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The Associations Between Personality Traits, Leisure Activities, and Memory Performance in Older Adulthood

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Abstract: The present study examines the links between personality traits, leisure activities, and memory in older adults after controlling for leisure activities and demographic factors. The research sample consisted of 24,930 individuals aged 65 to 101 years from 27 European countries (43.2% men and 56.8% women). Data from the 7th Wave of the Survey of Health, Ageing, and Retirement in Europe was analyzed. Memory was assessed using a modified version of Rey's Auditory Verbal Learning Test (RAVLT). Personality traits were assessed using the BFI-10 Personality Traits Questionnaire. Data analysis revealed that personality traits such as openness to experience and neuroticism allow for the prediction of memory capacity in older adulthood. These relationships remained significant even after controlling for cognitively stimulating leisure activities and age. These results show that personality traits such as neuroticism and openness to experience might be valuable in predicting memory functioning among older adults.

Keywords: personality traits, memory, leisure activities, older adults, SHARE.

Introduction

During recent decades, the global population has rapidly become an ageing one. Because of this, cognitive functioning and age-related cognitive changes, especially the deterioration of memory, have become some of the most significant concerns of modern society (Park and Festini, 2017; Cadar et al., 2017). Memory not only provides opportunities to learn new things and properly function in everyday life, but also allows individuals to accumulate memories of their experiences that are important for shaping and preserving a sense of identity (Erber, 2012). There is evidence that even a minor decline in memory reduces a person's independence (Ikeda et al., 2019). Therefore, memory impairment can become not only a cause of mundane day-to-day issues due to forgetting important tasks, but can also cause emotional suffering and have a negative impact on relatives and carers. The reduction in independence due to memory impairment can also cause indirect losses to a country's economy (Chaves et al., 2015; Hock et al., 2014).

Memory consists of various systems, and not all of them undergo age-related changes. According to some studies, the working and episodic memory systems are particularly sensitive to aging processes (Nyberg et al., 2012). The deterioration of these systems is an individual process, and may depend on a series of different factors. These changes are mainly associated with education, IQ, and professional and leisure activities. Studies show that people with higher levels of education, IQ, and professional activity have a better memory capacity in later adulthood and exhibit less age-related memory decline (Stern, 2002, 2009). These relationships are often explained by the cognitive reserve hypothesis, which states that there are interpersonal differences in how individuals are able to cope with neuropathology (Stern, 2002, 2009; Newton et al., 2016). It is assumed that the education, professional experience, and leisure and social activities that a person has acquired—as well as other possible factors—enable compensatory cognitive strategies at the onset of age-related cognitive decline or other neurodegenerative processes (Walker and Tesco, 2013; Stern, 2002; Newton et al., 2016), and ensure better memory capacity in later adulthood. Current studies provide evidence to confirm this assumption by shedding more light on the role

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of leisure activities (Litwin, Schwarts and Noam Damri, 2017; Adam et al., 2013; Mousavi-Nasab, Kormi-Nouri and Nilsson, 2014). It is hypothesized that various activities might be associated with formation and preservation of cognitive reserve (Adam et al., 2013; Stern, 2002, 2009).

Recent research shows that personality traits may also be associated with memory in later adulthood, and are considered to be contributing factors in building a cognitive reserve (Klaming, Veltman and Comijs, 2016; Soubelet and Salthouse, 2011; Hill et al., 2014; Leavitt et al., 2017). Personality shapes how a person copes with various challenges throughout their life and, accordingly, engages in a variety of activities or behaviors (Newton et al., 2016; Jackson et al., 2019) that may be directly related to brain health (Klaming, Veltman and Comijs, 2016; Curtis, Windsor and Soubelet, 2015).

