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Subjective Memory Complaints, Cognitive Performance, and Psychological Factors in Healthy Older Adults

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Abstract

Objective: To determine whether subjective memory complaints (SMCs) are associated with performance on objective cognitive measures and psychological factors in healthy, community-dwelling older adults. **Method:** The cohort was composed of adults, 65 years and older with no clinical evidence of cognitive impairment ($n = 125$). Participants were administered: CogState computerized neurocognitive battery, Prospective Retrospective Memory Questionnaire, personality and meaning-in-life measures. **Results:** SMCs were associated with poorer performance on measures of executive function ($p = 0.001$). SMCs were also associated with impaired delayed recall ($p = 0.006$) but this did not remain significant after statistical adjustment for multiple comparisons. SMCs were inversely associated with conscientiousness ($p = 0.004$) and directly associated with neuroticism ($p < 0.001$). Higher scores on SMCs were associated with higher perceived stress ($p = 0.001$), and ineffective coping styles ($p = 0.001$). Factors contributing to meaning-in-life were associated with fewer SMCs ($p < 0.05$). **Conclusions:** SMCs may reflect early, subtle cognitive changes and are associated with personality traits and meaning-in-life in healthy, older adults.

Keywords

subjective memory complaints, cognitive performance, meaning-in-life, healthy, older adults, personality traits

Introduction

The field of Alzheimer's disease (AD) is advancing toward earlier detection and diagnosis of the disease. Ultimately, the goal is to identify individuals who are asymptomatic but at risk of developing AD. Subjective memory complaints (SMCs) represent a type of complaint made by individuals with cognitive symptoms or complaints but no clear impairment on objective psychometric testing. Evidence suggests that individuals with SMCs may be at increased risk of dementia, with several studies showing that patients with cognitive complaints have a higher rate of progression to mild cognitive impairment (MCI) or AD than those without.[1-4] Studies have also reported that, compared to those without cognitive complaints, individuals with SMCs show greater medial temporal lobe atrophy,[5-8] regional brain hypometabolism,[9] higher prevalence of an AD-like cerebrospinal fluid profile,[10] and more frequent AD pathology at autopsy.[11] As such, SMCs may be a "pre-MCI" stage in the evolution of normal aging to clinical AD and might represent a potential target for intervention trials.

Despite the burgeoning interest, there is still little research on the association between SMCs and cognitive performance in otherwise still healthy, community-dwelling older adults. Although it is generally assumed that individuals with SMCs have relative deficiencies in memory, the extent to which memory complaints reflect a decline in other cognitive domains such as attention, language, and executive function is not established. By definition, individuals with SMCs perform within the "normal range" on standard psychometric measures, although the individuals themselves, close family or friends, report subtle decline in cognitive

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abilities. The dissociation between patients' self-assessment and clinical testing may be due to several factors, including lack of sensitivity of psychometric measures, limited sample size, demographics (eg, education), lack of insight, psychiatric symptoms, or personality traits. Standard psychometric tests have poor resolution, particularly in detecting subtle cognitive changes in very early AD.[12-15] Cognitive reserve factors, such as education level, have also been implicated to account for the discrepancy between subjective complaints and objective cognitive performance, such that individuals with higher education levels can cope longer before manifesting cognitive deficits.[16] Although some studies suggest that negative emotional states and personality traits can also contribute to the dissociation,[17-19] these studies are limited, with mixed results.[20]

The first goal of the present study was to examine the relationship between SMCs and objective cognitive performance using a computerized cognitive battery, with demonstrated sensitivity to subtle changes in cognitive function.[21-24] We examined a cohort of healthy, community-dwelling older adults with SMCs using this cognitive battery to determine the nature of cognitive deficits in individuals with subjective complaints. The second goal was to examine the association of SMCs with meaning-in-life and personality traits, not as yet reported in the literature, as well as negative emotional states and stress. It was hypothesized that SMCs would be associated with negative emotional states (eg, anxiety and depression), personality traits (eg, neuroticism and conscientiousness), stress, and elements of the meaning-in-life.

