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RESEARCH PAPER

Mediators of the Relationship Between Cognition and Subjective Well-Being

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Abstract

Cognitive functioning has consistently found to predict subjective well-being (SWB), but it remains unclear why this relationship exists. Several potential explanations for this relationship have been offered in the literature, one of which is that a third variable accounts for this relationship. The current study examines this hypothesis by testing need for cognition (NfC), self-rated health, physical activity, cognitive activity, emotional stability, and conscientiousness as mediators of the relationship between cognitive ability (*g*) and indices of well-being. Data were drawn from the Virginia Cognitive Aging Project, a study of community-dwelling adults aged 18–99 ($N = 4354$). A composite variable representing cognition was created using measures of episodic memory, perceptual speed, reasoning ability, and spatial visualization. SWB was conceptualized as life satisfaction, positive affect, and negative affect; the three facets of SWB were treated as separate outcomes. Results indicate that NfC, self-rated health, emotional stability, and conscientiousness partially mediate the relationship between cognition and all facets of SWB. Neither physical activity nor cognitive activity mediated the relationship between cognition and SWB. The results of this study support the hypothesis that the cognition-SWB relationship can partially be explained by third variables and provide insight into the personality and individual difference characteristics that underlie this relationship.

Keywords Cognition · Subjective well-being · Positive affect · Negative affect · Life satisfaction

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1 Introduction

The cognitive processes associated with fluid intelligence (i.e., process domains) have been shown to decline with age. Research has shown that in cross-sectional samples performance on measures of processing speed, reasoning ability, and memory decline linearly beginning in the second decade of life (e.g., Salthouse 2004). In contrast, crystallized intelligence, or the domains of cognition which reflect knowledge, have been shown to increase across adulthood until about the mid-50s (Salthouse 2004). Cognitive functioning has consistently been linked to subjective well-being (SWB; e.g., Isaacowitz and Smith 2003; Jones et al. 2003; Siedlecki et al. 2020). Interestingly, despite age-related declines in many domains of cognitive functioning, SWB appears to remain stable or even increase with age (Braun et al. 2017; Gana et al. 2012; Stone et al. 2010). One explanation for this paradoxical finding is that the cognition-SWB relationship can be explained by mediating variables. In this study, we examine six potential mediators of the cognition-SWB relationship: need for cognition (NfC), self-rated health, physical activity, cognitive activity, emotional stability, and conscientiousness.

SWB has been operationalized in different ways. One common conceptualization of SWB is as a three dimensional construct comprising life satisfaction, positive affect, and negative affect (e.g., Diener et al. 1999). High life satisfaction, frequent positive affect, and infrequent negative affect are indicative of high levels of SWB. There is evidence of a strong relationship between SWB and objective well-being in adulthood; higher levels of SWB in adulthood are associated with positive physical and mental health, as well as fewer problems with activities of daily living (Lyubomirsky et al. 2005; Allerhand et al. 2014). High levels of SWB may be particularly beneficial for older adults. For example, a meta-analysis found that well-being was associated with a decreased risk of mortality for both healthy adults and adults living with illness, particularly for individuals over age 60 (Chida and Steptoe 2008).

The individual components of SWB are also uniquely linked to indicators of successful aging; positive affect has been found to positively predict mobility, functional status, and two-year survival in a sample of adults aged 65 to 99 (Ostir et al. 2000), and higher life satisfaction has similarly been found to predict fewer mobility issues over an eight-year period in adults aged 54 to 91 years (Collins et al. 2008). Accordingly, high levels of SWB are considered a hallmark of positive aging (Rowe and Kahn 1997, 1998).

There is evidence that cognitive functioning predicts facets of SWB in adulthood. For example, Isaacowitz and Smith (2003) report that general intelligence predicts both positive and negative affect in a sample of adults aged 70 to 105 years old. Using a battery of tests of broad cognitive ability, Jones et al. (2003) found that cognitive functioning predicts life satisfaction and positive, but not negative, affect in a sample of older adults. Furthermore, the literature suggest that specific cognitive functions have particularly strong relationships with SWB. Both cross-sectional (Siedlecki et al. 2020) and longitudinal (Enkvist et al. 2013) studies have found that processing speed predicts positive affect. Executive function, verbal recall, and processing speed have been found to predict overall well-being in a longitudinal sample of adults aged 50 to 90 years old (Allerhand et al. 2014).

1.1 Mechanisms for Cognition-SWB Relationship

Although cognitive functioning is consistently found to predict SWB, it is unclear why SWB remains stable or increases despite age-related declines in fluid intelligence. Several possible explanations for this relationship have been suggested. Stawski and colleagues (2010) report that adults with higher levels of fluid ability experience more daily stressors, but also experience smaller decreases in positive mood and smaller increases in negative mood in response to these stressors. This suggests that better cognitive functioning lessens the impact of daily stress, thus serving as a protective factor for well-being. Another explanation is that better cognitive functioning allows individuals to be more engaged with daily life, which, in turn, allows for more enjoyment of life (Isaacowitz and Smith 2003). Similarly, Jones and colleagues (2003) posit that better cognitive functioning allows adults to better "utilize available resources or adapt to circumstances in a fashion that facilitates happiness" (p.14), thus leading to higher SWB.