To assess the relationship between cognitive abilities—including memory—and personality, the Big Five model is most commonly used. The model states that there are five universal personality traits common for each individual—neuroticism, extraversion, openness, agreeableness, and conscientiousness (Costa and McCrae, 1992; Rammstedt, Lechner and Danner, 2018). Usually, neuroticism is most commonly associated with memory and other cognitive abilities. High levels of neuroticism are associated with poorer cognitive abilities and faster, as well as more abrupt, cognitive decline over the course of an individual's life (Stephan et al., 2020; Maldonato et al., 2017; Luchetti et al., 2016; Curtis, Windsor and Soubelet, 2015; Sutin et al., 2019). This relationship is primarily explained by behavioral aspects: personality traits might have an impact on a person's dietary choices, drug use, adherence to treatment instructions, etc. (Terracciano et al., 2008; Mõttus et al., 2012; Axelsson et al., 2011). Individuals with higher levels of neuroticism are more likely to choose an unhealthy lifestyle due to weaker impulse control, not follow treatment instructions, and experience sleep disorders (Terracciano and Costa, 2004; Sutin et al., 2016; Lahey, 2009; Duggan et al., 2014). Factors such as these have an adverse effect on brain health and, consequently, on memory abilities (Boyle et al., 2010). The relationship between memory and personality can also be explained by neurophysiological mechanisms. Individuals with higher levels of neuroticism are more likely to experience stronger emotions when faced with stressful situations. Therefore, their blood cortisol level is usually higher than that of less neurotic individuals (Hock et al., 2014). Increased emotional sensitivity eventually damages neural connections in the brain, and is associated with a decrease in cortical volume in the frontal lobe area and a faster loss of gray matter (Hock et al., 2014; Klaming, Veltman and Comijs, 2016; Jackson, Balota and Head, 2011).

There is also evidence to indicate links between memory and openness (Luchetti et al., 2016; Leavitt et al., 2017; Weinstein et al., 2019; Stephan et al., 2020). Studies show (Stephan et al., 2020; Leavitt et al., 2017), that a higher level of openness is associated with better memory and a lower risk of memory impairment regardless of age, education, or IQ. However, the exact mechanism of this relationship is still unclear, and the relationship itself is sometimes considered to be indirect. People who are open to new experiences are more likely to engage in a variety of mentally engaging activities (Schwaba et al., 2018; Stephan et al., 2020; Jackson et al., 2019), and often pursue higher education—which is frequently linked to better cognitive capacity (Chapman et al., 2012; Jackson et al., 2019). Other studies point out that higher level of openness is also linked to more physically active life-style and healthier eating patterns (Sutin et al., 2016), which are known to benefit memory performance in older adulthood (Schott and Krull, 2019). There is also evidence to suggest that openness to new experiences may be associated with neurophysiological mechanisms—for example, dopamine neurotransmitters (Maldonato et al., 2017). Dopamine is one of the physiological factors that stimulates human action while influencing cognitive processes (Maldonato et al., 2017). Despite these findings, there are studies that show negative correlations or no correlations at all between memory and openness (Uttl et al., 2013; Waris et al., 2018).

Some studies show positive associations between memory and the trait of extraversion. Higher levels of extraversion are associated with better memory, especially long-term memory (Meier, Perrig-Chiello and Perrig, 2002; Graham and Lachman, 2014; Maldonato et al., 2017). Extraversion is often seen as a propensity toward greater social stimulation (Newton et al., 2016). This means that extroverted individuals are more likely to engage in various activities, communicate with others, explore new places, and so forth. Existing studies confirm this assumption (Stephan et al., 2020; Newton et al., 2016). This provides opportunities to gain miscellaneous experience that is associated with better memory performance. These links can also be explained by some neurophysiological studies. Extroverts are considered to be individuals who show more optimistic attitudes, and to seek to cultivate more positive emotions in their environment. It is assumed that if the process of encoding information (i.e. remembering something) is accompanied by positive emotions, then certain markers—which are stored together with the so-called memory trace (a hypothetical constant change in the nervous system that occurs when someone remembers something)—are formed in the brain. These markers then enhance the retrieval of a particular memory. In other words, certain information becomes easier to remember (Curtis, Windsor and

Soubelet, 2015). However, just as is the case with openness, some studies show the opposite association between extraversion and memory (Luchetti et al., 2016; Chapman et al., 2012).

