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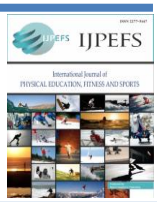

Mindfulness, Self-Compassion, Executive Functioning, and Stress: Exploring a Process Model in Adolescents

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Abstract: The association of trait mindfulness with emotional well-being has been found to be mediated by executive functioning. However, there is little empirical evidence on this process in adolescents. Therefore, this study tested these associations using an adolescent sample participating in a physical education yoga class. This study extended previous research by also including self-compassion and state mindfulness in addition to trait mindfulness. A prospective design employed a pilot yoga curriculum in a high school physical education class. Adolescents (N = 20) completed assessments of trait mindfulness and self-compassion at baseline, state mindfulness experienced during yoga classes over the 12 week physical education yoga class, and six indices of executive functioning and stress at the end of the 12 weeks. Path analysis was used to test the process model found by Short with the extensions of self-compassion and state mindfulness. Self-compassion directly predicted problems with activity level impulse control and indirectly predicted stress. When self-compassion did not predict specific executive functioning indicators, state mindfulness experienced in yoga predicted stress. This study contributes preliminary evidence that suggests further research into the unique effects of trait and state mindfulness as well as self-compassion on adolescent cognitive and affective outcomes. Results support the use of contemplative practices, such as yoga, in adolescent physical education as a strategy to boost emotion regulation processes.

Key Words: State Mindfulness, Physical Education, Psychological Resilience, Affect, Yoga

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1. Introduction

Lazarus and Folkman [1] conceptualize psychological stress as an emotional response to one's *appraisal* of an imbalance between a stressor and one's perceived ability to cope with it. Perceived pressure, unrealistic expectations, unfavorable comparisons to others and fear of failure contribute to appraisal processes that fuel psychological stress

for adolescents [2]. Thus understanding mechanisms that impact the appraisal process is a critical step in mitigating negative adolescent emotional experiences. Mindfulness-based school interventions have recently exploded in order to enhance adolescent cognitive and emotional well-being [3-5]. Although the emerging evidence is promising it is clear that we have much to learn about the processes explaining how mindfulness serves this purpose during adolescence [3- 6].

Mindfulness is defined as present-focused attention with characteristics of nonjudgment and openness to one's experience [7, 8]. The processes underlying the effects of mindfulness on stress are not fully elucidated [e.g., 9], particularly with adolescent samples. Mindfulness research with adults demonstrates that mindfulness is associated with neurocognitive self-regulation processes of executive functions, attention, and memory [10]. Teper, Segal, & Inzlicht [11] proposed a model suggesting that mindfulness activates self-regulation processes through the present-moment awareness and non-judgmental acceptance of emotional experiences, thus providing cues which stimulate executive functions in order to modulate emotional well-being. Thus, mindfulness may reduce a negative stress response by way of executive functions moderating the appraisal process, to apply Lazarus and Folkman's perspective. This model theoretically links mindfulness with emotional experiences, such as stress, by way of executive functioning, a neuropsychological construct representing skills involved in forming, maintaining, and shifting mental sets used in goal-directed behavior [12].

Short, Mazmanian, Oinonen, and Mushquash [13] explored a model to evaluate whether the relationship between trait mindfulness and emotional well-being was mediated by executive functioning and self-regulation using a two phase study in young adults. In phase one, self-reported dispositional mindfulness and neurocognitive performance were assessed. Four weeks later, in phase two, self-reported executive functioning, self-regulation, and emotional well-being were assessed. Results supported a model where self-reported trait mindfulness at time one directly predicted time two assessed self-reported executive functioning and self-regulation, and indirectly predicted emotional well-being. A recent study found inverse associations between distress and trait mindfulness and executive functioning in a cross sectional study with early adolescents [14], however, there is limited evidence of how these variables associate in adolescent populations. In addition to trait mindfulness, there is evidence that state or situational mindfulness has independent associations with emotional well-being [15-17]. However, there is no research examining trait and state mindfulness side by side as potential mechanisms for explaining stress in adolescents.

