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Physical, cognitive, and social activities as mediators between personality and cognition: evidence from four prospective samples

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ABSTRACT

Objectives: The present study examined how activity engagement mediates the association between personality and cognition.

Methods: Participants were middle-aged and older adults (Age range: 24–93 years; $N > 16,000$) from the Midlife in the United States Study, the Health and Retirement Study, the English Longitudinal Study of Ageing, and the Wisconsin Longitudinal Study of Aging. In each sample, personality traits and demographic factors were assessed at baseline, engagement in cognitive, physical, and social activities was assessed in a second wave, and cognition was measured in a third wave, 8 to 20 years later.

Results: Random-effect meta-analyses indicated that lower neuroticism and higher extraversion, openness, and conscientiousness were prospectively associated with better cognition. Most of these associations were partly mediated by greater engagement in physical and cognitive activities but not social activities. Physical activity accounted for 7% (neuroticism) to 50% (extraversion) and cognitive activity accounted for 14% (neuroticism) to 45% (extraversion) of the association with cognition.

Conclusion: The present study provides replicable evidence that physical and cognitive activities partly mediate the prospective association between personality traits and cognitive functioning.

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Personality; activities; lifestyle; cognition; aging; longitudinal

Introduction

Worse cognitive function is associated with a range of outcomes, including limitations in independent activities of daily living (Chan et al., 2022), higher risk of dementia (Calvin et al., 2019; Josefsson et al., 2023), and mortality (Batty et al., 2016; Sabia et al., 2010). Identifying pathways that contribute to cognitive functioning can help build knowledge about how to maintain and promote healthy brain aging.

Five-Factor Model (FFM) personality traits (McCrae & John, 1992) have been consistently related to cognitive function in adulthood and old age (Chapman et al., 2012; Curtis et al., 2015; Graham et al., 2021; Soubelet & Salthouse, 2011; Sutin et al., 2019, 2023; Terracciano et al., 2022). In particular, higher neuroticism (the tendency toward distress and negative emotions) is associated with worse cognition, whereas higher conscientiousness (the tendency to be responsible and self-disciplined) and openness (the tendency to be unconventional and curious) are related to better cognitive function (Chapman et al., 2012; Graham et al., 2021; Hock et al., 2014; Luchetti et al., 2016; Soubelet & Salthouse, 2011; Sutin et al., 2023). Extraversion (the tendency toward positive emotions and sociability) and agreeableness (the tendency to be trusting and cooperative) tend to have less consistent associations with cognitive function (Graham et al., 2021; Luchetti et al., 2016). The present study aimed to advance knowledge by examining the pathways through which personality traits are associated with cognition in adulthood.

Lifestyle factors, such as engagement in physical, cognitive, and social activities, have been proposed as potential explanatory behavioral pathways that link personality to cognition (Graham et al., 2021; Luchetti et al., 2016; Sutin et al., 2023; Terracciano et al., 2022). Indeed, personality traits such as lower neuroticism, higher conscientiousness, and higher openness are associated with greater engagement in physical activity (Sutin et al., 2016) and participation in more social and cognitive activities (Kuper et al., 2023; Oлару et al., 2023; Stephan et al., 2014). Higher neuroticism is characterized by a higher vulnerability to stress and a higher tendency to experience negative emotions, which may interfere with the adoption of an active lifestyle (e.g. too anxious to participate in social gatherings). In contrast, the tendency to be curious reflected by openness (e.g. open-minded toward a new class), and to be thoughtful, organized, and self-disciplined associated with conscientiousness may motivate involvement in these activities (e.g. persist in a hobby or physical exercise). In turn, higher engagement in physical, cognitive, and social activities is associated with better cognitive functioning across adulthood (James et al., 2023, 2011; Wilson et al., 2013). Indeed, these activities are implicated in better brain health (Gu et al., 2020; Seider et al., 2016), which may manifest in better cognition. Consistent with these findings, activity engagement has been found to mediate the association between personality and cognition. Higher neuroticism, for example, has been related to lower cognition partly through its association with more sedentary behaviors in the English Longitudinal Study of Aging (ELSA; Allen et al., 2019) and lower

engagement in cognitive activities in the Health and Retirement Study (HRS; Sutin et al., 2020). Higher conscientiousness has been associated with better cognitive functioning through its association with fewer sedentary behaviors, more physical activity in ELSA (Allen et al., 2019), and more cognitive activities in HRS (Sutin et al., 2020, 2022). Greater engagement in cognitive activities (Hogan et al., 2012; Ihle et al., 2019; Jackson et al., 2020; Mercuri & Holtzer, 2021; Montoliu et al., 2023; Sutin et al., 2020), but not physical activity (Allen et al., 2019), has been found to explain part of the association between openness and better cognition.