There is little evidence to link the trait of conscientiousness to memory abilities, and results in this vein are scarce and contradictory. On the one hand, positive correlations are found between conscientiousness and memory (Luchetti et al., 2016; Leavitt et al., 2017; Sutin et al., 2019). On the other hand, some researchers provide data showing that the relationship between conscientiousness and cognitive abilities is a negative one (Chapman et al., 2012; Waris et al., 2018). Currently, evidence to link the personality trait of agreeableness to memory is also lacking. Several studies show weak links between agreeableness and better memory (Hock et al., 2014), and yet, according to other studies, no significant associations are found (Luchetti et al., 2016).

Despite various studies, the question remains as to what level of influence personality traits have on changes in memory over the course of life, and, if an influence is present, how this is exerted. Some studies show that there are associations between some personality traits and faster cognitive decline, weaker cognitive abilities in general, and an increased likelihood of dementia in old age (Hock et al., 2014; Luchetti et al., 2016; Boyle et al., 2010; Duberstein et al., 2011). On the other hand, not all studies provide such results (Wetherell et al., 2002).

In the current study, we aimed to examine the links between personality traits and memory performance in older adults after controlling for leisure activities and demographic factors. We used the data from the 7th Wave of the Survey of Health, Ageing, and Retirement in Europe. Correlation coefficients were calculated to assess the links between personality traits, memory, and leisure activities. Hierarchical multiple regression models were constructed to assess the prognostic value of personality traits on memory performance in older adulthood over and above the demographic and leisure activity factors. It was expected that memory capacity and such personality traits as extroversion, neuroticism and openess to experience will be significantly related. Involvement in leisure activities was also expected to be related to memory capacity in older adulthood. Finally, It was expected that personality activities will allow for the prediction of memory capacity in older adulthood even after controlling for cognitively stimulating leisure activities and other demographic factors.

Materials and Methods

Study design

This study was conducted using data from the Survey of Health, Ageing, and Retirement in Europe (SHARE), which has been performed every two years since 2004. SHARE involves more than 140,000 people aged 50 and above from 27 European countries and Israel (Bergmann et al., 2019a, 2019b). Survey materials are administered as a Computer Assisted Personal Interview (CAPI), supplemented by a paper questionnaire. The questions cover various socioeconomic, health-related, and psychological variables, and interviews are conducted in respondents' homes, lasting approximately 90 minutes. Data collection was approved by the internal review board of the University of Mannheim, Germany (until 2011), and by the Ethics Council of the Max Planck Society for the Advancement of Science (2011 onward).

Participants

Data for the present study has been drawn from the 7th wave of SHARE (Börsch-Supan, 2019; Börsch-Supan et al., 2013; Bergmann et al., 2019b). To increase the reliability of results, subjects with neurological diseases (Parkinson's and Alzheimer's disease) or comorbidities that may affect cognitive abilities (cancer, affective disorders, etc.) were excluded from the sample. Therefore, the final analytic sample consisted of 24,930 individuals from following countries: Austria (N = 1363), Germany (N = 629), Sweden (N = 1036), Spain (N = 1130), Italy (N = 1549), France (N = 1320), Denmark (N = 822), Greece (N = 1393), Switzerland (N = 1136), Belgium (N = 1590), Israel (N = 661), Czech Republic (N = 1426), Poland (N = 1315), Luxembourg (N = 139), Hungary (N = 628), Portugal (N = 141), Slovenia (N = 1198), Estonia (N = 1951), Croatia (N = 764), Lithuania (N = 631), Bulgaria (N =772), Cyprus (N = 470), Finland (N = 613), Latvia (N = 631), Malta (N = 461), Romania (N = 704), and Slovakia (N = 528). The age of the participants was 65 to 101 years (M = 73.67; SD = 6.74), 43% of participants were men, and 56.8% were women. Of the participants, 67.1% were married and cohabited, 1.0% lived in a partnership, 1.1% were married but did not cohabit, 3.9% were single, 6.9% divorced, and 20.0% widowed.

