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Coping strategies mediate the relation between executive functions and life satisfaction in middle and late adulthood: A structural equational analysis

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Abstract

Recent studies have suggested that executive functions (EF) predict life satisfaction for older adults. However, the mechanism is not known. By analyzing a sample (N = 3,287, ages 32- 84 years) from the Midlife Development in the United States 2, we examined the mediational role of coping strategies in the relation between EF and life satisfaction. Both active coping and behavioral disengagement mediated the relation between EF and life satisfaction, and age significantly moderated the mediational pathways. Specifically, the positive effect of EF on active coping was more pronounced in middle-aged and older adults than in young adults. However, the negative effect of EF on behavioral disengagement was apparent only in older adults, disappeared in middle-aged adults and reversed in younger adults. Our findings underscore EF as crucial cognitive resources that facilitate the adoption of healthy coping strategies, which in turn, affect life satisfaction in middle and late adulthood.

Keywords: Executive function, subjective well-being, coping strategies, middle and late adulthood

Introduction

A considerable amount of scholarly attention has been devoted to life satisfaction, which refers to a person's cognitive judgment and evaluation of their quality of life as a whole (E. D. Diener et al., 1985) based on specific evalutions of major life domains (e.g., work, health, family, social life, etc.; Schimmack et al., 2009; Weber & Huebner, 2015). Despite the essential role of cognitive processes in the judgment and evaluation of life satisfaction, however, relatively little is known about the impact of cognitive abilities, especially executive functions (EF), on life satisfaction among aging individuals (Toh et al., 2019). EF refer to a set of cognitive-control processes that are responsible for goal-directed behaviors, emotions, and thoughts (Friedman & Miyake, 2017; Miller & Cohen, 2001). Previous studies have suggested that individual differences in EF can predict a wide range of key outcomes, such as occupational success, mental and physical health, and marital harmony (Diamond, 2013), all of which are pertinent to life satisfaction (E. Diener et al., 2018). This highlights the link between EF and life satisfaction.

In particular, past research suggests that EF are vital for older adults because of their cognitive decline with aging (Rhodes & Kelley, 2005) caused by progressive neural losses in the prefrontal cortex (e.g., white matter lesions and myelination; Raz & Rodrigue, 2006), an area that is closely associated with higher cognitive processes (Miyake et al., 2000). In a similar vein, Vaughan and Giovanello (2010) demonstrated that executive processes significantly predicted older adults' mobility outcomes (Gothe et al., 2014); cognitive function, as assessed by the Mini-Mental State Examination (Ng et al., 2007);

performance-based instrumental activities of daily living, which are closely associated to dementia (Barberger-Gateau et al., 1992); and transition from mild cognitive impairment to Alzheimer's disease (Halawa & Marshall, 2018). Together, these lines of evidence suggest that EF play a critical role in older adults' functional independence, adaptive cognitive adjustment, and mental lucidity (Johnson et al., 2007), all of which are important for successful aging and constitute the essence of life satisfaction in later adulthood. Consistent with this notion, studies found that despite age-related decline in EF for middle-aged and older adults (Rhodes & Kelley, 2005), those who retain better EF skills likely demonstrate better adaptability and adjustment to aging (Nieto et al., 2020; Puccioni & Vallesi, 2012) and thereby experience higher satisfaction with life (Toh et al., 2019).

In view of these findings, our goals are twofold. First, we set out to identify psychological factors that may indirectly mediate the relation between EF and life satisfaction in middle-aged and older adults. Scant research has focused on understanding this important underlying mechanism. Thus, we chose to examine coping strategies (i.e., active coping and behavioral disengagement) as mediating factors because they closely reflect core aspects of adaptive adjustment and successful regulation across different ages (Folkman & Lazarus, 1980; Murberg & Bru, 2001). Second, given that the importance of EF, as critical cognitive resources, likely varies with age (Nieto et al., 2020), we sought to investigate the moderating role of age in the mediational pathway between EF and coping.

Coping as a mediator

Coping refers to a person's cognitive and behavioral efforts to manage internal or external stressors that are perceived as taxing or exceeding their resources (Carver et al., 1989; Folkman, 1984). Considering the central importance of EF as cognitive resources (Miyake et al., 2000), there are several empirical findings that lend support for the mediating role of coping strategies in the relation between EF and life satisfaction.

The first line of evidence supports the pathway from EF to coping strategies. Given that EF are adaptive and goal-directed process, they likely affect people's choice and execution of coping strategies by influencing the primary appraisal of a stressor (Manera et al., 2014). For instance, it has been shown that EF substantially predict cognitive appraisals (for a review, see McRae et al., 2012), which are significantly correlated with coping strategies (Folkman et al., 1986; Parkes, 1984). Similarly, EF have been shown to be an important predictor of coping for patients with a variety of neurological conditions, such as posttraumatic brain injury (Krpan et al., 2007) and stroke (Kegel et al., 2014). This suggests the role of EF as a cognitive reserve, which has been shown to facilitate the resiliency of the brain in terms of its efficiency and flexibility (Steffener & Stern, 2012) despite brain damage or other adverse health conditions. In view of these findings, it is reasonable to believe that EF benefit coping by promoting planning, perspective taking, and cognitive flexibility, which are essential for adaptive and active coping strategies (Hofmann et al., 2012; Nieto et al., 2020).

The second line evidence supports the well-established pathway from coping to life satisfaction. Specifically, given that people who actively adopt coping strategies tend to overcome adversities and experience fewer negative emotions caused by stressors, studies have shown that coping is significantly associated with life satisfaction (Aldwin & Park, 2004; Sprague et al., 2011). Further, prior studies have suggested that coping predicts numerous life-satisfaction outcomes – e.g., relationship satisfaction (Herzberg, 2013); physical health (for a review, see Aldwin & Park, 2004); and other mental health outcomes (Rohde et al., 1990) – which are similarly predicted by EF. Together, considering this empirical evidence that highlights potential relations between EF, coping, and life satisfaction, we conjecture that EF likely influence coping strategies, which in turn modulate life satisfaction in middle-aged and older adults.