The relationship between cognition and SWB may also be explained by the value-as-a-moderator model. Proposed by Oishi et al. (1999), the value-as-a-moderator model posits that individual differences in SWB are influenced by the concordance between one's daily experiences and the values that are salient in one's life, such that activities that are more congruent with one's values increase life satisfaction more than value-incongruent activities. Values change throughout the lifespan (Cantor and Sanderson 1999) and there is some evidence that the value placed specifically on cognitive function changes with age. Siedlecki and colleagues (2008) found that fluid intelligence predicts life satisfaction in early and middle adulthood (ages 18–59), but not in older adulthood (ages 60+). They hypothesize that this may be due to lifestyle changes associated with aging, specifically that fewer older adults are in the workforce compared to younger adults, who may value fluid intelligence more highly as it contributes to upward career mobility. Thus, it may be as value placed on cognitive functioning declines as with age, the negative impact of cognitive decline on SWB decreases.

Another potential explanation is that the relationship between cognition and SWB is indirect such that a third variable accounts for the stability in SWB despite age-related cognitive decline. Previous attempts to find mediators in the relationship between cognition and SWB have been unsuccessful. Braun and colleagues (2017) included physical health (both self- and physician-rated), personality (neuroticism and conscientiousness), internal control, and education as covariates in their models examining the associations between cognitive function and SWB, but found little evidence that any of these variables influenced that relationship. Accordingly, no study to date successfully identified meditators of the cognition-SWB relationship. Below, we describe six potential mediators of the cognition-SWB relationship, which will be examined in the current study.

1.2 Need for Cognition

One potential mediator of the cognition-SWB relationship is NfC, which reflects individuals' tendency to enjoy and engage in effortful cognitive activities, such as problem-solving and reasoning tasks (Cacioppo and Petty 1982; Cacioppo et al. 1984). Existing research has established that NfC is related to broad measures of fluid intelligence (*r*s range from 0.25 to 0.34; Fleischhauer et al. 2010; Soubelet and Salthouse 2010; von Stumm 2013) and is predicted by domain-specific measures of cognition such as episodic memory ($\beta = 0.29$),

processing speed ($\beta = 0.27$), reasoning ($\beta = 0.38$), and spatial visualization ability ($\beta = 0.39$) (Soubelet and Salthouse 2017).

High levels of NfC are also associated with higher levels of well-being. NfC is correlated with broad measures of psychological well-being ($r = 0.39$; Cole and Korkmaz 2013) as well as indices of well-being such as life satisfaction ($r = 0.14$; Gauthier et al. 2006), positive affect ($r = 0.34$; Strobel et al. 2017), negative affect ($r = -0.24$; Fleischhauer et al. 2010) and depressive symptoms ($r = -0.17$; Baer et al. 2013). Strobel et al. (2017) hypothesize that the enhancements in memory associated with high levels of NfC provide people with "a broader basis of situations to refer to especially with a focus on the aspects of these situations that helped to cope with them" (p. 6). They suggest, therefore, that NfC enhances well-being because people high in NfC are better able to use their past experiences to cope with current threats to well-being.

1.3 Self-rated Health

Given the theoretical explanation that better cognitive functioning allows individuals to engage in and enjoy daily life more leading to higher levels of SWB (Isaacowitz and Smith 2003), health may mediate this relationship because poorer health may prevent adults from engaging in day-to-day activities, leading to lower levels of SWB. Health has been linked to both cognition and well-being (e.g., Barger et al. 2009; Tolea et al. 2015). The literature generally supports a directional relationship between health and cognition such that poorer cognitive functioning predicts poorer health (Kim et al. 2005; Tolea et al. 2015). For example, one longitudinal study of community-dwelling adults found that impairments in cognitive functioning predicted declines in physical health over time, while lower physical health at baseline did not predict changes in cognitive functioning (Tolea et al. 2015).

Research also indicates that there is a positive relationship between physical health and SWB in both clinical (Matthews et al. 2002) and nonclinical (Barger et al. 2009) samples. A recent meta-analysis examining 29 studies using samples drawn from the general population and individuals with chronic illness found that there was a positive, medium-sized relationship between health status and SWB, and that this relationship was particularly strong for the life satisfaction facet of SWB (Ngamaba et al. 2017). Interestingly, there is evidence that subjective appraisals of health are more strongly related to SWB than more objective measures of health such as physical mobility, vision, and hearing (Smith et al. 2002). This may be because individuals differ in the extent to which they adjust to or cope with changes in ability (Lucas 2007) which objective measures of health do not account for.