Variables

Memory was selected as a dependent variable, which consisted of two measures: immediate and delayed recall. Memory was assessed using a modified version of Rey's Auditory Verbal Learning Test (RAVLT), which is designed to evaluate working memory (Dal Bianco, Garrouste and Paccagnella, 2013; Litwin, Schwartz and Damri, 2017) and is also used to evaluate episodic memory (Cheke and Clayton, 2013). In the modified version of the test, participants were asked to remember as many words as possible from a list of ten words, which was read by a researcher. After 5–10 minutes, participants were asked to remember as many words as possible from the list read earlier. Each respondent's score was then calculated from 0 to 10 based on the number of correct responses.

Personality traits were chosen as independent variables, and leisure activities were selected as control variables. Personality assessment was based on the Big Five model (Sutin et al., 2019), which states that there are five universal dimensions of personality traits for all people: neuroticism (shows a person's tendency to experience negative feelings and is associated with less emotional stability and resistance to stress); extraversion (related to a person's sociability, activity, propensity to communicate a lot, optimism, and arousal); openness to experience (associated with a person's aesthetic sensitivity, desire for knowledge, propensity for creativity, and curiosity); agreeableness (defined by a person's modesty, ability to understand and empathize with others, efforts to help, and altruism); and conscientiousness (includes personal control and discipline, ability to plan, organize, set goals and objectives, and the need to achieve something new) (Costa and McCrae, 1992). Personality traits were assessed using the BFI-10 Personality Traits Questionnaire (Sutin et al., 2019). This version of the questionnaire is based on the longer Big Five Inventory 44 (BFI-44), and is often used in studies covering a wide range of factors with limited research opportunities due to a lack of time or other restricting circumstances. The BFI-10 consists of only 10 questions, where each trait is assessed with two questions on the Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). To ensure the reliability of the questionnaire, the comparability between BFI-10 and BFI-44 has been assessed by its creators. Significant and strong correlations ranging from $r = 0.74$ (agreeableness) to $r = 0.89$ (extraversion) were found. Test–retest results were also satisfactory—correlations between $r = 0.65$ (openness) and $r = 0.79$ (extraversion) were identified over a period of 6 to 8 weeks in a sample of American students. Research shows that the BFI-10, even with very few questions, has satisfactory psychometric characteristics, and is therefore a suitable tool for measuring personality traits (Sutin et al., 2019). To test the internal consistency of the BFI-10 in the present sample, Cronbach's alpha was calculated for each personality trait as follows: neuroticism = 0.30; agreeableness = 0.20; extraversion = 0.43; conscientiousness = 0.41; and openness = 0.18.

Participation in leisure activities was assessed by asking respondents if they had taken part in any of the following activities in the past year: voluntary or charity work; educational or training courses; sport, social, or other similar clubs; political or community-related organizations; word or number games (such as crossword puzzles/Sudoku); reading books, magazines, or newspapers; or playing card games or games such as chess. Responses were coded either 0 (for nonparticipation in a certain activity) or 1 (for participation in a certain activity).

The study also considered other sociodemographic variables that may have been important in understanding the links between personality traits, memory, and leisure activities. Age and place of residence by country were taken into account. The countries were grouped by region into four groups based on the UN Geoscheme for Europe produced by the UN Statistics Division: north (Sweden, Denmark, Ireland, Spain, Lithuania, Finland, Latvia); west (Austria, Germany, the Netherlands, France, Switzerland, Belgium, Luxembourg); east (Czech Republic, Poland, Bulgaria, Hungary, Romania, Slovakia); and south (Spain, Italy, Greece, Israel, Portugal, Slovenia, Croatia, Cyprus, Malta). The variables were transformed into dummy variables by selecting the countries of the northern region as the reference group.

Data analysis

IBM SPSS Statistics 22 software was used for statistical data analysis. Descriptive statistics and Pearson's correlation coefficients were calculated, and linear and hierarchical multiple regression models were constructed.

Results

The links between personality traits and memory were assessed first, and Pearson's correlation coefficients were calculated for this purpose (Table 1). Memory showed statistically significant but weak correlations with all personality traits, with its strongest relationship being found with openness to experience ($r = 0.18$, $p < 0.001$; $r = 0.17$, $p < 0.001$). Higher levels of openness were associated with better immediate and delayed recall among older adults.

