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Differential Relationships of Somatic and Cognitive Anxiety with Measures of Processing Speed in Older Adults

Chelsea B. Schoen, M.A.[1] and **Roee Holtzer, Ph.D.**[1,2]

[1]Ferkauf Graduate Schoen of Psychology, Yeshiva University

[2]Department of Neurology, Division of Cognitive & Motor Aging, Albert Einstein College of Medicine

Abstract

Research suggests a reciprocal relationship between late-life anxiety and cognition, particularly attention and executive functions. Whereas evidence supports a conceptual distinction between cognitive and somatic dimensions of anxiety, their differential relationship with cognitive outcomes has not been examined, particularly on tests of attention/executive functions that rely on processing speed. Study goals were threefold: (a) to describe levels of overall, cognitive, and somatic anxiety in a sample of older adults without dementia, (b) to determine if overall anxiety is associated with performance on select measures of attention/executive functions that rely on processing speed, and (c) to determine if a differential relationship exists between cognitive and somatic anxiety and cognitive performance. Participants were 368 community-dwelling older adults. Results showed that elevated levels of somatic, but not cognitive anxiety were associated with poorer performance across measures. Findings suggest that the nature of anxiety symptoms may have important implications for cognitive performance in older adults.

Keywords

anxiety; attention; executive functions; processing speed; aging

Anxiety and Older Adults

The prevalence of anxiety disorders in late life is high though noticeably variable, with estimates ranging from 1.2% to 15% in community-dwelling samples and from 1% to 28% in clinical samples of older adults (Therrien & Hunsley, 2012). Prevalence rates of older adults who report anxiety symptoms but do not meet criteria for anxiety disorders are even higher, ranging from 15% to 52.3% in community-dwelling samples (Bryant, 2010). Late-life anxiety has been linked to subjective distress, reduced life satisfaction, and functional impairment (Mendlowicz & Stein 2000). Furthermore, older individuals who present with some anxiety symptoms have been found to be just as negatively affected in their quality of life as those who meet diagnostic criteria for an anxiety disorder (De Beurs et al. 1999).

Correspondence: Roee Holtzer, Ph.D., Professor, Ferkauf Graduate School of Psychology, Department of Neurology - Albert Einstein College of Medicine/Yeshiva University, 1225 Morris Park Avenue, Bronx, NY 10461, Phone: (718) 430 3962, Fax: (718) 430-3829, roee.holtzer@einstein.yu.edu.

Despite high prevalence rates, research on anxiety in older adults has grown at a much slower rate compared to research on anxiety in younger populations (Therrien & Hunsley, 2012). In fact, relatively little is known about the presentation and experience of anxiety among the older adult population, particularly in individuals with milder, sub-clinical symptoms. This knowledge gap extends to limitations in evidence-based assessment of anxiety in aging (Dennis, Boddington, & Funnell, 2007). Although the assessment of anxiety in older adults is notably challenging for a variety of reasons, self-report measures continue to be the dominant method for gathering information about anxiety in both clinical and research settings (Therrien & Hunsley, 2012).

Distinguishing Between Cognitive and Somatic Domains

Prominent theories of emotion, stress, and anxiety have laid the groundwork for the conceptual distinction between cognitive and somatic domains. These theories posit important interactions between cognitive and physiological factors. That is, cognitive appraisals and expectations play a role in the generation of emotional arousal, and arousal feedback influences the ongoing process of appraisal and reappraisal (Lazarus & Folkman, 1984). Despite the apparent functional relatedness of cognitive and affective systems, traditional models assert that they are distinctive aspects of the anxiety process, reflected in individual differences in the experience and expression of anxiety reactions (Davidson & Schwartz, 1976; Deffenbacher, 1980).