Of various coping strategies, we focused on two prevalent types as mediators: active coping and behavioral disengagement. Active coping, a problem-focused approach strategy, refers to the process of removing or circumventing stressors in a stepwise fashion (Carver et al., 1989). Prior studies suggest that EF skills are essential for active coping strategies, since active coping demands substantial cognitive resources (e.g., skills or knowledge) to facilitate goal prioritization, planning, conflict resolution, decision-making, obstacle overcoming, and, ultimately, the removal of stressors (Grech et al., 2016; Lazarus & Folkman, 1984). Specifically, given that EF comprise inhibition, updating, and shifting (Miyake et al., 2000), prior studies suggest that individuals with better updating (the ability to actively hold and manipulate information in working memory) are able to regulate their emotions by positively or neutrally appraising negative emotional experiences (Schmeichel et al., 2008). Inhibition (the ability to suppress irrelevant goals or instructions) is also necessary to actively repress prepotent impulses and habitual "mindless" behaviors that interfere with problem solving (Diamond, 2013). Shifting (the ability to switch back and forth between multiple goals or instructions) is expected to facilitate flexibility in switching between different frames of thinking or means and identifying one that best serves the goal (Miyake & Friedman, 2012). Considering that these aspects of EF are crucial for coping, it is plausible that well-controlled EF skills should facilitate life satisfaction by promoting problem-focused, approach-oriented active coping through proactive strategies to remove the stressor or to reduce its effects.

Another prevelant coping is behavioral disengagement, which refers to an avoidant strategy that manages the emotional distress from a stressor by giving up on goals or reducing efforts to deal with the stressor (Carver et al., 1989). Behavioral disengagement coping may be useful in the short term, especially for older adults who may not have sufficient cognitive resources to deal with a stressor but who are motivated to maintain positive affectivity and mitigate emotional distress (Fisher et al., 2003). As a result of the notable cognitive decline and increasingly prioritized emotional goals with age (Carstensen, 2006), older adults may be prone to adopt strategies of behavioral disengagement by downscaling their goals or aspirations in the face of challenges or constraints (Skinner et al., 2003). This notion is in line with socioemotional selectivity theory, which posits that older adults are more motivated to pursue and maximize satisfying socioemotional goals than knowledge-related goals (e.g., information acquisition or career planning; Carstensen, 2006), since they perceive the temporal/time horizon of mortality as more salient. However, relying on behavioral disengagement may not ultimately be adaptive or improve life satisfaction (Dijkstra & Homan, 2016), because although the strategy seems to be effective at temporarily reducing emotional tension and stress, it eventually gives rise to negative emotions such as incompetence or inferiority, which in turn adversely influence life satisfaction (Aldao, Nolen-Hoeksema & Schweizer, 2010). Hence, it is plausible that healthy, functioning older adults with high EF skills are less likely to engage in behavioral disengagement strategies in order to promote life satisfaction in the long run.

The present study

Existing research on EF and life satisfaction has two major drawbacks. First, past studies have not resolved the task-impurity issues that are inherent to most EF tasks (Miyake et al., 2000). EF tasks not only tap individuals' EF abilities but also non-EF abilities, such as the ability to read or discriminate colors. Given this, it is essential that we use a latent variable approach that allows us to statistically exclude idiosyncratic non-EF processes that are specific to individual EF tasks (Miyake et al., 2000). Second, although the three-factor model of EF – which comprises the separable but moderately related functions of updating, inhibition, and shifting – is the most widely aceepted theoretical model (Miyake et al., 2000), previous studies with older adults have failed to replicate the three-factor structure of EF. Instead, researchers suggest that either one-factor or two-factor models of EF fit older adults' data better (Adrover-Roig et al., 2012; Ettenhofer et al., 2006; De Frias et al., 2006; Hull et al., 2008). Thus, further research is needed to determine the factor structure of the construct of EF in middle-aged and older adults.

In view of these methodoglogical limitations, we employed a rigorous structural equation modeling and large batteries of EF to test its construct validity and examine the relations between EF and life satisfaction, while ruling out measurement errors. Specifically, our primary goal was to examine the mechanism that underlies the relation between EF and life satisfaction in middle-aged and older adults by focusing on two major coping strategies: active coping and behavioral disengagement. Further, given that EF skills have been deemed more critical for older adults than for middle-aged adults (Giogkaraki et al., 2013; Speer & Soldan, 2015), we aimed to examine the moderating role of age in the mediating relation between EF and life satisfaction via active coping and behavioral disengagement strategies. To address our goals, we analyzed data from a nationally representative adult cohort (aged 30 to 84) from the Midlife Development in the United States 2 study (MIDUS 2; 2004 to 2006; Brim et al., 2004). We controlled for a wide range of common covariates (e.g., gender, depression/anxiety, health status, and positive and negative affective states) in testing our hypothesized modes.

Methods

Participants

We analyzed data from the MIDUS 2 study (Brim et al., 2004), which sampled over 5,000 American adults across 48 states using random digit dialing (Brim et al., 2004). Of these participants, a subset of 4,512 participants was recruited to be part of the cognitive project, in which participants completed a comprehensive battery of cognitive tasks (Ryff et al., 2017; Ryff & Lachman, 2017). The cognitive tasks were verbally administered to respondents over a 30-minute phone interview. The self-administered questionnaires were mailed to respondents. For the purpose of a cleaner analysis, we use the inclusion criteria of Toh et al. (2019): (a) complete EF responses; (b) trials without technical malfunctions, distraction from external events, or failure to follow instructions; and (c) at least 75% accuracy in the switch task. Accordingly, we analyzed data from 3,287 adults (ages 32–84 years; M_{age} = 56.04, *SD* = 12.18) who met the above inclusion criteria and had complete demographic, psychosocial, physical, and mental health information. We controlled for several common covariates (e.g., gender, health, depression/anxiety, and positive and negative affective states) that have been shown to influence coping strategies, assessment of life satisfaction, and EF (Palmore & Luikart, 1972; see Table 1 for descriptive statistics and zero-order correlations).