Methods

Participants

The population consisted of older adults without clinical evidence of cognitive impairment who consented to participate in a longitudinal study of 3 years duration with visits occurring annually. The participants met the following eligibility criteria: (1) age 65 years or older; (2) no clinical evidence of cognitive impairment on a measure of global cognitive functioning Montreal Cognitive Assessment (26-30)[25]; and (3) no acute or serious medical conditions. Participants were recruited for this baseline visit by the University of Pennsylvania Alzheimer's Disease Center from its "normal control" cohort and in outreach efforts to a suburban residential setting for independent living, from an Older Adult Registry for African Americans interested in research participation, and other community-dwelling individuals in the greater Philadelphia area. The study population was administered the prescreening Telephone Interview for Cognitive Status to eliminate potential participants who clearly did not meet the protocol requirements. Those with scores >28 were eligible as per established norms for definitely (range 33-41) and probably nonimpaired (range 26-32).[26] The mean for our population was 35 (standard deviation [SD] = 2.6; range 28-41). The review of medical conditions revealed a multitude of age-related illnesses, controlled by treatment and not exclusionary. One individual had significant Parkinson's disease that precluded writing, and another was undergoing chemotherapy that affected mental clarity. A total of 150 potential participants were approached and screened; of these, 10 withdrew, 12 declined, and 3 did not meet the eligibility criteria. The final sample was 125. There were no significant differences in age, gender, education, or race between the participants and the nonparticipants. The mean age of the cohort was 77 (SD = 7.2; range 65-95). The mean years of education was 16 (SD = 2.8; range 6-20). Women constituted 66% of the sample. The racial distribution was African American: 24% and caucasian: 76% (Table 1). The University of Pennsylvania institutional review board approved the study, and all participants provided informed consent.

Table 1. Characteristics of the Population (N = 125).

Characteristic	Number (%)
Age, years	
65-74	53 (42)
75-84	49 (39)
85-95	23 (18)
Gender	
Male	46 (34)
Female	89 (66)
Education, years	
≤12	30 (22)
13-17	58 (43)
>18	47 (35)
Highest level of occupation	
Professionals and technical workers	73 (57)
Managers/administrators, clerical, sales	45 (35)
Operative, service workers	3 (2)
Craftsmen and foremen	3 (3)
Race	
Caucasian	95 (76)
African American	30 (24)
Marital status	
Married	73 (54)
Widowed	32 (23)
Single, never married	11 (8)
Divorced	20 (15)
Residence	
Suburban independent senior living	52 (42)
Urban community residence	73 (58)
Body mass index	
Underweight <18.5	8 (6)
Normal weight 18.5-24.9	34 (27)
Overweight 25-29.9	44 (35)
Class I obesity 30-34.9	27 (21)
Class II obesity 35-39.9	5 (4)
Class III obesity 40 plus	9 (7)
Tobacco history	
Never smoked	11 (8)
Current smoker	50 (37)
Former smoker	73 (55)
Tobacco consumption >1 pack/d	62 (46)
Duration of smoking ≥20 years	47 (35)
Alcohol history	
Current drinker	43 (39)
Former drinker	66 (61)
Alcohol consumption ≥3 drinks/d	7 (11)
Duration of drinking ≥20 years	30 (28)

Table 2. Subjective Memory Complaints and Their Associations With Cognitive Performance (N = 125).[a]

CogState Subtest	Coefficient	Standard Error	R^2	95% Confidence Interval	*P*
Executive function	0.098	0.028	.0964	0.043 to 0.153	**.001**[b]
Verbal memory immediate	0.209	0.135	.0199	−0.477 to 0.593	.13
Verbal memory delay recall	0.927	0.329	.0633	−1.599 to −0.274	.006
Paired associate learning	5.380	5.576	.0079	−5.663 to 16.423	.33
Detection task	1.252	2.235	.0027	−3.176 to 5.679	.57
Identification task	1.392	3.064	.0018	−4.677 to 7.461	.45
One Back	−1.800	3.123	.0028	−7.986 to 4.384	.57
Two Back	0.405	3.746	.0001	−7.014 to 7.825	.91
One Card Learning task	−6.042	5.602	.0098	−17.138 to 5.054	.28