The current knowledge on the mediating role of activity engagement in the association between personality and cognition is limited to a few studies, and there has not been a systematic attempt to replicate the identified association across cohorts. Furthermore, most studies on cognitive activities have focused on the association between openness and cognition, and less is known about the extent to which such activities explain the association between other personality traits and cognition. Finally, the mediating role of physical and cognitive activities has been examined in separate studies, which makes it difficult to compare their relative contributions. To our knowledge, no study has examined the mediating role of social activity. To address these knowledge gaps, the present study uses a multi-cohort design to identify replicable patterns of mediation of physical, cognitive, and social activities in the association between personality and cognition.

The present study examined how activity engagement mediates the association between personality and cognition in four large longitudinal samples of middle-aged and older adults. The conceptual model is depicted in Figure 1. It was hypothesized that engagement in fewer physical, cognitive, and social activities would mediate the association between higher neuroticism and lower cognition. Furthermore, it was hypothesized that engagement in more physical, cognitive, and social activities would mediate the association between higher conscientiousness and openness and better cognition.

Methods

Participants

Data from four longitudinal studies were used in the present study: The Midlife in the United States Study (MIDUS), the HRS, the ELSA, and the Wisconsin Longitudinal Study (WLS). These

studies were selected because they included three waves of measurement, including the assessment of (1) all FFM personality traits at baseline, (2) physical, cognitive, and social activities at an intermediate wave, and (3) cognition at follow-up. Participants from each sample provided written informed consent approved by the local Institutional Review Board (IRB). The present study used publicly available de-identified data and was exempt from IRB review. Descriptive statistics for the four samples are in Table 1.

The Midlife in the United States Survey (MIDUS) is a longitudinal, nationally representative study of noninstitutionalized US adults in the contiguous US, initially aged from 20 to 75 years. Data on personality and demographic factors were obtained from the first wave (MIDUS 1, 1995–1996), data on activities were obtained from the second wave (MIDUS 2, 2004–2006), and cognition was measured in the third wave (MIDUS 3, 2013–2014). A total of 6116 participants provided complete personality and demographic data at baseline. Of this sample, 3712 participants had complete data on activities in MIDUS 2. The final sample was composed of 2318 participants aged 24 to 74 years (56% women; mean age = 45.36; SD = 11.00) who also had complete cognition data at MIDUS 3. Attrition analyses indicated that participants with complete data at all three waves were younger ($d=0.19$), more educated ($d=0.42$), had lower neuroticism ($d=0.08$), higher conscientiousness ($d=0.18$), were less likely to be African/American (3% vs. 7%) and more likely to be women (56% vs. 50%) than participants without data on mediators and cognition at follow-up. No differences were found for extraversion, openness, and agreeableness. MIDUS data is available at <http://midus.wisc.edu/index.php>.

The HRS is a nationally representative longitudinal study of Americans 50 years and older and their spouse. Baseline data on personality traits and demographic factors were obtained in 2010 for half of the sample and in 2012 for the other half. Activities were measured in 2014 (for the 2010 sample) and 2016 (for the 2012 sample), and cognition was assessed in 2018 (for the 2010 sample) and 2020 (for the 2012 sample). The baseline sample was composed of 13023 participants. From this sample, 9142 individuals provided complete data on activities. The final sample had 6831 individuals aged 50 to 93 years (60% women; mean age = 64.71; SD = 9.02) who also had complete cognition data at follow-up. Compared with participants with only baseline data, participants with complete data across the three waves were younger ($d=0.52$),

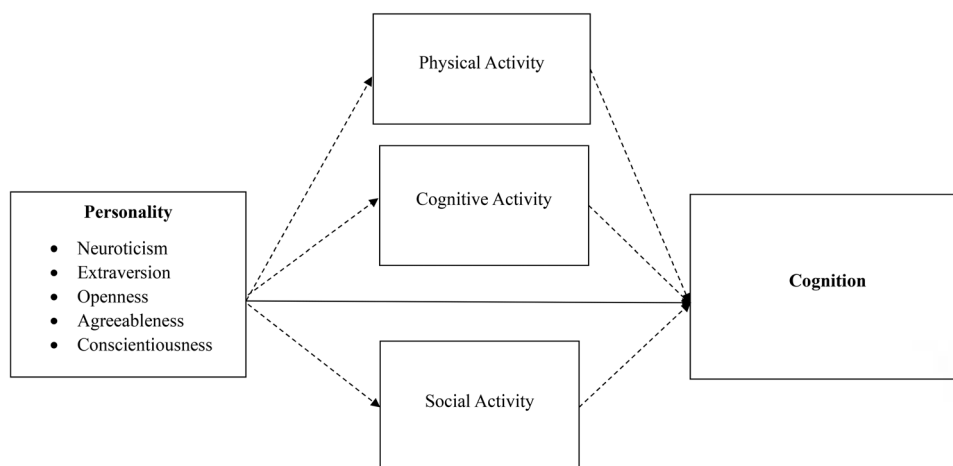


Figure 1. Conceptual mediational model of the relationship between personality and cognition through engagement in activities.