Several studies have built upon this theoretical framework to provide further evidence for the cognitive-somatic distinction. The literature suggests that while cognitive and somatic symptoms interact with one another, they may also be elicited by different classes of antecedents. For example, threat of electric shock has been shown to have its primary influence on somatic anxiety, whereas social or performance evaluation tends to have a stronger eliciting effect on cognitive anxiety (Morris, Harris, & Rovins, 1981; Morris & Liebert, 1973). In addition, the issue of anxiety-reduction treatment efficacy provides further support. Given the individual differences that exist in the manifestation of anxiety symptoms (i.e., cognitive, somatic, or both), specific treatments are often directed at the most strongly activated response system. For example, cognitive anxiety symptoms have been shown to respond effectively to cognitively-oriented approaches such as cognitive restructuring or processing. On the other hand, somatic symptoms have demonstrated strong responsiveness to physiologically-based approaches including biofeedback and relaxation (Morris, Davis, & Hutchings, 1981; Michelson, 1986). This body of research, and the cognitive-affective model on which it is based, stimulated the development of numerous multidimensional anxiety measures in years to follow (Smith, Smoll, & Schutz, 1990).

In an original factor analysis of the Beck Anxiety Inventory (BAI), a widely used self-report anxiety questionnaire, Beck and colleagues (1988) found that the BAI yielded two factors, corresponding mainly to cognitive and somatic dimensions of anxiety. The authors broadly defined cognitive anxiety as “negative expectations, worries, and concerns about oneself, the situation at hand, and potential consequences” and somatic anxiety as “the perception of one’s physiological arousal.” A similar two-factor structure was replicated in a number of studies, with the somatic factor containing items such as “numbness,” “unsteadiness,” and

"feeling hot" and the cognitive factor consisting of items such as "fear of the worst happening," "terrified," and "fear of losing control" (Hewitt & Norton, 1993; Kabacoff, Segal, Hersen, & Van Hasselt, 1997). Researchers have also reported more complex factor solutions depending on the sample examined and statistical approach used (Therrien & Hunsley, 2012). Nonetheless, a robust body of evidence supports the conceptual distinction between cognitive and somatic domains of anxiety, in younger and older populations alike (Smith et al., 1990).

Late-Life Anxiety and Cognition

As the literature on anxiety in older adults has expanded, a focus on the relationship between late-life anxiety and cognition has emerged. The bidirectional nature of this association is evident, as the presence of anxiety has been linked to poorer prognosis for cognitive impairment (Lyketsos et al., 2000) and cognitive decrements have shown to be predictive of poorer prognosis for late-life clinical anxiety (Mohlman & Gorman, 2005). Thus, a better understanding of this relationship may elucidate the pathophysiological mechanisms by which age-related cognitive decline occurs and furthermore, may facilitate improved treatment development for anxiety in older adults (Beaudreau & O'Hara, 2008).

Cross-sectional investigations generally support the hypothesis that the presence and severity of anxiety are both associated with poorer cognitive performance in older adults (Beaudreau & O'Hara, 2008). Older adults reporting elevated state, trait, or clinical anxiety symptoms have been shown to demonstrate poorer global cognitive function on screening assessments (Schutz, Moser, Bishop, & Ellingrod, 2005) as well as poorer performance on challenging neuropsychological tests (Hogan, 2003). However, the specific cognitive domains most affected by late-life anxiety are still not well delineated in the literature (Beaudreau & O'Hara, 2008). Findings from previous studies examining the impact of late-life anxiety symptoms on objective memory performance are mixed, as some authors have demonstrated a significant inverse linear relationship between anxiety levels and memory performance (Mantella et al., 2007; Stillman, Rowe, Arndt, & Moser, 2012), while others have reported no significant associations or inverted U-shape relationships (Bierman, Comjis, Rijmen, Jonker, & Beekman, 2008). Notably, a robust body of evidence supports the notion that elevated anxiety levels are associated with increased subjective memory complaints among older adults Kliegel, Zimprich, & Eschen, 2005; Pearman, Hertzog, & Gerstorf, 2014). These findings are consistent with previous work showing links between self-reported cognitive complaints and models of health anxiety, such as dementia worry, suggesting that older adults with increased concern about developing dementia may be more likely to demonstrate subjective, but not objective decline, leading to potential misdiagnosis, unnecessary treatment, and/or increased anxiety levels (Kinzer & Suhr, 2016).