[a] Subjective memory complaints are measured by the Prospective Retrospective Memory Questionnaire (PRMQ). Objective Cognitive Performance was measured using the CogState a computerized neurocognitive battery of tests. Performance was calculated for Executive Function by totaling the errors and for Verbal Memory by totaling the number of correct responses. Each row represents a distinct linear regression analysis with 1 outcome and 1 independent variable. Errors in executive function increased as subjective memory complaints increased. Delayed recall on verbal memory (International Shopping List task) declined with higher scores on the PRMQ. No other significant associations were found for the following administered tests: working memory (One Back and Two Back), continuous paired associate learning, the detection task for psychomotor speed, the 1 card learning task for visual recognition memory, and identification for attention.
[b] Statistically significant after adjustment for multiple comparisons using a Bonferroni adjustment of 0.05/9 = 0.005 as the threshold for significance.

Procedures

Subjective Memory Complaints. The SMCs were evaluated with the Prospective Retrospective Memory Questionnaire (PRMQ).[27] The PRMQ contains 16 questions. Participants rated how often each thing happened using a 5-point scale, ranging from (1) never to (5) very often. The minimum score is 16, and the maximum 80. Higher scores on the PRMQ indicate more SMCs. The PRMQ is a measure of self-reported minor memory problems tested in the general population (ages 17-94) for which the reliability and concurrent and predictive validity have been established The mean for the PRMQ is 38.88 (SD = 9.15; range 17-67) for the general adult population aged 18 to 93.[28]

Cognitive Testing. The CogState computerized tests have been shown to be valid, reliable, and sensitive to cognitive impairment.[21-24] Participants were administered the following CogState tests by the trained Geriatric Psychiatrist (SS) over a 35-minute period: Detection task (psychomotor speed), Identification task (attention), One Card Learning task (visual recognition memory), One Back (working memory), Two Back (working memory), Continuous-Paired Associate Learning (CPAL; paired associate learning) task, Groton Maze Learning task (GMLT; executive function), and International Shopping List task (ISLT; verbal learning and memory). The CogState normative data relevant to our findings are as follows. The mean for the GMLT for those 65 to 74 is 64.98 (SD 25.93); for those 75 to 84 is 72.11 (SD 29.01), and for those 85 to 95 is 77.20 (SD 11.54). The mean for the ISLT-delayed age group 65 to 74 is 8.80 (SD 1.94) and for those 75 to 84 is 7.47 (SD 2.57). Histograms were drawn for each outcome variable. Outliers that were 2 or more SDs from the mean were not included in the analysis (1 participant for CPAL and 1 participant for GMLT). Four participants had missing data for ISLT and were removed from the analysis for this task.

Personality Traits. The NEO-Five Factor Inventory assessed 5 dimensions of personality (neuroticism, extraversion, openness, agreeableness, and conscientiousness). Each trait measured the degree individuals agreed with 12 statements rated on a 5-point scale ranging from 0 to 4, with higher scores indicating more of the trait in question. Item scores were summed to yield trait scores that could range from 0 to 48. The psychometric properties of this scale have been extensively documented.[29] Personality traits have been associated with cognitive performance, and our goal was to determine whether they were also associated with SMCs.

Psychological Stress. Psychological distress was assessed using the stress subscale Depression, Anxiety, and Stress Scale (DASS),[30] adaptive and destructive coping styles (Brief Cope),[31] and appraisal of stressful events (Perceived Stress Scale).[32] The mean for the DASS stress subscale from a normative sample between age 50 to 59 was 8.20 (SD 8.64).[33]

Mood Measures. The 15-item version Geriatric Depression Scale (GDS)[34] was administered with a cut point of ≥5 suggesting depression. The mean for the DASS depression subscale for a normative sample was 5.28 (SD = 7.80) and DASS anxiety subscale 3.55 (SD = 5.39).

Meaning-in-Life. The Distress Cognition Study Measure[35] measures factors contributing to meaning-in-life (eg, purpose, values, goals, reconciliation with the past, and emotional support) as well as negative interpersonal interactions and recent financial stress. Each factor is measured by the degree to which individuals agreed with the statements rated on a 4-point scale ranging from 1 to 4, with higher scores indicating stronger agreement. Greater meaning-in-life has been associated with reduced risk of MCI and AD in community-dwelling older persons.[36] Our goal was to investigate a possible association between meaning-in-life and SMCs.

