues to reaffirm this notion (Baer et al., 2006). In 2006, Baer and colleagues factor analyzed a combined pool of items from five of the most popular mindfulness self-report scales in attempts to break down mindfulness into its discrete components. In their analyses, five
distinct sub-components emerged across the different scales, further lending support to the multifaceted conceptualization of mindfulness.

In addition to the multidimensional nature of mindfulness, its overall conceptualization is nuanced by the fact that it appears to be plastic, or modifiable, through either meditation training or even brief, one-time inductions (Chiesa et al., 2011). Given the complexities inherent in this broad construct, attempts to pin down the associated neural and cognitive correlates of mindfulness have yielded slightly different results depending on a variety of factors.

**Neural and Cognitive Correlates of Mindfulness**

Although there is divergence in specific findings due to methodological differences, mindfulness in healthy college and middle-aged adults seems to be generally associated with enhanced activity in prefrontal cortical areas involved in attention and executive functioning (Allen et al., 2012; Creswell, Way, Eisenberger, & Lieberman, 2007; Dickenson, Berkman, Arch, & Lieberman, 2012). For example, a seminal study examining links between mindfulness and cortical activity found that higher self-reported dispositional mindfulness was related to increased pre-frontal cortical activity during an affect-labeling task. The researchers discovered especially robust enhancements in the medial prefrontal cortex, a brain area that has long been associated with monitoring and self-awareness (Creswell et al., 2007).

Studies investigating the neural correlates of mindfulness in healthy older adults are only recently appearing in the literature, yet early evidence suggests similar findings to those found in other populations. For example, a recent study investigating
dispositional mindfulness and functional connectivity in the elderly found an association between mindfulness and connectivity in a pivotal brain network consisting of the medial prefrontal and posterior cingulate cortices that has also been implicated in self-referential thought (Prakash, De Leon, Klatt, Malarkey, & Patterson, 2013). Age-related declines in connectivity have long been observed in this network, implying a preventative effect of mindfulness against certain cognitive deficits that accompany older age (Prakash et al., 2013). Thus, there is some converging evidence across age groups that trait mindfulness is associated with increased functioning in executive prefrontal cortical areas (Allen et al., 2012; Creswell et al., 2007; Dickenson et al., 2012; Prakash et al., 2013).

Similarly, studies of cognitive links to mindfulness have generated complex and nuanced results that differ depending on a variety of factors. Improvements in attention, memory, executive functioning, metacognition, and visuo-spatial processing have all been reported in the context of increased mindfulness, though these domains and their subcomponents are variably implicated depending on the methodology of the specific experiment (as reviewed in Chiesa et al., 2011).

For example, the effects of mindfulness on attentional abilities appear to differ depending on how mindfulness is conceptualized in a given study (Chiesa et al., 2011; Jha, Krompinger, Baime, 2007). However, other cognitive faculties appear to be associated with mindfulness in general, whether induced or dispositional, short term or long term – these include working memory, verbal fluency and visuo-spatial processing (Chiesa et al., 2011; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). In separate studies on both brief and long-term mindfulness inductions in college and middle-aged
populations, researchers have replicated cognitive improvements in these three domains (Chiesa et al., 2011; Zeidan et al., 2010). In addition, both visuo-spatial processing and executive functioning have been associated with dispositional levels of different mindfulness facets in college students (Anicha, Ode, Moeller, & Robinson, 2012). These findings are critical in that they highlight cognitive improvements that seem to be consistent across different conceptualizations and operational definitions of mindfulness.

Much like the neural correlates of mindfulness, the cognitive links to mindfulness have not been thoroughly investigated in healthy older adults. However, new evidence is converging with that of younger adults, and appears promising from a clinical standpoint. In a 2010 study, McHugh, Simpson, & Reed discovered that improvement in mindfulness lead to increased attention in healthy older adults. This study suggests that mindfulness may be a modifiable mechanism to enhance cognitive performance in older adult populations.

**Current Study**

As reviewed above, examination of cognitive awareness in healthy older adults via use of the same global neuropsychological measures used by clinicians when assessing anosognosia in patient populations would be of benefit in providing a “healthy” baseline for clinicians to compare patient awareness and determine if anosognosia is present. In addition, it appears likely that dispositional mindfulness could underlie or moderate cognitive awareness in healthy older adults, as higher levels of mindfulness are overall associated with better functioning of many of the same neural substrates
implicated in anosognosia (e.g. fronto-parietal attention networks, etc.) (Salmon et al., 2006; Prakash et al., 2013). Thus, the present study had two primary aims.