Table 1. Descriptive Statistics for the four samples.

Variables	MIDUS		HRS		ELSA		WLS	
	M/%	SD	M/%	SD	M/%	SD	M/%	SD
Age (Years)	45.36	11.00	64.71	9.02	64.17	7.43	63.75	3.68
Sex (% women)	56%	–	60%	–	55%	–	57%	–
Race (% African American/Black)	3%	–	15%	–	2% ^a	–	0%	–
Ethnicity (% Hispanic)	–	–	9%	–	–	–	0%	–
Education	7.51	2.43	13.43	2.68	4.63	2.11	14.17	2.53
Physical activity	4.25	1.36	2.78	0.88	3.06	0.73	2.17	1.03
Cognitive activity	3.17	0.80	3.61	1.06	5.49	3.30	4.83	1.88
Social activity	3.57	5.06	2.04	0.97	1.62	1.43	1.45	0.35
Neuroticism	2.21	0.66	1.99	0.60	2.08	0.58	2.98	0.89
Extraversion	3.20	0.55	3.21	0.57	3.18	0.53	3.81	0.87
Openness	3.02	0.50	2.97	0.54	2.92	0.53	3.63	0.75
Agreeableness	3.47	0.49	3.53	0.48	3.51	0.47	4.80	0.69
Conscientiousness	3.47	0.42	3.42	0.45	3.35	0.46	4.80	0.67
Cognition	0.04	0.68	15.68	4.39	17.30	3.78	11.92	3.88

^aPercent of non-white participants. See the method section for differences in measures across the samples.

MIDUS: $N = 2318$; HRS: $N = 6831$; ELSA: $N = 4228$; WLS: $N = 3499$.

more likely to be women (60% vs. 55%), more educated ($d = 0.27$), had lower neuroticism ($d = 0.08$), higher extraversion ($d = 0.14$), openness ($d = 0.18$), agreeableness ($d = 0.10$), and conscientiousness ($d = 0.21$). There were no differences for race and ethnicity. HRS data is available at <https://hrs.isr.umich.edu/data-products>.

ELSA is a panel study of a representative cohort of men and women living in England aged 50 years and over. Personality traits and demographic factors were obtained from Wave 5 (2010/2011), activities were assessed in Wave 7 (2014/2015), and cognition was measured during Wave 9 (2018/2019). Complete data on personality and demographic factors were obtained from 8117 participants at baseline. From this sample, 5731 individuals had data on physical, cognitive, and social activities. The final sample was composed of 4228 participants who had cognition data at follow-up (55% women, mean age = 64.17, $SD = 7.43$). Attrition analyses indicated that participants with complete data at the three waves were younger ($d = 0.47$), more educated ($d = 0.44$), had lower neuroticism ($d = 0.07$), and higher extraversion ($d = 0.13$), openness ($d = 0.15$), and conscientiousness ($d = 0.22$) than those without complete data on mediators and cognition. There was no difference in agreeableness, sex, and race. ELSA data are publicly available from the UK Data Service (UKDS, <https://www.ukdataservice.ac.uk/>).

The WLS is a longitudinal study of a random sample of individuals who graduated from Wisconsin high schools in 1957 and their selected siblings. Personality and demographic factors were obtained in 2003–2007, activities were obtained in 2011, and cognition was assessed in 2020. Complete baseline data were obtained from 9627 individuals. Of the baseline sample, a total of 6318 participants had complete data on activities. With the exclusion of participants without cognition data at follow-up, the final sample was 3499 participants aged 34 to 82 years (57% women, mean age = 63.75, $SD = 3.68$) who had complete data at the three waves. Attrition analyses indicated that participants with complete data were younger ($d = 0.19$), more likely to be women (57% vs. 52%), more educated ($d = 0.24$), had lower neuroticism ($d = 0.10$), higher extraversion ($d = 0.07$), openness ($d = 0.12$), agreeableness ($d = 0.07$), and conscientiousness ($d = 0.09$) than those without complete data on mediators and cognition. WLS data is available at <http://www.ssc.wisc.edu/wlsresearch/data/>.