Table 1. Descriptive statistics and correlation for main variables

	M	SD	1	2	3	4	5	6	7	8	9
1. Executive functions	0.00	0.51	-	-	-	-	-	-	-	-	-
2. Active coping	3.14	0.54	.08**	-	-	-	-	-	-	-	-
3. Behavioral disengagement	1.71	0.56	−.23***	−.46***	-	-	-	-	-	-	-
4. Life satisfaction	7.65	1.14	.02	.39***	−.32***	-	-	-	-	-	-
5. Age	56.04	12.18	−.54***	.05*	.14***	.17***	-	-	-	-	-
6. Gender[1]	0.46	0.50	.13***	−.05*	−.15***	−.01	.03	-	-	-	-
7. Depression/ anxiety[2]	0.18	0.39	−.06**	−.10***	.21***	−.30***	−.05**	−.16***	-	-	-
8. Health[3]	0.77	0.42	−.17***	−.05*	.10***	−.15***	.21***	−.08***	.26***	-	-
9. Positive affect	3.58	0.75	−.01	.42***	−.31***	.61***	.13***	.02	−.31***	−.14***	-
10. Negative affect	1.53	0.51	.01	−.22***	.29***	−.53***	−.19***	−.07***	.39***	.15***	−.46***

Note. A higher score denotes a higher level in each dimension. *$p < .05$, **$p < .01$, ***$p < .001$.
[1]Gender (1 = Male, 0 = Female)
[2]Depression/anxiety is a binary variable with 1 indicating having experienced or been treated for depression/anxiety or other emotional disorder and 0 its absence.
[3]Health status is a binary variable with 1 indicating the presence of chronic illness and 0 its absence.

Measures

Executive functions (EF). The four tasks of the Brief Test of Adult Cognition by Telephone and the Stop and Go Switch Task (SGST) were chosen as meausres of EF (Lachman et al., 2010). These tasks are described below.

The digit span backward was used to index updating. Participants heard a series of numbers and were asked to repeat them backward. The maximum number of digits recalled up to eight was recorded. The category fluency task, which required participants to produce as many words as possible from each category within 60 seconds, indexed verbal ability and processing speed (Drachman & Leavitt, 1972). The backward counting task assessed participants' speed of processing by computing the total number of correctly reported items in counting backward from 100. In the number series task, participants were asked to infer the next number in strings of number (e.g., 2, 4, 6, 8; the next is 10). The total number of correct answers was recorded.

The SGST assessed inhibitory control and task-switching. The task contained two single-task blocks and one mixed-task block. The first block of congruent (normal) trials required participants to answer "stop" and "go" in response to the vocal cue of "red" and "green," respectively. The second block of incongruent (reversed) trials required participants to reverse their answers by saying "go" and "stop" in response to "red" and "green," respectively. In the third mixed-task block of both congruent and incongruent trials, participants responded based on the vocal cue of "normal" and "reverse." Participants' inhibition was indexed using the difference in reaction time (RT) between the incongruent trials and the congruent trials. Switching was indexed using the difference in mean RT on switch and non-switch trials in the mixed-task block.

Active coping. Active coping was assessed using a 4-item scale by Carver et al., 1989). Participants were asked to rate the extent to which they devoted effort to directly resolving a problem (e.g., "I take direct action to get around the problem."). These items were measured on a 4-point scale (1 = *a lot*, *4* = *not at all*). All of the items in the scale were reverse-coded, with higher scores denoting greater usage of active coping ($\alpha = .75$).

Behavioral disengagement. Behavioral disengagement was assessed using a 4-item scale (Carver et al., 1989). Participants were asked to rate the extent to which they put less effort into tackling a problem (e.g., "I reduce the amount of effort I'm putting into solving the problem.") from 1 (*a lot*) to 4 (*not at all*). All of the items in the scale were reverse-coded, with higher scores denoting greater usage of behavioral disengagement ($\alpha = .73$).

Life satisfaction. A six-item scale (Prenda & Lachman, 2001) was used to measure life satisfaction. Each item asked participants to rate how satisfied they were with their overall life, work, health, finances, relationship with spouse/partner, and relationship with children at present on an 11-point scale (0 = *the worst possible*, 10 = *the best possible*). Higher mean scores on each facet of life satisfaction denote higher levels of overall life satisfaction ($\alpha = .73$).

Positive and Negative Affective Schedule (PANAS). Given that subjective well-being has been conceptualized to consist of affective (positive and negative affect) and cognitive (i.e., life satisfaction) dimensions, which are related but partially independent of each other (Lucas et al., 1996), we measured positive and negative affect as a covariate to more precisely estimate the relation between coping strategies and life satisfaction. Nine items were used to assess the experience of positive (active, attentive, enthusiastic, and proud) and negative (afraid, ashamed, irritable, jittery, and upset) emotions over the previous 30 days (Mroczek & Kolarz, 1998) on a 5-point scale (1 = *all of the time*, 5 = *none of the time*). Responses were reverse-coded to calculate mean scores for corresponding items, with higher scores indicating positive affectivity and negative affectivity, respectively.

