Openness and age influence cognitive progression: a longitudinal study

Abertura e idade influenciam a progressão de cognição: um estudo longitudinal

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Abstract

Background Some psychological and personality characteristics of individuals seem to determine behavioral patterns that are associated with better health throughout life and, consequently, prevent the progression of early cognitive changes to dementia.

Objective To identify which individuals have modified cognitive ratings after 24 months of follow-up and correlating with personality traits.

Methods One hundred and two volunteers were evaluated clinically and for personality characteristics and neuropsychological testing. Of these, 25 subjects were classified as cognitively normal (CN), 25 as subjective cognitive decline (SCD), 28 as nonamnestic mild cognitive impairment (naMCI), and 24 as amnestic mild cognitive impairment (amMCI) at baseline. Follow-up occurred over 2 years from the initial assessment, and the cognitive categories of the participants were re-analyzed every 6 months to observe differences in their classification.

Results Out of the 102 subjects, 65 remained at follow-up. The sample followed-up longitudinally was composed predominantly of women (65%), white (74%), with a mean age of 78 (±7.5) years old and 12 (±4.8) years of schooling. Throughout the process, 23% of CN, 15% of SDC, and 27% of naMCI individuals worsened cognitively. Amnestic with mild cognitive impairment volunteers remained stable or improved. Individuals with older age show more significant cognitive deterioration, and those with very low or high rates of the openness personality trait are associated with cognitive decline utilizing the Fisher exact test, probably because the open extremes influence choices, stress management, and behavioral maintenance.

Conclusion The factors most associated with cognitive change in this group of older adults were age and the intensity of the openness aspects of personality.

Keywords
- Cognitive Dysfunction
- Dementia
- Personality
- Lifestyle

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Resumo

Antecedentes Algumas características psicológicas e de personalidade determinam padrões comportamentais que se associam a uma melhor saúde ao longo da vida e, consequentemente, impedem a progressão de alterações cognitivas para demência.

Objetivo Identificar quais indivíduos modificaram cognitivamente após 24 meses de acompanhamento e correlacionar com traços de personalidade.

Métodos 102 voluntários foram avaliados clinicamente por características de personalidade e testes neuropsicológicos. Destes, 25 indivíduos foram classificados como cognitivamente normais (CN), 25 como com declínio cognitivo subjetivo (DCS), 28 com comprometimento cognitivo leve não amnéstico (CCLNa) e 24 com comprometimento cognitivo leve amnéstico (CCLAm) no início do estudo. O acompanhamento ocorreu ao longo de 2 anos a partir da avaliação inicial, e as categorias cognitivas dos participantes foram reanalisadas a cada 6 meses para observar diferenças em sua classificação.

Resultados Dos 102 indivíduos, 65 permaneceram em acompanhamento. A amostra acompanhada longitudinalmente foi composta predominantemente por mulheres (65%), brancas (74%), com média de idade de 78 ($\pm$7,5) anos e 12 ($\pm$4,8) anos de escolaridade. Ao longo do processo, 23% dos indivíduos CN, 15% dos DCS e 27% dos indivíduos CCLNa pioraram cognitivamente. Os voluntários CCLAm permaneceram estáveis ou melhoraram. Indivíduos com idade mais avançada apresentam deterioração cognitiva mais significativa, e aqueles com taxas muito baixas ou altas do traço de personalidade abertura estão associados ao declínio cognitivo utilizando o teste exato de Fisher. Provavelmente, a característica abertura influencia as escolhas, o gerenciamento do estresse e a manutenção do comportamento.

Conclusão Os fatores mais associados à alteração cognitiva neste grupo de idosos foram a idade e a intensidade dos aspectos abertura da personalidade.

