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Sadness, but not anger or fear, mediates the long-term leisure-cognition link: an emotion-specific approach

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ABSTRACT

Past research has provided some evidence of positive relationships between leisure and cognitive functioning, but questions remain regarding their mechanisms. We argue that specific negative emotions may provide promising theoretical mechanisms for the leisure-cognition link. Guided by theories of leisure and emotion-specificity, we used a large-sample, longitudinal dataset of adult participants ($N = 3536$; 1940 females; $M_{age} = 56.16$) to examine the leisure-cognition link over about a decade and to test whether sadness, anger, or fear would be supported as emotion-specific mediators of the leisure-cognition link. Analyses were performed using observed variable path analyses and latent variable structural equation modelling. Controlling for demographics (age, gender, education level) and baseline cognitive functioning, leisure predicted better episodic memory and executive function a decade later. Moreover, both observed variable and latent variable mediational analyses supported sadness as a mediator of the link between leisure and episodic memory as well as executive function, such that leisure predicted reduced sadness, in turn predicting improved cognitive functioning. In contrast, neither fear nor anger were supported as mediators of the leisure-cognition link. Thus, the results support long-term links between leisure and cognitive functioning and also support sadness as an emotion-specific mediator of these relationships.

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Leisure activities have been linked to cognitive benefits (Singh-Manoux et al., 2003), and some evidence suggests that affective mediators could explain the leisure-cognition link (Power et al., 2018). However, unanswered questions remain regarding whether these relationships would be supported in the long term, and the precise role that specific emotions may play remains unclear. While emotion researchers have argued for the theoretical importance of emotion-specificity (Lerner & Keltner, 2000), few studies have examined its relevance in naturalistic settings. In the present research, we address these gaps in the literature by examining (1) whether leisure reliably predicts long-term cognitive functioning a decade later even after accounting for baseline cognitive functioning, and (2) whether specific negative emotions (sadness, anger, or fear) would mediate the link between leisure and long-term cognitive functioning.

Empirical evidence largely shows that leisure activities are beneficial for cognitive functioning. For example, physical, cognitive, as well as social leisure activities are linked to various cognitive benefits such as improved memory and reduced risks of late-life cognitive dysfunctions (Dregan & Gulliford, 2013; Litwin et al., 2016; Wang et al., 2002). However, while research suggests that leisure activities are beneficial for cognitive functioning, analyses explaining why this is the case are less forthcoming. As leisure activities are fundamentally affective in nature (e.g. Fullagar, 2008; Wang & Wong, 2013), emotions may provide especially promising mechanisms for explaining the general benefits of leisure on cognitive functioning. Indeed, some evidence suggests that the relationship between leisure activities and cognitive functioning assessed two years later was mediated by lower levels of perceived

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stress rather than by improvements in biological vascular functions (Power et al., 2018).

However, the explanatory power of such affective mediators over a longer time period remains unclear. Moreover, perceived stress is highly conflated with negative emotions and is vague about the specific negative emotions which are at work. Indeed, there is evidence that specific negative emotions may differentially affect cognitive functioning—for example, some experimental work suggests that cognitive deficits are caused by anxiety but not anger (Shields et al., 2016). Examining specific rather than global negative emotions would hence provide more nuanced findings concerning the affective mechanisms involved in the leisure-cognition link. While leisure could also promote positive emotions (Wang & Wong, 2013), positive emotions have been linked primarily to creativity rather than cognitive functions (Phillips et al., 2002), and positive emotions have also often been found to encourage simplistic cognitive processes (Bodenhausen et al., 1994), which suggests that they should be less relevant as potential mediators of the leisure-cognition link. In the present paper, we hence focussed on comparing three naturalistically experienced negative emotions—sadness, anger, and fear—as possible emotion-specific mediators of the leisure-cognition link over about a decade. These three negative emotions are basic emotions which underlie most of the negative emotions that people have in daily life (Ekman, 1992) and are thus of practical relevance.

Guided by appraisal theory, clear distinctions can be made between these three negative emotions in their appraisal profiles (Moors et al., 2013), which allow more precise predictions to be made in relation to leisure and cognitive functioning. Specifically, sadness is a highly self-focused negative emotion (Wood et al., 1990) involving appraisals of uncontrollability and powerlessness (Roseman et al., 1990). While fear also involves losses in control and powerlessness, attentional focus is externally directed towards sources of threat (Lerner & Keltner, 2001), and appraisals of unpredictability are also heightened in experiences of fear (Roseman et al., 1990). Finally, anger is predominantly an externally focussed negative emotion in which aspects of one's circumstances are appraised as unjust, although contrary to sadness and fear, anger experiences typically inflate perceptions of control and power (Levine, 1996; Roseman et al., 1990).

Complementing the distinctions between sadness, anger, and fear made by appraisal theory, theories of leisure enable clearer predictions about whether leisure may be more likely to alleviate certain specific negative emotions over others. For example, Kleiber et al. (2002) conceptualised leisure as a resource that protects the self from the debilitating effects of negative life events, restores the self's sense of optimism and control, and promotes transformation of the self towards growth. Other researchers have provided similar conceptualizations of leisure activities as resources that allow self-development (Tinsley & Eldredge, 1995) and personal growth (Heo et al., 2017). In other words, leisure has psychological benefits which are uniquely focussed towards promoting positive appraisals of the self. Frequent engagement in leisure activities should therefore promote behavioural and psychological contexts which enhance positive self-appraisals that are antithetical to the negative self-appraisals implicated in sadness (e.g. Roseman et al., 1990), thus in turn reducing experiences of sadness. Indeed, sadness is the prototypical emotion implicated in depressive states, which leisure provides adaptive buffers against (Lu, 2011; Pressman et al., 2009).