1.4 Physical Activity

Physical activity has been consistently linked to improved cognitive functioning across the lifespan (e.g., Hillman et al. 2008). Of particular interest is the influence of physical activity on moderating the age-related declines in cognition. Colcombe and Kramer (2003) conducted a meta-analysis of studies examining the relationship between aerobic fitness and cognition. They found that increased physical activity (via intervention participation) was associated with enhanced cognitive functioning. This effect was particularly strong for executive functions such as planning, inhibition, and working memory (Colcombe and Kramer 2003). Physical activity has also been found to slow cognitive decline in older adults living with dementia (Kemoun et al. 2010), indicating that both clinical and

non-clinical samples show enhanced cognitive functioning after physical activity. Several potential explanations for the positive relationship between physical activity and cognitive function have been proposed, such as increased blood flow to the brain, decreased risk of cardiovascular diseases, and a reduction in stress (for a review, see Fratiglioni et al. 2004).

Physical activity also contributes to well-being. There is evidence that increased physical activity is associated with a reduction in depressive symptoms (Dunn et al. 2001) and increased life satisfaction, although this effects appears to be stronger for men (Dolan et al. 2014). Physical activity interventions have also been found to foster well-being; one study of a four-week fitness program found that increased physical activity contributes increases in individuals' life satisfaction (Wicker et al. 2015). Dolan et al. (2014) propose that physical activity is positively associated with well-being because individuals perceive exercise as healthy, pleasurable, and purposeful (e.g., socialization, skill development), all of which contribute to a sense of well-being.

1.5 Cognitive Activity

Another potential mediator in the cognition-SWB relationship may be the level of cognitive activity individuals engage in regularly. Frequent engagement in cognitively stimulating activities which are perceived as enjoyable (e.g., reading novels, working on crossword puzzles) enhance SWB, while also being dependent on individuals cognitive functioning. The mental-exercise hypothesis, which posits that higher levels of cognitive engagement help preserve one's cognitive functioning or prevent cognitive decline (Hultsch et al. 1999), is one common explanation for the benefits of cognitive activity on functioning (but see Salthouse 2006). Prospective longitudinal work indicates that a higher frequency of engagement in cognitive activity in childhood, early adulthood, and middle adulthood predict slower cognitive decline in older adulthood after accounting for related cognitive and environmental influences (Wilson et al. 2013).

In addition to the enjoyment derived from participating in cognitively engaging leisure activities which may increase SWB, many cognitively engaging activities include a social or interpersonal component (e.g., socializing with friends, teaching or attending lectures/classes, volunteering) which may foster well-being.

1.6 Emotional Stability

Emotional stability is a highly stable personality trait in adulthood (Costa and McCrae 1998) that reflects individuals' tendency to experience emotional distress or negative emotions. There is evidence that high levels of neuroticism (i.e., low emotional stability) are associated with increased cognitive difficulties in adulthood. For example, a twelve-year longitudinal study of older adults found that individuals who reported high neuroticism were 40% more likely to experience mild cognitive impairment than individuals who scored in the bottom 10th percentile on a measure of neuroticism (Wilson et al. 2007a, b, c) and individuals higher in neuroticism have been found to have lower levels of general cognitive ability (*g*; Chapman et al. 2012). Higher levels of neuroticism have also been linked with more rapid cognitive decline in old age (Chapman et al. 2012; Wilson et al. 2006) and pathological development such that individuals with a higher level of this trait experience increased risk of developing Alzheimer's disease after accounting for physical, social, and cognitive activity, as well as depressive symptoms (Wilson et al. 2006). Neuroticism appears to have particularly strong concurrent relationships with episodic memory

and perceptual speed, and is predictive of later declines in several domains of memory (episodic, semantic and working; Wilson et al. 2006). Other work, however, suggests that neuroticism does not affect cognitive functioning or contribute to cognitive decline (Jelicic et al. 2003).

Low levels of neuroticism (higher emotional stability) have also been found to be associated with higher scores on indices of happiness and life satisfaction (Hayes and Joseph 2003). One large, representative study of American adults found that high emotional stability was positively correlated with positive affect ($r = 0.46$) and life satisfaction ($r = 0.36$) and negatively correlated with negative affect ($r = -0.75$); emotional stability also predicted positive affect, negative affect, and life satisfaction (βs = 0.31, −0.70, and 0.26, respectively; Duckworth et al. 2012). The relationship between emotional stability and SWB is attributed to increased negative affect in individuals high in neuroticism or increased positive affect in individuals with higher emotional stability (McNiel and Fleeson 2006).