Table 1
Pearson's correlation coefficients linking memory and personality traits (N = 24,930)

	Immediate recall	Delayed recall	Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness
Immediate recall	1						
Delayed recall	0.730**	1					
Extraversion	0.065**	0.067**	1				
Agreeableness	0.022**	0.020**	0.160**	1			
Conscientiousness	0.035**	0.029**	0.172**	0.159**	1		
Neuroticism	**−0.080****	**−0.085****	0.214**	−0.234**	−0.136**	1	
Openness	**0.175****	**0.166****	0.131**	0.014*	0.094**	−0.071**	1

*Note. *p < 0.05; **p < 0.01; ***p < 0.001.* The highest value is marked in bold

The relationship between cognitively stimulating leisure activities and memory in older adults was also examined, first by calculating Pearson's correlation coefficients (Table 2). Memory had statistically significant but weak correlations with all leisure activities. The strongest statistically significant relationship was found with reading books, magazines, or newspapers ($r = 0.26$, $p < 0.001$; $r = 0.27$, $p < 0.001$), and solving puzzles (such as crosswords or Sudoku puzzles) ($r = 0.22$, $p < 0.001$; $r = 0.25$, $p < 0.001$). Reading books, magazines, or newspapers and solving verbal or numerical puzzles is associated with better immediate and delayed recall among older adults.

Table 2
Pearson correlation coefficients between memory and leisure activities (N = 24,930)

	1	2	3	4	5	6	7
Immediate recall	0.171**	0.159**	0.193**	0.090**	**0.260****	**0.268****	0.170**
Delayed recall	0.175**	0.166**	0.195**	0.089**	**0.223****	**0.253****	0.170**

Note: 1 = voluntary or charity work; 2 = educational or training courses; 3 = sport, social, or other similar clubs; 4 = political or community-related organizations; 5 = books, magazines, or newspapers; 6 = word or number games (such as crossword puzzles/Sudoku); and 7 = card games or games such as chess; **p < 0.01; ***p < 0.001. The highest values are marked in bold.

Finally, a four-step hierarchical linear regression analysis was applied to assess the prognostic value of personality traits on memory performance in older adulthood over and above the demographic (i.e., age and country of residence) and leisure activity factors (Figure 1). In the first regression model (Table 3), immediate recall was selected as a dependent variable; and in the second (Table 4), delayed recall was chosen. Independent variables were included in four stages: 1) age; 2) country group (European countries were divided into 4 groups according to the geographical regions of east, west, south, and north); 3) leisure activities; and 4) personality traits.

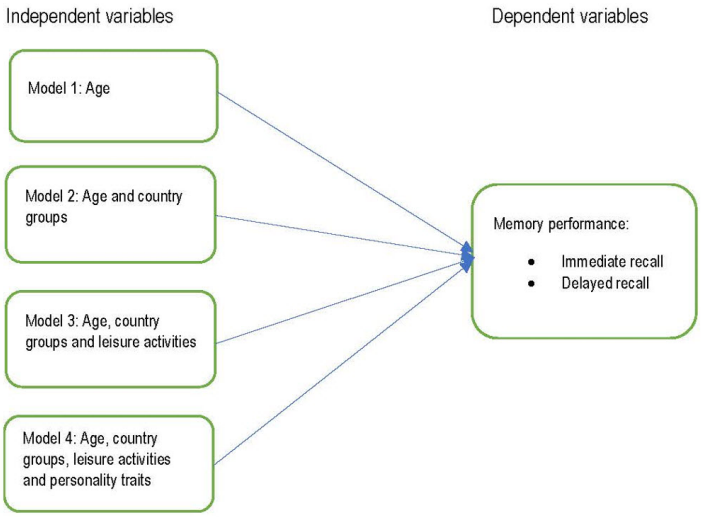

Figure 1. Graphic model of 4- step hierarchical multiple regression analysis assessing prognostic value of personality traits on memory performance in older adults over and above the demographic and leisure activity factors

There were no outliers in the data (all Cook's distance values were < 1), and no multicollinearity problem was identified (all VIF values < 4). Based on the plotting of residuals, no problems of homoscedasticity were identified. The results of the hierarchical linear regression models are presented in Tables 3 and 4.