Self-compassion is another core mechanism that may help explain adolescent emotional well-being. Self-compassion involves a compassionate stance towards one's self in times of failure or suffering through self-kindness, a sense of common humanity, and mindfulness [18] and has received initial support for adolescents' adaptive regulation of cognitions and emotions [19]. Although there is some conceptual overlap with mindfulness, self-compassion explains unique variance in emotional well-being beyond mindfulness in adults [20, 21]. Though self-compassion strategies have been included as part of mindfulness programming in schools (see 22, 23) we only have limited evidence linking aspects of self-compassion with adolescent stress [19, 24, 25] and no empirical tests linking self-compassion to adolescent executive functioning. Given the similar functions underlying mindfulness and self-compassion, executive functioning may also serve to mediate the association between self-compassion and emotional responses. Exploring these processes is especially important given the interest in contemplative programs, such as yoga, for youth and limited empirical evidence.

The purpose of this study was to extend the model supported by Short et al. [13] to an adolescent sample and to include both trait and state mindfulness as well as self-compassion to predict stress by way of executive functioning. We tested our proposed model (see Figure 1) with a pilot study employing a 12-week yoga curriculum.

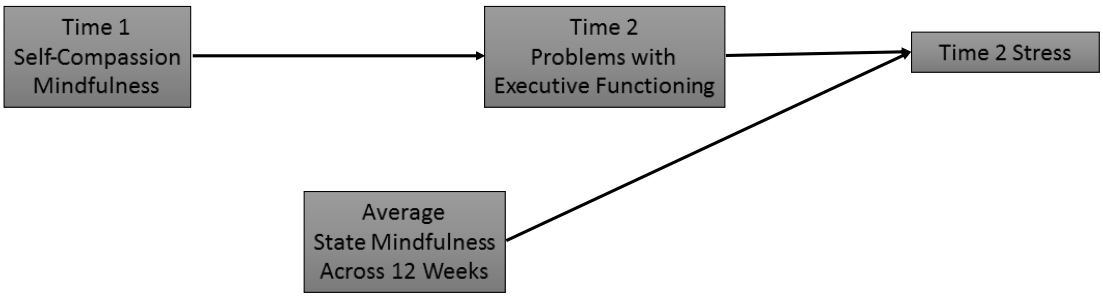

Figure 1. Hypothesized Model

This model was relevant to test in this context given that no mean changes were observed in trait level mindfulness, self-compassion, or stress[1]. Based on Short et al. we hypothesized that trait mindfulness and self-compassion at time one would negatively predict problems with executive functioning directly and stress indirectly at time two. Based on Brown Ryan [15], Kiken et al. [16], and Weinstein et al. [17], we hypothesized that students' average levels of state mindfulness experienced during the yoga classes across the 12 weeks would negatively predict stress directly.

2. Methods

2.1 Participants and Procedures

Participants (N = 20) were primarily Caucasian (85.0%) and female (90%) and in 10th through 12th grades (M_{age} = 16.45, SD = 1.0). Twenty-three students participated in the yoga curriculum[2] as part of their physical education (PE) class (one student joined late and was not included; another student had developmental difficulties and one student did not complete the final assessments). Each week of the 12-week curriculum was led by a certified yoga instructor (200-hour Anusara Yoga Teacher Training certification program) and focused on a theme (e.g., self-compassion; overcoming obstacles) that was integrated into two yoga sessions that week (1 50-minute and 1 80-minute). Each yoga practice included an introduction and centering exercise, practice moving through and holding different asanas (i.e., poses) and a closing and meditation exercise. Students in this class typically elect this class to fulfill their PE requirement, do not participation in school sports, may have low interest in traditional physical education, and are mostly female. The majority (90%) of participants reported beginning to beginning intermediate yoga experience. Participants completed the measures of trait mindfulness and self-compassion the week before beginning a 12-week yoga program (time one) in their physical education class. State mindfulness was assessed immediately following one yoga class per week. At the end of twelve weeks, participants completed the measures of executive functioning and stress (time two).

2. 2 Measures

Trait mindfulness was assessed using Cardaciotto, Herbert, Forman, Moitra, & Farrow's [26] 20-item Philadelphia Mindfulness Scale. Two subscales capture trait awareness (e.g., "I am aware of what thoughts are passing through my mind") and acceptance (e.g., "There are things I try not to think about"). Responses fall on a 5-point Likert scale of *never* to *very often*, with higher scores on each scale reflecting higher levels of mindful awareness or acceptance. This measure has supporting evidence of internal consistency reliability and validity [26]. Alpha reliability was low for both trait mindfulness scales. Several items[3] had low inter-item correlations. With these items removed, reliability improved for the awareness scale (α = .71) and the acceptance scale (α = .69).