In contrast, to the extent that leisure primarily functions by restoring positive appraisals of the self, its role in alleviating fear and anger may be weaker given that these emotions more strongly involve appraisals that are directed externally rather than internally. Indeed, while fear also involves appraisals of uncontrollability and helplessness which leisure could alleviate via its self-restorative functions, appraisals of threat caused by an external agent are also implicated in fear (e.g. Lerner and Keltner, 2001), for which there are less theoretical bases to make predictions regarding leisure. Finally, anger is overwhelmingly an outward-focused emotion experienced when one's circumstances are appraised as being unjust or wrong, and positive self-appraisals can also be heightened in anger. Thus, the appraisal profiles of anger show no clear links to the functional properties of leisure which promote positive self-appraisals, and existing theories do not support predictions that leisure would reduce anger.

While state negative emotions can occasionally have cognitive benefits (e.g. Harmon-Jones et al., 2013), prolonged experiences of negative emotions in daily life are generally detrimental to cognitive functions (e.g. Curci et al., 2013; Lupien et al., 1999), though the extent to which different specific negative emotions influence cognitive functioning may differ (Biringer et al., 2005). In particular, existing evidence suggests that the specific negative emotion of sadness should have the clearest links to cognitive functioning. For example, given that sadness involves negative self-appraisals of helplessness and loss of control, experiences of sadness reduce motivational intensity and increase withdrawal tendencies, which should lead to a deactivation of attentional and cognitive functions that serve motivational purposes (Harmon-Jones et al., 2013). Furthermore, appraisals of uncontrollability in sadness may be linked to impairments in cognitive control (Nixon et al., 2013) and naturalistic depressive states involving sadness are indeed associated with poorer cognitive outcomes (Danhauer et al., 2013; Wei et al., 2019). Leisure, by reducing sadness, should thus counteract these processes and facilitate better cognitive outcomes.

Although there is some evidence that fear-related states like anxiety could impair cognition experimentally (Shields et al., 2016), more naturalistic examinations have not supported this (Biringer et al., 2005). Furthermore, while fear has commonly been linked to impairments in aspects of cognitive processing (Eysenck et al., 2007), researchers have argued that the appraisals of external threat involved in fear may also elicit strategies that compensate for these effects and lead to adaptive cognitive processes (Robinson et al., 2013). Indeed, both fear and anger are motivationally intense negative states in which appraisals of external agency are heightened, which could narrow attentional focus and improve cognitive functions required to address fear-inducing or anger-inducing stimuli within one's environment (Harmon-Jones et al., 2013). Naturalistic examinations of how anger influences cognitive functioning have rarely been done, though some evidence indicates that state anger does not impair cognitive functions (Shields et al., 2016). Given these findings, there are no theoretical reasons to expect links between anger and cognitive functioning, while perspectives regarding fear are inconsistent and do not permit clear predictions.

Summarising the above theoretical considerations, three primary hypotheses could be made. Firstly, consistent with past work on leisure and cognitive functioning, leisure should predict better long-term episodic memory and executive function even after accounting for baseline cognition. Secondly, guided by theories of emotion-specificity, sadness should mediate the leisure-cognition link, such that leisure would predict reduced experiences of sadness, which would in turn predict better cognitive functioning. Thirdly, existing theoretical considerations do not support links between leisure and anger or between anger and cognitive functioning, and hence, we expect that anger would not mediate the leisure-cognition link. Finally, theoretical support for whether fear might mediate between leisure and cognitive functioning is unclear and therefore, we make no a priori predictions pertaining to fear and simply examine in an exploratory manner whether fear would be a possible mediator. To test the above predictions, we used a large-scale dataset from the Midlife Development in the United States (MIDUS) study to perform longitudinal analyses of whether leisure would predict cognitive functioning in the long-term as well as whether this would be mediated by sadness, anger, or fear.

Method

Respondents

Data for this study were obtained from the Midlife Development in the United States (MIDUS) study, a multi-phase longitudinal study which drew from a nationally representative random-digit-dial sample of respondents from the United States. For our analyses, data from the MIDUS2 Main Survey and MIDUS2 Cognitive Project, which were conducted between 2004 and 2006, served as the first time point (T1). Respondents first completed a phone interview, followed by a questionnaire they received via mail. Subsequently, starting from approximately two weeks later, cognitive measures were administered via the phone by trained cognitive interviewers. Respondents who completed these measures in MIDUS2 received a US$60.00 incentive. Data from the MIDUS3 Main Survey and MIDUS3 Cognitive Project, which were conducted between 2013 and 2014, served as the second time point (T2). Much like the preceding wave, respondents first completed a phone interview and a questionnaire received via mail before being contacted approximately two weeks later for cognitive tests that were administered over the phone by trained interviewers. Respondents who completed MIDUS3 received US$62.00 as incentive. The temporal order of the variables assessed in MIDUS2 and MIDUS3 are presented in Figure 1. In total, data at T1 was available for 3536 participants (1940 females; $M_{age} = 56.16$, $SD_{age} = 12.26$, age range: 32–84 years), though there was substantial attrition. Out of 3536 participants available at T1, 2256 had complete data for main effects analyses while 1966