Palavras-chave

- Disfunção Cognitiva
- Demência
- Personalidade
- Estilo De Vida

INTRODUCTION

Population aging justifies studies on chronic degenerative conditions such as neuropsychiatric disorders, as these are frequent in the elderly population.[1] The understanding of anticipatory conditions to dementia, especially mild cognitive impairment (MCI), is growing in medical practice with a preventive diagnostic function of neurodegenerative conditions.[2]

To date, studies on the characterization of risk factors for dementia and protective factors for the maintenance of healthy aging have been more frequent in determining cognitive evolution.[3] Thus, the association between the worse cognitive outcome in individuals with hypertension, diabetes, obesity, smoking, physical inactivity, and neuropsychiatric symptoms has already been evidenced.[4] Similarly, certain individual psychological and personality characteristics determine behavioral patterns and are associated with better health throughout life, preventing the progression of prodromal states to dementia.[5,6]

Mild cognitive impairment is defined as a cognitive complaint confirmed by an objective assessment of the different cognitive domains with preserved functionality.[7,8] The annual risk of MCI progression to dementia is estimated at 5 to 15% compared with a rate of 1% in cognitively normal elderly individuals.[9] Its rates are lower in younger individuals and increase with age. However, some individuals with MCI never progress to dementia syndromes.[10]

Although neurodegeneration may be the most frequent cause of MCI, cognitive deterioration may evolve due to other clinical conditions, such as cardiovascular or infectious diseases, as well as other factors, such as educational levels and cultural or personality traits.[11]

Another similar condition is subjective cognitive decline (SCD), which refers to an individual's awareness of cognitive decline, compared with previous cognitive status without a trigger and without change in cognitive tests, as occurs in MCI.[12]

Some studies indicate that such subjective memory complaints are more strongly related to depression, sleep disorders, adverse effects of medication or personality traits.[13] It is believed that personality traits have biological bases, reflecting neurophysiological processes mediated by brain networks.[14] Personality traits are also known to be highly inheritable, even though personality also results from interactions between the brain and the environment.[15] The most widespread explanatory model of personality used in research, known as the *Big Five*, refers to the personality structure as the individual fusion of five major factors: neuroticism (susceptibility to stress), agreeableness (interpersonal interaction and empathy), conscientiousness (control and motivation to achieve goals), extroversion (need for stimulation, the existence of self-confidence and spontaneity), and openness