While it is evident that the association between late-life anxiety and memory functioning is complex, the relationship between anxiety and executive functioning in older adults is similarly unclear. Interestingly, recent work by Yochim and colleagues (2013) suggests that the association between late-life anxiety and memory may in fact be mediated by poor executive abilities. Additional studies have provided support for the notion that the presence of late-life anxiety is associated with decreased performance on measures of executive

functions. Specifically, in a study of 102 healthy older adults aged 60 and older, higher BAI scores were associated with poorer performance on measures of inhibitory control (Stroop Test) and processing speed/shifting attention (Symbol Digit Modality Test; SDMT), but not verbal fluency (Controlled Oral Word Association Test; COWAT) (Beaudreau & O'Hara, 2009). Another study of community-dwelling older adults showed that anxiety levels explained some of the variance on Trail Making Test B time, but not Stroop performance (Booth, Schinka, Brown, Mortimer, & Borenstein, 2006). Finally, Hogan (2003) reported that higher anxiety was associated with poorer divided attention on word-comparison and pursuit-rotor tasks in older, but not younger adults. Taken together, these studies highlight the variability among neuropsychological tests selected and correspondingly, the specific facets of executive functioning potentially impacted by sub-clinical symptoms of late-life anxiety. Based on the existing literature, further investigation is required to identify the specific mechanisms underlying the relationship of anxiety with reduced performance on measures of executive functions.

Processing Speed and Cognitive Aging

The processing speed theory of cognitive aging posits that a major factor contributing to age-related decline across cognitive domains is attributed, in part, to slower speed of processing (Salthouse, 1996; Finkel, Reynolds, McArdle, & Pederson, 2007). Contemporary views of cognitive aging increasingly recognize the importance of psychological variables, such as affective processing, in theoretical models developed to better understand age-associated decrements in cognition (McDaniel, Einstein, & Jacoby, 2008). Traditionally, the mediating role of anxiety in these age-related changes has been conceptualized in terms of cognitive symptoms. In other words, anxiety reduces neuropsychological performance by diverting some of the brain's processing capacity to internal threat such as fear or worry (Deptula, Singh, & Pomara, 1993). However, the individual contribution of somatic anxiety symptoms to this theoretical framework is unclear. Specifically, it is possible that a specific subset of anxiety symptoms (e.g., somatic or cognitive) may compromise performance on measures that assess speed of processing. Processing speed is a key determinant in many measures of executive functions and its effect on performance differences on such measures has been well documented (Salthouse, 1996). Given previous research linking late-life anxiety to reduced performance on various measures of executive functions (Beaudreau & O'Hara, 2009), further investigation is needed to clarify the role of anxiety, and specific types of anxiety symptoms, on measures of executive functions that rely more heavily on processing speed.

The Present Study: Specific Domains of Anxiety & Cognitive Performance

Since Beck and colleagues (1988) proposed a two-factor structure in their original factorial analysis of the BAI, several researchers have discussed the importance of the conceptual distinction between cognitive and somatic domains of anxiety (Burton, 1988; Smith et al., 1990). It remains unknown, however, whether a differential relationship exists between these two domains of anxiety and cognitive performance and, in particular, on attention and executive tasks that rely on processing speed. The current study was designed to address the gap in knowledge concerning the relationship between distinct dimensions of anxiety and

cognitive performance in aging. Specifically, the aims of the present study were threefold: (a) to descriptively examine symptoms of overall, cognitive, and somatic anxiety in a sample of community-residing older adults without dementia, (b) to determine if overall anxiety is associated with performance on select measures of attention and executive functions that rely on processing speed, and (c) to determine if a differential relationship exists between cognitive and somatic anxiety and these select measures. Ultimately, the present study provides an opportunity for improved understanding of the neuropsychological correlates of sub-clinical anxiety symptoms among a rapidly growing population of healthy aging, community-dwelling older adults. Moreover, it offers valuable insight into the relative impact of cognitive versus somatic anxiety symptoms on cognition, which could have important implications for clinical and neuropsychological practice.