1.7 Conscientiousness

Research findings regarding the relationship between the personality trait of conscientiousness and cognition are inconsistent. While some studies report that conscientiousness is unrelated to general cognitive ability (*g*; Austin et al. 2002; Chapman et al. 2012; Wilson et al. 2007a, b, c), other work support the relationship between conscientiousness and specific domains of cognition. For example, conscientiousness has been found to positively predict perceptual speed, numeric facility, and verbal comprehension in a large, diverse sample (Schaie et al. 2004). However, these associations may not apply throughout the lifespan; Soubelet and Salthouse (2011) report that conscientiousness is positively associated with perceptual speed only in adults aged 40–59. Higher levels of conscientiousness also appear to be associated with more gradual cognitive decline in older adults both broadly (*g*; Chapman et al. 2012; Wilson et al. 2007a, b, c) and in specific domains such as episodic and working memory, perceptual speed, and verbal ability (Wilson et al. 2007a, b, c). Furthermore, since conscientiousness has been found to predict exercise participation (Huang et al. 2007), and physical activity promotes cognitive functioning (Hillman et al. 2008), conscientiousness may influence cognitive functioning both directly and indirectly via health behaviors.

Conscientiousness, however, has been consistently linked to higher levels of SWB. For example, Duckworth et al. (2012) found that higher levels of conscientiousness are both correlated with and predictive of high positive affect, low negative affect, and high life satisfaction after accounting for personality, demographic variables, and cognitive ability (absolute values of *r*s range from 0.29 to 0.56; absolute values of βs range from 0.17-0.20). There are several potential explanations for the strong relationships between conscientiousness and facets of SWB. First, increased participation in exercise attributed to higher levels of conscientiousness has been found to contribute to self-reported increases in psychological health (e.g., "I can manage stress after exercise"; Huang et al. 2007). So, more conscientious individuals may exercise more, which contributes to higher levels of physical and psychological well-being. Alternatively, Duckworth and colleagues propose that the behavior of highly conscientious individuals is motivated by "long-term, global goals, and standards when there is a temptation to do otherwise" (p. 6). This goal-driven behavior may foster professional and interpersonal success which enhances SWB. Finally, conscientiousness appears to be a robust predictor of academic performance even after accounting

for intelligence (Poropat 2009); academic success may further contribute to SWB (Duckworth et al. 2012).

1.8 The Current Study

While research has demonstrated a robust relationship between cognitive functioning and SWB, it is unclear what mechanisms explain this relationship. One potential explanation is that a third variable accounts for the association between cognition and SWB. Using data from the Virginia Cognitive Aging Project (VCAP; Salthouse 2014), the purpose of this study was to examine six potential variables as mediators of the cognition-SWB relationship. Specifically, we were interested in examining NfC, self-rated health, physical activity, cognitive activity, emotional stability, and conscientiousness as mediators in the relationship between cognitive ability (*g*) and three indices of well-being, namely life satisfaction, positive and negative affect. These variables have been previously shown to be related to cognition, well-being, or both. We therefore expected that the relationship between cognition and each of three facets of SWB would be partially explained by at least one of the six proposed mediators.

2 Method

2.1 Participants

Data were drawn from the Virginia Cognitive Aging Project (VCAP; Salthouse 2014). VCAP is a study of community-dwelling adults aged 18 to 99 years old ($N = 5,430$). Adults were eligible to participate if they were (1) fluent in English, (2) had earned a high school degree or equivalent, and (3) had no significant impairments in hearing or vision that would prevent them from completing the study. For the current analyses, those that scored below a 24 on the Mini Mental Status Exam (MMSE; Folstein et al. 1975) or who had no available MMSE data were excluded ($n = 1076$). Participants were recruited from the community through flyers, referrals, and advertisements in newspapers. VCAP is a longitudinal study (data were collected between 2001 through 2018); for each wave of data collection, in-person measures were completed across three two-hour sessions within a two-week period, as well as an at-home questionnaire packet. Participants provided written consent prior to participation. Data were collected with approval from the local Institutional Review Board and in compliance with the Helsinki Declaration.

The current study uses the baseline assessment for each participant. At each occasion, participants visited the lab three times over the period of two weeks. During each session participants completed a series of cognitive tasks. Different versions of the same tasks were administered across the three sessions. The data for the current study includes cognitive scores from session 1 of their baseline visit. The sample used in this study comprises 4354 individuals ($M_{age} = 51.50$, $SD = 18.06$), 65.39% of whom identified as female ($n = 2847$). 78.81% of the sample identified as White ($n = 3435$), 11.67% identified as Black or African American ($n = 508$), 2.07% identified as American Indian/Alaskan Native ($n = 90$), 1.47% identified as Asian ($n = 64$), 0.25% identified as Native Hawaiian or other Pacific Islander ($n = 11$), 4.85% identified as more than one race ($n = 211$) and 35 (0.80%) did not report their race/ethnicity. Of the sample, 87 participants identified as Latino/a (2%). Table 1 presents descriptive statistics for variables of interest in the current sample.