Measures

Personality

The Midlife Development Inventory (Zimprich et al., 2012) was used to assess the five personality traits in ELSA, HRS, and the MIDUS. A 26-item version was used in HRS and ELSA, and a 25-item version was used in the MIDUS. Participants rated adjectives on a scale from 1 (not at all) to 4 (a lot) on how well they described them. Examples of adjectives are moody (neuroticism), lively (extraversion), curious (openness), softhearted (agreeableness), and organized (conscientiousness). The WLS measured personality with a 29-item version of the Big Five Inventory (John et al., 1991). Participants rated their agreement with a list of descriptive statements from 1 (*disagree strongly*) to 6 (*agree strongly*). Example items are: "To what extent do you agree that you see yourself as someone who worries a lot?" (neuroticism), "To what extent do you agree that you see yourself as someone who is full of energy?" (extraversion), "To what extent do you agree that you see yourself as someone who values artistic, aesthetic experiences?" (openness), "To what extent do you agree that you see yourself as someone who is generally trusting?" (agreeableness), and "to what extent do you agree that you see yourself as someone who does things efficiently?" (conscientiousness). Mean scores were calculated for each trait in the four samples. Higher means indicated higher neuroticism, extraversion, openness, agreeableness, and conscientiousness. Cronbach alphas for neuroticism, extraversion, openness, agreeableness, and conscientiousness were respectively 0.75, 0.77, 0.76, 0.81, and 0.58 in the MIDUS, 0.71, 0.76, 0.79, 0.79, and 0.65 in the HRS, 0.68, 0.75, 0.75, 0.80, and 0.68 in ELSA, and 0.74, 0.78, 0.63, 0.69, and 0.68 in the WLS.

Cognitive activity

In MIDUS and HRS, cognitive activities were assessed by asking participants to indicate how often they read books/magazines or newspapers, do word games, play cards or other games, attend educational lectures/courses, write, and use a computer. A scale from 1 (never) to 6 (daily) was used in the MIDUS, and a scale from 1 (never) to 7 (daily) was used in the HRS. In ELSA, participants indicated whether they read a newspaper, and whether they use a computer for sending/receiving e-mails, for finding information about goods and services, for searching for information for learning, for research, for fact finding, for searching for information about specific health issues, for finances (banking, paying bills), for shopping/buying goods or services, for selling goods or services over the internet (e.g. *via* auctions), for using social networking sites, for creating, uploading, or sharing content, for News/Newspaper/blog websites, for streaming/downloading live or on demand TV/radio, for games, and for looking for a job or sending a job application. A yes/no format was used, and answers to each item were summed. In the WLS, participants were asked to report the number of hours per week during the last year that they spent in different types of reading activities (e.g. biographies and other nonfiction books, the bible or other religious materials, magazines or newspapers, fiction), and how many hours per month they spent writing letters (including e-mails), playing cards or board games, including games on a computer, going to lectures, concerts, plays, museums or other similar activities, doing crossword puzzles or other word games. For each item, answers were recoded as 1 (at least 1 h per month) and 0 (<1 h per month or none) and summed across items.

Social activity

In the MIDUS, social activities were measured with three items on the frequency of attending meetings of union, sport, or other social groups outside the job in a typical month. For each activity, participants were asked to report the number of times they participated in a typical month. In HRS, participants indicated on a scale ranging from 1 (never) to 7 (daily) how often they did volunteer work with children or young people, participated in other volunteer activities or charity work, went to a sport, social, or other club, or attended meetings of nonreligious organizations, such as political, community, or other interest groups. Answers were averaged across the four items. Participants in the WLS indicated the extent to which they were involved in social groups (e.g. church, temple, or other places of worship, church-connected groups, labor unions, veterans' organizations, fraternal organizations or lodges, business or civic groups, parent-teachers' associations, community centers, organizations of people of the same nationality, sport teams, youth groups, professional groups, political clubs or organizations, neighborhood improvement organizations, hobby groups, charity or welfare organizations, group for senior men or women) during the last 12 months. Items were rated on a scale from 1 (not involved) to 5 (a great deal) and averaged. In ELSA, participants indicated whether they were members of social groups (e.g. political party, trade union or environmental groups, tenant groups, resident groups, neighborhood watch, church, or other religious groups, education, arts or music groups, evening classes, charitable associations, social clubs, sports clubs, gyms, exercise classes, other organizations, club, or societies). Answers were given using a yes/no format and summed across items.

Physical activity

In the HRS and ELSA, physical activity was assessed with three items on how often individuals participated in vigorous, moderate, and mild/light physical activity from 1 (more than once a week) to 4 (hardly ever or never). Answers were averaged across the three items in both samples. In the WLS, participants reported on the hours per month spent doing vigorous or light physical activities, both alone and with others, during the last year. Answers were recoded as 1 for at least 1 h (and 0 for less than hour or none) and summed across the four items. In the MIDUS, participants indicated how often they engaged in vigorous, moderate, and light leisure physical activity during both the summer and winter months from 1 (never) to 6 (several times a week or more). Answers were averaged across items.

Cognition

The modified Telephone Interview for Cognitive Status (TICS_m) (Crimmins et al., 2011) was used to measure cognition in HRS, ELSA, and the WLS. The TICS_m included three tasks: Immediate and delayed recall of 10 words that measured memory (range: 0–20), serial 7 subtraction assessing working memory (range: 0–5), and backward counting that measured attention and processing speed (range: 0–2). The three tasks were summed into a possible 27-point TICS_m score. In MIDUS, cognition was measured with the Brief Test of Adult Cognition by Telephone (BTACT) (Lachman et al., 2014). The BTACT included immediate and delayed recall, digits backward, category fluency, number series, and backward counting. These tasks were z-scored and averaged to give an overall cognition score. For both the TICS_m and the BTACT, higher scores indicated better cognition.