**Aim 1.** Determine the relationship between objective cognitive performance and subjective cognitive complaint in healthy older adults.

The first aim of this study was to provide the first estimate, to our knowledge, of cognitive awareness in healthy older adults using clinically relevant measures, by comparing a self-report (subjective) measure of cognitive difficulties to objective scores on a global composite derived from a battery of clinical neuropsychological tests. We hypothesized that subjective cognitive report would be significantly correlated with objective cognitive testing.

**Aim 2.** Determine to what extent mindfulness moderates the relationship between subjective cognitive complaint and objective cognition.

The second aim of this study was to determine if dispositional mindfulness moderates the relationship between healthy older adults’ self-report of cognitive difficulties and actual neuropsychological performance. It was predicted that mindfulness would significantly moderate this relationship, with the strength of the relationship between objective performance and subjective report increasing with scores of trait mindfulness. In other words, those high in mindfulness would provide more accurate estimates of their cognitive ability, and those low in mindfulness would be less accurate.
Chapter III – Methods

Participants

The current study included 59 cognitively healthy older adults recruited via advertisement at a local health and wellness center. English-speaking older adults ages 50-80 with no history of brain injury, neurological impairment, or severe mental illness were eligible for the study. Participants were 96.6% Caucasian, 3.4% African American, and ranged in age from 50-78 ($M=64.3$, $SD=7.3$), with an average years of education of 15.3 ($SD=2.9$), and an approximately 1:3 male to female ratio.

Instruments

Global cognitive functioning. The current study employed the Montreal Cognitive Assessment (MoCA) to estimate global cognition and screen for cognitive impairment (Nasreddine et al., 2005). Past research has shown the MoCA to be a reliable and valid measure of the cognitive functioning of older adults, with new evidence indicating high sensitivity and specificity in detecting cognitive impairment (Luis, Keegan, & Mullan, 2009). Based upon this previous literature, raw total scores were used to estimate global cognitive ability, and all prospective participants with sub-threshold scores (MoCA $\leq 23$) were excluded from the study to ensure the cognitive health of the sample.

Neuropsychological Test Battery: The neuropsychological battery used for the current study included individual measures of attention, executive function, language, visuospatial ability, learning, and memory. Clinically standardized scores of these
domain-specific measures were then combined to create a composite measure of global
cognitive ability for use in analyses. The following measures were included in the
composite score:

**Attention.** The Trail Making Test A (TMT-A) requires individuals to rapidly
connect numbered circles with a continuous line (Reitan, 1958). Neuropsychological
literature indicates that the total time to complete TMT-A is a reliable and valid measure
of visual scanning and attention (Dikmen, Heaton, Grant, & Temkin, 1999). As such,
TMT-A completion time reflected the domain of attention in the current study.

**Executive function.** A combination of the Trail Making Test B, Frontal
Assessment Battery, and Phonemic Fluency tests were used to assess executive function
in this study. The Trail Making Test B (TMT-B) requires individuals to connect circles
containing alternating numbers and letters with a continuous line (Reitan, 1958). Total
time to complete this task is a reliable and valid indicator of executive function, and was
used to measure this domain in the current study (Dikmen et al., 1999).

The Frontal Assessment Battery (FAB) requires participants to carry out multiple
tasks related to executive function, including verbal conceptualization (e.g., identifying
similarities between words) and fronto-motor (e.g., complex alternating movements)
tasks (Dubois, Slachevsky, Litvan, & Pillon, 2000). This measure has strong
psychometric properties in terms of reliability and validity, and can consistently detect
frontal lobe impairment in older adults (Yoshida et al., 2009). The FAB total score was
used in part to reflect executive function in this sample.
The Phonemic Fluency Test (FAS) requires individuals to name as many words starting with a given letter (F, A, or S) as possible in one minute (Tombaugh, Kozak, & Rees, 1999). This task is a well-established measure that is sensitive to frontal lobe impairment in various populations (Tombaugh et al., 1999). The total score on this measure was used as the final component of the executive function domain.