The first regression model—using age as a prognostic factor—explained 9% of the variance of immediate recall and 8% of delayed recall. This suggests that memory declines as the age of participants increases.

The second regression model included another sociodemographic variable (country groups), and explained 13% of the variance of both the immediate and delayed recall results. R2 change = 0.03 and R2 change = 0.04 were statistically significant (F change = 321.25, $p < 0.001$; F change = 421.8, $p < 0.001$). This suggests that the first and second models were statistically significantly different. The country group variable, included in the regression equation along with age, additionally explained 3% of the variance of immediate and 4% of delayed recall. These results suggest that living in western and northern countries predicts better memory capacity in older adulthood.

The third regression model included leisure activities, and explained 21% of the variance of immediate recall and 19% of delayed recall. R2 change = 0.08 and R2 change = 0.06 were statistically significant (F change = 362.03, $p < 0.000$; F change = 283.48 $p < 0.001$). This shows that the second and third regression models were statistically significantly different. The leisure activities variable, included in the regression equation along with the age and country groups, additionally explained 8% of the variance of immediate and 6% of delayed recall. In this equation, memory was most strongly predicted by the age variable and leisure activities such as verbal and numerical games (crosswords or Sudoku puzzles) and reading.

Table 3

Results of hierarchical multiple regression analysis with the results of immediate recall as a dependent variable (N = 24,930)

Prognostic factors	Model			
	Age	Age and country groups	Age, country groups, and leisure activities	Age, country groups, leisure activities, and personality traits
	Beta (β)			
Age	−0.32***	**−0.33*** **	**−0.28*** **	**−0.28*** **
Country group 1		**−1.11*** **	−0.00	0.01
Country group 2		−0.09***	−0.00	−0.00
Country group 3		−0.09***	0.07***	0.06***
ALY: done voluntary or charity work			0.06***	0.05***
ALY: attended an educational or training course			0.06***	0.05***
ALY: gone to a sport, social or other kind of club			0.07***	0.07***
ALY: taken part in a political or community-related organization			0.02***	0.02**
ALY: read books, magazines or newspapers			**0.14*** **	**0.12*** **
ALY: did word or number games (crossword puzzles/Sudoku...)			**0.15*** **	**0.14*** **
ALY: played cards or games such as chess			0.03***	0.03***
Openness				**0.10*** **
Neuroticism				−0.03***
R^2	**0.09**	**0.13**	**0.21**	**0.22**

*Note. *p < 0.05; **p < 0.01; ***p < 0.001.* All ANOVA values of the models are statistically significant. The largest value in each model is marked in bold. ALY = activities in last year.

The final regression model included personality traits, and explained 22% of the variance of immediate recall and 20% of delayed recall. R2 change = 0.01 and R2 change = 0.01 were statistically significant (F change = 65.21, p < 0.001; F change = 58.25, p < 0.001). Therefore, the third and the final regression models also differ statistically significantly, which means that—even when controlling for leisure activities—personality traits improve the prediction of immediate and delayed recall by 1%. However, in this equation, memory was predicted only by the traits of openness to experience and neuroticism.

Table 4

Results of hierarchical multiple regression analysis with the results of delayed recall as a dependent variable (N = 24,930)

Prognostic factors	Model			
	Age	Age and country groups	Age, country groups, and leisure activities	Age, country groups, leisure activities, and personality traits
	Beta (β)			
Age	**−0.30*** **	**−0.31*** **	**−0.27*** **	**−0.26*** **
Country group 1		**−0.14*** **	−0.05***	−0.04***
Country group 2		−0.10**	−0.02**	−0.02**
Country group 3		0.09***	0.07***	0.07***
ALY: done voluntary or charity work			0.06***	0.05***
ALY: attended an educational or training course			0.07***	0.06***
ALY: gone to a sport, social or other kind of club			0.07***	0.07***
ALY: taken part in a political or community-related organization			0.02**	0.02**
ALY: read books, magazines or newspapers			**0.09*** **	**0.07*** **
ALY: did word or number games (crossword puzzles/Sudoku...)			**0.14*** **	**0.13*** **
ALY: played cards or games such as chess			0.04***	0.04***
Openness				0.09***
Neuroticism				−0.04***
R^2	**0.08**	**0.13**	**0.19**	**0.20**

Note. *p < 0.05; **p < 0.01; ***p < 0.001. All ANOVA values of the models are statistically significant. The largest value in each model is marked in bold. ALY = activities in last year.