Health. Given that EF have been shown to relate differently to coping strategies in healthy cohorts (O'Rourke et al., 2020) versus unhealthy ones (Kegel et al., 2014; Krpan et al., 2007), we assessed health as a covariate using a single item that asked about any chronic conditions the individual experienced in the previous 12 months (1 = *having at least one chronic condition*; 0 = *not having any chronic conditions*). Overall, 77.1% of the sample reported at least one chronic health condition, while 22.9% of the sample did not report any chronic condition.

Depression/anxiety. We selected depression/anxiety as a covariate since prior studies have suggested that depression changes the associations between coping strategies, EF, and life satisfaction (Morris et al., 2015; Reppermund et al., 2011). Depression/anxiety was assessed using a single item that asked whether the individual experienced or was treated for conditions such as anxiety, depression, or another emotional disorder in the previous 12 months (1 = *yes*; 0 = *no*). 18.1% of the sample reported having experienced or been treated for depression/anxiety, while 81.9% of the sample reported that they had not.

Results

We conducted structural equation modeling using Mplus 8.4 (Muthen & Muthen, 1998) with maximum likelihood estimation. EF, active coping, behavioral disengagement, and life satisfaction were modeled as latent variables. Indicators for the latent variables of active coping, behavioral disengagement, and life satisfaction were scale items, whereas the five EF tasks (i.e., Z scores) served as indicators for the latent variable of EF (Khoo & Yang, 2020). To ensure that the indicators represented their intended latent constructs, we conducted confirmatory factor analysis to evaluate their respective measurement models (see Figure A1 in the Appendix). Missing values for covariates and dependent measures were imputed using a reliable multiple imputation technique that involved a two-stage iterative algorithm based on a Bayesian estimation method (Sinharay, Stern & Russell, 2001).

Following this, we fitted the structural equation model to determine whether the relation between EF and life satisfaction was mediated in parallel by the two coping strategies (active coping and behavioral disengagement). We tested the unadjusted structural equation model first without any covariates and then adjusted the model by adding covariates (gender, health, depression/anxiety, and positive and negative affective states) to control for their potential effects. Model fit indices for all measurement and structural (i.e., parallel mediation) models were evaluated based on Hu and Bentler's (Hu & Bentler, 1999) criteria: confirmatory fit index (CFI) > 0.95; root mean square error of approximation (RMSEA) < 0.05, and standardized root mean square residual (SRMR) < 0.08. All reported path coefficients are standardized estimates that are indicative of effect sizes.

Lastly, we performed a moderated mediation analysis to examine whether the parallel mediation between EF and life satisfaction was conditional on participants' age. As Mplus 8.4 does not generate traditional model fit indices to evaluate the interaction term, we relied on log-likelihood values and informational criteria, such as the Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample-size adjusted BIC (Wang & Wang, 2020); note that smaller information criteria indicate a better model fit to the data.

Measurement models

We first tested the measurement model for EF. In line with studies that suggest using either a one-factor or a two-factor model of EF for older adults (Adrover-Roig et al., 2012; Ettenhofer et al., 2006; De Frias et al., 2006; Hull et al., 2008), we tested whether a unidimensional construct of EF versus a two-factor model – comprising two latent factors (i.e., processing speed and updating) – would fit the data better (see Table 2 for model fit indices). We found that both measurement models of EF had excellent fit to the data with significant factor loadings for all five cognitive tests, $p < .001$, but the one-factor model had smaller AIC and BIC, indicating a better-fitting and more parsimonious model of EF for middle-aged and older adults. Hence, we chose the one-factor model of EF for our subsequent structural equation analysis.

Table 2. Fit indices for measurement and structural models

	χ2	*df*	RMSEA	CFI	SRMR	AIC	BIC	Adjusted BIC
Measurement models								
Active coping	9.06**	1	0.05	1	0.01			
Behavioral disengagement	12.18**	2	0.04	1	0.01			
Life satisfaction	13.05*	4	0.03	1	0.01			
Executive functions (EF)								
One-factor model	24.02***	3	0.05	1	0.01	43,678.02	43,781.68	43,727.66
Two-factor model[1]	118.52***	4	0.09	0.96	0.03	43,770.51	43,868.07	43,817.23
Full measurement model	522.99***	138	0.03	0.97	0.03	169,877.47	170,310.41	170,084.81
Structural model								
Parallel mediators	1099.12***	218	0.04	0.94	0.04	168,159.96	168,684.36	168,411.10
Moderated mediation	-	-	-	-	-	169,830.49	170,287.82	170,049.51

Note. [1]The two-factor EF consists of two latent factors. The first factor is based on number series, digit backward, and stop and go switch task and the second factor is based on category fluency and backward counting. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

We found that our measurement models for active coping and behavioral disengagement had good model fit to the data. All corresponding scale items loaded as significant indicators, $p < .001$ (see Table 2 for model fit indices; Figure A1 in the Appendix for factor loadings). Lastly, the measurement model for life satisfaction also showed a good fit, with significant factor loadings, $p < .001$. Consistent with our conceptualization of life satisfaction as a person's quality of life as a whole (Pavot & Diener, 1993), our latent variable of life satisfaction indicates a domain-general evaluation of life satisfaction since it reflects common variance statistically extracted from specific evaluations of major life domains (i.e., work, health, financial situation, relationship with children, current marriage/relationship, overall life satisfaction). Finally, the full measurement model with the predictor, mediators, and outcome variable had excellent model fit. The fit of the overall measurement model was good, $\chi^2(138) = 522.99$, $p < .001$, RMSEA = .03, SRMR = .03, CFI = .97.