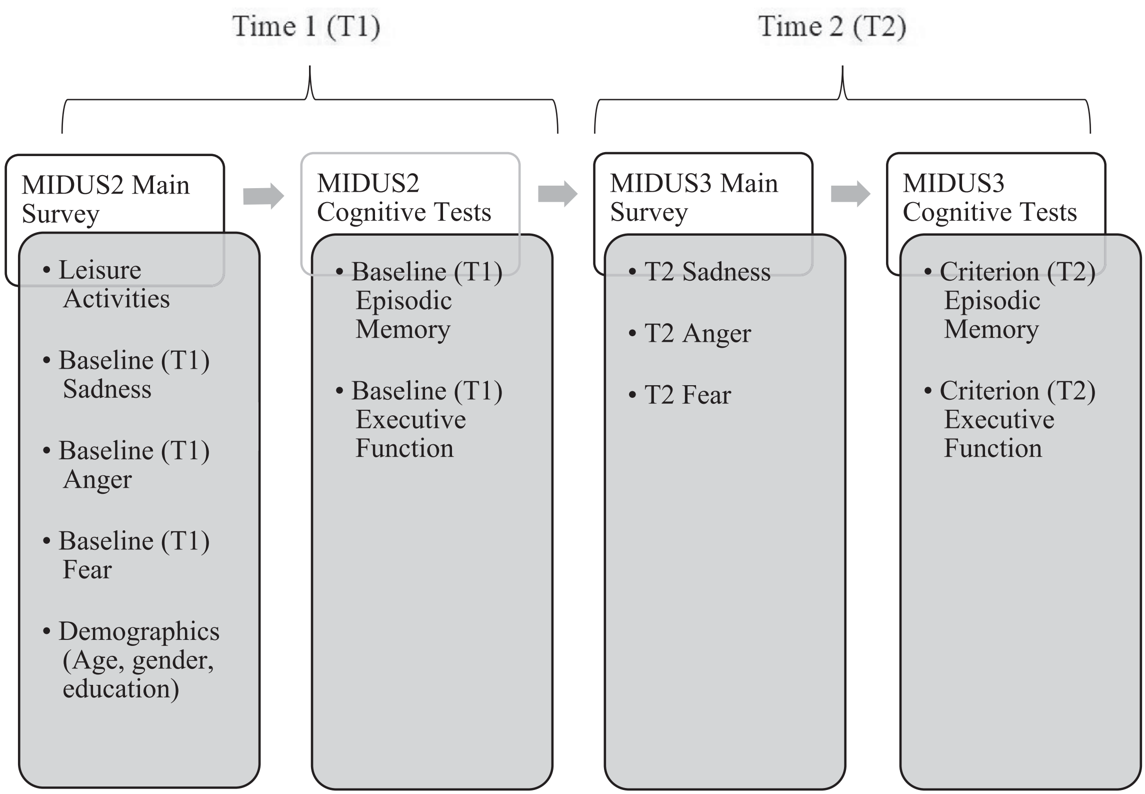

Figure 1. The temporal order of all variables used.

had complete data for mediational analyses. Power analyses indicated that the present sample size would enable even small effect sizes to be detected with the conventional alpha of .05 and power of above .90. Included participants differed slightly from excluded participants—participants with lower age ($r = -.06$, $p < .001$), higher education ($r = .14$, $p < .001$), better episodic memory ($r = .13$, $p < .001$), and better executive function ($r = .20$, $p < .001$) at T1 were more likely to participate in the follow-up at T2.[1]

Design

Leisure was operationalised via general frequency of participation in activities, while cognitive function was measured using a validated cognitive battery which assessed episodic memory and executive function (Tun & Lachman, 2006). The first wave (T1) consists of the measure of leisure as well as demographic covariates, including age (Murman, 2015), gender (Maitland et al., 2000) and education (Falch and Massih, 2011), which affect cognitive functions and also influence one's tendency to participate in leisure activities (e.g. Attanasio et al., 2012; Nimrod & Shrira, 2016). Additionally, baseline episodic memory and executive function were included at T1 to rule out the alternative interpretation that predisposed levels of cognitive functioning may drive the relationship between leisure and later cognitive functioning. Finally, measures of baseline sadness, anger, and fear at T1 were used to rule out the involvement of baseline emotion in the proposed mediational pathway. The second wave (T2) consisted of the key criterion variables (episodic memory and executive function) as well as the mediators (sadness, anger, and fear).

Measures

Leisure activities

Frequency of engaging in leisure activities was measured using 14 items. Six items assessed respondents' frequency of engaging in physical leisure activities of varying intensities in the summer and winter (e.g. "*How often do you engage in moderate physical activity during your leisure or free time during the winter?*") on a 6-point Likert scale from 1 (*Several* *times a week*) to 6 (*Never*). Six items assessed respondents' monthly frequency of engaging in various leisure activities, including reading, playing word games, playing cards or other games, attending educational courses and lectures, writing, or using the computer to send emails or surf the web (e.g. "*How often do you read books, magazines, or newspapers?*", "*How often do you do word games such as crossword puzzles or scrabble?")* on a 6-point Likert scale from 1 (*Daily*) to 6 (*Never*). All the above items were reverse-coded so that higher scores reflected greater frequency. Finally, two items assessed respondents' frequency of social leisure activities by asking them to report the number of times they meet up in sports or social groups in a typical month and the number of hours they spend on average a month volunteering for various organisations, such as hospitals, schools, political organisations, or other causes. All fourteen items were standardised and averaged to determine respondents' frequency of engaging in general leisure activities ($\alpha = .76$).