Method

Study Design and Participants

Participants in this study were recruited from an ongoing cohort study of older adults entitled Central Control of Mobility in Aging (CCMA). The primary aims of the study are to determine cognitive and neurobiological predictors of mobility performance, decline, and disability in aging. Potential participants, identified from a population list of individuals aged 65 and older were first contacted by mail and then by telephone inviting them to participate. A structured telephone interview was then administered to screen potential participants for eligibility. The telephone interview consisted of verbal consent, a brief medical history questionnaire, mobility questions (Verghese et al., 2004), and validated assessments to screen for possible dementia (AD8 Dementia Screening Interview ≥2 and the Memory Impairment Screen <5, validated for use via telephone) (Buschke et al., 1999; Galvin et al., 2005; Lipton et al., 2003). Exclusion criteria were inability to speak English, inability to ambulate independently, positive screen for possible dementia, significant loss of vision and/or hearing, current or history of neurological or psychiatric disorders, recent or anticipated medical procedures that may affect mobility, and receiving hemodialysis. After completing the telephone interview, eligible individuals were scheduled for two in-person visits at the research center lasting approximately three hours per visit. During the visits, participants received comprehensive neuropsychological, cognitive, psychological, and mobility assessments as well as a structured neurological examination. Participants' current medications were recorded by the study physician. Participants are followed longitudinally at yearly intervals. Written informed consents were obtained on site according to study protocols and were approved by the institutional review board. Study protocols have been described in detail in previous work (Holtzer, Wang, & Verghese, 2014).

Measures of Anxiety, Processing Speed, and Global Cognitive Function

The Beck Anxiety Inventory (BAI)—The BAI (Beck & Steer, 1993) is a 21-item self-report scale that measures severity of anxiety symptoms and requires about 5–10 minutes to complete. Participants are asked to indicate how much each of 21 different anxiety symptoms bothered them during the "past week, including today." Items are rated on a 4-point Likert-type scale with 0 = "not at all," 1 = "mildly, it did not bother me much," 2 = "moderately, it was very unpleasant," and 3 = "severely, I could barely stand it." Responses

were summed to provide a score ranging from 0 to 63, with higher scores indicative of higher levels of anxiety. Although the BAI was developed and normed with psychiatric adult outpatients, the scale was found to have adequate psychometric properties with heterogeneous samples of older adults (Morin et al., 1999).

Trail Making Test (TMT)—The TMT (Reitan, 1958) consists of two parts, each including 25 circles on a single sheet of paper. In the present study, both parts A and B were administered. In part A (TMT A), circles contain numbers from 1 through 25 and participants are asked to connect the circles in ascending numerical order as rapidly and accurately as possible. Part B (TMT B) contains 13 circles numbered 1 through 13 and 12 circles lettered A through L. In this task, participants are asked to connect the circles in sequential order alternating between numbers and letters (i.e. 1, A, 2, B, 3, C, etc.). Scores were based on seconds to completion and attempts were discontinued after 5 minutes (300 seconds). The TMT has high reliability (Yochim, Mueller, & Segal, 2013) and has been used extensively as a measure of attention and executive functions in both normal and clinical samples of older adults (Kowalczyk, McDonald, Cranney, & McMahon, 2001; Oosterman et al., 2010).

Digit Symbol Substitution Test (DSST)—The DSST (a subtest of the Wechsler Adult Intelligence Scale – Revised) (Wechsler, 1981) includes a key with nine numerical digits matched with corresponding symbols. After completing practice items, participants are given 120 seconds to match numerical digits with corresponding symbols. Scores are calculated as total number of correctly matched symbols. The DSST has high test-retest reliability and has been shown to be a valid measure of executive functions including working memory, perceptual organization, visuomotor coordination, shifting attention, and processing speed (Rosano, Newman, Katz, Hirsch, & Kuller, 2008).

Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)—The RBANS (Randolph, 1998) is a relatively brief battery consisting of 10 neurocognitive tests measuring memory (immediate and delayed), attention, language, and visuospatial abilities. It has been used to detect and characterize deficits in a variety of disorders, including dementia, track the advancement of neurological disorders, and screen for neurocognitive status (Karantzoulis, Novitski, Gold, & Randolph, 2013). The RBANS was used to describe overall level of cognitive function in the CCMA sample.

Covariates

Structured clinical interviews were used to identify self-reported medical conditions. Dichotomous rating (presence or absence) of diabetes, chronic heart failure, arthritis, hypertension, depression, stroke, Parkinson’s disease, chronic obstructive lung disease, angina, and myocardial infarction was used to calculate a disease comorbidity summary score (range 0–10) (Holtzer, Verghese, Wang, Hall, & Lipton, 2008; Holtzer et al., 2014). The Geriatric Depression Scale (GDS) was used to measure self-reported depressive symptoms (Yesavage et al., 1983). Quantitative measures of both medical comorbidities and depressive symptoms were included as covariates in order to account for elevated levels of

somatic symptomatology due to medical illness or depression, rather than anxiety itself. Additional covariates included age, education, and gender.