Covariates

Age in years, sex (0 = male, 1 = female), and education were controlled for in each sample. Education was assessed on a scale ranging from 1 (no grade school) to 12 (doctoral level degree) in the MIDUS, from 1 (no qualification) to 7 (NVQ4/NVQ5/Degree or equivalent) in ELSA, and in years in the HRS and the WLS. Race (0 = white, 1 = person of color) was controlled for in HRS, ELSA, and MIDUS. Ethnicity (0 = non-Hispanic/Latinx, 1 = Hispanic or Latinx) was included as an additional covariate in the HRS. Supplementary analyses included baseline disease burden and depressive symptoms as additional covariates (see [Supplementary material](#)).

Data analysis

The PROCESS macro (Hayes, 2018), using 5000 bootstrapped samples and 95% bias-corrected confidence intervals, was used to test physical, cognitive, and social activities as mediators between personality and cognition in each sample. The three types of activities were examined simultaneously in each analysis. Personality traits were examined separately. All continuous variables were standardized to z-score in each sample to aid interpretation and facilitate comparisons across samples. Demographic factors were included as covariates in each analysis. The proportion of the total effect accounted for by the mediator was calculated as the ratio of the indirect over the total effect (proportion mediated, ab/c). Results from the four samples were combined in a random-effect meta-analysis conducted with JAMOVI 2.3.18. Three sets of supplementary analyses were conducted: (1) to account for disease burden and depressive symptoms as additional covariates, (2) to test the five traits simultaneously, and (3) to exclude participants with cognitive impairment at baseline in the HRS and ELSA (MIDUS and WLS did not have a validated cut-off to identify cognitive impairment at baseline; see the [Supplementary material](#) for the cognitive status assessment).

Results

Pearson correlations between personality and activities are in [Supplemental Table S1](#), and results from each sample are in [Supplemental Table S2](#). The meta-analysis of indirect effects is in [Table 2](#). The meta-analysis indicated that higher neuroticism was associated with worse cognition ([Figure 2](#)), whereas higher extraversion, openness, and conscientiousness were related to better cognition; agreeableness was unrelated to cognition ([Figure 2](#)).

As expected, higher neuroticism was associated with less engagement in physical, cognitive, and social activities, whereas higher extraversion and openness were related to more physical, cognitive, and social activities ([Figure 2](#)). Higher conscientiousness was associated with more physical and cognitive activities but not with social activity ([Figure 2](#)).

Lower engagement in physical and cognitive activities partly mediated the association between higher neuroticism and worse cognition ([Table 2](#)). Higher extraversion and higher openness were associated with better cognition in part through their relationship with greater participation in physical and cognitive activities ([Table 2](#)). Physical and cognitive activities explained respectively 7% and 14% of the association between neuroticism and cognition, 16% and 44% of the association between openness and cognition, and 50% and 45% of the association between

Table 2. Meta-analytic findings of the mediating effects of physical, cognitive, and social activities in the association between personality and cognition.

	Indirect effect	I^2
Neuroticism		
Physical activity	−0.005*** (−0.006; −0.003)	36.03
Cognitive activity	−0.010** (−0.016; −0.004)	85.79
Social activity	−0.001 (−0.002; 0.001)	66.34
Extraversion		
Physical activity	0.010*** (0.006; 0.015)	71.74
Cognitive activity	0.009** (0.004; 0.014)	80.35
Social activity	0.003 (−0.001; 0.007)	74.41
Openness		
Physical activity	0.008*** (0.004; 0.012)	76.73
Cognitive activity	0.022*** (0.018; 0.026)	47.11
Social activity	0.002 (0.000; 0.004)	70.13
Agreeableness		
Physical activity	0.003* (0.000; 0.005)	59.81
Cognitive activity	0.006* (0.001; 0.011)	75.52
Social activity	0.001 (0.000; 0.002)	56.17
Conscientiousness		
Physical activity	0.006* (0.001; 0.011)	80.67
Cognitive activity	0.006 (−0.001; 0.012)	87.81
Social activity	0.000 (0.000; 0.001)	39.97

* $p < .05$, ** $p < .01$, *** $p < .001$.

extraversion and cognition. The association between higher conscientiousness and better cognition was partially mediated by higher physical activity (10% explained) (Table 2, Figure 2). Social activity did not mediate the association between the traits and cognition (Table 2, Figure 2). Although agreeableness was not related to cognition, there was an indirect effect through physical and cognitive activities (Table 2, Figure 2).