Negative emotions

Eleven items assessed how frequently respondents experienced various negative affective states over the past 30 days. Items were measured on a 5-point Likert scale from 1 (*All the time*) to 5 (*None of the time*) and were reverse-coded so that higher scores reflected greater frequency. We then calculated separate composites representing the three negative emotions of sadness, anger, and fear.

Sadness. Five items assessed emotional states involving negative self-focus and self-evaluations ("*so sad no one could cheer you up*", "*hopeless*", "*worthless*", "*lonely*", and "*ashamed*"), which is characteristic of sadness. The five items were averaged to obtain a composite representing sadness at both T1 ($\alpha = .84$) and T2 ($\alpha = .84$).

Anger. Three items assessed emotional states involving external-focused evaluations of injustice or thwarted goal attainment ("*angry*", "*frustrated*", "*irritable*"), which is characteristic of anger. The three items were averaged to obtain a composite representing anger at both T1 ($\alpha = .81$) and T2 ($\alpha = .81$).

Fear. Three items assessed emotional states involving negative evaluations of one's circumstances as uncertain or threatening ("*nervous*", "*afraid*", "*jittery*"), which is characteristic of fear. The three items were averaged to obtain a composite representing fear at both T1 ($\alpha = .75$) and T2 ($\alpha = .75$).

Cognitive functioning

Cognitive functioning was assessed using measures from the Brief Test of Adult Cognition by Telephone (BTACT; Tun & Lachman, 2006). Interviewers, who received special training, were hired to administer a total of seven sub-tests which were then used to form two composites: episodic memory and executive function. The BTACT has been found to have strong psychometric properties (e.g. Lachman et al., 2014). The two composites were assessed at both T1 (used as measures of baseline cognitive ability) and T2 (used as criterion variables).

Episodic memory. Episodic memory was assessed using two sub-tests which are part of the BTACT (Tun & Lachman, 2006). The word list immediate subtest was the first sub-test to be administered, and interviewers recited a list of 15 words (e.g. "*flower*", "*truck*") after which participants were assessed on the number of words they correctly recalled. The word list delayed subtest was administered at the end of all the cognitive sub-tests, and respondents were instructed to recall as many words as possible from the same list of 15 words recited to them previously at the start of the cognitive interview. A composite representing episodic memory was created by averaging the z-scores of the above two sub-tests.

Executive function. Executive function was assessed using five sub-tests which are part of the BTACT (Tun & Lachman, 2006). In the digits backward subtest of working memory, respondents heard strings of 2–8 digits (e.g. "*7-1-3*"), and the highest number of digits they were able to recite backwards was measured. In the category fluency subtest of verbal ability and speed, respondents were assessed on the number of animal names they were able to produce within a minute. In the number series subtest of fluid intelligence, respondents were tested on the total number of correct answers they were able to obtain on a series of number pattern completion questions (e.g. "*18, 20, 24, 30, 38, ____*"). In the backwards counting sub-test of processing speed, respondents were assessed on the total number of digits they were able to count backwards from 100 within 30 s. In the stop and go switch sub-test of attention and inhibitory control, respondents received instructions to respond with either "stop" or "go" when respectively presented with "red" or "green" as well as instructions to reverse their responses to the same prompt, and their overall reaction time across all trials was assessed. A composite representing respondents' level of executive functioning was created by averaging the z-scores of these five sub-tests.

Demographics

Age, gender (1 = *female*, 0 = *male*), and education level (from 1 representing '*no education or some grade school*' to 12 representing "*PhD or other comparable qualifications*") were used as demographic covariates.

Results

Observed variable analyses

We summarised key descriptive statistics in Table 1, while inter-correlations between variables are summarised in Table 2. Initial bivariate analyses found that frequency of leisure at T1 was positively correlated with T2 episodic memory, $r = .24$, $p < .001$, as well as T2 executive function, $r = .31$, $p < .001$. For both episodic memory and executive function, we examined the prediction that T1 leisure would predict better cognition at T2 when baseline cognition (episodic memory and executive function) at T1 and the demographic covariates (age, gender, education) were controlled for. No evidence of multicollinearity was found in any analyses (VIFs < 2). Path coefficients predicting T2 episodic memory and T2 executive function are summarised in Table 3. As shown in Table 3, path analyses indicate that having accounted for baseline cognition and demographics, T1 leisure continued to be a robust predictor of T2 episodic memory ($b = .16$, $SE = .04$, $p < .001$, 95% CI [.09, .24], $\beta = .08$) as well as T2 executive function ($b = .08$, $SE = .02$, $p = .001$, 95% CI [.03, .12], $\beta = .05$), providing evidence that leisure can uniquely predict benefits for cognitive functioning about 10 years later.

We then performed path analyses bootstrapped with 10000 resamples to examine sadness, anger, and fear as mediators of the leisure-cognition link. Controlling for age, gender, education and the baseline negative emotions at T1, T1 leisure significantly predicted lower T2 sadness ($b = -.08$, $SE = .02$, $p = .001$, 95% CI [−.13, −.04], $\beta = -.08$) as well as lower T2 fear ($b = -.07$, $SE = .03$, $p = .010$, 95% CI [−.12, −.02], $\beta = -.06$), but did not significantly predict T2 anger ($b = -.04$, $SE = .03$, $p = .25$, 95% CI [−.10, .02], $\beta = -.03$). In turn, controlling for age, gender, education and baseline cognition, T2 sadness significantly predicted poorer T2 episodic memory ($b = -.13$, $SE = .05$, $p = .007$, 95% CI [−.22, −.03], $\beta = -.07$) as well as poorer T2 executive function ($b = -.10$, $SE = .03$, $p = .001$, 95% CI [−.16, −.04], $\beta = -.07$). In contrast, neither T2 fear ($b = .004$, $SE = .04$, $p = .93$, 95% CI [−.08, .09], $\beta = .002$) nor T2 anger ($b = .003$, $SE = .04$, $p = .94$, 95% CI [−.07, .07], $\beta = .002$)

Table 1. Descriptive statistics for all key variables.

