DISSERTATION

ECOLOGICAL MOMENTARY ASSESSMENT OF MECHANISMS OF CHANGE DURING A MINDFULNESS-BASED INTERVENTION FOR ADOLESCENTS EXPOSED TO CHRONIC STRESSORS

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ABSTRACT

ECOLOGICAL MOMENTARY ASSESSMENT OF MECHANISMS OF CHANGE DURING A MINDFULNESS-BASED INTERVENTION FOR ADOLESCENTS EXPOSED TO CHRONIC STRESSORS

Adolescents exposed to chronic stressors (e.g., financial instability) are at heightened risk for developing mental health problems. Chronic stressors may contribute to greater mental health problems by interfering with adolescents' ability to effectively regulate emotions. According to the mindfulness stress buffering hypothesis, mindfulness acts as a buffer against the deleterious effects of life stressors by ameliorating maladaptive stress appraisals and by improving emotion regulation. However, an assumption of this hypothesis is that individuals can maintain mindfulness and regulate their emotions during periods of stress. These two papers explore this assumption by first investigating the real-time, dynamic relationship between life stressors, mindfulness, and emotion regulation difficulties (Study 1) and then by exploring if mindfulness training may help to ameliorate the negative effects of life stressors on mindfulness and emotion regulation (Study 2). Eighty-one participants who were 10-18 years of age (M_{age}=13.75 years, SD=2.17; 56% male; 57% Caucasian; 24% Hispanic/Latino; 7% Native American; 7% more than race; and 5% Asian/Pacific Islander or Black/African American) completed ecological momentary assessments (EMA) three times a day for seven days at three different intervals (baseline, mid-intervention and post-intervention) throughout the study, contributing to a total of 3,178 EMA reports. Multilevel structural equation modeling revealed that the presence (versus absence) of stressors and the greater severity of stressors both were associated with lower

mindfulness and greater emotion regulation difficulties concurrently in the same moment, but not prospectively from one moment to the next. In other words, life stressors may only be more immediately associated with lower mindfulness and greater emotion regulation difficulties as short-term, delayed effects from one moment (T1) to the next moment (T2) were not observed. Also, mindfulness training, compared to an active control group, was protective at post-intervention against the negative (concurrent) effects of stressors on mindfulness and emotion regulation (Study 2). Findings highlight that adolescents' life stressors may degrade untrained mindfulness and emotion regulation at given moments, but mindfulness training may help to buffer against these negative impacts of life stressors. Going forward, it will be helpful to investigate these relationships in the context of mental and physical health outcomes and to include longer periods of follow-up to determine the sustainable benefits of mindfulness training for adolescent health.

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Chapter 1: Disentangling the Real-Time Dynamics Among Life Stressors, Mindfulness, and Emotion Regulation Difficulties with Ecological Momentary Assessment

Greater dispositional mindfulness, a trait-like characteristic of paying attention on-purpose to the present moment with an attitude of equanimity and non-judgment, is often associated with positive indicators of mental health, including lower levels of anxiety and depression symptoms, among adults (Brown & Ryan, 2003; Tomlinson et al., 2018) and adolescents (Cortazar & Calvete, 2019; Greco et al., 2011). Mindfulness is likely associated with these outcomes because it theoretically improves emotion regulation, a core regulatory component of mental health (Aldao et al., 2010; Pepping et al., 2016). Adolescents faced with chronic stressors (e.g., family financial instability, interpersonal violence) are at heightened risk for developing mental health problems, likely due to a wide range of adversities including difficulties with emotion regulation (Kim et al., 2013; Sheth et al., 2017). Mindfulness may be particularly well suited to ameliorate these processes. According to the mindfulness stress buffering hypothesis (Creswell & Lindsay, 2014), mindfulness is proposed to buffer individuals from the impacts of stressors. Empirical evidence that supports this theory for adolescents is limited (Cortazar & Calvete, 2019; Lucas-Thompson et al., 2021). Yet, a general assumption of this theory is that individuals can maintain mindfulness during periods of stress. Interestingly, however, this assumption is relatively untested within both adult and adolescent populations (Lucas-Thompson et al., 2021). Although the stress buffering hypothesis is theoretically sound, it is also important to empirically test how momentary periods or episodes of stress may influence one's ability to remain mindful and regulated in order to understand the true buffering effects of mindfulness. The goal of this paper was to investigate how life stressors may be associated with

both mindfulness and emotion regulation within daily life among adolescents exposed to chronic stressors.

