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The effect of personality traits on risk of incident pre-dementia syndromes.

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Abstract

Objectives: Personality traits have been shown to be associated with risk of dementia; less is known about their association with pre-dementia syndromes. The aim of the present study was to examine the role of personality traits as predictors of incident pre-dementia syndromes; Motoric Cognitive Risk (MCR) and Mild Cognitive Impairment (MCI) syndromes.

Design: We prospectively examined the association between five personality traits (neuroticism, extraversion, conscientiousness, agreeableness, and openness) and risk of incident MCR or MCI. MCR builds on MCI operational definitions, substituting the cognitive impairment criterion with slow gait, and is associated with increased risk for both Alzheimer's Disease and vascular dementia.

Setting: Community based.

Participants: Non-demented participants (n=524, 62% women), aged 65 and older.

Measurements: Cox proportional-hazard analysis, adjusted for demographics and disease burden, was used to evaluate the risk of each pre-dementia syndrome based on baseline personality traits, measured using the Big Five Inventory.

Results: Over a median follow-up of 3.0 years, 38 participants developed incident MCR and 69 developed incident MCI (41 non-amnestic and 28 amnestic subtypes). Openness was associated with reduced risk of developing incident MCR (adjusted Hazard Ratio (aHR): 0.94, 95% Confidence Interval (CI): 0.89-0.99), whereas neuroticism was associated with increased risk of incident non-amnestic MCI (aHR: 1.06 95% CI: 1.01-1.11). These associations remained significant even after considering the confounding effects of lifestyle or mood. None of the personality traits were associated with MCI overall or amnestic MCI.

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Conclusions: These findings provide evidence of a distinct relationship between personality traits and development of specific pre-dementia syndromes.

Keywords

Mild Cognitive Impairment; Motoric Cognitive Risk Syndrome; Personality; Cognitive Outcomes

INTRODUCTION

The five-factor model (neuroticism, extraversion, openness, agreeableness, and conscientiousness) is widely used to describe and define aspects of personality.[1] Longitudinal associations between personality traits with cognitive outcomes in older adults have been described, and link neuroticism and conscientiousness to incident cognitive syndromes.[2-7] However, results regarding effects of other personality traits on cognitive states are more mixed. Several studies have reported associations between lower levels of openness and increased risk for Mild Cognitive Impairment (MCI)[5] and Alzheimer's Disease[8], while others report no association[6]. An association between lower agreeableness and increased risk for dementia was reported in one study[3], but not in others.[7] Extraversion was not associated with risk for MCI or dementia in previous studies.[7] The mixed results reported for certain personality traits may be due to the relationship between certain personality traits and specific cognitive domains.[9]

The association between personality traits and Motoric Cognitive Risk (MCR) syndrome[10] was recently examined.[11] MCR builds on the operational definition of MCI, substituting the objective cognitive criterion assessed through neuropsychological testing with slow gait; increasing clinical accessibility.[10, 12] MCR is common in older adults, and predictive of dementia.[10, 12] Only partial overlap between individuals diagnosed with MCR and MCI syndromes was reported[10, 12], indicating that risk factors and cognitive trajectories for these syndromes may vary. Stephan, et al. identified cross-sectional associations of prevalent MCR with lower openness, extraversion and conscientiousness as well as higher neuroticism in two large aging cohorts.[11]

This prospective study builds on previous research to examine whether the five major personality traits[1] are associated with risk of incident pre-dementia syndromes, MCR and MCI syndromes, as well as MCI subtypes (amnestic and non-amnestic MCI). We hypothesized that higher levels of openness and conscientiousness would be associated with lower risk of MCR and MCI, while higher levels of neuroticism would be associated with increased risk MCI and MCR. We did not expect to find a relationship between agreeableness with either pre-dementia syndrome, and expected to find a relationship between extraversion and MCR alone.