Discussions

The aim of this study was to examine the relationship between personality traits and memory abilities in older adulthood. The current study contributes to our understanding of the relationship between personality traits and memory by also examining engagement in leisure activities. These results have revealed that, although age is the strongest predictor of memory performance in older adulthood, there are significant associations between leisure activities, memory, and personality traits. Leisure activities such as reading books and solving puzzles predict memory capacity in older adulthood, however associations between memory and personality are traitspecific. Although all five personality traits are related to memory, only neuroticism, extraversion, and openness to experience predict memory abilities in older adulthood. After controlling for sociodemographic variables and leisure activities, only neuroticism and openness to experience significantly predicted memory. However, it must be noted that the size of this effect was quite small, and therefore these results need to be interpreted carefully. Never-theless, these findings support previous literature on the relationship between personality traits and memory (Klaming, Veltman and Comijs, 2016; Soubelet and Salthouse, 2011; Leavitt et al., 2017), and also allow new assumptions to be made.

Our results show that memory abilities in older adulthood might be predicted by the trait of neuroticism—a finding consistent with other studies. This relationship is often explained by behavioral factors: individuals with higher levels of neuroticism are more likely to experience anxiety during cognitive assessment, and this might affect their final cognitive results (Curtis, Windsor and Soubelet, 2015;

Maldonato et al., 2017; Katsumi, Denkova and Dolcos, 2017). Long-term behavioral factors may also be important, as various studies have shown that people with high levels of neuroticism are more likely to choose an unhealthy lifestyle due to weaker impulse control, not follow treatment instructions, and experience sleep disorders (Terracciano and Costa, 2004; Lahey, 2009; Duggan et al., 2014). These factors have an adverse effect on brain health and, consequently, on memory abilities (Boyle et al., 2010). According to Maldonato and colleagues (2017), neuroticism is also often associated with a poorer socioeconomic situation, which restricts a person's access to involvement in mentally stimulating activities (leisure activities, for example). Poorer experiences are in turn associated with poorer cognition in older adulthood. However, in our study, neuroticism predicted memory even after controlling for involvement in leisure activities. This suggests that there are other possible mechanisms which link this trait to memory.

According to our study, higher levels of extraversion and openness to experience—the latter in particular—predict better memory. These associations are also often explained by indirect mechanisms. For example, people with higher levels of openness are more likely to engage in a variety of mentally engaging activities (reading books or newspapers, solving crossword puzzles, or playing musical instruments), pursue higher education, use technologies, engage in social and cultural activities, and so on (Wang et al., 2013; Fancourt and Steptoe, 2018; Chapman et al., 2012; Jackson, Balota and Head, 2011). Extraversion is also seen as a prerequisite for greater social stimulation (Meier et al., 2002; Maldonato et al., 2017), as extroverted individuals are more likely to be involved in various activities, communicate, go out and explore new places, etc.

One possible mechanism for explaining the relationship between openness, extraversion, and memory is the cognitive reserve hypothesis (Stern, 2002, 2009). This idea states that people who are more open to experience and prone to extraversion are more likely to engage in a variety of leisure activities and gain a wide range of experiences, and these factors are protective of a level of cognitive performance that includes memory (Hultsch et al., 1999; Clare et al., 2017; Arenaza-Urquijo, Wirth and Chételat, 2015; Scarmeas and Stern, 2003; Leavitt et al., 2017). However, the results of the present study show that even after controlling for involvement in leisure activities, openness to experience significantly predicts memory abilities in older adulthood. Thus, it can be assumed that there are other mechanisms that link openness to experience and memory—and these results are consistent with those of other studies. For example, Soubelet and Salthouse (2011) conducted a study to examine the impact of involvement in various general and leisure activities on the association between openness and cognitive abilities. Although the study also showed a relationship between openness and cognitive abilities, it could not be explained by the effect of involvement in leisure activities. In fact, the links between measures of activity and both openness and cognition were modest. Therefore, it was concluded that the relationship between openness and cognitive functioning might not be due to engagement in activities.