Statistical Analysis

Characteristics of the study sample, including levels of overall, cognitive, and somatic anxiety as well as performance on measures of attention/executive functions that rely on processing speed were tabulated. Three separate linear regressions were conducted to examine the relationship between overall anxiety (as measured by Total BAI Score) and performance on the three neuropsychological tests. Total BAI Score was used as the predictor variable and raw scores on each cognitive measure (specified above) served as the outcome variables. The predictors and covariates were entered simultaneously.

Items of the BAI were categorized into two domains: cognitive and somatic, according to the original two-factor structure proposed by Beck and colleagues (1988). The “cognitive” domain included 8 items and the “somatic” domain included 13 items. BAI item scores were summed for both domains and used as predictor variables to examine associations with performance on the three neuropsychological tests. Three linear regression analyses were performed to examine the relations of somatic and cognitive BAI scores and covariates, entered simultaneously, with each neuropsychological outcome measure. Data were inspected descriptively and graphically and model assumptions were formally tested. Fully adjusted models controlled for gender, age, education, depression, and disease comorbidity. Statistical analyses were performed using International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) version 20 (IBM, Somers, NY).

Results

Participants in this study were recruited from CCMA between 6/27/11 and 7/15/14. During this period, 407 individuals completed phone interviews, were deemed eligible for participation, and attended at least one in-person visit at our research center. Of these 407 individuals, 27 individuals did not attend their second in-person visit, during which the BAI is administered. Reasons for not returning for in-person visits include but are not limited to change in health status, lack of interest, time conflicts, and change in residence. A total of 380 participants completed both day 1 and day 2 protocols and this sample was frozen in order to preserve the integrity of the data. These participants were not demented, as determined by established diagnostic clinical case conference procedures as previously described (Holtzer et al., 2008). At the time of the data freeze, 8 participants were excluded due to incomplete or invalid TMT B or DSST protocols and an additional 4 were excluded due to incomplete BAI data. Thus, 368 participants were analyzed for the current study, with a mean age (76.42 years; ±6.71), education (14.54 years; ±2.99), and gender distribution (%female = 56.8) that is broadly representative of the demographic characteristics of individuals in this age group who reside in the study catchment area. The sample was also not different from the larger CCMA cohort in terms of key demographic characteristics. The mean disease comorbidity summary score (1.21 ± 0.98) was indicative of relatively good health and the mean Repeatable Battery for the Assessment of Neuropsychological Status standardized total score (91.27 ± 15.24) was in the Average range of cognitive function.

Scaled scores for each of the three selected outcome measures also fell within the Average range (TMT A = 10; TMT B = 9; DSST = 11). Of note, raw scores were used in all linear regression analyses. The mean Beck Anxiety Inventory Total Score (4.95 ± 5.72) was in the Minimal range of anxiety severity (Beck & Steer, 1993). Mean total somatic and cognitive anxiety scores were 2.85 ± 3.71 and 2.10 ± 2.87, respectively. Baseline cohort characteristics are presented in Table 1.

The linear regression analyses revealed that the relationship between overall levels of anxiety (Total BAI Score) and processing speed was not significant (Table 2).

Table 3 summarizes the results of three separate linear regression analyses examining the relationship of cognitive and somatic domains of anxiety with measures of attention/ executive functions that rely on processing speed. As expected, correlation between somatic and cognitive domains were moderately significant (Pearson Correlation = .507; p<0.001), but did not pose a threat to model stability. Somatic anxiety was related to performance on all three neuropsychological tests. Elevated levels of somatic symptoms were associated with greater time to completion on TMT A ($\beta = .148$, $p < .05$) and TMT B ($\beta = .19$, $p < .01$). Additionally, somatic symptoms were associated with lower number of correct responses on DSST ($\beta = -.138$, $p < .05$). Table 3 also reveals a significant inverse relationship between cognitive anxiety and time to completion on TMT B ($\beta = -.158$, $p < .05$). However, the association between cognitive anxiety and the remaining two tests were not significant.