Adolescence: A Striking Paradox

Adolescence, a period of development occurring between the ages of 10-25 years (Steinberg, 2014), is a "striking paradox" (Dahl, 2004, p. 4). It is a time of significant maturation and strength as well as a time of increased vulnerability. Compared to children, adolescents are more physically, cognitively, and emotionally advanced (Dahl, 2004). In addition, many adolescents begin to establish a sense of identity and increased autonomy during this period of development (McElhaney et al., 2009; Meeus, 2016; Spear & Kulbok, 2004). In several different domains, adolescence is a time of opportunity as well as growth, and many adolescents fare relatively well during this stage of development (Dahl, 2004; Steinberg, 2005, 2014). However, adolescence is also a time of increased vulnerability for developing mental health problems such as anxiety and depression (Dahl, 2004). Indeed, the age-of-onset of many mental health disorders occurs during this stage of development (Fairchild, 2011; Kessler et al., 2010). A minimum of one in five U.S. adolescents meets criteria for a mental health disorder with severe impairment (Merikangas et al., 2010). This rate has continued to climb over the past decade (Bitsko et al., 2018; Perou et al., 2013), with additional concerns about escalating mental health concerns in adolescence during and in the aftermath of COVID-19 (de Miranda et al., 2020; Guessoum et al., 2020).

Not only are these population trends alarming, but mental health problems that occur during adolescence can have long-term consequences for mental and physical health. Specifically, mental health problems during adolescence predict adult psychopathology (Lancefield et al., 2016) and contribute to long-term stress-related physical health problems such

as cardiometabolic diseases and type 2 diabetes (Aarons et al., 2008; Suglia et al., 2016). Taken together, the paradox of adolescence is demonstrated by the fact that this developmental period is one of significant strength and maturation as well as a time of increased vulnerability for the development of mental health problems that can have lasting effects on mental and physical health throughout the life course.

Adolescent Development and Stressors

Adolescent vulnerability to mental health problems can be attributed to a complex interaction of many biological, genetic, social, and emotional factors, with two large factors being adolescent brain development and an increased sensitivity to stressors (Sheth et al., 2017; Steinberg, 2014). The adolescent brain experiences pruning and remodeling to refine areas that experience a normative overproduction of synapses throughout early development (Sheth et al., 2017; Steinberg, 2014). One region where this process is the most dynamic is the prefrontal cortex, which is also the brain region most responsible for coordinating and regulating emotional processes (Sheth et al., 2017). This remodeling process occurs through brain plasticity where circuits in the brain are molded by life experiences and the environment (Sheth et al., 2017; Steinberg, 2014). As adolescents experience life events, the brain learns and adapts to those experiences (Steinberg, 2014). For example, brain plasticity is the reason that we remember not to touch hot surfaces without something to protect our hands.

Although this plasticity is essential for development and growth, this increased sensitivity to life experiences also means that there is an increased sensitivity to stressors (Steinberg, 2014). Stressors refer to events or situations that are appraised as being stressful or eliciting the stress response (Anisman & Merali, 1999). Stress is generally defined as the body's response when physical, emotional, and/or cognitive demands exceed regulatory capacities (Cohen et al., 2013).