Table 1 Descriptive statistics and zero-order correlations for study variables

	M (*SD*)	1	2	3	4	5	6	7	8	9	10	11	12
1. Life satisfaction	22.84 (7.21)	(.90)											
2. Positive affect	30.97 (7.95)	.29*	(.90)										
3. Negative affect	13.32 (5.11)	− .38*	− .11*	(.89)									
4. Cognition	− 0.01 (0.70)	.08*	− .18*	− .07*	(.85)[a]								
5. Need for cognition	61.86 (12.87)	.14*	.19*	− .15*	.31*	(.90)							
6. Self-rated health	2.20 (0.90)	− .27*	− .17*	.16*	− .21*	− .12*	–						
7. Physical activity	25.29 (29.84)	− .08*	.09*	− .03	.02	.08*	− .13*	–					
8. Cognitive activity	38.00 (23.11)	− .01	.07*	− .06*	.08*	.16*	− .04*	− .01	–				
9. Emotional stability	6.51 (1.98)	.41*	.24*	− .36*	.02	.10*	− .17*	.07*	.03	(.88)			
10. Conscientiousness	21.78 (4.07)	.21*	.25*	− .16*	.00	.13*	− .20*	.06*	.02	.17*	(.80)		
11. Age	51.50 (18.06)	.11*	.18*	− .17*	− .56*	− .05*	.09*	− .02*	− .02	.13*	.12*	–	
12. Gender	–	.02	− .01	− .02	.05*	− .10*	− .02	− .12*	.02	− .10*	.11*	.00	–
13. Education (years)	15.59 (2.93)	.15*	.03	− .14*	.23*	.30*	− .15*	− .03*	.11*	.07*	.09*	.16*	− .03

*$p < .01$. For gender, 1 = male and 2 = female. Cronbach alphas are reported in parentheses

[a]This represents the reliability of mean performance across four composite variables representing mean performance on episodic memory, processing speed, reasoning, and spatial visualization

3 Measures

3.1 Subjective Well-Being (SWB)

3.1.1 Life Satisfaction

Life satisfaction was measured using the Satisfaction with Life Scale (SWLS; Diener et al. 1985), which asks participants to evaluate life satisfaction on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The SWLS includes five items (e.g., "In most ways my life is close to my ideal" and "If I could live my life over, I would change almost nothing"); scores can range from 5 to 35 with a score of 20 representing the neutral point (Pavot and Diener 1993) and higher scores representing higher life satisfaction. Temporal stability of the SWLS is well established with a retest reliability of $r = 0.82$ over two-months (Diener et al. 1985).

3.1.2 Positive and Negative Affect

Positive and negative affect were measured with the Positive and Negative Affect Scale (PANAS; Watson et al. 1988). Participants were asked to rate the extent to which 10 positive and 10 negative adjectives described how they currently felt on a five-point Likert Scale (1 = very slightly or not at all, 5 = extremely). The PANAS has high internal consistency (Cronbach's α range from 0.86 to 0.90 for PA scale and 0.84 to 0.87 for NA scale) and adequate temporal stability (ranging from $r = 0.47$ to $r = 0.68$ for PA scale and from $r = 0.39$ to $r = 0.71$ for NA scale over an eight-week period; Watson et al. 1988).

3.2 Cognition

Four cognitive domains were included in the current analyses: episodic memory, perceptual speed, reasoning ability, and spatial visualization. Episodic memory was assessed with a word recall task (Wechsler 1997a), paired associate learning (Salthouse et al. 1996), and logical memory (Wechsler 1997a). Perceptual speed consisted of the mean of scores on the digit symbol substitution test (Wechsler 1997b), and the pattern comparison and letter comparison tests (Salthouse and Babcock 1991). Reasoning ability was measured by performance on the matrix reasoning task (Raven 1962), series completion task (Zachary 1986), and letter sets (Ekstrom et al. 1976). Spatial visualization was assessed with the spatial relations (Bennett et al. 1997), paper folding (Ekstrom et al. 1976), and form boards (Ekstrom et al. 1976) tasks. A description of each task is available in the supplemental material.

3.3 Mediator Variables

3.3.1 Need for Cognition

The Need for Cognition Scale (Cacioppo et al. 1984) comprises 18 items assessing individuals' proclivity for engaging in and enjoying activities that require cognitive effort. Participants were asked to rate items such as "I would rather do something that requires little

thought than something that is sure to challenge my thinking abilities" and "I prefer my life to be filled with puzzles that I must solve" on a five-point scale (1 = extremely uncharacteristic, 5 = extremely characteristic). Sum scores, calculated after reverse coding negatively worded items, were used in analyses. The Need for Cognition Scale has been found to be reliable (Cronbach alphas ≥ 0.85) across diverse samples (Cacioppo et al. 1996).