Self-compassion was assessed using Neff's [27] Self-Compassion Scale. The 26-item scale assesses three positive (self-kindness, common humanity, mindfulness) and three negative (self-judgement, isolation, over-identification) dimensions underlying self-compassion. Participants respond to how often they experience a particular response to pain and suffering (e.g., "I see my failings as part of the human condition" – common humanity; "When I'm feeling down I tend to obsess and fixate on everything that is wrong" – over-identification) using a 5 point scale ranging from *almost never* to *almost always*. A total average score was calculated where higher scores reflect higher self-compassion. Conceptual and psychometric properties of the scale are supported, including for adolescents [28, 29].

Stress was assessed using the Perceived Stress Scale [30]. The PSS items tap into the perceived level of stress experienced *in the last week* (modified from last month to provide a more proximal indicator of perceived stress; similar modifications are not expected to decrease validity) (e.g., "In the last week, how often have you felt difficulties were piling up so high that you could not overcome them"). The PSS contains 14 items and is scored on a 5 point scale with response options ranging from *never* to *very often*. The PSS has supporting evidence for psychometric properties [30] and use in adolescent samples (e.g., 24).

Executive functioning was assessed with the self-report form of the Delis Rating of Executive Functions (D-REF) [31], a rating scale of reported behavioral problems for 11-18 year-olds. There are 36 items asking the individual to rate the frequency of behaviors in the last 6 months on a 4-point scale ranging from *seldom or never* to *daily*. These items are used to calculate six scores or indices of executive function. Three scores represent dysfunction relative to 1) behavior ("I say things I wish I hadn't"), 2) emotion ("I try to control my anger but I just can't"), and 3) cognition ("I have a difficult time putting my thoughts down in writing"). There are also three clinically derived scores representing dysfunction of 1) attention & working memory ("I get confused when I have two or more things to do at the same time"), 2) activity level impulse control ("I just can't help doing things that I'm told not to do"), and 3) compliance & anger management ("I get really upset when people interfere with what I'm doing"). The six indices are presented as T scores, age and gender adjusted, with values of 50 representing the norm sample average. Evidence supports reliability, content, construct, and concurrent validity [31]. Internal consistency reliability information was not available for scores obtained through the DREF online interface.

State mindfulness experienced during the yoga classes was assessed immediately following class each week using the State Mindfulness Scale for Physical Activity (SMS-PA) [32]. The SMS-PA has six items each capturing mindfulness of mental (e.g., "I was aware of different emotions that arose in me") and physical objects (e.g., "I felt present in my body") during a specific experience. Responses to how much each item was experienced fall on a 5-point scale ranging from *not at all* to *very much*. All 12 items were averaged with higher scores representing higher mindfulness during the yoga class. Weekly scores were averaged across the twelve weeks to represent average state mindfulness experienced in the yoga class. Initial evidence supports the internal consistency reliability, factorial, and construct validity using adult samples [32] and with youth samples as young as 10 years-old [33]. Alpha reliability was good across assessments (α_{range}= .76 - .97) and when averaged across time points ($\alpha_{average}$ = .90).

2. 3 Data Analysis

Data screening for missing values and normality was conducted and descriptive statistics were calculated. Hypothesized mediational models were tested with path models using Mplus 7. Time one scores of mindfulness (i.e., trait acceptance, and awareness) and self-compassion were entered into the model directly predicting executive functioning at time two and indirectly predicting stress at time two through executive functioning as per Short et al. [13]. Average state mindfulness during the yoga classes across the 12 weeks was also entered as a direct predictor of stress at the end of the 12 weeks (see Figure 1). Six separate models were run to test each

of the six indices of executive functioning. To obtain 95% confidence intervals, we conducted bootstrapping specifying 5000 samples to reduce standardized error bias and for type I error correction (see [34]). Completely standardized path coefficients were reported along with absolute and incremental model fit indices [35]. Given the exploratory nature of our study and small sample size, we report exact p values, confidence intervals and effect sizes for broad interpretation as reliance on significance levels is limiting. Confidence intervals that do not cross 0.00 were interpreted as reliable. Effect sizes were interpreted as minimal (.04), moderate (.25), and strong (.64).