Stressors often precipitate stress (Anisman & Merali, 1999). For adolescents, life stressors such as school and family life stressors are relatively common (LaRue & Herrman, 2008), and at moderate levels, stress can be adaptive (Dhabhar, 2014). Yet, repeated exposure to stressors can lead to chronic activation of stress systems (Grant et al., 2004; Sheth et al., 2017). This chronic activation can then overwhelm and negatively impact the developing adolescent brain and contribute to the development of mental health problems and overall decreased well-being (Grant et al., 2004; Sheth et al., 2017). In addition, it is important to note that these biological and social processes do not occur in isolation, but rather in coordination with genetic risk factors such as variations in genetic codes associated with mental health problems (Gatt et al., 2015). Although we have an incomplete understanding of which genes and particular environmental characteristics are predictive of mental health problems, extant research suggests that both may interact to produce mental health risk in adolescence (Lenroot & Giedd, 2008; Tsuang et al., 2004; Wainberg et al., 2022).

Adolescents are not only highly sensitive to stressors, but they also have high levels of stress that rival adult stress levels (Bethune, 2014). According to a survey conducted by the American Psychological Association prior to COVID-19 (Bethune, 2014), most adolescents reported that their stress levels are higher than what they believe to be healthy. In addition, adolescent stress levels during the school year tend to be even higher than stress levels reported by adults (Bethune, 2014). Adolescent stress reported during the summer months also increased from 2014 to 2018 (4.6 vs. 5.3)(American Psychological Association, 2018; Bethune, 2014) and many adolescents are at risk for developing stress-induced mental and physical health problems. The transactional model of chronic stress posits that chronic stress is a state that develops over time from a continuous imbalance between demands and resources, which is often coupled with

inadequate coping (Thoresen & Eagleston, 1983). Chronic stressors for adolescents may include poverty, financial instability, systemic inequities, parental unemployment, and interpersonal violence (American Psychological Association, 2012; Kim et al., 2013; Thoresen & Eagleston, 1983). As such, adolescents exposed to chronic stressors may be at greatest risk for chronic stress and the downstream negative consequences (Kim et al., 2013; Sheth et al., 2017). Taken together, stress levels among adolescents are consistently high and many adolescents, especially those exposed to chronic stressors, are at significant risk for developing stress-induced mental and physical health problems.

Stressors and Emotion Regulation

Emotion regulation is a key component in understanding how stressors impact adolescent health. Emotion regulation is commonly defined as a process of influencing the intensity, duration, and type of emotional expression (Gross, 2014). When individuals experience an emotion-eliciting or stressful situation, emotion regulation is the response to both the external event and internal (affective/cognitive) experience elicited by the event (Diamond & Aspinwall, 2003; Wang & Saudino, 2011). Adaptive emotion regulation is robustly associated with better health and well-being, whereas difficulties with emotion regulation are associated with more mental health problems (Aldao et al., 2010). Common mental health problems of adolescence like anxiety and depression symptoms can result, in part, to not being able to effectively regulate one's emotions in response to life events and stressors (Aldao et al., 2010). Importantly, the capacity for emotion regulation, as well as self-regulation of behaviors and actions, increases across adolescence (Steinberg, 2014). Chronic stressors can alter adolescents' ability to effectively regulate emotions by interacting with the developing brain and by producing structural changes within the prefrontal cortex (Sheth et al., 2017). These structural changes then

result in less top-down control of emotion regulation, which then contributes to greater mental health problems (Sheth et al., 2017). Interestingly, acute stressors, as opposed to chronic stressors, can contribute to improvements in emotion regulation among adult men, but not among adult women (Langer et al., 2020). Among adolescents, adaptive emotion regulation has also been shown to help bolster resilience in the face of stressors (Troy & Mauss, 2011). However, relative to adults, adolescents exposed to chronic stressors may not be as able to effectively regulate their emotions when faced with life stressors experienced throughout the day, in part due to impairments in the developing prefrontal cortex that can occur after experiencing chronic stressors (Sheth et al., 2017). Although the notion that life stressors may contribute to difficulties with emotion regulation among adolescents exposed to chronic stressors is theoretically supported (Sheth et al., 2017; Steinberg, 2014), empirical evidence for this is limited. This study aims to clarify how life stressors measured multiple times throughout the day may impact emotion regulation difficulties within daily life among adolescents exposed to chronic stressors.