3.3.2 Self-Rated Health

The at-home questionnaire packet also included a single-item measure of self-rated health. Participants responded to an item assessing health ("How would you rate your health at the current time?") on a five-point Likert scale (1 = excellent, 5 = poor).

3.3.3 Physical Activity

Participants were asked to report the length of time (in minutes) they spent engaging in a variety of physical activities (i.e., running/jogging, walking, yard work, aerobics, swimming, tennis, rowing, cycling, calisthenics, and sports) on each occasion that they engaged in these activities in the past month. A measure of physical activity was calculated as the sum of time spent engaging in each activity (Salthouse 2014).

3.3.4 Cognitive Activity

The cognitive activity questionnaire (Salthouse et al. 2002) lists 22 activities and asks participants to estimate the number of hours in a typical week spent exclusively on each activity and to rate how cognitively demanding each activity is. Consistent with previous work using this measure (Salthouse 2014), cognitive activity was measured as the sum of the number of hours per week participants reported spending on seven activities rated as most cognitively demanding: reading newspapers or magazines, using a computer, driving a car, reading nonfiction books or articles, working on problem solving activities (e.g., crossword puzzles), handling finances (e.g., balancing checkbook), and writing (e.g., letters, creative writing).

3.3.5 Emotional Stability and Conscientiousness

The 50-item version of the Big-Five 5 Broad Domains from the International Personality Item Pool (IPIP; Goldberg 1999) was administered as a measure of personality. Participants were asked to read the statements describing behaviors and rate how accurately each statement described them (1 = very inaccurate, 5 = very accurate). The emotional stability measure was the sum of responses to 10 items such as "I am relaxed most of the time" and "I change my mood a lot" after reverse scoring negatively worded items. Conscientiousness was measured with 10 items such as "I pay attention to details" and "I often forget to put things back in their proper place". Negatively worded items were reverse scored; the sum of the items on the conscientiousness subscale was used in analyses.

3.4 Analytic Plan

A cognitive composite variable was created to represent overall cognition. To examine whether each of the six variables mediated the relationship between cognition and each

SWB facet, bootstrapping with the PROCESS macro in SPSS (Hayes 2017) was used. For each mediation model, age, gender, and education were included as covariates. An alpha level of 0.01 was used for all analyses.

4 Results

Table 1 presents the zero-order correlations for the study variables. The correlations between cognition, SWB, and the potential mediators were examined. Cognition was significantly positively correlated with life satisfaction ($r = 0.08$), and significantly negatively correlated with positive affect ($r = -0.18$) and negative affect ($r = -0.07$). Overall, each of the six proposed mediators were significantly correlated with some, if not all, indices of SWB and cognition ($p < 0.01$). Among the mediators, cognition had the strongest relationship with NfC ($r = 0.31$, $p < 0.01$).

Before conducting mediation analyses, hierarchical linear regression analyses were run to examine the predictive validity of cognition on each facet of SWB, after controlling for sociodemographic variables. In step 1, age, gender, and education were included as predictors. In step 2, the cognition composite variable was included. The results of the hierarchical analyses predicting the SWB variables are presented in Table 2, and Table 3 presents the results of the R^2 and change statistics. After statistically controlling for age, gender, and education, cognition was a significant positive predictor of life satisfaction ($\beta = 0.19$*), and a significant negative predictor of positive affect ($\beta = -0.12$*) and negative affect ($\beta = -0.22$*). For each of the linear regressions, both steps 1 and 2 were associated with a significant increase in R^2 (see Table 3).

Table 2 Summary of hierarchical regression models coefficients predicting subjective well-being from step 2 (the full model) of each regression

	B	*SE B*	*β*
DV: Life satisfaction			
Age	0.08	0.01	.21*
Gender	0.15	0.24	.01
Education	0.11	0.04	.05*
Cognition	1.94	0.21	.19*
DV: Positive affect			
Age	0.05	0.01	.11*
Gender	−0.14	0.25	−.01
Education	0.06	0.04	.02
Cognition	−1.37	0.22	−.12*
DV: Negative affect			
Age	−0.08	0.01	−.29*
Gender	−0.10	0.16	−.01
Education	−0.05	0.02	−.03
Cognition	−1.63	0.14	−.22*

DV dependent variable. For gender, 1 = male and 2 = female; *$p < .01$

Table 3 Change statistics for the hierarchical regression models predicting subjective well-being

				Change statistics			
	R	R^2	Adjusted R^2	R^2 change	*F* change	*df*1	*df*2
DV: Life satisfaction							
Step 1[a]	0.15	0.02	0.02	0.02	29.90*	3	3867
Step 2[b]	0.21	0.04	0.04	0.02	86.10*	1	3866
DV: Positive affect							
Step 1[a]	0.18	0.03	0.03	0.03	47.29*	3	4184
Step 2[b]	0.2	0.04	0.04	0.01	37.85*	1	4183
DV: Negative affect							
Step 1[a]	0.19	0.04	0.04	0.04	51.73*	3	4184
Step 2[b]	0.26	0.07	0.07	0.03	133.73*	1	4183