Discussion

The present study was designed to examine the manifestation of anxiety symptoms in a cohort of community-dwelling older adults without dementia and to evaluate the relationship between overall, somatic, and cognitive anxiety with performance on three select tests of attention and executive functions that rely on processing speed. Our results indicated that overall anxiety, as measured by Total BAI Score, was unrelated to the cognitive outcomes in this study. However, separating overall anxiety into distinct domains revealed that higher somatic but not cognitive anxiety was related to worse performance on all three neuropsychological measures.

The few studies examining the association between late-life anxiety and cognition have consistently found an inverse relationship between anxiety and performance on select neuropsychological tests of executive functions (Booth et al., 2006; Hogan, 2003; Yochim et al., 2013). In this literature, however, the variability among measures of anxiety and cognitive functions is a limitation. Beaudreau and O'Hara (2009) examined a sample of community-dwelling older adults without dementia and found that anxiety, as assessed by the BAI, was associated with worse performance on cognitive tests measuring processing speed, shifting attention, and inhibition. The present study serves to further elucidate and extend these previous findings by examining specific domains of anxiety in addition to overall anxiety levels.

Despite frequent references to the conceptual distinction between cognitive and somatic anxiety in the literature, the present study is the first to examine the differential relationship of these two domains of anxiety with performance on neuropsychological tests. In fully adjusted models, elevated somatic but not cognitive anxiety was associated with poorer performance on the three tests reported herein. In the context of the processing speed theory of cognitive aging (Salthouse, 1996; Finkel, Reynolds, McArdle, & Pederson, 2007), these results suggest that somatic anxiety may have a greater capacity for interference with processing speed compared to cognitive anxiety, particularly among older adults with milder, sub-clinical symptoms. Specifically, the potential for somatic symptoms (e.g., autonomic hyperactivity, motor tension) to tax the attentional system may be substantial, thus diminishing the availability of cognitive resources required for time-sensitive cognitive tasks. Alternatively, the presence of somatic symptoms may lead to impairments in functional status that cause significant concern. This concern may serve as powerful task-irrelevant information, reducing attentional resources as well as the speed at which challenging neuropsychological tests are performed. Given that processing speed is a fundamental component of the tests selected for this investigation, the effect of somatic anxiety on processing speed in aging appears to be robust. Additionally, past research examining anxiety and sports performance suggests that somatic anxiety symptoms may more negatively impact functioning on motor tasks compared to cognitive anxiety symptoms, particularly on tasks requiring fine motor skills (Smith et al., 1990). This research offers an additional interpretation of this study's findings, given that all three cognitive measures require the examinee to provide written responses. Thus, it is possible that the mechanism underlying the inverse relationship between somatic anxiety and test performance involves a more direct interference with the fine motor skills required for optimal performance on neuropsychological tests that entail writing or drawing under attention-demanding conditions.

In contrast to previous findings, our results revealed that overall anxiety was unrelated to performance on select tests of executive functions that involve processing speed. One reason for this discrepancy, aside for variability among cognitive measures, may lie in the covariates selected for analyses, which were unclear in Beaudreau and O'Hara's (2009) study. However, without adjustments, a trend was observed for an inverse relationship between Total BAI Score and DSST ($\beta = -.253$, $p = .051$).

The results revealed that cognitive anxiety was unrelated to performance on TMT A and DSST. However, lower cognitive anxiety was associated with slower completion time on TMT B, suggesting that higher levels of cognitive anxiety may be related to improved performance on a complex task requiring processing speed, visuomotor sequencing, and switching attention. Because significant associations were not found between cognitive anxiety and the other two neuropsychological tests, this may be a spurious finding that should be cautiously interpreted. Nonetheless, it is important to consider that the relationship between anxiety and cognitive performance may be complex due to interactions between anxiety and test difficulty (Hogan, 2003) and that subthreshold anxiety symptoms may in fact facilitate cognitive performance (Beaudreau & O'Hara, 2008). Furthermore, the differential association between somatic and cognitive anxiety with tests of attention and executive functions that rely on processing speed may obscure this relationship when

anxiety is assessed as a single domain, as in previous studies. Thus, by examining cognitive and somatic domains individually, the present study provides further insight into the potentially facilitative effect of cognitive anxiety on test performance. One possible explanation for this result is that cognitive anxiety, often associated with evaluative anxiety (i.e. worry, fear of outcome), may activate some facilitative response system when presented with a more complex task such as TMT B.