Structural model

In line with our hypothesis, we found a significant indirect effect of EF on life satisfaction through active coping (β = .02, *SE* = .004, *p* = .001) such that EF positively predicted active coping (β = .11, *SE* = .02, *p*< .001), which, in turn, positively predicted higher life satisfaction (β = .13, *SE* = .03, *p*< .001; see Figure 1; for adjusted and unadjusted models, see Figures A2 and A3 in Appendix). Similarly, we found a significant indirect effect of EF on life satisfaction through behavioral disengagement (β = .01, *SE* = .01, *p = .04*). Specifically, EF negatively predicted behavioral disengagement (β = −.22, *SE* = .02, *p*< .001), which then negatively predicted life satisfaction (β = −.05, *SE* = .02, *p*= .04). We found that both coping strategies fully mediated the relationship between EF and life satisfaction.

Moderated mediation model

Next, we performed a first-stage moderated mediation analysis to examine whether age moderated the mediational pathway of EF to life satisfaction through active coping and behavioral disengagement (See Figure 2). We found a significant interaction effect between age and EF on active coping (β = .03, *SE* = .01, *p*< .001), which suggests that the relation between EF and active coping varied as a function of age. When the Johnson-Neyman procedure was employed to probe this interaction further by determining the significance region for the slope of EF that predicts active coping, the positive relation between EF and active coping was significant in those older than 44.14 years (−.98 *SD*), but not among younger participants. These results highlight the stronger relationship between EF and active coping in middle-aged and older adults than in younger adults.

Figure 1. Structural equation model for the relation between executive functions (EF) and life satisfaction (LS). circles represent latent variables. rectangles represent indicators (manifest variables). values for long single-headed arrows signify factor loadings, which are all significant at the .05 level. DB = Digit Backward, CF = Category Fluency, BC = Backward Counting, NS = Number Series, SGST = Stop and Go Switch Task, AC = Active Coping and BD = Behavioral Disengagement. all bolded statistics are statistically significant at the .05 level. there is a correlation between residual error variances of AC and BD

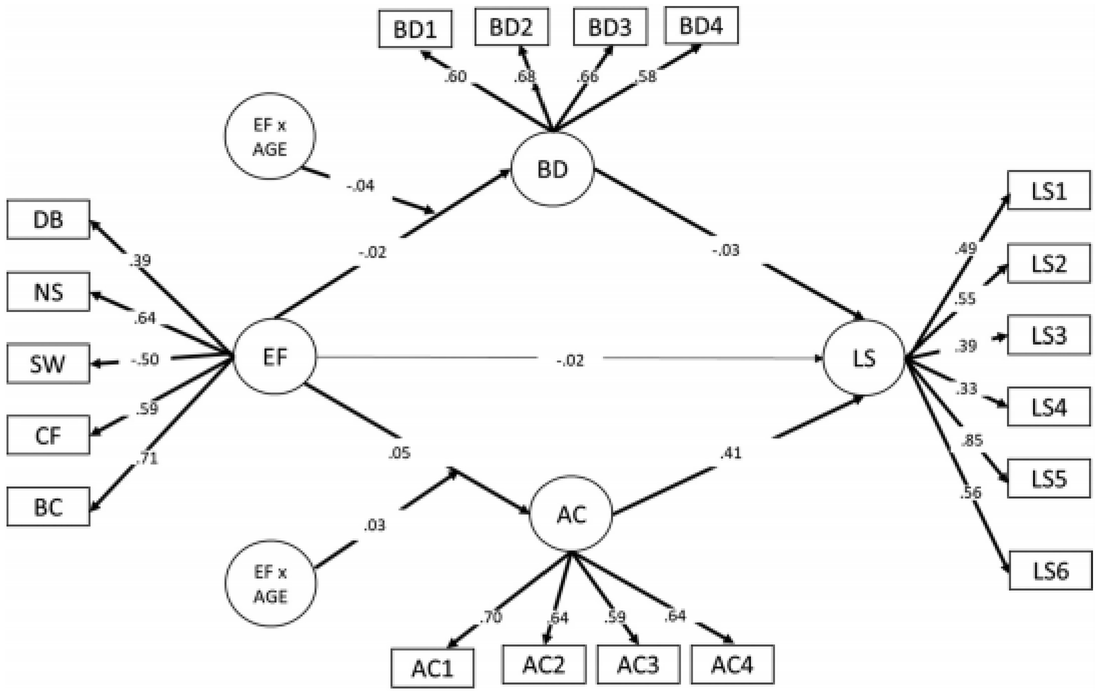
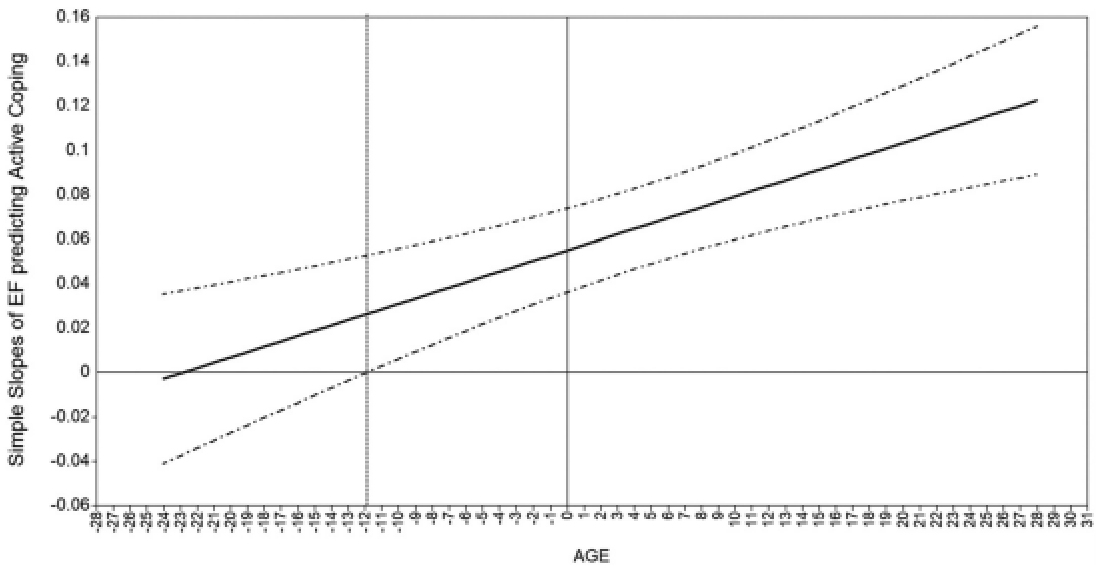
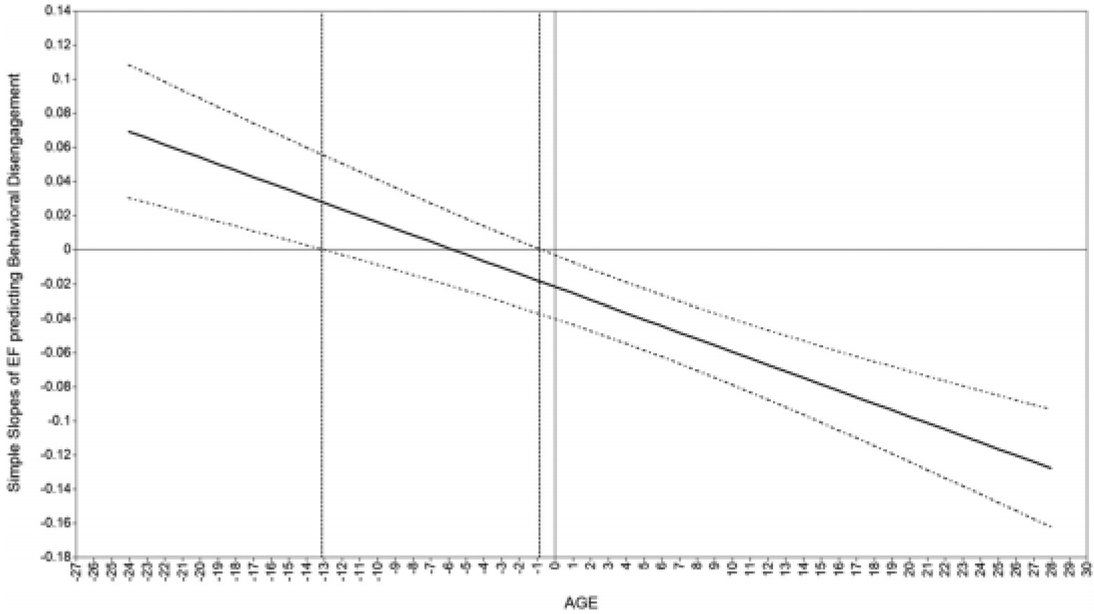