METHODS

Participants:

We studied community-residing adults age 65 and older enrolled in the "Central Control of Mobility in Aging" (CCMA) study. The primary goal of CCMA is to determine cognitive

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control of mobility.[13, 14] CCMA procedures have been reported.[13, 14] In brief, potential participants were identified from a Westchester County Registered Voter List, which included individuals aged 65 and older who voted in local or national elections in the past two years. They were first contacted by mail and then by telephone inviting them to participate. Potential participants were assessed for eligibility using a structured telephone screening interview and to rule out dementia using cognitive screeners[13, 14]. Exclusion criteria included; inability to speak English, inability to ambulate independently, presence of dementia (previous physician diagnosis or using cut scores on the validated cognitive screeners [15, 16]), 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. Eligible individuals were scheduled for in-person visits at the research center. During study visits, participants received comprehensive cognitive, psychological, and mobility assessments. Neuropsychological tests were administered by research assistants under the supervision of a licensed neuropsychologist, and included a test of general cognitive function, Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)[17], as well as tests to assess various cognitive domains including the Digit Symbol Substitution Test (Subtest of Wechsler Adult Intelligence Scale-Third Edition)[18], the Trail Making Test[19], Free and Cued Selective Reminding Test[20], Controlled Oral Word Association Test–Semantic and Phonemic Fluency[21] and Boston Naming Test[22]. Diagnosis of dementia was assigned according to the Diagnostic and Statistical Manual of Mental Disorders, fourth edition[23] at consensus diagnostic case conferences, as previously described.[24] CCMA participants were followed longitudinally at yearly intervals. The study protocols were approved by the Albert Einstein College of Medicine institutional review board, and written informed consents were obtained at study visits.

The Big Five Inventory (BFI):

The BFI is a 44-item self-report measure designed to assess five dimensions of personality[25] (neuroticism, extraversion, conscientiousness, agreeableness, and openness).[1] Participants were asked by trained research assistants to rate the extent to which they agreed or disagreed with each item using a 5-point Likert scale where 1 = “Disagree strongly” and 5 = “Agree strongly”. Scores range from 0 to 40 for each of the five personality traits. The scale was shown to have good validity and reliability (alpha = 0.83) in previous studies.[26]

Pre-dementia syndrome diagnoses:

MCI and MCR diagnostic procedures in CCMA have been reported[12, 24, 27], and are based on published guidelines.[28] In brief, non-demented participants with subjective cognitive complaints but without a dementia diagnosis or functional limitations were classified as amnestic MCI if they had impairments on tests of the memory domain or non-amnestic MCI if they had impairments on tests of non-memory domains. Impairment was defined as 1.5 standard deviations (SD) below age and education adjusted norms on relevant cognitive tests. MCI was diagnosed at consensus case conferences attended by study clinicians and neuropsychologists using Diagnostic and Statistical Manual fourth edition criteria.[23]

MCR syndrome is defined as presence of subjective cognitive complaints and slow gait speed in older individuals without dementia or mobility disability.[10, 12, 29] Subjective

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cognitive complaints were assessed by a score of ≥1 on the AD8-dementia screener[15] or a 'yes' response to the memory item on the Geriatric Depression Scale (GDS) ("Do you feel that you have more problems with memory than most?").[30] Gait speed at 'normal pace' was measured on a computerized walkway (180 x 35.5 x 0.25 inches) with embedded pressure sensors (GAITRite, CIR systems).[31] From footfalls recorded on the walkway, the software computes gait parameters including gait speed (cm/s). GAITRite is widely used, and has excellent reliability.[31] Slow gait was defined as walking speed one SD or more below age and sex specific means.[10, 12, 29]

Covariates:

Data collected at each visit from participants included sociodemographic information (age, sex, race/ethnicity and years of education), cognitive status, mood, activities of daily living, and lifestyle variables. A summary multi-morbidity index score (0–10) was derived by assigning individuals a score based on a sum of prevalent physician diagnosed conditions, including angina, arthritis, chronic heart failure, chronic obstructive pulmonary disease, depression, diabetes, hypertension, myocardial infarction, Parkinson's Disease and stroke. Depressive symptoms were measured using the 30-item GDS (higher scores worse).[30] The Beck Anxiety Inventory[32] (BAI) is a 21-item self-report measure of the severity of anxiety symptoms over the last week (range 0 to 63, higher scores worse). Participants reported the number of days per week that they typically engaged in cognitive leisure activities[33] over the past year. Activities including reading, writing for pleasure, crossword puzzles, playing board games or cards, participating in organized group activities or discussions, and playing musical instruments. Through these responses, we generated a scale where one point corresponds to participation in one activity for one day per week. We added the activity-days for each activity to generate a total cognitive-activity score for each participant, with scores ranging from 0 to 42.[33] This cognitive leisure activity score has been shown to predict MCI and dementia.[33, 34]

Data analysis:

Baseline characteristics of participants who did and did not develop MCR and MCI were compared using independent samples t-test for continuous variables and Pearson's χ^2 test for categorical variables. Cox proportional-hazards models adjusted for age, sex, education and the multi-morbidity index score were used to compute adjusted hazard ratios (aHR) with 95% confidence intervals (CI) for developing MCR, MCI or subtypes of MCI based on baseline BFI scores. Each personality trait score was entered into a separate model to examine the individual effect of each trait on the cognitive outcomes. Secondarily, we further examined traits with significant associations with cognitive outcomes in tertiles to detect any threshold effects to aid clinical applicability of findings. Time to event was from baseline to the first visit at which a pre-dementia syndrome was diagnosed or to final study contact, whichever came first. The eligible sample did not include any individuals with dementia at baseline. Prevalent cases of pre-dementia syndromes were also excluded; prevalent cases of MCI were excluded from incident MCI analyses and prevalent cases of MCR were excluded from incident MCR analyses. Proportional hazards assumptions of all models were examined analytically and graphically, and were adequately met. All analyses were conducted using SPSS version 25 (SPSS Inc., Chicago, IL).

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We conducted a number of sensitivity analyses to further examine the relationship between personality and our cognitive outcomes. We additionally adjusted for baseline total RBANS scores to account for baseline cognition in the primary models looking at MCI and MCR outcomes. Symptoms of depression and anxiety were adjusted for in models examining neuroticism and openness due to the previously established relationship between anxiety, depression, openness and neuroticism.[35, 36] Individuals with higher openness have been posited to be protected against cognitive decline due to participation in cognitive activities[37]. Hence, we examined an interaction between participation in cognitive activities and openness. We examined the possibility that personality changes may occur early in the transition from normal cognitive function to dementia, as reported in some[38, 39] but not all studies[5, 40], by excluding those who were diagnosed with MCR or MCI in the first two years of follow-up. We also examined the association of the traits with incident dementia.

RESULTS

Study population:

Data collection for this study began in June 2011 and ended August 2018. Of the 588 participants seen during this period, at baseline 12 did not complete BFI, 9 had prevalent dementia, and 26 had missing cognitive test data. Of the 541 in the eligible sample at baseline, 58 had MCI, 22 had MCR and 17 had both MCI and MCR. Supplementary Table S1 shows baseline characteristics of the sample by prevalent cognitive diagnosis. There were significant group differences on extraversion and openness. Pairwise comparisons indicated significant differences in extraversion between groups with both MCI and MCR compared to normal ($p = 0.009$), and between MCI and those with both MCI and MCR ($p = 0.008$).

Table 1 shows characteristics of the baseline sample after excluding the 17 participants with both MCR and MCI at baseline ($n = 524$). The mean age was 76.5 years, they had 14.7 years of education on average, and majority were women (62%). Compared to people who did not develop a pre-dementia syndrome over follow-up, people who developed MCR (76.3 vs. 79.8 years, $p = 0.001$) or MCI were significantly older at baseline (75.8 vs. 78.6 years, $p = 0.001$). Those who developed MCI had lower RBANS scores at baseline (87.2 vs. 94.6, $p < 0.001$). Those who developed MCR had higher GDS scores (6.8 vs. 4.3, $p < 0.001$), BAI scores (6.5 vs. 4.2, $p = 0.014$) and more prevalent morbidities (2.0 vs. 1.6, $p = 0.026$). They also had lower scores on the personality trait of openness (35.6 vs. 38.2, $p = 0.018$). People who developed MCI did not differ from those who remained healthy on any of the personality trait scores at baseline.