Several limitations to the present study should be considered. Although the BAI was found to have adequate psychometric properties with samples of healthy aging older adults (Morin et al., 1999), issues inherent in the standardized assessment of late-life anxiety must be acknowledged. Previous studies have discussed the potential for confusion between anxiety symptoms and medical illnesses, comorbid psychological disorders, and aspects of normal aging (Kogan, Edelstein, & McKee, 2000). Despite controlling for disease comorbidity in statistical analyses, it is possible that physical ailments unrelated to anxiety may still have served to obscure the origin of symptoms endorsed on the BAI. Also, the extent to which older adults underreport psychological symptoms is unknown and may potentially differ generationally or by gender (Fuentes & Cox, 2002). Moreover, the present study examined a sample of older adults that was relatively cognitively and psychiatrically healthy, which limited the generalizability of our findings to populations with more severe levels of anxiety, depression, and/or cognitive function. Hence, replicating and extending the findings reported herein to more diverse samples in terms of psychological and neurological functions would be important. Additionally, it is well documented that individuals of Anglo-European background are more likely to recognize anxiety as cognitively derived, while Hispanic and Asian populations tend to experience anxiety somatically (Rao, Poland, & Lin, 2012). However, the sample examined in the present study was predominantly Caucasian, making it difficult to determine the impact of specific ethnic identity on the degree of reported somatic versus cognitive anxiety. Therefore, future studies should investigate the relationship between these major domains of anxiety and cognitive performance in more culturally and ethnically diverse populations of older adults.

Furthermore, the multi-faceted nature of neuropsychological tests of executive functions must be acknowledged, as these measures tap into multiple underlying abilities including processing speed, shifting attention, visuomotor sequencing, mental flexibility, and inhibition. We note that the measures employed in the current study were not designed to fully capture all aspects of attention and executive functions, nor were they assumed to rely entirely on speed of processing. Hence, it remains to be evaluated whether or not the differential association of somatic and cognitive anxiety with cognitive outcomes generalizes to measures that do not rely on speed of processing and fine motor skills. In addition, given the cross-sectional design of this study, causality cannot be inferred. Thus, future studies are necessary to examine these associations longitudinally. Lastly, the relationship between somatic anxiety and neuropsychological performance should be further evaluated in more diverse samples of older adults, particularly in terms of anxiety severity and levels of cognitive functioning.

Summary: The present study is the first to report on the association of specific domains of anxiety with cognitive performance in a sample of older adults without dementia. Greater

levels of somatic but not cognitive anxiety were related to poorer performance on select measures of attention and executive functions that require speed of processing and fine motor skills. Taken together, these findings confirm previous reports that subthreshold anxiety symptoms uniquely impact cognitive functioning, even after controlling for depression, in a growing population of community-dwelling older adults. Moreover, they suggest that the specific nature of anxiety symptoms may have important implications for cognitive performance. Our results highlight the value of moving beyond the use of a composite score and assessing major sub-domains of late-life anxiety in clinical practice, as somatic and cognitive symptoms may differentially impact cognition. Whether in the context of a clinical neuropsychological interview or by further analysis of a standardized BAI score, clinicians may benefit from gathering information about their patient's specific anxiety symptomatology. Ultimately, this could help to elucidate the factors influencing test performance, facilitate case conceptualization, and/or improve diagnostic clarity.

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Table 1

Summary of Sample Characteristics, Anxiety Scores, and Attention/Executive Functions at Baseline

Total Sample (n=368)	Mean (SD)	%ile (SS)	Range
Females: number (%)	209 (56.8)		
Caucasian: number (%)	322 (87.5)		
Age (years)	76.42 (6.71)		65.00 – 95.00
Education (years)	14.54 (2.99)		5.00 – 28.00
Disease Comorbidity Index	1.21 (0.98)		0.00 – 5.00
RBANS (standard total score)	91.27 (15.24)		62.00 – 137.00
GDS	4.77 (3.98)		0.00 – 21.00
BAI Total Score	4.95 (5.72)		0.00 – 34.00
BAI Total Somatic Score	2.85 (3.71)		0.00 – 23.00
BAI Total Cognitive Score	2.10 (2.87)		0.00 – 19.00
TMT A	50.28 (25.77)	50 (10)	16.31 – 300.00
TMT B	131.72 (64.29)	37 (9)	41.88 – 300.00
DSST	52.80 (14.21)	63 (11)	0.00 – 95.00