The overall pattern of mediation was attenuated but persisted when disease burden and depressive symptoms were included as covariates (Supplementary Table S3). There were some exceptions, however. The association between extraversion and cognition was no longer significant in the HRS and the WLS, the association between agreeableness and cognition was no longer significant in the HRS, and the association between openness and cognition was no longer significant in the WLS. In ELSA, physical activity was no longer a significant mediator of the association between neuroticism and cognition. In the WLS, physical activity did not mediate the association between conscientiousness and cognition. Across the four samples, the pattern of mediation of the associations between neuroticism, openness, conscientiousness, and cognition through activities remained almost similar when all five traits were included simultaneously (Supplementary Table S4). Finally, sensitivity analyses in the HRS and ELSA indicated that the overall pattern of mediation remained mostly unchanged when individuals with cognitive impairment were excluded.

Discussion

The present study examined whether physical, cognitive, and social activities mediated the association between personality

and cognition in four large longitudinal samples of middle-aged and older adults. The results indicated that lower engagement in physical and cognitive activities partially mediated the association between higher neuroticism and worse cognition. Higher engagement in physical and cognitive activities also explained part of the association between higher openness and higher extraversion and better cognition. The association between conscientiousness and higher cognition was mediated by more physical activity. There was little replicable evidence that social activity mediated the association between personality and cognition. The overall pattern of mediation was robust and replicated across samples, across different follow-up lengths, across different measures of personality, activities, and cognition, and mostly persisted when disease burden and depressive symptoms were accounted for, when all five traits were examined simultaneously, and when individuals with cognitive impairment were excluded. This study examined the largest samples to date and provides the most systematic test of activity engagement as a mediator between personality and cognition. The findings support our hypothesis that activity engagement is a pathway that links personality to cognition (Graham et al., 2021; Luchetti et al., 2016; Sutin et al., 2023; Terracciano et al., 2022).

Our findings replicate and extend previous research. First, the association between personality and cognition was mostly explained by physical and cognitive activities, but not by social activity, which was not related to cognitive functioning. This finding mirrors a recent meta-analysis that found a stronger association between cognitive and physical activities and lower risk of dementia compared to social activity (Su et al., 2022). Second, our findings are consistent with evidence that physical and cognitive activities contribute to better brain health in older adults (Gu et al., 2020; Seider et al., 2016). We add to this literature that individuals who score lower on neuroticism and higher in extraversion, openness, and conscientiousness are more likely to engage in a physically and cognitively active lifestyle, which in turn fosters better cognition. Third, the mediational role of physical and cognitive activities in the association of neuroticism, extraversion, and openness with cognition is consistent with existing evidence (Allen et al., 2019; Hogan et al., 2012; Jackson et al., 2020; Mercuri & Holtzer, 2021; Sutin et al., 2020). Overall, the findings of the present study are also informative with regard to cognitive reserve (Stern et al., 2020). The mediation model suggests that personality traits such as higher extraversion, openness, and conscientiousness may increase cognitive reserve, which in turn leads to better cognition, even in the presence of brain changes that may occur with aging or diseases. In contrast, higher neuroticism may lower cognitive reserve, resulting in lower cognition.

The basic tendencies of each personality trait may partly explain their association with involvement in the three types of activities. For extraversion, the propensity to experience positive emotions, seek stimulation, and be energetic (Costa & McCrae, 1992) may lead extraverted individuals to engage in cognitive and physical activities. Extraverted individuals are also well-known to engage in social activities (Olaru et al., 2023), but those activities were unrelated to cognition. Open individuals are characterized by a tendency to be curious, engage in intellectually stimulating or creative hobbies, and be open to new experiences (Costa & McCrae, 1992), which may motivate involvement in different activities. The tendency to be industrious, planful, self-disciplined, and thoughtful of conscientious individuals (Costa & McCrae, 1992) may lead them to identify physical