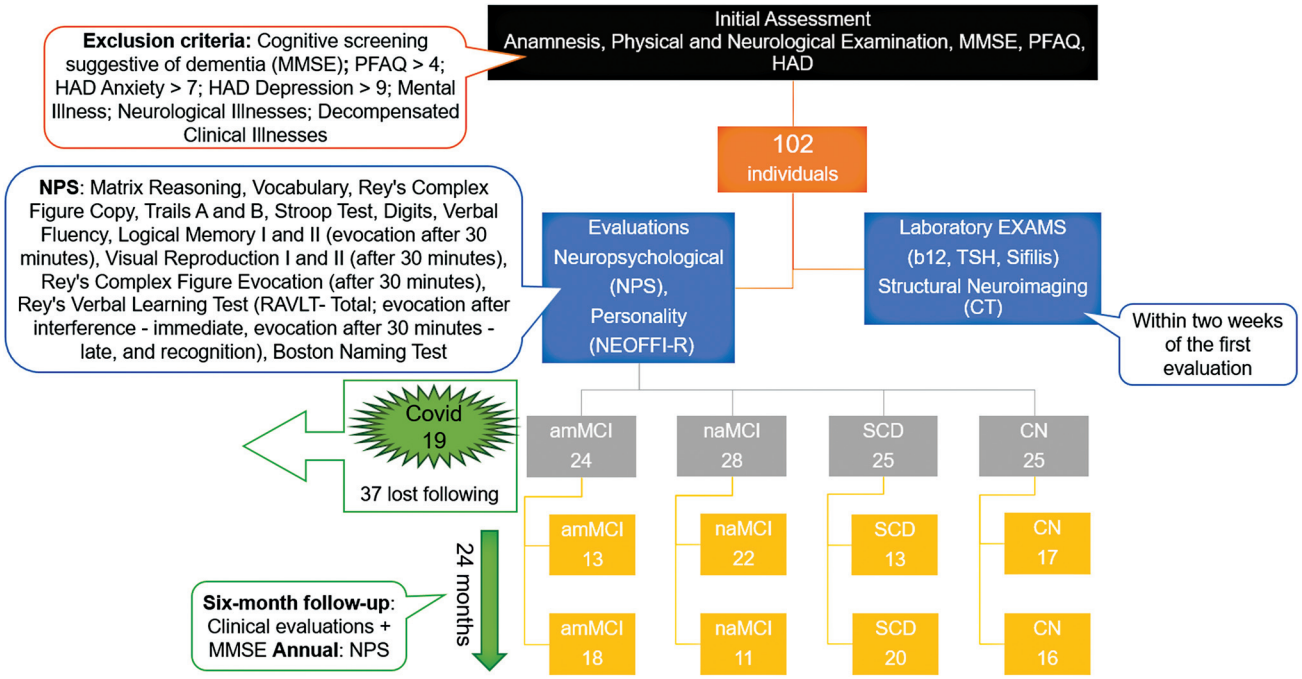

Figure 1 Flowchart of the study population. Abbreviations: amMCI, amnestic mild cognitive impairment; CN, cognitively normal; HAD, Hospital Anxiety and Depression Screening Questionnaire; MMSE, Mini-Mental State Examination; naMCI, non-amnestic mild cognitive impairment; NEO-FFI-R, Personality Inventory NEO-Revised; PFAQ, Pfeffer Functional Activities; SCD, subjective cognitive decline.

(exploratory behaviors to experiences and reflective behavior).[17]

Research indicates a relationship between MCI and personality traits such as neuroticism, openness, and conscientiousness. There are also data showing that neuroticism scores increase and openness scores decrease in MCI cases that progress to dementia.[18]

Understanding the relationship between personality and cognitive ability in older adults is considered important since personality traits affect cognitive decline mainly by interfering with cognitive reserve, which is an active process that is closely related to motivation, interest, and intensity of effort, characteristics that result from personality traits.[19,20] Our aim is to observe, after 24 months of follow-up, which factors interfere with the evolution of cognitive disorders in the MCI patients.

METHODS

This is a longitudinal study with volunteers > 60 years old who participate in the Brazilian Aging Memory Study (BRAMS), of the Hospital das Clínicas of the Faculdade de Medicina of the Universidade de São Paulo (HC/FMUSP, in the Portuguese acronym). The study included 102 individuals from January 2017 to January 2019, who were classified and evaluated according to the flowchart described in ►**Figure 1** after signing the Free and Informed Consent form. The data were collected prospectively for 24 months, and at the end of the segment, 65 older adults remained in the follow-up.

We excluded from the study individuals with a) functional changes, assessed by the Pfeffer Functional Activities Questionnaire (PFAQ > 4); b) cognitive screening suggestive of dementia, tested with scores from the Mini-Mental State Examination (MMSE) and the Brief Cognitive Screening Battery; c) predominant symptoms of anxiety and depression, as assessed by the Hospital Anxiety and Depression Scale (HAD anxiety > 7; HAD depression > 9); d) a psychiatric illness; e) a decompensated clinical illness; and f) antecedents or signs of neurological diseases.

The patients underwent at least two comprehensive neuropsychological assessments and the criteria used for categorizing the sample were Petersen/Winblad,[7] and/or Jak/Bondi.[21] For both criteria, participants with MCI were also classified as "amnestic" when memory was impaired, or as "nonamnestic" when one or more domains except memory were impaired. Individuals classified as SCD were those with cognitive complaints, but with neuropsychological test results within normal parameters for age and education. Cognitively normal (CN) elderlies were those without cognitive complaints or changes in cognitive tests. After each evaluation, the participants were reclassified as to their cognitive diagnosis, which could remain the same, be progressive for cognitive worsening, or reversible (with cognitive improvement).

The personality assessment was performed using the NEO Personality Inventory-Revised (NEO-FFI-R), based on the Big Five theory, which uses the models of extroversion, neuroticism, amiability, conscientiousness, and openness as the main characteristics (►**Supplementary Material** - https://www.arquivosdeneuropsiquiatria.org/wp-content/uploads/2023/07/ANP-2023.0001-Supplementary-Material.pdf).[22]

The computer system of the test publisher performed the scoring of the NEO-FFI-R. The computer score system transforms the numerical rating of the test into qualitative