Figure 2. This Johnson-Neyman plot illustrates how the simple slope of EF that predicts active coping (represented by the solid line, with dash-dot lines indicating 95% confidence intervals) varies across values of mean-centered age, which ranges between −24.04 (−1.97 *SD; 32 years*) and +27.96 (+2.30 *SD; 84 years*). The influence of EF on active coping was significantly positive at 44.14 years (−.98 *SD*) and above, as indicated by the vertical dashed line



Similarly, our analysis revealed significant interaction effects of age and EF on behavioral disengagement (β = −.04, *SE* = .01, *p*< .001; see Figure 3). When the Johnson-Neyman procedure was used to probe simple slopes for the relation between EF and behavioral disengagement at various ages, we found that the negative relation between EF and behavioral disengagement was significant in those aged 42.84 years and younger (−1.08 *SD*) and in those 55.14 years and older (−0.07 *SD*), but not between those years. More specifically, the effect of EF on behavioral disengagement was positive in adults aged 55.14 years and above, while this effect was reversed in those aged 42.84 years and younger.

Figure 3. This Johnson-Neyman plot illustrates how the slope of EF that predicts behavioral disengagement (represented by the solid line, with dash-dot lines indicating 95% confidence intervals) varies across ages between which ranges between −24.04 (−1.97 *SD; 32 years*) and +27.96 (+2.30 *SD; 84 years*). At ages 55.14 years and above (−.07 *SD*) and 42.84 years and below (−1.08 *SD*), as indicated by the vertical dashed line, the effect of EF on behavioual disengagement is significant



Discussion

Using a large sample of middle-aged and older adults, a comprehensive battery of EF measures, and a robust latent variable approach, we observed four major findings. First, we found that EF indirectly predicted life satisfaction when key covariates (i.e., age, gender, health, depression/anxiety, and positive and negative affective states) were taken into consideration. These results are consistent with the prevailing view that the evaluation of life satisfaction has cognitive underpinnings (Pavot & Diener, 2008).

Second, consistent with our hypothesis, we found that active coping and behavioral disengagement mediated the relation between EF and life satisfaction. Specifically, EF facilitate active coping, which in turn engenders greater life satisfaction; in contrast, EF restrain the use of behavioral disengagement, which lowers life satisfaction. Given that EF facilitate a goal-directed action repertoire, individuals with greater EF can be more proactive in altering a situation or circumventing a problem, and thereby experience greater life satisfaction. In the same vein, individuals with higher EF are less likely to adopt behavioral disengagement, because it ultimately results in an unfulfilled life if unresolved problems persist and plague an individual over a long period – even though disengaging from challenging goals might provide temporary respite from a stressor. These results corroborate previous findings on the positive association between working memory and life satisfaction in young adults (Pe et al., 2013). Further, our findings are in line with those of Morris et al. (2015), whereby less engagement with primary control coping (e.g., problem-solving) and greater disengagement coping contributed to more depressive symptoms, which have been shown to be negatively associated with life satisfaction (Weisz et al., 2010). Additionally, given that Toh et al. (2019) highlighted the mediating role of sense of control in the relationship between EF and life satisfaction in middle-aged and older adults, our study elucidates another prominent mediating factor – i.e., approach versus avoidant coping strategies.