Incident pre-dementia syndromes:

Over a median follow-up of 3.0 ± 2.0 (range: 0.9–7.0) years, there were 69 incident MCI cases (28 amnestic and 41 non-amnestic subtypes) and 38 incident MCR. The mean time to incident MCI was 2.4 ± 1.6 years; for those without incident MCI mean time to final contact was 3.6 ± 1.7 years. The mean time to incident MCR was 2.6 ± 1.5 years; for those without incident MCR, mean time to final contact was 3.6 ± 1.8 years. Over follow-up, 26 cases developed MCR and MCI and 4 were diagnosed with both at the same visit. Table 2 shows that openness at baseline was associated with a reduced risk of incident MCR (aHR 0.94,

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95% CI: 0.89–0.99), whereas neuroticism was associated with increased risk of incident non-amnestic MCI (aHR 1.06, 95% CI: 1.01–1.11). None of the personality traits predicted MCI overall or amnestic MCI. Personality traits also did not predict the 26 incident dementia cases (data not shown).

We further examined personality traits of openness and neuroticism in tertiles as predictors of MCR and non-amnestic MCI, respectively. Participants scoring in the highest tertile of openness had lower risk of developing MCR compared to those in the lowest tertile (aHR 0.38, 95% CI 0.16–0.93, p = 0.033), but not those in the middle tertile (aHR versus lowest tertile 0.79, 95% CI 0.37–1.70, p = 0.548). Similarly, participants with the highest tertile of neuroticism were more likely to develop non-amnestic MCI compared with those in the lowest tertile (aHR 3.00, 95% CI 1.32–6.84, p = 0.009) but not those in the middle tertile (aHR 1.48, 95% CI 0.59–3.78, p = 0.405).

Sensitivity analyses:

After additionally adjusting for baseline cognition (RBANS score), openness was still associated with reduced risk for MCR (aHR 0.94, 95% CI: 0.89–0.99, p = 0.023); however, neuroticism was no longer associated with risk for non-amnestic MCI (p = 0.118).

The interaction term of cognitive leisure activities * openness was not significant (p = 0.726) when added to our primary model, indicating that participation in cognitive leisure activities did not drive the association between openness and MCR.

When adjusted for depressive symptoms (GDS), neuroticism still predicted non-amnestic MCI (aHR 1.07, 95% CI: 1.00–1.14, p = 0.037), but the effect of openness on MCR was attenuated (aHR 0.95, p = 0.059). Adjusting for levels of anxiety using BAI moderated the effect of neuroticism on risk of non-amnestic MCI (aHR 1.04, 95% CI: 0.99–1.10, p = 0.098).

We excluded incident non-amnestic MCI (n=20) and MCR cases (n=19) diagnosed in the first two years of follow-up to account for cases that reverted back to normal or were misclassified as normal at baseline. Neuroticism remained a predictor of non-amnestic MCI (aHR 1.09, 95% CI 1.02–1.16, p = 0.013), but openness did not predict MCR (aHR 0.97, 95% CI 0.90–1.04, p = 0.345) occurring two years after the baseline.

DISCUSSION

Our findings demonstrate that different dimensions of personality are associated with specific pre-dementia syndromes. Openness was associated with reduced risk of MCR, while neuroticism was associated with increased risk for non-amnestic MCI. These findings are consistent with previous studies, which have indicated that neuroticism is a risk factor for cognitive impairment[3], and openness provides a protective effect against cognitive impairment.[2, 4]

Our findings are consistent with a recent study which examined the cross-sectional relationship between personality traits and prevalent MCR[11], but also shows some differences that may be attributed to the difference in study designs. Stephan et, al., showed

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that in addition to openness, as in our study, neuroticism, extraversion and conscientiousness were associated with MCR at cross-section.[11] The additional personality traits associated with MCR at cross-section may be a feature of a later pre-dementia stage.