	M	*SD*	*Min*	*Max*
Education	7.33	2.54	1	12
Leisure	0.01	0.49	−1.54	1.65
T1 Anger	1.90	0.69	1.00	5.00
T2 Anger	1.80	0.68	1.00	5.00
T1 Fear	1.47	0.57	1.00	5.00
T2 Fear	1.41	0.55	1.00	5.00
T1 Sadness	1.31	0.51	1.00	5.00
T2 Sadness	1.30	0.51	1.00	5.00
T1 Executive Function	0.09	0.95	−4.64	3.36
T1 Episodic Memory	0.05	1.00	−3.04	3.83
T2 Executive Function	−0.14	0.74	−5.63	2.02
T2 Episodic Memory	−0.02	0.98	−2.50	3.42

Table 2. Correlation matrix for all key variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Leisure	-													
2. T1 Episodic Memory	.28*	-												
3. T2 Episodic Memory	.24*	.54*	-											
4. T1 Executive Function	.38*	.43*	.36*	-										
5. T2 Executive Function	.31*	.32*	.42*	.77*	-									
6. T1 Sadness	−.11*	−.01	−.002	−.05*	−.05*	-								
7. T2 Sadness	−.13*	−.06*	−.09*	−.09*	−.13*	.53*	-							
8. T1 Anger	−.02	.06*	.07*	.08*	.09*	.60*	.36*	-						
9. T2 Anger	−.05*	−.003	.01	.06*	.03	.41*	.60*	.53*	-					
10. T1 Fear	−.06*	.003	.03	.05*	−.05*	.65*	.40*	.59*	.41*	-				
11. T2 Fear	−.09*	−.03	−.04	−.10*	−.12*	.40*	.64*	.35*	.60*	.50*	-			
12. Age	−.18*	−.34*	−.39*	−.42*	−.48*	−.12*	−.05*	−.28*	−.20*	−.13*	−.09*	-		
13. Gender	.04*	.23*	.25*	−.10*	−.11*	.09*	.05*	.03	.01	.10*	.10*	−.03*	-	
14. Education	.39*	.20*	.17*	.42*	.36*	−.08*	−.10*	−.004	−.04	−.06*	−.09*	−.14*	−.11*	-

* $p < .05$. Gender was coded with "0" representing males and "1" representing females.

Table 3. Path coefficients predicting T2 Episodic Memory and T2 Executive Function in observed variable path analyses as well as latent variable structural equation modelling.

	T2 Episodic Memory				T2 Executive Function			
	b	*SE*	*95% CI*	*β*	*b*	*SE*	*95% CI*	*β*
Observed								
Age	−.02***	.002	[−.02, −.02]	−.23	−.02***	.001	[−.02, −.01]	−.22
Gender	.34***	.03	[.27, .41]	.17	−.04*	.02	[−.08, −.003]	−.03
Education	.002	.01	[−.01, .02]	.01	.01	.004	[< .001, .02]	.03
T1 EM	.38***	.02	[.34, .42]	.37	.01	.01	[−.01, .03]	.02
T1 EF	.14***	.02	[.10, .18]	.13	.53***	.01	[.50, .55]	.64
T1 Leisure	.16***	.02	[.09, .24]	.07	.08**	.04	[.03, .12]	.05
Latent								
Age	−.01***	.002	[−.02, −.01]	−.19	−.01***	.001	[−.01, −.004]	−.14
Gender	.31***	.04	[.24, .38]	.17	.001	.01	[−.03, .03]	.001
Education	−.03*	.01	[−.05, −.003]	−.07	−.01**	.01	[−.02, −.01]	−.07
T1 EM	.42***	.03	[.37, .47]	.41	−.01	.01	[−.03, .003]	−.03
T1 EF	.38***	.08	[.23, .54]	.13	1.01***	.06	[.90, 1.12]	.86
T1 Leisure	.33**	.10	[.14, .53]	.14	.17***	.04	[.09, .24]	.13

* $p < .05$, ** $p < .01$, *** $p < .001$.
Note. EF = Executive Function; EM = Episodic Memory. Gender was coded with 0 = Male, 1 = Female.

significantly predicted T2 episodic memory. Similarly, neither T2 fear ($b = -.02$, $SE = .03$, $p = .50$, 95% CI [−.07, .03], $\beta = .02$) nor T2 anger ($b = .02$, $SE = .02$, $p = .41$, 95% CI [−.02, .05], $\beta = -.01$) significantly predicted T2 executive function.

Overall, T2 sadness significantly mediated the relationship between T1 leisure and T2 episodic memory (indirect effect = .01, $SE = .01$, 95% CI [.002, .02]) as well as between T1 leisure and T2 executive function (indirect effect = .01, $SE = .003$, 95% CI [.003, .02]). In contrast, the indirect effects of leisure on episodic memory via T2 fear (indirect effect < .001, $SE = .003$, 95% CI [−.01, .01]) and T2 anger (indirect effect < .001, $SE = .002$, 95% CI [−.004, .003]) were non-significant, and the indirect effects of leisure on executive function via T2 fear (indirect effect = .001, $SE = .002$, 95% CI [−.002, .01]) and T2 anger (indirect effect = −.001, $SE = .001$, 95% CI [−.003, .001]) were also non-significant. Thus, observed variable analyses provided evidence that participating in leisure activities is reliably linked to better episodic memory and executive function nearly ten years later even after accounting for baseline cognition, and that these relationships were mediated specifically by the alleviative benefits of leisure on sadness rather than anger or fear. The mediational results are depicted in Figure 2.