The Stress Buffering Hypothesis

Dispositional mindfulness, one's present moment attention and non-judgmental stance towards sensations and experiences (Brown & Ryan, 2003), is one process that may be helpful in ameliorating the negative effects of chronic stressors. Dispositional mindfulness has been consistently associated with lower emotion regulation difficulties in adolescents (Pepping et al., 2016), fewer adolescent mental health problems (Ciesla et al., 2012; Cortazar & Calvete, 2019; Fossati et al., 2011; Greco et al., 2011; Liu et al., 2022; Lucas-Thompson et al., 2021; Tan & Martin, 2016) and better health behaviors (Black et al., 2012; Pivarunas et al., 2015). According to the mindfulness stress buffering hypothesis, greater mindfulness protects individuals from the impacts of stressors by lowering individuals' stress appraisals and reducing stress reactivity

(Creswell & Lindsay, 2014). Indeed, greater dispositional mindfulness is often associated with more positive reappraisals of stress (Garland et al., 2011), less perceived stress (Bao et al., 2015; Lucas-Thompson et al., 2021), and less stress reactivity (Arch & Craske, 2010; Lucas-Thompson et al., 2019) among adults and adolescents. Furthermore, there is evidence that greater dispositional mindfulness lowers perceived stress by reducing emotion regulation difficulties among adults (Prakash et al., 2015).

Research on the buffering effects of mindfulness is relatively consistent for adults, but research on this topic for adolescents is both limited and more variable. In adults, there is cross-sectional evidence that greater dispositional mindfulness protects adults from the impacts of stressors on depression symptoms (Bergin & Pakenham, 2016; Bränström et al., 2011; Cole et al., 2015; Dixon & Overall, 2016; van Son et al., 2015), anxiety symptoms (Bergin & Pakenham, 2016; van Son et al., 2015), substance use (i.e., self-reported alcohol use; Adams et al., 2015), and broad-based mental health problems (de Frias & Whyne, 2015). Importantly, most of this existing literature was conducted using cross-sectional data, as opposed to longitudinal data, limiting our understanding of causal inferences.

For adolescents, there is some cross-sectional evidence that dispositional mindfulness buffers adolescents from the psychological effects of life hassles (Marks et al., 2010) as well as from the effects of stressors on internalizing symptoms (Lucas-Thompson et al., 2021). However, three longitudinal studies (Calvete et al., 2017, 2019; Cortazar & Calvete, 2019) and two daily diary studies (Ciesla et al., 2012; Lucas-Thompson et al., 2021) suggested that key elements of dispositional trait mindfulness and state mindfulness (measured within the daily dairy studies) including, mindful acting with awareness and mindful non-judgment, might not significantly buffer adolescents from mental health problems in the face of life stressors. For

example, greater dispositional mindfulness (Cortazar & Calvete, 2019) and state mindfulness (Lucas-Thompson et al., 2021) did not significantly buffer adolescents from the impacts of life stressors on depression symptoms or psychological distress. Instead, on days when adolescents reported more negative/stressful events, they also experienced significantly lower levels of state mindfulness and consequently, greater psychological distress (Lucas-Thompson et al., 2021). Although mindfulness is associated with a myriad of positive outcomes (e.g., Cortazar & Calvete, 2019; Greco et al., 2011), the buffering effects for adolescents appear to vary.

Mindfulness and Adolescent Development

Variations in the buffering effects of mindfulness for adolescents may be due to factors that are unique to adolescent development. Although adolescents are capable of practicing mindfulness (Galla, 2016; Goodman et al., 2017), the cognitive capacities that support mindfulness are still developing (Dahl, 2004; Steinberg, 2014). In particular, mindfulness is supported by meta-cognitive processes such as executive functioning that support attention allocation and self-regulation of cognition, emotion, and behavior (Jankowski & Holas, 2014). In order to "be mindful," one must exhibit "intentional regulation of attention" (Jankowski & Holas, 2014, p. 4), which highlights both elements of executive functioning and self-regulation. Indeed, one primary task of adolescence is the development and refinement of these meta-cognitive abilities (Dahl, 2004; Steinberg, 2014). As such, it is possible that adolescent mindfulness and the underlying processes that support adolescent mindfulness may not be sufficiently developed to effectively buffer adolescents from the impacts of life stressors to the same extent as adults.