Statistical Analysis

Given the sample of 125 participants, and the following assumptions: type I, α, error of 5% and 2-sided tests, this study has 80% power to detect an effect size of 0.25 SD units for continuous covariates. Descriptive statistics were used to characterize the

Table 3. Descriptive Statistics for Categorical Variables Significantly Associated With the PRMQ (N = 125).

Variables	Mean	Standard Deviation	Minimum	Maximum
CogState				
Executive Function	82.647	27.874	37	218
Verbal Memory Delayed	7.655	2.392	2	12
Personality traits				
Neuroticism	16.232	7.533	0	40
Extraversion	28.032	5.982	12	46
Conscientiousness	35.352	5.229	21	47
Psychological stress				
Perceived stress: out of control	7.902	4.951	0	21
Negative coping style	13.216	2.884	9	21
DASS: stress	6.552	6.716	0	35
Mood measures				
Geriatric Depression Scale	2.456	2.529	0	12
DASS: depression	4.36	5.692	0	28
DASS: anxiety	3.128	4.096	0	23
Meaning-in-Life				
Clear goals	9.2	2.345	0	12
Reconciled with the past	13	2.609	0	16
Negative interpersonal interaction	11.952	3.377	7	23

Abbreviations: DASS, Depression, Anxiety, and Stress Scale; PRMQ, Prospective Retrospective Memory Questionnaire.

study population. To identify factors associated with cognitive performance, multivariable linear regression models were developed. In linear regression models that adjusted for age, sex, education, race, and multiple comparisons, the PRMQ was entered a an outcome variable, and the CogState tests, personality traits, and psychological stress, mood, and meaning-in-life measures entered as independent variables. Table 2 represents a distinct linear model, with each row representing the association between the outcome measure (PRMQ) and each of the independent variables (eg, CogState subtest). All analyses were performed using Stata Version 12 (StatCorp, College Station, Texas) with 2-tailed tests and a type I error of 0.05.

Results

Characteristics of the Study Population

There were 125 participants in the study. The mean age of the cohort was 77 (SD = 7.2; range 65-95). The mean years of education was 16 (SD = 2.8; range 6-20). The majority were women and married. Most participants engaged in occupations of high mental demands. The racial distribution reflects the population in the Delaware Valley (African American: 24% and caucasian: 76%). The mean number of years of education was significantly higher for caucasians than African Americans (15.9, 14.2, $t = 2.98$, degrees of freedom (df) = 123; $P = .004$.) Yet, there were no statistically significant differences by race in their cognitive performance on the CogState tests associated with SMCs, executive function (14, 16.5, $t = -1.63$, $df = 117$, $P = .107$), or delayed verbal memory (7.79, 7.72, $t = 1.073$, $df = 117$, $P = .286$). The participants were health conscious being former smokers and former drinkers with a mean body mass index of 28.5 in the overweight but not obese class (SD = 6.2; range 18-58; Table 1).

Subjective Memory Complaints and Their Associations

The mean score on the PRMQ in our population was 36 (SD = 8.8; range 20-69) similar to that in the literature.[36] The mean scores on the GMLT and the ISLT delayed were also similar to that reported by CogState. Table 3 displays the mean, SD, and range for each categorical variable significantly associated with SMCs. The Pearson's correlation table for continuous variables in Appendix A corroborates the associations revealed by the regression models.

Subjective Memory Complaints and Cognitive Performance

As Table 2 indicates, although higher scores on the PRMQ are significantly correlated with poor performance on memory measures, such as verbal memory delayed recall, a significant association beyond the memory domain was also observed for executive function.

Subjective Memory Complaints, Cognitive Performance Personality Traits

Subjective memory complaints were also significantly associated with personality traits, where higher PRMQ scores were related to lower scores on extraversion, conscientiousness, and higher scores on neuroticism (Table 4).

We also compared performance on CogState measures to personality traits. Significant associations were observed for GMLT (executive function), where more errors were related to higher scores on neuroticism (coefficient 0.594; standard error 0.284, 95% confidence interval [CI] 0.031 to 1.157; $P = .04$). Furthermore, greater accuracy on the ISLT (verbal memory) was associated with extroversion (coefficient 0.081; standard error 0.037, 95% CI 0.006 to 0.156; $P = .03$) and conscientiousness (coefficient 0.133; standard error 0.042, 95% CI 0.049 to 0.217; $P = .002$).