[a]Predictors: age, gender (1 = male, 2 = female), education; [b]Predictors: age, gender (1 = male, 2 = female), education, cognition; DV = dependent variable; * $p < 0.01$

4.1 Mediation Analyses

To examine whether the cognition-SWB relationship was mediated by NfC, health, emotional stability, conscientiousness, physical activity, and cognitive activity, bootstrapping was used and the 99% confidence intervals for the unstandardized indirect effects were obtained with 5000 bootstrap resamples. The results of the mediation analyses are presented in Table 4 where each row reflects the results of a separate analysis. That is, mediation analyses were run separately for each SWB facet and for each mediator (i.e., three separate models per mediator). For each analyses, age, gender, and education were again included as covariates. Inspection of the 99% confidence intervals showed that NfC, health, emotional stability, and conscientiousness were significant mediators of the relationship between cognition and each of the SWB facets (life satisfaction, positive affect, and negative affect). Physical activity and cognitive activity were not significant mediators in any of the models.

5 Discussion

Although the relationship between cognitive functioning and SWB is well-established (e.g., Isaacowitz and Smith 2003; Jones et al. 2003; Siedlecki et al. 2020), the mechanisms underlying this relationship are less clear. One proposed explanation is that a third variable mediates this relationship, but previous work examining whether covariates affected this relationship yielded null effects (e.g., Braun et al. 2017). The purpose of the current study was to examine potential mediators of the relationship between cognitive functioning and SWB, conceptualized as life satisfaction, positive affect, negative affect, in a large sample spanning adulthood. Our results show that NfC, self-rated health, emotional stability, and conscientiousness were significant mediators of the relationship between cognition and all facets of SWB, although the magnitude of the indirect effects indicates that these variables only partially mediate the cognition-SWB relationship. Neither physical activity nor cognitive activity mediated the relationship between SWB and cognition.

Table 4 Results of Mediation Analyses (Unstandardized Coefficients)

	Direct effect	SE	Indirect effect	SE	99% confidence interval		*N*
					Lower limit	Upper limit	
NfC as the mediator							
Cognition → SWLS	1.60*	0.22	**0.34**	0.08	0.14	0.53	3856
Cognition → PA	−2.40*	0.23	**1.04**	0.11	0.76	1.30	4176
Cognition → NA	−1.39*	0.15	**−0.25**	0.05	−0.39	−0.13	4176
Self-rated health as the mediator							
Cognition → SWLS	1.46*	0.20	**0.48**	0.07	0.29	0.67	3871
Cognition → PA	−1.81*	0.22	**0.44**	0.07	0.26	0.61	4188
Cognition → NA	−1.45*	0.14	**−0.18**	0.03	−0.27	−0.10	4188
Emotional stability as the mediator							
Cognition → SWLS	1.33*	0.19	**0.61**	0.09	0.38	0.83	3861
Cognition → PA	−1.74*	0.22	**0.39**	0.06	0.24	0.55	4179
Cognition → NA	−1.28*	0.13	**−0.35**	0.05	−0.49	−0.22	4179
Conscientiousness as the mediator							
Cognition → SWLS	1.80*	0.21	**0.14**	0.05	0.02	0.26	3861
Cognition → PA	−1.58*	0.22	**0.22**	0.06	0.06	0.38	4179
Cognition → NA	−1.56*	0.14	**−0.07**	0.02	−0.14	−0.02	4179
Physical activity as the mediator							
Cognition → SWLS	1.71*	0.23	0.00	0.02	−0.04	0.04	3244
Cognition → PA	−1.38*	0.25	−0.04	0.03	−0.06	0.08	3559
Cognition → NA	−1.55*	0.15	−0.00	0.01	−0.02	0.01	3559
Cognitive activity as the mediator							
Cognition → SWLS	1.98*	0.21	−0.01	0.01	−0.05	0.01	3857
Cognition → PA	−1.40*	0.22	0.04	0.02	−0.01	0.10	4174
Cognition → NA	−1.62*	0.14	−0.02	0.01	−0.04	0.01	4174

Indirect effects that are significant are presented in bold font

SWLS Satisfaction with Life Scale, *PA* positive affect, *NA* negative affect; *$p < .01$

The finding that NfC partially mediates the relationship between cognition and SWB may be explained by the value-as-a-moderator model (Oishi et al. 1999), which posits that value-congruent activities have a larger effect on SWB than value-incongruent activities. Hill and colleagues (2013) suggest that individuals high in NfC work harder on cognitive tasks or persist longer on these tasks because they enjoy cognitively effortful activities and find cognitive effort to be emotionally rewarding. Thus, NfC may mediate the relationship between cognition and SWB because it is an indicator of how much individuals value cognitive effort, and therefore may explain how changes in cognitive functioning impact SWB. Furthermore, it has been suggested that individuals high in NfC have better memory which provides them with a broader reference for coping with challenges (Strobel et al. 2017). Thus, NfC may mediate the cognition-SWB relationship because individuals high in NfC are better able to cope with stressors, allowing them to preserve or enhance SWB despite age-related cognitive decline.