Table 1 Inference of variables for negative evolution after 24 months

Variable		Cognitive weakness - Negative conversion		*p-value*
		No	Yes	
Age (years old) - Mean (CI)		77.6 (75.77–79.44)	81.91 (75.14–88.68)	0.05*
Schooling (years) - Mean (CI)		12.42 (11.14–13.69)	14.55 (10.94–18.16)	0.27
MMSE (points) - Mean (CI)		28.4 (27.92–28.87)	28.18 (27.19–29.17)	0.42
IQ (points) - Mean (CI)		104.13 (100.64–107.62)	101.45 (93.91–109)	0.61
HADD - Mean (CI)		3.52 (2.7–4.34)	4.8 (2.42–7.18)	0.25
HADANS - Mean (CI)		3.84 (3.02–4.66)	4.1 (2.24–5.96)	0.62
Sex ($n=65$)	Male ($n=23$)	70% (16)	30% (7)	0.09
	Female ($n=42$)	88% (37)	12% (5)	
Age ($n=65$)	Caucasian ($n=49$)	79% (39)	21% (10)	0.85
	Black ($n=7$)	86% (6)	4% (1)	
	Eastern ($n=9$)	88% (8)	12% (1)	
Hypertension ($n=65$)	Present ($n=34$)	23% (8)	77% (26)	0.35
	Absent ($n=31$)	87% (27)	13% (4)	
Diabetes ($n=65$)	Present ($n=13$)	85% (11)	15% (2)	1.0
	Absent ($n=52$)	81% (42)	19% (10)	
Dyslipidemia ($n=65$)	Present ($n=26$)	77% (20)	23% (6)	0.52
	Absent ($n=39$)	84% (33)	16% (6)	
Hypothyroidism ($n=64$)	Present ($n=11$)	100% (11)	0	0.1
	Absent ($n=53$)	77% (41)	23% (12)	
Cardiopathy ($n=65$)	Present ($n=17$)	70% (12)	30% (5)	0.16
	Absent ($n=48$)	85% (41)	15% (7)	
Neoplasia ($n=65$)	Present ($n=5$)	80% (4)	20% (1)	1.0
	Absent ($n=60$)	81%(49)	19% (11)	
Opening ($n=65$)	Very low ($n=11$)	64% (7)	36% (4)	0.0005*
	Low ($n=22$)	95% (21)	5% (1)	
	Mean ($n=24$)	92% (22)	8% (2)	
	High ($n=8$)	37% (3)	63% (5)	
	Very high ($n=0$)	0% (0)	0% (0)	
Amability ($n=65$)	Very low ($n=0$)	0% (0)	0% (0)	0.4
	Low ($n=13$)	85% (11)	15% (2)	
	Mean ($n=35$)	77% (27)	23% (8)	
	High ($n=14$)	93% (13)	7% (1)	
	Very high ($n=3$)	67% (2)	33% (1)	
Consciousness ($n=65$)	Very low ($n=2$)	100% (2)	0	0.35
	Low ($n=5$)	60% (3)	40% (2)	
	Mean ($n=36$)	83% (30)	17% (6)	
	High ($n=20$)	85% (17)	15% (3)	
	Very high ($n=2$)	50% (1)	50% (1)	
Extroversion ($n=65$)	Very low ($n=5$)	80% (4)	20% (1)	0.9
	Low ($n=21$)	76% (16)	24% (5)	
	Mean ($n=25$)	84% (21)	15% (4)	
	High ($n=14$)	86% (12)	14% (2)	
	Very high ($n=0$)	0% (0)	0% (0)	

(*Continued*)

Table 1 (*Continued*)

Variable		Cognitive weakness - Negative conversion		*p-value*
		No	Yes	
Neuroticism ($n=65$)	Very low ($n=17$)	77% (13)	23% (4)	0.79
	Low ($n=27$)	85% (23)	15% (4)	
	Mean ($n=18$)	78% (14)	22% (4)	
	High ($n=3$)	100% (3)	0% (0)	
	Very high ($n=0$)	0% (0)	0% (0)	
Cognitive group ($n=65$)	CN ($n=17$)	76% (13)	24% (4)	0.24
	SDC ($n=13$)	86% (11)	15% (2)	
	naMCI ($n=22$)	73% (16)	27% (6)	
	amMCI ($n=13$)	100% (13)	0% (0)	

Abbreviations: CI, confidence interval; HADANS, Hospital Depression and Anxiety Screening Questionnaire Anxiety Scope; HADD, Hospital Depression and Anxiety Screening Questionnaire Depression Scope; IQ, intelligence quotient; MMSE, Mini-Mental State Examination.
Note: *Statistically significant values.