3. Results

There was negligible missing data (.02%) and Little's MCAR test was non-significant ($\chi 2$= 40.34 (47), p = .74), therefore Expectation Maximization imputation was used on all constructs except executive functioning indices (.01% missing but not imputed as recommended [31] and state mindfulness (used all available weekly state scores to create average state scores, average of 8.6 of 11 scores available). Data screening showed variables to be approximately normal. See Table 1 for descriptive statistics.

In all the path models the acceptance and awareness trait mindfulness subscales did not significantly predict any of the indices of executive functioning. We therefore removed these subscales and proceeded to test the six mediation models with only self-compassion and state mindfulness. All models provided good fit and explained 17% to 46% of the variance in stress (see Table 2). Self-compassion significantly predicted *behavioral functioning* and *activity level impulse control*, with a significant indirect effect to stress through *activity level impulse control*.

Table 1. Means, Standard Deviations, Internal Consistency Reliability, and Bivariate Correlations.

	1	2	3	4	5	Mean	SD	Possible Range
1 Self Compassion						2.55	0.69	1-5
2 Acceptance^	.24					1.57	0.42	1-5
3 Awareness^	.58*	.51*				2.94	0.43	1-5
4 State Mindfulness	.17	.30	.16			2.74	0.56	1-5
5 Stress	-.29	.29	.08	-.37		2.34	0.56	1-5
6 BF	-.42	.20	-.11	-.30	.46*	57.75	8.15	20-80
7 EMF	-.19	.14	-.06	-.11	.42	57.65	8.28	20-80
8 CF	-.20	.21	.08	-.16	.28	59.70	8.22	20-80
9 AWM	-.24	.27	.09	-.06	.24	59.45	8.31	20-80
10 AIC	-.35	.24	.06	-.20	.64**	57.61	6.93	20-80
11 CAM	-.14	.17	.02	-.05	.22	56.63	8.35	20-80
α [1]	.93	.69	.71	.90	.81			

Notes. ^Trait mindfulness subscales; BF = behavior functioning, EMF = emotional functioning, CF = cognitive functioning, AWM = attention & working memory, AIC = activity level & impulse control, CAM = compliance & anger management. * p < .05 **p < .01.

Table 2. *Mediation Path Analysis Result*

Mediator	Direct Effects (95% CI)			Indirect Effect (95 % CI)	Model Fit					R^2	
Executive Functioning Indices	self-compassion to mediator	mediator to stress	state mindfulness to stress	self-compassion	$\chi^2(2)$	*p*	RMSEA	SRMR	CFI	Mediator	Stress
Behavioral	-.42, *p*=.02 (-.72 to -.12)	.39, *p*=.09 (.01 to .76)	-.27, *p*=.19 (-.59 to .06)	-.16, *p*=.17 (-.36 to .03)	1.59	.45	.00	.08	1.00	.18	.23
Emotional	-.19, *p*=.28 (-.48 to .09)	39, *p*=.09 (.01 to .77)	-.34, *p*=.04 (-.60 to- .07)	-.08, *p*=.34 (-.20 to .06)	0.87	.65	.00	.05	1.00	.04	.27
Cognitive	-.20, *p*=.39 (-.56 to .17)	.23, *p*=.32 (-.16 to.62)	-.34, *p*=.05 (-.62 to - .06)	-.05, *p*=.58 (-.18 to .09)	1.29	.53	.00	.06	1.00	.04	.17
AWM	-.24, *p*=.25 (-.59 to .10)	.22, *p*=.26 (.10 to .55)	-.36, *p*=.03 (-.63 to - .09)	-.05, *p*=.46 (-.18 to .07)	0.83	.66	.00	.05	1.00	.06	.19
AIC	-.43, *p*=.02 (-.74 to -.13)	.64, *p*=.00 (.31 to .96)	-.19, *p*=.30 (-.50 to .11)	-.28, *p*=.05 (-.50 to -.05)	1.44	.49	.00	.10	1.00	.19	.46
CAM	-.14, *p*=.52 (-.48 to .21)	.20, *p*=.38 (-.19 to.59)	-.36, *p*=.04 (-.64 to -.09)	-.03, *p*=.67 (-.14 to .08)	1.05	.59	.00	.05	1.00	.02	.18

Notes. AWM = attention & working memory, AIC = activity level & impulse control, CAM = compliance & anger management.