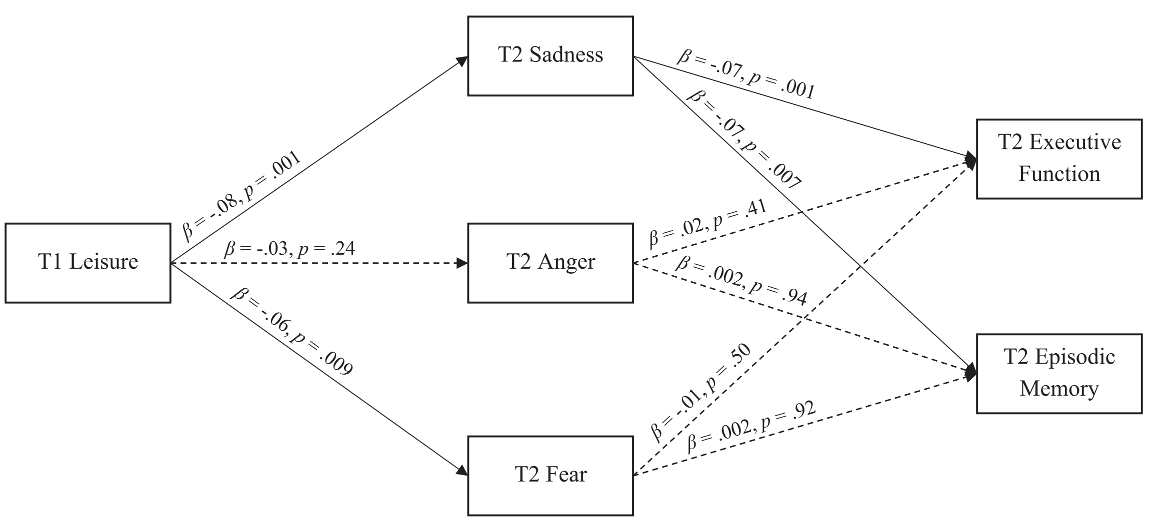

Figure 2. Path analysis of T1 Leisure predicting T2 Episodic Memory and T2 Executive Function Mediated by T2 Sadness, T2 Anger, or T2 Fear. Dashed lines indicate non-significant pathways.

Latent variable analyses

Next, we verified the findings using latent variable structural equation modelling, which allows us to partial out measurement error as well as obtain more accurate estimates (Kline, 2016; Ledgerwood & Shrout, 2011). Furthermore, we applied full-information maximum likelihood (FIML) estimation for missing data, which are widely recommended as gold-standard procedures for addressing missing data (Enders & Bandalos, 2001). We first specified and tested the measurement model using confirmatory factor analyses. For the latent variable of leisure, we collapsed the 14 items into 8 indicators based on semantic overlap[2]—three indicators represented physical activities, one indicator represented social leisure activities, one indicator represented cognitive leisure activities such as writing or attending lectures, while three indicators each represented reading books/magazines, playing various types of games, and using a computer respectively. Following the recommendations of Tun and Lachman (2006), the latent variables for episodic memory at T1 and T2 were indicated by the standardised scores of the two subtests used to assess episodic memory, while the latent variables for executive function at T1 and T2 were indicated by the standardised scores of the five subtests used to assess executive function. We also specified covariances between these indicators at T1 and their respective indicators at T2 to account for their shared error variances. Finally, as the three indicators for physical leisure overlapped highly in item phrasings and were also substantially intercorrelated, we specified their covariances to account for their shared measurement error. The results of the confirmatory factor analysis indicated that the measurement model fit the data well, χ^2 (189) = 1251.16, $p < .001$, CFI = 0.96, RMSEA = 0.040, SRMR = 0.041.

Next, we tested the structural model, specifying T2 episodic memory and T2 executive function as the key outcome variables with the latent variable of leisure as the key predictor variable, controlling for age, gender, education, and T1 episodic memory as well as T1 executive function. We also specified pathways between age, gender, and education with T1 leisure, T1 sadness, T1 episodic memory, and T1 executive function to account for demographic variations in baselines. Results indicated that the structural model fit the data well, χ^2 (242) = 2713.70, $p < .001$, CFI = 0.91, RMSEA = 0.054, SRMR = 0.059. Latent variable path analyses provided converging evidence with those found in the observed variable analyses, such that T1 leisure significantly predicted better T2 episodic memory ($b = .33$, $SE = .10$, $p = .001$, 95% CI [.14, .53], $\beta = .14$) as well as T2 executive function ($b = .17$, $SE = .04$, $p < .001$, 95% CI [.09, .24], $\beta = .13$) after accounting for all covariates.