The pathway for openness is still mostly unknown, however the scientific literature provides the assumption that openness and cognitive ability may be related because they largely measure the same construct. Another possible explanation is that there might be some behavioral factors that mediate the relationship between openness and better memory capacity in older adulthood. For example, individuals who are more open to experience often choose a healthier diet and are more physically active (Sutin et al., 2016) and the fact that these factors preserve cognitive function in older adulthood is documented (Schott and Krull, 2019). The latest research also provides an opportunity to explain the association between personality and cognitive abilities from a neurophysiological perspective. There is evidence that openness to experience may be associated with the release of dopamine, which is considered to be one of the main physiological factors that stimulates human action while influencing cognitive processes (Maldonato et al., 2017). There is little research examining these links, however, and so the need for further research is emphasized.

This study did not avoid some limitations. Firstly, only the links between major traits and memory were assessed. In recent years, there has been a growing body of research showing that the low-er-level traits (facets) of the Big Five model may be associated differently with the same cognitive functions (Chapman et al., 2012; Rammstedt, Lechner and Danner, 2018; Graham and Lachman, 2014; Maldonato et al., 2017). This means that some facets may have positive associations while others have negative ones, or even no association with cognition at all. Thus, the final result of the study might be skewed, and this may partially explain the diversity of current data in the scientific literature (Curtis, Windsor and Soubelet, 2015). An analysis of the relationship between lower-level personality traits and cognition would provide an opportunity to take a new look at the role of personality in cognitive functioning over the course of life (Graham and Lachman, 2014). It should also be noted that only the relationships between separate personality traits and memory were assessed. A complex analysis including different combinations of various personality traits and their associations with cognition could expand the field of research and

reveal different results. It is also important to mention that, in order to analyze data from more countries, only one wave (the 7th and latest) of SHARE data was used for the analysis. The inclusion of other waves could provide more comprehensive data and would allow for the identification of longitudinal changes in memory performance over time.

Despite these limitations, the current study employs a large community-dwelling sample and sheds light on the association between personality traits and memory performance among older adults. The data adds to existing research in the field by showing that personality might be an important factor in understanding individual differences in memory capacity in older adulthood, and contributes to a better understanding of cognitive aging.

Conclusions

In future research, it would be useful to examine more complex associations between personality and cognition, taking into account that facets of the same personality trait might interact differently with each other. For example, neuroticism can affect memory depending on the level of conscientiousness. A narrow focus on personality traits and an analysis of their interactions with memory could benefit the theorists who research age-related issues and significantly expand the field of existing knowledge (Colombo et al., 2019). Waris and colleagues (2018) suggest also taking into account the context in which one or another personality trait manifests. This knowledge might not only occupy the niche of absent data, but could also be useful for planning interventions for individuals with memory impairment. In future, it will also be important to conduct longitudinal research that examines the causal relationships between personality traits and memory, and perform a mediation analysis of these relationships that takes into account other potentially important variables.

In conclusion, personality traits are associated with memory in older adulthood. Higher levels of neuroticism predict worse memory, while higher levels of openness and extraversion predict better memory. These associations might be explained by indirect mechanisms such as certain behaviors or lifestyle factors that contribute to building both the cognitive reserve and neurophysiological processes. Identifying the relationships between personality traits and cognition helps to better understand individual cognitive differences and age-related changes in cognition. While personality traits are known to be quite stable over the course of life, some of them can be influenced to some extent. Thus, despite the limitations of this study, the research contains important results that not only provide a better understanding of the relationship between personality, memory, and leisure activities, but also contribute to our ability to predict cognitive functioning in older adulthood and thereby help to shape appropriate support programs for people with memory impairment.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, V.Ivleva and A.Kairys; methodology, V.Ivleva and A.Kairys; formal analysis, V.Ivleva; writing -original draft, V.Ivleva; writing - review and editing, V.Ivleva and A.Kairys; supervision, A.Kairys. All authors have read and agreed to the published version of the manuscript.

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