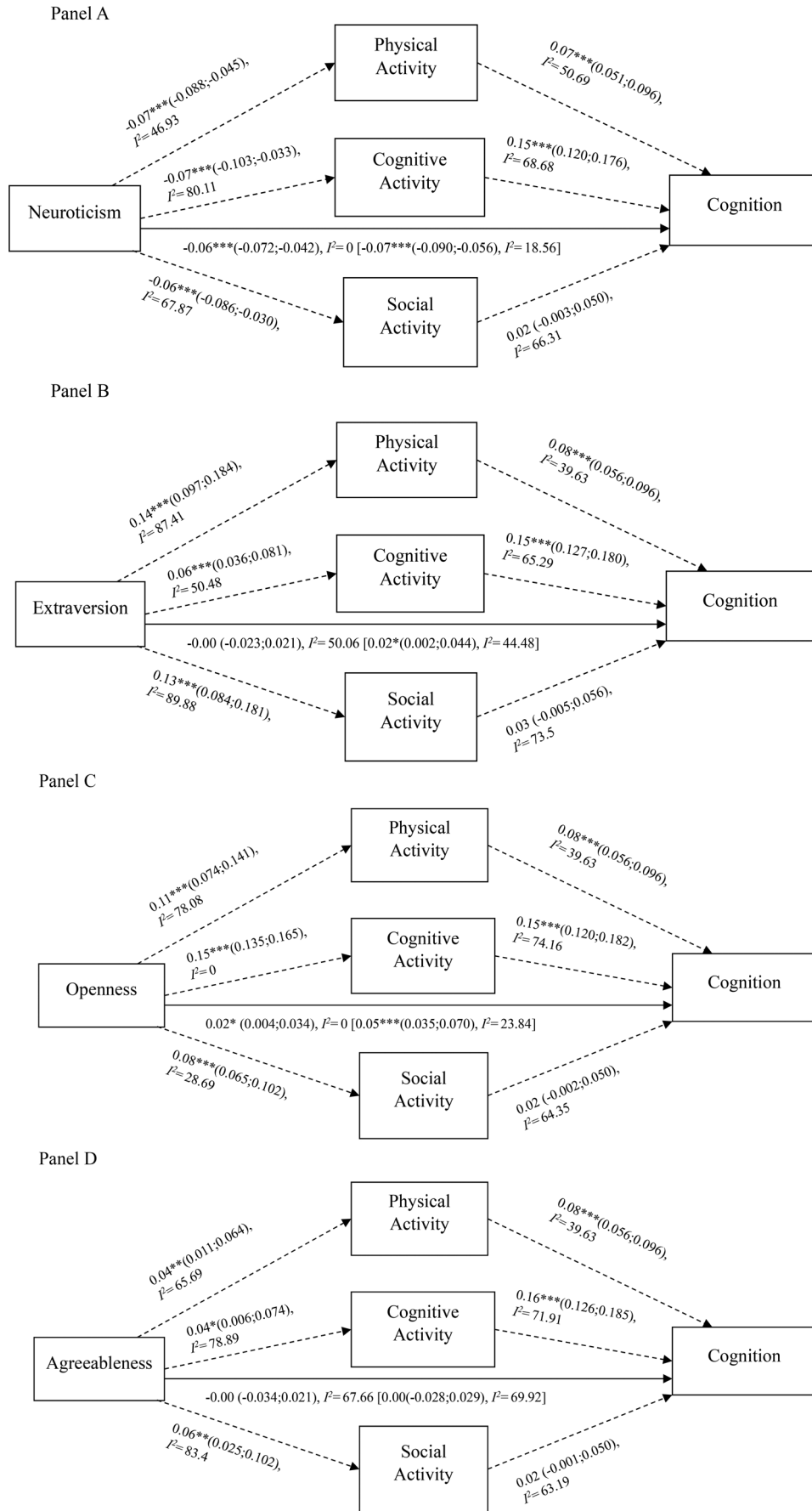


Figure 2. Graphic representation of meta-analytic models testing activities as mediators of the association between neuroticism (Panel A), extraversion (Panel B), openness (Panel C), agreeableness (Panel D), conscientiousness (Panel E), and cognition. The total effect of personality on cognition is presented between brackets. * $p < .05$, ** $p < .01$, *** $p < .001$.

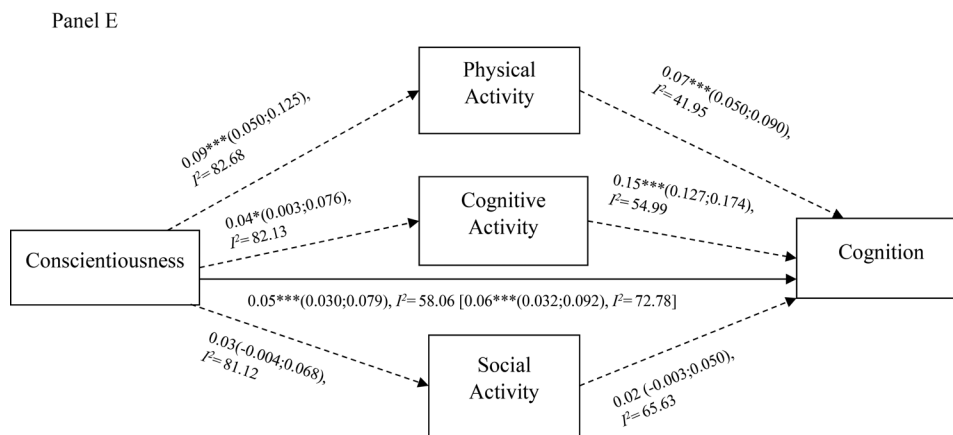


Figure 2. Continued.

activity as a mean to achieve their desired goals. Surprisingly, it was only physical and not cognitive or social activities that played a role in the association between conscientiousness and cognition. Neuroticism is characterized by a propensity to experience negative emotions and distress, to be withdrawn and impulsive, as well as to ruminate and engage in maladaptive coping (Costa & McCrae, 1992); these tendencies interfere with the engagement in an active lifestyle and can lead to deleterious effects on brain health and cognitive function.