**Language.** The Semantic Fluency Test (Animal) requires participants to name as many animals as they can within a one-minute period (Tombaugh et al., 1999). Research has shown this measure to be significantly associated with activity in the temporal lobes as well as linguistic ability (Baldo, Schwartz, Wilkins, & Dronkers, 2006). A total score derived from this measure was used to assess the domain of language in the current study.

**Visuospatial.** The Rey-Osterrieth Complex Figure Test (RCFT) is a reliable and valid measure of visuospatial abilities that initially requires individuals to copy a complex 18-piece geometric figure (RCFT copy) (Loring, Martin, Meador, & Lee, 1990). To complete the task correctly, the components of the figure must be drawn correctly and in the correct place. Total scores on RCFT copy were thus used to estimate visuospatial ability in this study.

**Learning & Memory.** The Hopkins Verbal Learning Test (HVLT-R) requires individuals to systematically learn (HVLT learning), recall (HVLT recall), and recognize (HVLT recognition) a list of 12 vocabulary words that can be semantically clustered (Brandt, 1991). It is highly specific and sensitive in the detection of dementia, and total scores on HVLT learning and HVLT recall/recognition were used in this study to assess the domains of learning and memory, respectively (Frank & Byrne, 2000).
The Rey-Osterrieth Complex Figure Test is also a reliable and valid measure of mnemonic abilities, as the copy phase is followed by a test of immediate recall of the figure (RCFT immediate) as well as 20 minutes later (RCFT delay) (Loring et al., 1990). Total scores on RCFT immediate and RCFT delay were used in conjunction with HVLT recall and recognition scores to assess memory in this sample.

**Subjective cognitive complaint.** The Cognitive Difficulties Scale (CDS) is a clinical measure that assesses subjective cognitive complaint, often in cases of MCI and dementia. The CDS is a 39-item Likert scale self-report measure about the frequency of common cognitive problems (e.g. I have trouble recalling frequently used phone numbers) (McNair & Kahn, 1983). It is psychometrically both reliable and valid, and is a well-established tool to detect anosognosia in patient populations through comparison with a more objective source (Derouesné et al., 1999). A total score derived from this scale was used to assess subjective complaint in this sample (McNair & Kahn, 1983).

**Mindfulness.** The Five-Factor Mindfulness Questionnaire (FFMQ) is a 39-item Likert scale self-report measure that assesses the level of trait mindfulness in an individual across five subscales which combine to yield a global score (Baer et al., 2006). This measure was developed through the factor analysis of a large pool of items from various mindfulness questionnaires, resulting in the subscales of observing, describing, non-judging, non-reacting, and acting with awareness (Baer et al., 2006). This measure is both reliable and valid, displaying a significant association with meditation experience (Baer et al., 2008). The current study employed the global score of this measure to assess participants’ level of trait mindfulness.
Procedures

The current study was approved by the local Institutional Review Board. Prior to enrolling in the study, trained graduate students conducted telephone screening of any prospective participants in order to assure a healthy sample, excluding those with any history of brain injury, neurological impairment, or severe mental illness. Participants meeting eligibility criteria and opting to enroll in the study first provided written informed consent. Next, participants completed the above described self-report measures. Clinically trained graduate students then administered a neuropsychological battery to all eligible participants as part of a larger study. For the current study, only individuals with MoCA >23 were retained for analyses.

Data Analysis Plan

Global composite cognitive scores were derived for each participant by combining clinically normed t-scores for each neuropsychological battery measure, and descriptive statistics were calculated for this composite score and all other variables included in the study. A moderation analysis predicting subjects’ total scores on the Cognitive Difficulties Scale (CDS) was then conducted using hierarchical linear regression. The first model included composite scores of global cognition (Composite) derived from the summation of clinically standardized scores on the above neuropsychological measures, as well as total scores on the Five Factor Mindfulness Questionnaire (FFMQ). The second model then included a cross-product interaction term derived by multiplying the Composite and FFMQ scores for each participant to test for a possible moderation effect.
Chapter IV – Results

Descriptive Statistics

Participants had a mean CDS total of 27.2 (SD=16.2), a mean FFMQ total of 145.1 (SD=16.0), and a mean MoCA total of 26.6 (SD=2.2).