There are a number of explanations for the association of specific personality traits with pre-dementia syndromes. First, specific personality traits are associated with decline in particular cognitive domains that are related to discrete pre-dementia syndromes. Previous longitudinal studies have shown neuroticism and conscientiousness to be associated with decline in episodic memory and working memory, while higher openness was associated with non-memory functions[9] such as better executive function and verbal memory.[41, 42] A previous study in our cohort found that prevalent MCR cases performed worse than those without MCR on measures of attention and language, but not memory.[27] Higher neuroticism was associated higher levels of systemic inflammation and reduced brain volume,[3, 7] which may explain the relatively consistent link with poor general cognitive function and working memory found in many studies[4, 9, 43], and supports our findings of the association with non-amnestic MCI. The lack of an association between neuroticism and MCR are in contrast with previous studies which found neuroticism to influence gait speed decline[44, 45], an important MCR criterion. These findings indicate that personality traits are markers of decline in specific areas of cognitive function, and may reflect distinct biological pathways in the transition from normal cognition to specific pre-dementia syndromes.

A second possibility is that specific traits are causal for dementia. Our study design and sample did not permit us to address the causal role of personality traits for dementia, which would also require personality assessments earlier in life and longer follow-up. It is possible that personality changes occur early in the transition from cognitively healthy to dementia in order to adapt to declining cognitive functions.[38, 39] This concept which can be referred to as ‘mild behavioral impairment[46]‘ is also an at-risk for dementia state that develops early in the transition from normal cognitive function. However, a recent investigation[40] in the Baltimore Longitudinal Study of Aging found no evidence for preclinical change in personality measured for up to 36 years before the onset of MCI or dementia.[40] Albeit limited, our results after excluding individuals who developed non-amnestic MCI within two years of baseline were unchanged providing support this earlier study. On the other hand, MCR was not significant when cases within two years of baseline were excluded. Our findings of no significant association between any of the personality traits and incident dementia may indicate that personality plays a role in transition to pre-dementia syndromes, but not from pre-dementia to dementia. Studies in younger cohorts with longer follow-up are needed to further explore these issues.

The small magnitude of the effect size of openness and neuroticism on MCR and non-amnestic MCI found in our study is in keeping with the multi-determinant nature of pre-dementia syndromes that are influenced by many behavioral and lifestyle factors. Personality traits could influence behaviors that increase risk (such as depression or anxiety) or decrease risk (such as participating in cognitive leisure activities[37]) for cognitive decline. It has been speculated that the protective cognitive effect of openness may result from increased cognitive reserve due to promotion of healthy behaviors such as participation in cognitively stimulating activities[37]; however, accounting for participation in cognitive leisure

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activities did not attenuate the association between openness and MCR. Personality traits are considered predictors of behaviors like depression and indicators of response to stress and anxiety. A previous study found that depression diagnosis was associated with higher neuroticism and lower extraversion in older adults, and that the effect of openness was mediated by level of education.[35] Adjusting for depressive symptoms did not affect the association between neuroticism and non-amnestic MCI, but attenuated the effect of openness on MCR, indicating that depressive symptoms may drive the effect of openness on reducing risk of MCR. This is supported by a previous meta-analysis, which showed that depressive symptoms predicted personality traits.[47] Our findings that levels of anxiety moderated the effect of neuroticism on non-amnestic MCI is supported by a previous study showing the effect of neuroticism on Alzheimer's disease was driven by vulnerability to stress and anxiety.[36]

Strengths of this study include a well characterized, relatively large sample, with a longitudinal design, and established clinical measures and procedures. However, several potential limitations are noted including a short follow-up time and a lack of diversity in race (81% of participants were white) and ethnicity (2% Hispanic) which limits generalizability. However, previous studies have not seen an effect of race/ethnicity on the association of personality traits with cognitive decline[3] and dementia[48]. Our covariates were based on self-report.