Subjective Memory Complaints, Cognitive Performance, Psychological Stress, Mood Measures, and Meaning-in-Life

Higher PRMQ scores were associated with higher scores on all measures of stress, stress perceived as out of control, negative coping style, and the DASS stress subscale. Higher PRMQ scores were also associated with subclinical depression and anxiety as measured by the DASS subscales and the GDS. It is noteworthy that our population had lower mean scores on the DASS subscales than the normative sample (Table 3). The GDS scores were well below the cut point of ≥ 5. Yet the associations persist.

Clear goals and being reconciled with the past were associated with lower PRMQ scores, whereas negative interpersonal relations were associated with higher scores (Table 4).

Table 4. Subjective Memory Complaints and Their Associations With Personality Traits, Psychological Stress, Mood Measures, and Meaning-in-Life (N = 125).

	Coefficient	Standard Error	R^2	95% Confidence Interval	*P*
Personality traits					
Neuroticism	0.506	0.099	.1686	0.310 to 0.701	**<.001**[b]
Extraversion	−0.471	0.130	.1123	−0.729 to −0.213	**<.001**[b]
Conscientiousness	−0.449	0.151	.0653	−0.749 to 0.149	**.004**[b]
Openness	0.006	0.138	.0000	−0.267 to 0.278	.967
Agreeableness	0.011	0.163	.0000	−0.31 to 0.333	.947
Psychological stress					
Perceived stress: out of control	0.552	0.159	.1084	0.236 to 0.869	**<.001**[b]
Negative coping style	0.849	0.264	.0776	0.327 to 1.371	**.002**[b]
DASS: stress	0.418	0.111	.1019	0.196 to 0.639	**<.001**[b]
Mood measures					
Geriatric Depression Scale	1.216	0.201	.1359	0.821 to 1.611	**<.001**[b]
DASS: depression	0.489	0.137	.1088	0.218 to 0.760	**<.001**[b]
DASS: anxiety	0.757	0.188	.1019	0.385 to 1.129	**<.001**[b]
Meaning-in-life					
Clear goals	−0.858	0.341	.6742	−1.532 to −0.184	**.01**
Reconciled with the past	−1.195	0.295	.3345	−1.78 to −0.612	**<.001**[b]
Negative interpersonal score	0.814	0.231	.0449	0.357 to 1.272	**.001**[b]
Acknowledged value system	−0.499	0.371	.0145	−1.234 to 0.236	.182
Sense of purpose	−0.488	0.266	.0266	−1.016 to 0.039	.069
Emotional support	−0.401	0.249	.0207	−0.895 to 0.092	.110

Abbreviations: DASS, Depression, Anxiety, and Stress Scale; PRMQ, Prospective Retrospective Memory Questionnaire.
[a] Each row represents a distinct linear regression analysis with 1 outcome and 1 independent variable (eg, total score of the PRMQ and neuroticism domain score). Subjective memory complaints (SMCs) were significantly and inversely associated with extraversion and conscientiousness and directly associated with neuroticism. The greater the number of SMCs, the higher the scores on stress perceived as out of control and negative coping style, stress levels, and mood. Factors contributing to purpose in life such as clear goals and being reconciled with the past were associated with fewer subjective memory complaints, whereas negative interpersonal relations were associated with more SMCs.
[b] The specific result within each domain (personality trait, psychological stress, etc) was statistically significant after adjustment for multiple comparisons. Adjustments were made using a Bonferroni method with 0.05/n, where n is the number of comparisons within each domain, as the threshold for significance.

Associations were also observed between mood measures and CogState tasks. For example, a greater number of errors on the GMLT were associated with higher scores on the DASS depression subscale (coefficient 1.112; standard error 0.478, 95% CI 0.165 to 2.058; $P = .02$), the DASS anxiety (coefficient 1.988; standard error 0.585; 95% CI 0.828 to 3.148; $P = .001$), and the GDS (coefficient 2.791; standard error 0.973; 95% CI 0.864 to 4.717; $P = .005$). In addition, decreased accuracy on the ISLT was associated with higher scores on the DASS depression subscale (coefficient −0.273; standard error 0.103; 95% CI −0.478 to −0.068; $P = .009$) and the GDS (coefficient −0.495; standard error 0.225; 95% CI −0.941 to −0.048; $P = .03$).