Global Cognition and Mindfulness are Associated with Subjective Complaint

The first block examining composite cognition and total FFMQ scores significantly predicted CDS total scores, $F(2,56)=6.47, p<0.01$. As seen in Table 1, composite cognitive scores were significantly related to CDS scores, with better cognition related to lower CDS totals ($\beta=-0.29, p=0.02$). FFMQ total scores were also associated with CDS scores ($\beta=-0.27, p=0.03$), with higher FFMQ scores related to lower CDS totals.

Interactive Effects of Cognition and Mindfulness on Subjective Complaint

The second block examining the interaction of Composite and FFMQ did not predict subjective cognitive complaint, $\Delta F(1,55)=0.71, p=0.40$. Also seen in Table 1, the cross-product interaction term derived from these two variables was not significantly associated with subjective complaint above and beyond the two variables alone ($\beta=-0.10, p=0.40$).
Chapter V – Conclusions

The current study investigated awareness of cognitive abilities in healthy older adults, and whether or not mindfulness strengthens the relationship between objective cognitive performance and subjective cognitive self-report. It was hypothesized that objective and subjective cognition would be significantly related, and mindfulness would be a significant moderator of this relationship, with higher mindfulness predicting a stronger relationship. As hypothesized, objective cognitive performance and subjective cognitive report were significantly related in this sample, with better cognition associated with lower cognitive complaint. However, mindfulness did not moderate this relationship, and does not appear to strengthen the relationship between subjects’ cognitive self-report and actual cognitive performance.

These results have important implications for the field of clinical neuropsychology. This is the first study, to our knowledge, to assess the level of cognitive self-awareness in healthy older adults using clinically relevant measures developed for use in the assessment of anosognosia in patient populations. Our results indicate that healthy older adults are aware of their own cognitive abilities as compared to an objective source, and anosognosia-like deficits in cognitive awareness do not accompany normal aging. These results also provide a healthy normative baseline from which neuropsychologists can compare the deficits of patient populations, and more accurately assess the impairments in awareness characteristic of certain disorders (e.g., Alzheimer's disease). Additionally, these results inform and reinforce metacognitive
literature that displays equivalent metacognition between younger and older healthy adults in various domains (Bieman-Copland & Charness, 1994; Connor et al., 1997; Rabinowitz et al., 1982; Walheim et al., 2011). Though some studies have found domain and method-specific impairments, these results suggest that at least overall and in terms of global cognition, healthy older adults are aware of their abilities (Souchay et al., 2000).

The current study also investigated the construct of mindfulness as a potential mechanism underlying cognitive awareness in healthy older adults. This was an important construct to examine, as many studies have shown mindfulness to be a plastic or modifiable factor that can be enhanced through meditation or direct induction (Chiesa et al., 2011). The efficacy of mindfulness in treating certain symptoms of cognitive disorders is still under study, and should thus be studied first as a potential underlying factor in normal cognition (Chiesa et al., 2011). Unfortunately, the current study does not support the notion that mindfulness underlies awareness. Although our results indicate that mindfulness is not related to enhanced cognitive awareness in healthy older adults, methodological choices within this study could potentially limit interpretation of this aspect of the current results.

One possible limitation of the current study is the use of a self-report inventory to measure mindfulness. We utilized a self-report measure of mindfulness for many reasons; specifically, this method allows for efficient data collection, and the Five-Factor Mindfulness Questionnaire (FFMQ) in particular displayed strong psychometric properties (Baer et al., 2008). Our decision was also informed by existing literature, which indicates that individuals with deficits in self-reporting of cognitive abilities can
still accurately report information regarding other constructs (Spitznagel & Tremont, 2005). However, it may still be argued that use of a self-report is suboptimal, as there is no way to ensure that any variability in accuracy or reporter bias reflected in CDS scores did not also distort the accuracy of FFMQ mindfulness scores. The fact that we observed a significant relationship between cognitive self-report and mindfulness, and not actual objective cognition and mindfulness in our regression analyses could also be interpreted as supportive of this notion.

Another possible limitation lies in our interpretation of clinical cognitive impairment on the MoCA, the cognitive measure utilized to screen participants for inclusion on the basis of cognitive health. The creators of this measure initially indicated a cut-off of 26 for detecting cognitive impairment, but recent literature suggests a cut-off of 23 actually enhances the specificity and sensitivity of the measure (Luis, et al., 2009; Nasreddine et al., 2005). Because we utilized this cut-off of 23 based on the most recent literature, some individuals in our sample fall below the initially suggested cut-off. However, exploratory analyses revealed that using a cut-off of 26 rather than 23 did not significantly change the results. As such, our use of the lower cutoff does not appear to be problematic (rather, it contributed to our power via larger sample size), and these results should be generalizable to healthy older adults.