Our third major finding is that age significantly moderated the mediational pathways from EF to coping strategies. Specifically, the relation between EF and active coping was significantly positive in middle-aged and older adults, but not in younger adults. These findings suggest that the implications of EF for different kinds of coping strategies vary with age. Our finding that EF enhances active coping was, in part, consistent with previous findings. Specifically, Villegas and Cruz (Rodríguez Villegas & Salvador Cruz, 2015) found a positive relationship between the flexible organization of EF and self-reported levels of purposeful, active, and highly focused problem solving in healthy middle-aged (43 to 52 years old) adults.

On the other hand, the negative (i.e., beneficial) effect of EF on behavioral disengagement was only apparent in older adults with better EF abilities, and this effect disappeared in middle-aged adults and was reversed in younger adults. Even though these findings seemingly contrast with those of prior studies that suggest that better performance on EF tasks is associated with less disengagement coping (Campbell et al., 2008; Morris et al., 2015), some other studies also yield a reverse pattern for the younger population. Specifically, Hocking et al. (2010) found that among youths, higher EF and selective attention predicted significant usage of disengagement coping. Nieto et al. (2020) also found that when executive functioning, short-term memory, and coping strategies among young and old healthy adults were compared, younger adults with higher EF than older adults reported greater usage of avoidance strategies (such as behavioral disengagement) in their daily lives. Overall, the negative relationship between EF and behavioral disengagement merits further examination. Taken together, our findings suggest that EF serves as a buffer against lowered life satisfaction among older adults who tend to experience cognitive decline (e.g., Kray & Lindenberger, 2000) by reducing stressors and the likelihood of down-scaling goals and aspirations when facing difficult circumstances.

Fourth, our findings contribute to reconciling the mixed findings regarding the relationship between EF and life satisfaction, which is an aspect of subjective well-being. For instance, Pe et al. (2013) found that updating positively valenced information in working memory is positively associated with subjective well-being. However, McRae et al. (2012) did not find a significant correlation between subjective well-being and the three components of EF (working memory, shifting, and inhibition) in younger adults. Our results shed light on discrepant findings. Given that previous studies relied on a single measure of EF and thus were unable to control for measurement errors, our usage of a latent EF variable based on multiple EF tasks highlights the importance of addressing the task-impurity problem in studying the relationship between EF and life satisfaction.

Our study is not without limitations. First, although the study's cross-sectional design reveals the mediating role of coping strategies in the relation between EF and life satisfaction, the lack of longitudinal analysis could limit causal inferences. That is, although individuals with high EF skills are likely to experience enhanced life satisfaction through better coping strategies, it is also possible that those who are more satisfied with their life experiences are more motivated to adopt better coping strategies to deal with stressors, which consequently improves executive functioning. Hence, a longitudinal study with a cross-lagged design is needed to delineate the exact causal direction among EF, coping strategies, and life satisfaction.

Second, given that our study focused on active versus behavioral disengagement coping strategies in particular, caution should be taken when generalizing these findings to related approach or avoidant coping strategies (e.g., planning versus denial). Given that coping strategies demand different degrees of cognitive resources, it is important to carefully interpret the contribution of EF to broader types of problem-focused or emotion-focused coping strategies.

Third, regarding the theoretical structure of EF, our data support a unidimensional construct of EF over a two-factor model (Adrover-Roig et al., 2012; Hull et al., 2008). Our findings align with the de-differentiation hypothesis, wherein neurodegenerative processes that occur during old age lead to an increased correlation among latent factors. Consistent with our results, de Fries et al. (De Frias et al., 2006) found evidence for a single factor model represented by both shifting and inhibition across different age groups and gender. Ettenhofer et al. (2006) also demonstrated a single latent EF (with five tasks that subsumed working memory, switching, and inhibition) in older adults across two time points over a 4- to 8-week period, suggesting a notable stability in the single-factor construct of EF over time. However, given that we used a limited number of EF tasks and thus were unable to test the three-factor model, it is essential that future studies administer a wider range of EF tasks to determine the precise factor structure of EF in older adults and capture the contribution of these factors to various coping strategies and life satisfaction in middle-aged and older adults.

In sum, given that healthy aging is a pertinent issue around the world, researchers have sought to identify key psychological factors that delay cognitive decline and thus contribute to life satisfaction in older adults. Although EF – as an essential cognitive construct that serves as a buffer against cognitive aging – has received a substantial amount of attention from researchers, little is known about the mechanism that underlies the beneficial effects of EF on life satisfaction. Our study is the first to emphasize the use of a healthy coping strategy in mediating the relation between EF and life satisfaction while limiting the use of a maladaptive coping strategy in middle-aged and older adults. Our findings open a promising new avenue for further research, while having important practical and clinical implications for aging policy and intervention programs that aim to improve life satisfaction in the aging population.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix

Figure A1. Individual measurement models of executive functions (EF), active coping (AC), behavioral disengagement (BD), and life satisfaction (LS) with standardized estimates. Circles represent latent variables. Rectangles represent indicators (manifest variables). Values for long single-headed arrows signify factor loadings and those for short single-headed arrows represent error variances. Values for curved, double-headed arrows indicate inter-factor correlations. DB = Digit Backward, CF = Category Fluency, BC = Backward Counting, NS = Number Series, SGST = Stop and Go Switch Task. All bolded statistics are statistically significant at the .05 level