Discussion

Results of this study support our first hypothesis that lower PRMQ scores would be associated with better cognitive test scores. Additionally, higher PRMQ scores were related to poorer performance on memory and executive function tasks. Our second hypothesis was that SMCs would be associated with negative emotional states (eg, anxiety and depression), personality traits (eg, neuroticism and conscientiousness), stress, and the elements of the meaning-in-life. Higher scores on SMCs were associated with the personality trait of neuroticism, subclinical levels of anxiety and depression, greater levels of stress, destructive coping styles, perceiving stress as unmanageable, and more frequent negative interpersonal interactions. Fewer SMCs were associated with the personality traits of extroversion and conscientiousness and certain elements contributing to meaning-in-life (eg, being reconciled with the past and clear goals). Our findings are concordant with previous work involving older adults, which report more SMCs in participants with stress, anxiety, and depression.[37-39] To the best of our knowledge, this is the first investigation examining the relationship between SMCs, meaning-in-life, and personality traits.

Further, understanding of the variables associated with SMCs may guide early identification of cognitive change and the institution of interventions for maintaining cognitive resilience. Such interventions might include (1) cognitive fitness training; (2) stress management for destructive coping styles and developing realistic perceptions; and (3) cognitive behavioral therapy focused on issues of adults in late life (eg, establishing clear goals, reconciling with the past, subclinical anxiety, and depression). Researchers have identified effective strategies for cognitive training. The Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study examined the impact of cognitive training (memory, reasoning, and processing speed) in healthy older individuals and found persisting benefits, especially on reasoning, an executive function.[33] Cognitive exercises were effective when computer based and administered at home.

In general, older adults do not seek help for SMCs.[40] Those seeking help may be turned away by health providers when formal neurocognitive tests report no impairment. In either case, older adults have a reduced opportunity to receive early intervention. We argue that measures used in this study would help in the identification of preclinical MCI individuals, particularly a self-report scale measuring SMCs in conjunction with brief measures of cognition, mood, and meaning-in-life.

The strength of this research is that it reports baseline data of an ongoing longitudinal study of community-dwelling adults in late life that continues into its third year. The focus is on personality, psychological distress, and mood that promote cognitive and functional resilience. It establishes and extends our knowledge of the associations of SMCs with personality traits and meaning-in-life. It highlights the significance of SMCs with respect to cognitive performance and general quality of life.

Some limitations should be considered in interpreting our results as well. This is a relatively small sample of well-educated, professionally successful, reasonably healthy participants with a greater involvement of woman and caucasians. The problem with generalizability was compensated for by nonrestrictive eligibility criteria and statistical adjustment for potential confounders. Selection bias is another potential limitation because the sample consisted of those who agreed to participate and had complete information. However, there was a low level of loss to follow-up, which was nondifferential across sites observed as the study continued.

In sum, SMCs were found to be associated with cognitive function (episodic memory and executive function), personality traits (neuroticism, extraversion, and conscientiousness), psychological stress (ie, stress perceived as unmanageable and negative coping style), mood (subclinical depression and anxiety), and meaning-in-life (ie, clear goals and reconciled with the past). These findings suggest the utility of a self-report scale measuring SMCs in conjunction with brief measures of cognition, mood, and meaning-in-life. This approach, neither costly nor labor intensive, will permit health care professionals to identify seniors vulnerable to changes in cognitive performance. Older adults could be assisted in instituting lifestyle changes (eg, cognitive training exercises, stress management, and brief cognitive behavior therapy focused on issues of adults in late life). For such benefits to be derived, however, an effort to increase awareness of the value of measuring SMCs among both practitioners and patients will be required.