One final potential limitation is the possibility that restricted range could have limited our analyses. Due to the fact that our sample displayed accurate cognitive awareness overall, it may have provided a sort of ceiling effect that prevented accurate assessment of whether or not mindfulness underlies this construct. In addition, our
sample also displayed a high degree of mindfulness that is comparable to that of experienced meditators used in the validation of the FFMQ, (Baer et al., 2008). Although it is possible that issues of self-report limit the validity of this measure, if genuine, we must consider reasons for such high levels of mindfulness, including our sampling methods. Because our sample was recruited from a local health and wellness center, these individuals tended to be highly active (e.g., regularly exercising), independent, healthy older adults. Maintaining physical activity has been associated with mindfulness in prior literature (Ulmer, Stetson, & Salmon, 2010). Therefore, our sample may have been too high on average in both cognitive awareness and mindfulness to detect a significant relationship in this study.

The limitations of the current study thus offer directions for future research. One direction might be to use an objective measure of mindfulness, which would avoid participant bias that can occur in self-report measures. While meditation experience or active mindfulness inductions are often used as objective measures of the mindfulness construct (Baer, 2003), the prior is not specific enough and the latter can be difficult to accomplish in cross-sectional research like the current study. Though longitudinal study is possible and encouraged, perhaps development of an objective one-time measure is more appropriate for cross-sectional work in this area of research. Creation and validation of a set of objective tasks related to the content of the more concrete items on the FFMQ and other measures of mindfulness may be something to investigate in this direction. For example, multiple items on the FFMQ are related to self-referential descriptive ability (e.g. “When I have a sensation in my body, it’s difficult for me to describe it because I
can’t find the right words”). Measures of the accuracy of an individual’s described bodily sensations (e.g., feelings of relaxation) in relation to controlled laboratory measurement (e.g., electromyography) could be developed to test this construct at a single time-point in a more objective manner.

In addition, conducting similar work in a sample that varies more in cognitive awareness and mindfulness might eliminate any concerns for restricted range that potentially limited this study. Different recruitment methods could be utilized to obtain a broader range of healthy older adults with different lifestyles (e.g. more sedentary older adults, etc.), as this may help achieve greater variability in awareness and mindfulness. Future directions might also include examining mindfulness and cognitive awareness across the spectrum of cognition (healthy older adults, individuals with MCI, and those diagnosed with dementia). Although it might be hard to parse apart the effects of cognitive impairment on awareness from those of mindfulness, there is some literature supporting the decoupling of cognitive impairment and awareness of impairment of those with MCI and dementia, so this confound may not be an issue (Cosentino & Stern, 2005; Michon et al., 1994; Salmon et al., 2006). Regardless, similar work with a broader range of impairment, awareness, and mindfulness could help clarify the relationships investigated in the current study.

In conclusion, the current study demonstrates that healthy older adults appear aware of their own cognitive abilities, and deficits associated with anosognosia do not seem to accompany normal aging. Mindfulness did not moderate the relationship between cognitive performance and self-report in this sample, but future work should attempt to
develop and employ an objective measure of mindfulness to clarify the relationships examined in this study, and do so in a more varied older adult sample without restriction in the range of cognitive awareness and mindfulness.
References


Table 1

*Predicting Subjective Cognitive Report with Objective Cognition and Mindfulness*

<table>
<thead>
<tr>
<th>Block 1</th>
<th>(\beta)</th>
<th>(p)</th>
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<tbody>
<tr>
<td>Composite</td>
<td>-0.29</td>
<td>0.02</td>
</tr>
<tr>
<td>FFMQ</td>
<td>-0.27</td>
<td>0.03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block 2</th>
<th>(\beta)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite*FFMQ</td>
<td>-0.10</td>
<td>0.40</td>
</tr>
</tbody>
</table>

*Note.* Composite = A composite global cognition score derived from summation of T-scores of individual measures from a comprehensive neuropsychological battery; FFMQ = Five Factor Mindfulness Questionnaire.