These findings provide preliminary evidence of personality traits as predictors of pre-dementia syndromes in aging, and raise the possibility that personality traits play an independent role in the risk for or protection against particular pre-dementia syndromes. These findings have important implications for practice emphasizing the importance of accounting for personality traits, particularly for patients who are on the high end of the neuroticism or openness spectrum when assessing for dementia risk.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Baseline characteristics of study population (n = 524). Values are means ± standard deviation unless otherwise noted.

Age, years	76.5 ± 6.5 [ab]
Sex, % (n) female	61.5 (272)
Race/Ethnicity	
White, % (n)	80.7 (423)
Black, % (n)	15.5 (81)
Hispanic, % (n)	2.1 (11)
Other, % (n)	1.7 (9)
Education, years	14.7 ± 2.9
RBANS[c] Total Score (62-138)	92.0 ± 11.6 [b]
Geriatric Depression Scale (0-30)	4.4 ± 3.7 [a]
Cognitive Leisure Activities Scale (0-42)	9.6 ± 4.7
Beck Anxiety Inventory (0-63)	4.4 ± 5.4 [a]
Summary multi-morbidity score (0-10)	1.6 ± 1.1 [a]
Depression, % (n)	10.5 (55)
Diabetes, % (n)	19.1 (100) [a]
Heart Failure, % (n)	1.5 (8)
Hypertension, % (n)	59.7 (313)
Myocardial Infarction, % (n)	6.3 (33) [b]
Angina, % (n)	3.6 (19)
Stroke, % (n)	5.3 (28) [ab]
Chronic Obstructive Lung Disease, % (n)	7.1 (37)
Arthritis, % (n)	53.6 (281) [a]
Big Five Inventory Scores by Personality Traits	
Extraversion	27.8 ± 6.2
Agreeableness	38.6 ± 4.7
Conscientiousness	37.7 ± 5.4
Neuroticism	18.1 ± 6.3
Openness	38.0 ± 6.7 [a]

[a] Indicates significant differences ($p<0.05$) between those who developed incident MCR and remained healthy.

[b] Indicates significant differences ($p<0.05$) between those who developed incident MCI and remained healthy.

[c] RBANS: Repeatable Battery for the Assessment of Neuropsychological Status

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Table 2.

Association of five personality traits with incidence of mild cognitive impairment (MCI) and motoric cognitive risk syndrome (MCR).

	Incident cases/Total, n	Adjusted HR (95% CI)[a], p-value
Extraversion		
MCI	69/466	1.00 (0.97-1.04), 0.860
Amnestic MCI	28/510	0.98 (0.93-1.04), 0.463
Non-amnestic MCI	41/480	1.02 (0.97-1.08), 0.395
MCR	38/500	0.98 (0.93-1.03), 0.450
Agreeableness		
MCI	69/466	1.04 (0.99-1.10), 0.147
Amnestic MCI	28/510	1.02 (0.94-1.11), 0.603
Non-amnestic MCI	41/480	1.06 (0.98-1.13), 0.138
MCR	38/500	1.03 (0.96-1.11), 0.453
Conscientiousness		
MCI	69/466	1.00 (0.96-1.05), 0.907
Amnestic MCI	28/510	0.99 (0.93-1.06), 0.783
Non-amnestic MCI	41/480	1.01 (0.96-1.07), 0.692
MCR	38/500	0.98 (0.92-1.03), 0.407
Neuroticism		
MCI	69/466	1.03 (0.99-1.07), 0.104
Amnestic MCI	28/510	0.99 (0.93-1.06), 0.847
Non-amnestic MCI	41/480	1.06 (1.01-1.11), 0.020
MCR	38/500	0.99 (0.94-1.05), 0.790
Openness		
MCI	69/466	0.99 (0.95-1.03), 0.543
Amnestic MCI	28/510	1.00 (0.95-1.06), 0.912
Non-amnestic MCI	41/480	0.98 (0.93-1.03), 0.351
MCR	38/500	0.94 (0.89-0.99), 0.015

[a]Hazard ratios (HR) with 95% confidence intervals (CI) are adjusted for age, sex, education and summary multi-morbidity score in all models.