Appendix A

Pearson's Correlation and P *values for Continuous Variables.*

	Executive Function	Verbal Memory	Neuroticism	Extroversion	Conscientious	Perceived Stress Out of Control	Negative Coping Style
Executive Function	1.0000						
Verbal Memory	-0.2708	1.0000					
	0.003						
Neuroticism	0.1311	-0.1752	1.0000				
	0.1554	**0.05**					
Extraversion	-0.0315	0.1786	-0.4168	1.0000			
	0.7334	**0.05**	**<0.001**				
Conscientiousness	-0.2197	0.2478	-0.1569	0.3644	1.0000		
	0.02	**0.006**	0.0806	**<0.001**			
Perceived Stress Out of Control	0.0445	-0.0694	0.4807	-0.2462	-0.1791	1.0000	
	0.6338	0.4572	**<0.001**	**0.006**	**0.05**		
Negative Coping Style	-0.1039	-0.0098	0.4012	-0.1841	-0.2147	0.4271	1.0000
	0.2608	0.9159	**<0.001**	**0.04**	**0.02**	**<0.001**	
DASS_Stress	0.0341	-0.1414	0.5388	-0.1405	0.0093	0.5650	0.3935
	0.7127	0.1250	**<0.001**	0.1180	0.9176	**<0.001**	**<0.001**
GDS	0.1176	-0.2306	0.5388	-0.5154	-0.2702	0.5219	0.3259
	0.2027	**0.01**	**<0.001**	**<0.001**	0.0023	**<0.001**	**<0.001**
DASS_Depression	0.0959	-0.1701	0.5612	-0.3570	-0.1785	0.6903	0.3716
	0.2993	0.06	**<0.001**	**<0.001**	0.0464	**<0.001**	**<0.001**
DASS_Anxiety	0.1213	-0.2102	0.4092	-0.1970	-0.0582	0.4633	0.2318
	0.1889	**0.02**	**<0.001**	0.0277	0.5189	**<0.001**	**0.009**
Clear Goals	-0.0331	-0.0301	-0.2309	0.2513	0.2974	-0.3284	-0.2020
	0.7207	0.7455	**0.01**	**0.005**	**0.001**	**0.001**	**0.02**
Reconciled with Past	-0.0039	-0.0600	-0.3919	0.2418	0.2660	-0.3666	-0.3602
	0.9662	0.5172	**<0.001**	**0.007**	**0.003**	**<0.001**	**<0.001**
Negative Interpersonal Interactions	-0.0041	-0.0488	0.3793	-0.0734	-0.0945	0.5456	0.3688
	0.9647	0.5980	**<0.001**	0.4160	0.2945	**<0.001**	**<0.001**

Appendix A. (continued)

		DASS_Stress	GDS	DASS_Depression	DASS_Anxiety	Clear Goals	Reconciled With Past
DASS_Stress	1.0000						
GDS	0.4176	1.0000					
	<0.001						
DASS_Depression	0.6988	0.6340	1.0000				
	<0.001	**<0.001**					
DASS_Anxiety	0.7113	0.4039	0.5657	1.0000			
	<0.001	**<0.001**	**<0.001**				
Clear Goals	-0.1684	-0.4071	-0.3800	-0.1731	1.0000		
	0.06	**<0.001**	**<0.001**	0.0535			
Reconciled With Past	-0.2789	-0.3435	-0.3693	-0.2068	0.5272	1.0000	
	0.002	**<0.001**	**<0.001**	**0.02**	**<0.001**		
Negative Interpersonal Interactions	0.4699	0.2821	0.3857	0.3795	-0.2269	-0.3515	1.0000
	<0.001	**0.001**	**<0.001**	**<0.001**	**0.01**	**<0.001**	

Legend: Abbreviations DASS Depression, Anxiety, Stress Scale; GDS Geriatric Depression Scale. This matrix correlation table displays the correlation between the categorical variables and p-values. For example, errors in executive function are inversely correlated to performance on verbal memory (p = 0.003) and conscientiousness (p = 0.02). More correct responses on delayed verbal memory tests are correlated with extroversion (p = 0.05) and conscientiousness (p = 0.006). While poor performance on verbal memory tests are correlated with GDS (p = 0.01) and DASS_Anxiety (p = 0.02). All measures of stress (e.g., stress perceived as out of control, negative coping styles, DASS-Stress), mood (GDS, DASS_Depression, DASS_Anxiety) and negative interpersonal interactions are directly and significantly correlated. All measures of stress and mood are inversely correlated to the contributors to meaning-in-life , extroversion and conscientiousness.

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Declaration of Conflicting Interests

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