categories ranging from very low to very high. Values are available in ►**Table 1**. Structural neuroimaging scans were acquired by tomography.[23]

For the statistical study, the correlation analyses were performed using the Spearman correlation coefficient and the verification of the null hypothesis, using the cutoff point value of $p < 0.05$ (5%). To detect significant differences in the variables between the different cognitive groups, analysis of variance (ANOVA) was performed for variables with normal distribution, and the Kruskal Wallis test for those not normally distributed. In the longitudinal evaluation, the cognitive improvement and worsening were calculated with t-tests (parametric) associated with normal variables and the Wilcoxon test for non-normal variables. Applying the Fisher exact test, tables of contingencies were used to verify the association of categorical variables. All participants signed the informed consent, and the present study was approved by the Ethical Committee (process no. 13640/2015).

RESULTS

The participants had a mean age of 77.61 (7.6) years old, ranging from 62 to 96 years old, and 12.8 (4.8) years of schooling, being mostly women (62%) of white ethnicity (75%). After the neuropsychological assessment, the participants were classified as cognitively normal ($n=25$; 24.5%), SCD ($n=25$; 24.5%), naMCI (n = 28; 27.5%) and amMCI ($n=24$; 23.5%). Regarding personality characterization, we observed no differences between the cognitive groups.

Over the 2-year follow-up, shown in ►**Figure 2**, it was possible to observe the changes in classification between the groups, and the heterogeneity of the cognitive trajectory of these elderly subjects. The classification remained stable in 67.5% of the subjects, while 18.5% showed cognitive worsening, and 14% showed cognitive improvement.

The contingency table showed the important association of two factors with cognitive worsening: age and the characteristic openness detected by the personality inventory. For age, the higher the value, the greater the expressiveness of the conversion. Regarding openness, it was observed that very low openness and high openness reduced cognitive worsening. The inferences of the variables related to cognitive worsening are shown in ►**Table 1**.

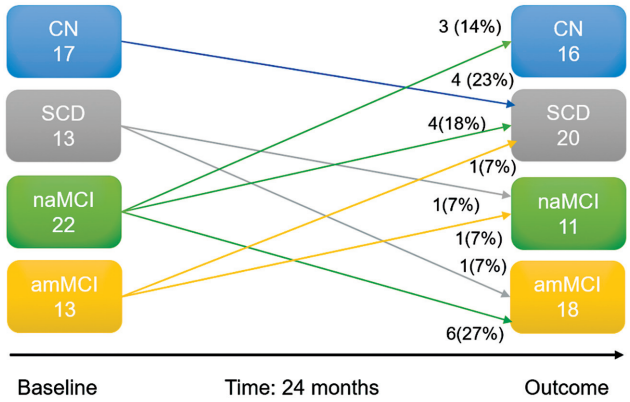

Figure 2 Demonstration of heterogeneity of the cognitive trajectories of elderly individuals followed-up for 24 months.

DISCUSSION

Our findings revealed that very low openness and high openness reduced cognitive worsening, and age was associated with a change in diagnoses. They are consistent with the current literature, which describes advanced age as an established risk of worsening cognitive performance due to greater brain vulnerability.[24] It is known that the prevalence rate of dementia doubles every 6 years, starting at 65, affecting 40% of people > 90 years old. In addition to structural brain issues, depletion of cognitive reserves and progressive social isolation, common in the elderly, also occur.[25]

Regarding personality traits, studies have shown that individuals with MCI who progressed to dementia have

increased neuroticism scores and decreased openness scores, according to data computed by the NEO-PI-R personality instrument.[26–28] More specifically, in a 2-year follow-up study, it was observed that among 510 healthy individuals aged ~ 51 years old, neuroticism scores increased, and openness scores decreased in MCI cases that progressed to dementia.[18]

Another relationship was elucidated with a cross-sectional study, with 44 cognitively normal individuals, 57 patients with MCI, and 9 with AD, when the openness characteristic correlated positively with the MMSE score. That is, the higher the score in the behavioral characteristic of interest in knowledge, curiosity, and search for novelty (characteristics of the openness aspect of personality), the higher the score in the cognitive evaluation. This fact can be understood considering that personality traits contribute to choices and lifestyle, influencing cognitive, social, and physical activities.[29]