All paths predicting executive functioning were negative. These results reflect minimal to moderate effect sizes (R^2 = .18, .19).The average experience of state mindfulness during the 12 weeks of yoga classes predicted stress in all models except for *behavioral functioning* and *activity level impulse control*, demonstrating a robust negative association with stress even with executive functioning included in the model. The effect sizes predicting stress were moderate (R^2 = .17 - .46).

4. Discussion

This study extended the literature with an initial exploration of state and trait mindfulness as well as self-compassion in predicting adolescent executive functioning and stress. Contemplative interventions with youth are popular, yet we know relatively little about the processes underpinning mindfulness and compassion. Preliminary support for the hypothesized role of executive functioning in explaining the relationship between self-compassion and stress was found in the prediction of *behavioral functioning* and *activity level impulse control*, with a significant indirect effect to stress through *activity level impulse control*. These results are consistent with Short et al [13] who also supported a model with self-reported dysfunction in executive functioning mediating the association of trait level psychological resilience (i.e., mindfulness) and negative emotional well-being (i.e., negative affect). Emerging empirical evidence linking self-compassion with the emotional well-being of adolescents [19, 24] coupled with the moderate effect sizes in our results indicate that self-compassion as a resilience factor in adolescents is worthy of more rigorous exploration.

Impulse control has been linked with managing emotional responses with short-term emotional relief over longer-term goal directed emotional well-being [36]. Self-compassion may reduce problems with impulse control and associated behavior regulation problems by allowing one to experience suffering in a gentle way and reducing the need to avoid negative emotional experiences through behavioral responses, such as speaking before thinking. Even with a limited sample size, we were able to detect these associations, with minimal to moderate effect sizes supporting our conceptualization of how self-compassion can impact psychological and behavioral manifestations of well-being.

Both trait, or dispositional levels of psychological variables, such as self-compassion, and state level experiences may be important to consider when examining the effects of contemplative interventions and is supported by work with adults demonstrating the independent effects of state and trait mindfulness (e.g., 15). Thus, interventions that foster state mindfulness and self-compassion may reduce stress responses, regardless of students' dispositional tendencies in mindfulness. Even in cases where students' dispositional tendencies do not change, as was the case in this study, these state-level experiences may effect change in well-being. These results reflect recent systematic reviews of the mindfulness literature which suggest that more than half of mindfulness interventions do not demonstrate significant self-reported mindfulness change [37] and that assessment of mindfulness *practice* is a significant predictor of emotional well-being [38, 17]. Further work using more rigorous experimental research designs could shed more light on the relative importance of changes in dispositions versus state experiences during contemplative-based interventions. Further, although we aligned our model with the procedures of Short et al [13], true mediation should be tested with executive functioning assessed prior to stress [39].

The trait mindfulness subscales (acceptance, awareness) did not significantly predict any of the indices of executive functioning. It is unclear if this was due to marginal reliability of these scales which have limited use with adolescent samples and/or low power. The Philadelphia Mindfulness Scale was used in this study as it conceptually aligned with the suggested mechanisms for the effectiveness of mindfulness through scales of both acceptance and awareness [11], however, validation with adolescent samples is needed. Research with adults has sometimes demonstrated the stronger role of self-compassion relative to mindfulness when predicting emotional well-being [20, 21], which could explain this finding. Further research is necessary to test the

hypothesized model with trait mindfulness, executive functioning and stress in larger, more representative adolescent samples.

Our results should be considered as preliminary and viewed within limitations of sample and design. Future studies can build from this preliminary evidence by examining larger, more diverse samples with the use of more rigorous experimental research designs to detail the unique effects of trait mindfulness, self-compassion, and state mindfulness in adolescent emotion regulation processes. The representation of executive functioning also deserves attention as there are a broad array of approaches to study executive functioning. Further research exploring more rigorous assessment of executive functioning is needed as well as both behavioral and self-reported assessments [40].

5. Conclusions

This study explored the association of mindfulness and self-compassion with executive functioning and stress in adolescents. By including self-compassion in this study we extended Short et al.'s findings to a construct that is both conceptually and empirically distinct from mindfulness. There is also recent interest in the role of mindful states, for example in reducing rumination, supporting further exploration of state mindfulness. This study also provides promising evidence supporting further examination of the role of state mindfulness and self-compassion in reducing adolescent stress, areas of study with minimal empirical research evidence, but high popularity and enthusiasm for implementation.

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Conflict of interest

None of the authors have any conflicts of interest to declare.

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