The effect sizes for the mediational role of physical and cognitive activities were comparable or stronger than those observed in recent research for physical performance (Stephan et al., 2023) and biological mediators (Stephan et al., 2023) using the HRS and ELSA. However, although both physical and cognitive activities significantly mediated the associations between neuroticism, extraversion, and openness and cognition, there were differences in their respective effect size. Indeed, the proportion explained by involvement in cognitive activity was twofold higher than involvement in physical activity for the link between neuroticism and cognition, and almost threefold higher for the openness-cognition link. Therefore, openness was associated with better cognition mostly because it was related to engagement in cognitively stimulating activities more than physical activity. Higher neuroticism was related to lower cognition mainly because it was associated with less engagement in cognitive activities more than physical inactivity. Physical and cognitive activity explained a comparable amount of the association between extraversion and cognition. Of note, cognitive activities did not mediate the link between conscientiousness and cognition, in contrast to past research (Sutin et al., 2020, 2022), which may be due, in part, to differences in the way cognitive activities were defined and measured across the studies. Therefore, this finding suggests that the link between conscientiousness and cognition may be mostly driven by involvement in health-related behaviors more than cognitively stimulating activities, and future research will need to identify the most beneficial types of activity.

Consistent with existing evidence (Graham et al., 2021; Luchetti et al., 2016), agreeableness was not directly related to cognition. The results did suggest, however, that higher agreeableness was indirectly associated with cognitive functioning. Indeed, higher agreeableness was related to a higher involvement in physical and cognitive activities, which in turn were associated with higher cognition. Agreeableness is characterized by higher compliance (Costa & McCrae, 1992) and assimilation to social norms (Gebauer et al., 2014), which may lead to

adopting an active lifestyle to conform to public health recommendations, with some potential cognitive benefits.

These findings have practical implications for tailored interventions to promote an active lifestyle to foster cognition in old age. Such interventions are particularly needed for individuals with higher neuroticism, lower extraversion, openness, and/or conscientiousness. These individuals are vulnerable to aging-related diseases (Aschwanden et al., 2021; Stephan et al., 2023), report lower well-being (Busseri & Erb, 2023), and are less responsive to treatments (Bucher et al., 2019). Interventions directed toward changing personality traits (Stieger et al., 2021) could have a secondary benefit of increasing physical and cognitive activities, which ultimately could improve cognition.

The present study adds to existing models and research by providing replicable evidence of a lifestyle pathway between personality and cognition. Furthermore, it is the first examination of the simultaneous mediation of physical, cognitive, and social activities, which extends existing research that examined these activities separately (Allen et al., 2019; Hogan et al., 2012; Jackson et al., 2020; Mercuri & Holtzer, 2021; Sutin et al., 2020). These findings also have indirect implications for understanding the association between personality and dementia. Indeed, leisure activities have been associated with dementia risk (Su et al., 2022), as has personality (Aschwanden et al., 2021). It is possible that less involvement in activities may be a pathway between higher neuroticism and lower conscientiousness and dementia risk.

The present study has several strengths, including testing the simultaneous mediation of cognitive, physical, and social activities in the relationship between personality and cognition, the use of four large longitudinal samples, and the three waves of measurement in each sample. Although the overall pattern of mediation was replicated across the four samples, there was also heterogeneity in effect sizes, which could be explained by the different measures of personality and activities, the follow-up length, and the age range across the samples. There are also additional limitations. The observational design of the present study does not support causal claims. Although activities were modeled as mediators of the association between personality and cognition, it is also possible that personality may mediate the association between activities and cognition. Furthermore, the MIDUS was characterized by a wide age range. Therefore, participants in this sample may have faced different life events than participants in the other three samples that may have influenced the pattern of relationships observed. However, the findings from MIDUS were broadly comparable to those of

the other samples. More research is also needed to examine whether activities mediate the link between personality facets and cognition. Indeed, a facet-level approach could provide a more detailed account of the specific personality characteristics associated with a cognitively enriching lifestyle. Future research could also extend the present finding by examining the mediators between personality and cognition decline. Finally, the present study focused on United States and European samples. Future research may examine whether the mediational role of activities replicates in other cultures.

Despite these limitations, the present study provides replicable evidence that activity engagement mediates the association between personality and cognition. Lower neuroticism and higher extraversion, openness, and conscientiousness were prospectively associated with better cognition, and most of these associations were partly mediated by engagement in physical and cognitive activities.

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Disclosure statement

The authors report there are no competing interests to declare.

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Data availability Statement

ELSA data are publicly available from the UK Data Service (UKDS, <https://www.ukdataservice.ac.uk/>); MIDUS data are available at <http://midus.wisc.edu/index.php>; HRS data are available at [\[umich.edu/data-products\]\(http://umich.edu/data-products\); WLS data are available at <http://www.ssc.wisc.edu/wlsresearch/data/>.](https://hrs.isr.</p>
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