Finally, we examined sadness as a mediator of the leisure-cognition link using latent variable analyses bootstrapped with 10000 resamples. As parsimony is favoured in structural models, we focussed specifically on verifying the mediational relationship of leisure on later cognition via sadness as observed variable analyses have established the non-significance of anger and fear as mediators of these relationships. The latent variables for leisure, episodic memory, and executive function were specified the same way as in the earlier structural equation model, while T1 and T2 sadness were indicated by the five items comprising sadness at each time point. Covariances were specified between the corresponding indicators of sadness at each time point to account for their shared error variances. Confirmatory factor analyses indicated that the measurement model fit the data well, χ^2 (428) = 1855.23, $p < .001$, CFI = 0.96, RMSEA = 0.031, SRMR = 0.034.

We then tested the structural model, specifying T2 sadness as being predicted by T1 leisure, controlling for age, gender, education, and T1 sadness. T2 episodic memory and T2 executive function were also specified as outcome variables predicted by T2 sadness, controlling for age, gender, education, T1 leisure, T1 episodic memory, and T1 executive function. We also specified pathways between age, gender, and education with T1 leisure, T1 sadness, T1 episodic memory, and T1 executive function to account for demographic variations in baselines. Results indicated that the structural model fit the data well, χ^2 (512) = 3455.84, $p < .001$, CFI = 0.93, RMSEA = 0.040, SRMR = 0.051. Latent variable path analyses supported the same conclusions, such that T1 leisure predicted lower T2 sadness ($b = -.21$, $SE = .06$, $p = .001$, 95% CI [−.34, −.09], $\beta = -.15$) after accounting for demographic covariates and baseline sadness, and T2 sadness in turn predicted poorer T2 episodic memory ($b = -.11$, $SE = .04$, $p = .003$, 95% CI [−.18, −.04], $\beta = -.06$) as well as poorer T2 executive function ($b = -.06$, $SE = .01$, $p < .001$, 95% CI [−.09, −.03], $\beta = -.07$) after accounting for demographic covariates and baseline cognition. Overall, sadness significantly mediated the relationship between T1 leisure and T2 episodic memory (indirect effect = .02, $SE = .01$, 95% CI [.01, .04]) as well as T2 executive function (indirect effect = .01, $SE = .01$, 95% CI [.004, .02]).

Discussion

Overall, across both observed and latent variable analyses, our findings support leisure as a predictor of better long-term cognitive functioning. Indeed, we expected and found small but robust effect sizes between leisure and cognitive outcomes across two criterion variables, and furthermore, these findings held even after controlling for baseline cognitive functioning, which rules out pre-existing levels of cognitive functioning as a possible confound. Critically, our findings also suggest that the positive associations between leisure and later cognitive functioning are mediated specifically by sadness and not anger or fear, which provides important theoretical advancements to the literature on the affective mechanisms involved in the leisure-cognition link.

Consistent with previous work on leisure and cognitive functioning (e.g. Singh-Manoux et al., 2003), frequency of engagement in leisure activities predicted better episodic memory as well as executive function nearly a decade later, and these relationships remained robust even though baselines were adjusted for. This suggests that leisure, in addition to its well-documented affective benefits, also has unique importance for the cognitive health of individuals. Engaging in leisurely activities in the course of daily life provides positive psychosocial contexts characterised by free choice, enjoyment, and intrinsic motivation (Kelly, 2009), which may buffer against negative psychological experiences which are detrimental for cognitive functioning (Iwasaki & Schneider, 2003; Power et al., 2018). Specifically, building on conceptualizations of leisure as a psychological resource which is restorative and protective for the self (Kleiber et al., 2002), we further theorised that the alleviative benefits of leisure on negative emotions would be most pronounced towards specific negative emotions which centrally involve negative appraisals of the self.

Providing support for this approach, leisure was associated with reduced feelings of sadness, in which one experiences negative self-focus as well as appraisals of the self as powerless or helpless (Roseman et al., 1990). As leisure has unique restorative benefits that are focussed on aspects of positive self-appraisals (Kleiber et al., 2002), frequent engagement in leisurely activities should increase attentional focus on positive aspects of the self and lead to reductions in appraisals of helplessness or powerlessness, therefore reducing experiences of sadness. In turn, considering that frequent experiences of sadness may divert attentional or cognitive resources away from controlled processing and therefore impair cognitive functioning (Danhauer et al., 2013), leisure should promote long-term cognition by providing a protective buffer against the adverse effects of sadness in everyday life. Indeed, our findings support sadness as an emotion-specific affective mediator between leisure and long-term episodic memory as well as executive function.

In contrast, we did not find either fear or anger to be supported as affective mechanisms for the leisure-cognition link. Though our theoretical considerations implied that leisure could also alleviate experiences of fear and thus promote long-term cognitive functioning, we found empirical support only for the pathway between leisure and fear, but not between fear and episodic memory or executive function. This implies that in addition to alleviating the emotion of sadness, the affective benefits of leisure are generalisable to reducing fear as well. Individuals who engage frequently in leisure benefit from expressions of autonomy as well as a sense of agency (Tinsley & Eldredge, 1995), which may increase the perception that external threats are controllable, therefore reducing experiences of fear. However, this reduction in fear did not translate into cognitive benefits, which is consistent with findings showing that fear-related states may not predict cognitive dysfunctions above sadness (Biringer et al., 2005) and provides further evidence for the specificity of sadness in predicting poorer cognitive functioning within naturalistic settings. Finally, supporting predictions that anger should show no clear associations with leisure activities or cognitive functioning, both pathways were unsupported by our data and anger was not supported as a mediator. Hence, our findings provide further clarity on the affective mechanisms underlying the leisure-cognition link and suggest that the specific negative emotion of sadness may have stronger explanatory power as a mediator than other distinct negative emotional states such as fear or anger.