RBANS: Repeatable Battery for the Assessment of Neuropsychological Status; GDS: Geriatric Depression Scale; BAI: Beck Anxiety Inventory; DSST: Digit Symbol Substitution Test (total number correct); TMT A: Trail Making Test Part A (time to completion in seconds); TMT B: Trail Making Test Part B (time to completion in seconds).

Table 2

Linear Regression Analysis of the Effect of Total Beck Anxiety Inventory Score on Attention/Executive Functions

	TMT A: *R* = .324; R^2 = .105; *p* = < .001			**TMT B: *R* = .368; R^2 = .135; *p* = < .001**		
Variables	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***
Age	.153	.208 to .967	.003	.192	.907 to 2.769	<.001
Gender	−.072	−8.958 to 1.483	.160	.042	−7.419 to 18.184	.409
Education	−.213	−2.683 to −.970	< .001	−.271	−7.912 to −3.713	<.001
Comorbidity Index	.100	.004 to 5.220	.050	−.017	−7.499 to 5.291	.734
GDS	.056	−.348 to 1.072	.316	.070	−.609 to 2.873	.202
BAI Total Score	.062	−.217 to .776	.269	.041	−.754 to 1.681	.454
	DSST: *R* = .385; R^2 = .148; *p* = < .001					
Age	−.182	−.590 to −.181	<.001			
Gender	.118	.567 to 6.182	.019			
Education	.259	.768 to 1.689	<.001			
Comorbidity Index	−.102	−2.870 to −.065	.040			
GDS	−.057	−.586 to −.177	.293			
BAI Total Score	−.078	−.460 to .740	.156			

Analyses controlled for age, sex, education, medical comorbidity, and depression. BAI: Beck Anxiety Inventory; GDS: Geriatric Depression Scale; TMT A: Trail Making Test Part A (time to completion in seconds); TMT B: Trail Making Test Part B (time to completion in seconds); DSST: Digit Symbol Substitution Test (total number correct).

Table 3

Linear Regression Analysis of the Effect of Cognitive and Somatic Anxiety on Attention/Executive Functions

	TMT A: *R* = .344; R^2 = .119; *p* = < .001			**TMT B: *R* = .399; R^2 = .159; *p* = < .001**		
Variables	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***
Age	.192	.210 to .965	.002	.192	.918 to 2.756	<.001
Gender	2.646	−2.592	.220	.054	−5.696 to 19.644	.279
Education	.434	−2.683 to −.970	<.001	−.258	−7.603 to −3.441	<.001
Comorbidity Index	1.326	−.338 to 4.876	.088	−.034	−8.586 to 4.120	.490
GDS	.092	−.137 to 1.326	.111	.117	.113 to 3.678	.037
BAI Somatic Score	.148	3.065 to 23.780	.011*	.169	12.971 to 63.450	.003**
BAI Cognitive Score	−.105	−16.558 to 1.496	.102	−.158	−50.417 to −6.421	.011*
	DSST: *R* = .396; R^2 = .157; *p* = < .001					
Age	−.182	−.589 to −.182	<.001			
Gender	.110	.353 to 5.964	.027			
Education	.251	.729 to 1.650	<.001			
Comorbidity Index	−.091	−2.721 to .090	.067			
GDS	−.086	−.702 to .087	.126			
BAI Somatic Score	−.138	−12.438 to −1.270	.016*			
BAI Cognitive Score	.070	−2.073 to 7.661	.260			

Analyses controlled for age, sex, education, medical comorbidity, and depression. BAI: Beck Anxiety Inventory; GDS: Geriatric Depression Scale; TMT A: Trail Making Test Part A (time to completion in seconds); TMT B: Trail Making Test Part B (time to completion in seconds); DSST: Digit Symbol Substitution Test (total number correct).

* $p < .05$,

** $p < .01$

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