Self-rated health was also found to mediate the relationship between cognition and each facet of SWB. Although this finding is inconsistent with previous work (Braun et al. 2017),

it is consistent with theoretical explanations for the cognition-SWB relationship that posit that better cognitive functioning allows individuals to be more engaged with daily life which allows for more enjoyment of life (Isaacowitz and Smith 2003). Better self-rated health may similarly allow individuals to engage in activities that promote well-being or mitigate the negative effects of stress on well-being, thus preserving SWB despite age-related cognitive decline. Subjective evaluations of health may be particularly salient, as individuals' beliefs about their own abilities based on health-related limitations may be more closely aligned with their engagement with daily life than objective indicators of health because of individual differences in coping with changes in ability (Lucas 2007).

Our results indicated the personality traits of emotional stability and conscientiousness also partially mediate the cognition-SWB relationship. Braun and colleagues (2017) did not find evidence that either personality trait affected this relationship; our findings may vary due to methodological and analytical differences. For example, Braun et al. operationalized cognition with three cognitive measures and we operationalized cognition with twelve measures representing four cognitive constructs. Our findings are consistent with previous research showing that better cognitive functioning buffers the negative effects of stress on well-being (Stawski et al. 2010). As emotional stability reflects individuals' tendency to experience emotional distress or negative emotions, individuals with high levels of this trait may experience less daily stress, therefore preserving well-being. Furthermore, higher levels of emotional stability are associated with lower levels of cognitive impairment (e.g., Chapman et al. 2012; Wilson et al. 2007a, b, c), suggesting that emotional stability may protect SWB both by preserving cognitive functioning and by serving as a buffer against stress.

It has been proposed that conscientiousness is related to SWB because higher levels of conscientiousness foster the accomplishment of goals (Duckworth et al. 2012) which enhances SWB. Given the positive associations between cognitive functioning and conscientiousness (e.g., Schaie et al. 2004), conscientiousness may mediate the cognition-SWB relationship because individuals with better cognitive functioning who are more conscientious may be more likely to pursue and accomplish goals that that are emotionally satisfying, leading to enhanced well-being. Conscientiousness is also related to better use of problem-solving, cognitive restructuring, and engagement (i.e., approach) coping strategies (Carver and Connor-Smith 2010), as well as higher appraisals of one's own coping ability (Penley and Tomaka 2002). Thus, conscientiousness may allow individuals to better cope with age-related cognitive decline, fostering higher levels of SWB.

Despite evidence that physical activity is related to indicators of well-being such as depressive symptomatology (Dunn et al. 2001) and life satisfaction (Dolan et al. 2014), our results indicated that physical activity did not mediate the relationship between cognitive functioning and facets of SWB. Finally, contrary to expectations, cognitive activity also did not mediate the relationship between cognitive functioning and any facet of SWB. Consistent with the research indicating that SWB is relatively stable despite age-related declines in cognitive functioning (e.g., Braun et al. 2017; Gerstorf et al. 2007), SWB may similarly be unaffected by individuals' engagement in cognitively stimulating activities.

6 Limitations

The current study has some limitations. First, data were drawn from a sample of community-dwelling adults and were restricted to those who scored 24 or higher on the MMSE, thus these findings may not be generalizable to adults who experience cognitive impairment

and may not replicate in clinical samples or individuals in institutionalized settings. Second, participants in this sample were highly educated ($M = 15.59$ years, $SD = 2.93$); future work should examine these relationships in more diverse samples. Finally, a few methodological limitations should be noted. Specifically, self-rated health was assessed with a single-item measure and cognitive activity was measured as the amount of time spent engaging in seven specific activities, however individuals may engage in a variety of other activities that they consider cognitively engaging.

7 Conclusion

Despite these limitations, however, to the best of our knowledge this study is the first to identify mediators in the relationship between cognitive functioning and SWB. Furthermore, this study has several strengths, including a large sample size and multiple measures of cognition and well-being. Our findings help elucidate the mechanism underlying the cognition-SWB relationship, and indicate that individual differences in NfC, self-rated health, emotional stability, and conscientiousness partially mediate the relationship between cognition and each facet of SWB. These results support the hypothesis that the cognition-SWB relationship can be partially explained by third variables and provide insight into the several personality and individual difference characteristics that underlie this relationship.

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