Nevertheless, it is possible that other mediators may simultaneously be operating alongside sadness. For example, frequently engaging in leisure activities may simultaneously provide affective buffers against sadness as well as provide cognitive stimulation (Wang et al., 2002), which in combination could account for improvements in cognitive functioning over time. A further possibility is that the mediational model at work may be a more complex sequence of both affective and cognitive mediators, such that leisure may provide general psychological contexts which are incompatible with sadness, which in turn may free up cognitive resources that allow for enhanced cognitive functioning. Given that we found evidence of longitudinal relationships between leisure, sadness, and cognitive functioning, biological and neurological mediators that could result in more permanent and long-lasting effects may also be at work. One speculative possibility provided by Wang et al. (2012) is that general participation in leisure may result in synaptic changes that enhance efficient cognitive processing. We further also speculate that over time, the self-restorative and self-protective functions of leisure may result in long-term synaptic changes that reduce the habitual tendency to react to negative life events with prolonged states of sadness, which may then translate to improved cognitive functioning longitudinally. These speculations, while compelling, remain open to empirical investigations.

Given the centrality of cognitive processes to an entire array of life outcomes e.g. (Roberts et al., 2007), there are highly pertinent theoretical and practical implications to the present findings. As tests of mediation between leisure and cognitive functioning remain rare, our findings clarify the specific negative emotions that may explain links between leisure and cognitive functioning. Furthermore, the episodic memory is necessary for anticipating future events, making it crucial for planning (Klein et al., 2002), while the executive function is a higher-order set of cognitive abilities that are critical to various complex functional behaviours (Banich, 2009). Indeed, the executive function is related to various important skills and outcomes such as self-regulation, creativity, organisational productivity, as well as socio-emotional development (Bailey, 2007; Diamond, 2013; Riggs et al., 2006). Of note, even after applying stringent adjustments for baseline cognition (Adachi & Willoughby, 2015), the effect sizes of leisure based on latent variable analyses closely approximated the effect sizes we found of age declines in cognitive function, while education level predicted cognitive function in the opposite direction once baseline was controlled. Given that age and education level are well-established antecedents of cognitive functioning (Falch & Massih, 2011; Murman, 2015), this implies that the practical significance of leisure is comparable to or even larger than other important demographical antecedents of cognitive functioning.

One further question that may be asked, however, is whether affective mediators might explain leisure-cognition relationships across all forms of leisure activities. Certain forms of leisure activities, such as competitive sports or competitive online gaming, may have characteristics that induce rather than reduce particular negative states (Eastin, 2007), which may suggest that such activities may either show non-positive associations with cognition or may show positive associations via a different mediational pathway. Furthermore, previous work has suggested that different forms of leisure activities may be related to the fulfilment of different psychological needs (Tinsley & Eldredge, 1995), and it is possible that the extent to which a specific leisure activity produces benefits on cognition via sadness may vary depending on what psychological needs are met. Future work should examine these possibilities and identify other possible mediational pathways that may be specific to particular forms of leisure activities.

Several limitations to the present study should be noted. One limitation to the present study is that definitive claims of causality cannot be made without experimental manipulations. However, experimental manipulations of leisure experiences are rarely possible due to ethical and practical difficulties, especially considering that free choice and intrinsic motivation are central to leisure (Kelly, 2009). Indeed, the key aim of the present study is to examine long-term relationships, and the present dataset permits conclusions that are naturalistic and ecologically valid for a large sample of adults, which is also a key strength of the present analyses. A second limitation is that we operationalised leisure solely using activity participation, which is in line with many studies (e.g. Power et al., 2018). However, leisure can also be operationalised in experiential terms, such as experiencing one's life as being generally leisurely, and the present analyses cannot distinguish whether different operationalizations may have differential associations with affective and cognitive outcomes. Thirdly, an important question concerns whether participating in leisure activities would have unique benefits beyond participating in other non-leisurely activities which may still share similar components with leisure activities, such as those which are physical, social, or mental in nature (Karp et al., 2006). Strong measures of non-leisurely activities were not available for the present analyses and thus, this question remains to be addressed in future research. Finally, while the episodic memory and executive function broadly capture a wide variety of general cognitive functions with important practical implications (Cacciaglia et al., 2018), other cognitive skills such as verbal comprehension or logical reasoning may not be adequately represented by these measures. Future research should examine whether the leisure-sadness-cognition link would generalise to these other forms of cognitive abilities.

Overall, the present study addresses important issues in research on the leisure-cognition link by providing further evidence that leisure has unique contributions to cognitive functioning about a decade later even after accounting for baselines, and by providing empirical support for a more nuanced emotion-specific approach to examining the affective mechanisms underlying the leisure-cognition link. Moreover, given the importance of cognitive functions to numerous life outcomes, our findings on the key role of leisure in promoting improved cognitive functioning has important practical implications. Organisations or policy-makers seeking to improve a wide variety of outcomes may benefit from the wisdom that all work and no play may indeed dull one's cognitive capacities.

Notes

1. The key results remained unchanged with or without addressing missing data using full-information maximum likelihood (FIML) procedures, attesting to the robustness of the findings despite issues with attrition and missingness.
2. We also explored analyzing the data using either 14 indicators, collapsing the items into 6 indicators, or collapsing the items into 3 indicators. Regardless of this, leisure consistently predicted episodic memory and executive function (*ps* < .02) and the indirect effects via sadness for both episodic memory and executive function remained significant (all 95% CIs did not include 0). As such, the results are robust regardless of the number of indicators used.

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