Openness is the personality trait that reflects creativity, mental flexibility, and abstract reasoning capacity, properties driven by the increased function of mesocortical networks.[30] Recent evidence has observed that tasks involving imagination, creativity, mental rambling, and fluid intelligence presuppose default mode network (DMN) connectivity activities.[31] These characteristics are inherent to the openness personality trait, which many studies evidence is related to the proportion of robustness, synchronized activity, and brain rest in the posterior cingulate and prefrontal regions.[32] It is known from several functional neuroimaging studies that the inactivation of frontal regions related to the DMN network was observed in participants with MCI compared with controls and even more significantly in AD patients.[33]

Another perspective proposes that higher values of openness do not necessarily lead to significant benefits.[34] Although there is no robust scientific evidence, it can be suggested that excessive openness refers to less persistent subjects and those whose lifestyle is constantly modified, causing scarcity of routines and behavioral patterns. Excessing this could hinder the establishment of protective attitudes to cognitive health, including physical activity practices and sleep and eating routines.[29,30,35] People with higher scores on openness are more likely to engage in irresponsible or thoughtless behavior. They can also go against established social norms and have a need for immediate satisfaction, regardless of the consequences.

Thus, low, and high openness would make it difficult to maintain social contacts, establish new cognitive and physical challenges, and overcome the resistance that emerges throughout life.[36]

As for other personality traits, unlike previous literature, the present sample did not show neuroticism as a factor of significant association with the cognitive evolution of individuals. This could be explained by the fact that the older adults in the sample were initially selected after the HAD screening, which addresses depressive and anxiety symptoms (contents addressed by the neuroticism dimension).

Meanwhile, it is clear that lifestyle factors determined by personality traits can modify the incidence of cognitive disorders.[22] This is because personality influences motivation, interest, and effort intensity that determines the stress response, health behavior choices, and cognitive stimulation activity of individuals with MCI.[14]

That is, personality is associated with dementia risk when factors that mediate this association are considered, such as personality influences choices, stress management, and behavioral maintenance.[30]

The classification changes between the spectrum, including normal cognition at one end and dementia at the other, may occur because heterogeneous etiologies cause MCI with different forms of appreciation. Thus, until the degenerative mechanisms stand out, fluctuations between the spectrum are expected.[31]

Although the results of the present study show an association between the age and openness variables for worse cognitive evolution, interpreting the predictors of cognitive evolution in the elderly is still developing. In an attempt to associate which factors are linked to prognosis, we perhaps mistakenly try to simplify highly heterogeneous situations.[37]

Despite the above contributions, the present study has certain limitations. First, the study sample primarily comprises women (62%). This is common in samples of Brazilian older adults, possibly because women are more concerned about health, more easily accept going to the health service, and thus have a higher life expectancy.[38] Second, the majority of the sample is white (75%), a class that had more social and educational opportunities in the past, justifying the high level of schooling found (~ 13 years) compared with the Brazilian population, which has 9.06 years of schooling for the general population.[39]

Finally, the loss of individuals in the research occurred for several reasons. Still, it was mainly due to the COVID-19 pandemic, which limited the elderly to perform re-evaluations and longitudinal follow-ups. Despite these limitations, we showed the first study of personality traits and MCI in Brazil, with a long-term follow-up with consecutive clinical and neuropsychological evaluations.

In conclusion, the 24-month follow-up of elderly individuals with different cognitive ratings was able to demonstrate that the most important factors for grouping changes were age (the older the individual, the lower the chance of cognitive improvement), and personality characteristics related to openness (search for novelty, creativity, and flexibility) in moderate proportions.

Despite the longitudinal design, complications led to the reduction of the final sample, limiting the robustness of statistical findings. For this reason, it is suggested to expand the number of participants and follow-up time, aiming at a better understanding of the interference of psychological and behavioral factors in the protection and evolution of mild cognitive disorders.

Authors' Contributions

SSM: conceptualization, formal analysis, investigation, methodology, project administration, validation, visualization, writing – original draft, writing – review and editing; SMDB: conceptualization, visualization, writing – review and editing.

Conflict of Interest
The authors have no conflict of interest to declare.

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