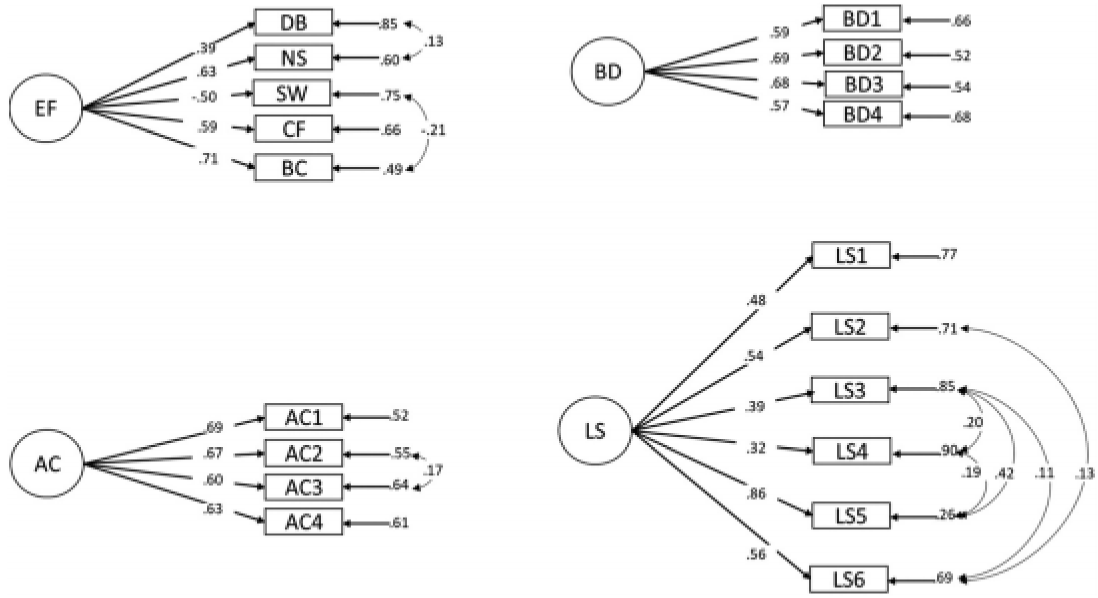

Figure A2. An adjusted structural equation model for the relation between executive functions (EF) and life satisfaction (LS). Circles represent latent variables. Rectangles represent indicators (manifest variables). Values for long single-headed arrows signify factor loadings, which are all significant at the .05 level. DB = Digit Backward, CF = Category Fluency, BC = Backward Counting, NS = Number Series, SGST = Stop and Go Switch Task, AC = Active Coping and BD = Behavioral Disengagement. All bolded statistics are statistically significant at the .05 level. There is a correlation between residual error variances of AC and BD.

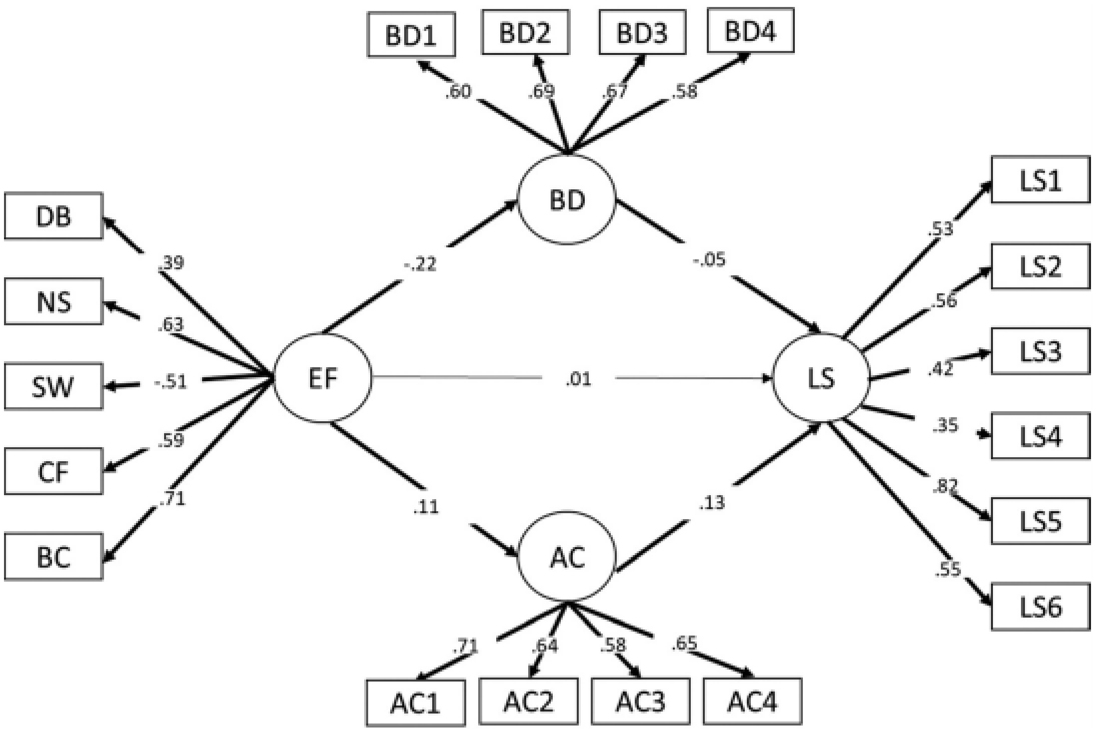

Figure A3. An unadjusted structural equation model for the relation between executive functions (EF) and life satisfaction (LS). Circles represent latent variables. Rectangles represent indicators (manifest variables). Values for long single-headed arrows signify factor loadings, which are all significant at the .05 level. DB = Digit Backward, CF = Category Fluency, BC = Backward Counting, NS = Number Series, SGST = Stop and Go Switch Task, AC = Active Coping and BD = Behavioral Disengagement. All bolded statistics are statistically significant at the .05 level. There is a correlation between residual error variances of AC and BD.