Similarly, the ability to remain mindful during a stressor may be particularly difficult for adolescents. By the age of 16 years, adolescents' cognitive abilities within situations of low

affective arousal are comparable to those of adults (Steinberg, 2005). Under situations of high affective arousal, however, adolescents' cognitive abilities and executive functioning are highly influenced by emotionality and situational factors (Steinberg, 2005; Zelazo & Carlson, 2012). For example, within "hot" situations where emotionality is high, adolescent decision making becomes riskier and more driven by "gut-feelings" (Steinberg, 2005, p. 73). Hot situations and highly stressful circumstances may then contribute to less capacity to remain mindful and regulated in the face of stress. However, research on this notion is extremely limited. Lucas-Thompson and colleagues (2021) were among the first to display that negative/stressful life events can decrease daily mindfulness and contribute to greater erraticism in levels of mindfulness from day-to-day among adolescents. At the daily level, adolescents were not able to remain consistently mindful in the face of daily life stressors (Lucas-Thompson et al., 2021). Taken together, it is a distinct possibility that, unlike adults, stressors may degrade adolescent mindfulness in such a way that mindfulness can no longer provide an effective buffer against stressors, but characterization of momentary stress and mindfulness processes in adolescence is much needed.

Momentary Level Processes

Lucas-Thompson and colleagues (2021) demonstrated that there is an association between life stressors and mindfulness at the daily level for adolescents, but mindfulness not only changes at the daily level, but also from moment-to-moment (Kabat-Zinn, 2003). As a result, there may be important momentary level processes that affect mental health. More specifically, momentary reports of mindfulness are associated with other momentary-level processes that underlie mental health such as affective dynamics (Keng & Tong, 2016) and stress reactivity (Aguilar-Raab et al., 2021; Chin, Slutsky, et al., 2019). Emotional/affective dynamics

such as intensity or stability of emotions are central to psychological health (Keng & Tong, 2016) and momentary reports of mindfulness are associated with more momentary positive affect and less momentary negative affect (Brown & Ryan, 2003; Enkema et al., 2020). In addition, within an observational study of college students, individuals who were more mindful on average were less likely to experience affective instability and less likely to linger on negative emotions within a day (Keng & Tong, 2016). In terms of stress reactivity, adults with greater momentary mindfulness also reported less perceived stress in the same moment as well as lower stress reactivity, from before to after a mindfulness intervention (Aguilar-Raab et al., 2021). Furthermore, individuals with more adaptive affective dynamics and less stress reactivity typically experience better mental health (Keng & Tong, 2016; Romeo, 2010). This literature highlights how momentary mindfulness may be a key process to improve emotional processes and stress reactivity and ultimately contribute to overall more positive mental health. However, it is unclear how life stressors experienced throughout the day impact mindfulness at the momentary-state level. In order to understand the true benefits of mindfulness for health, additional research on how momentary state mindfulness operates within moments of stress is necessary.

Furthermore, momentary reports of both mindfulness and emotion regulation have yielded differential findings than research that utilizes daily level data and retrospective reports of behavior (Enkema et al., 2020; Moore et al., 2016; Shin et al., 2022; Solhan et al., 2009), with differences supporting the importance of momentary methods. For example, within an intervention study for emotionally distressed older adults, momentary reports of mindfulness and symptoms of depression and anxiety were directly compared to retrospective reports of these outcomes (Moore et al., 2016). Significant changes in mindfulness, anxiety and depression from

before to after a mindfulness intervention were noted at the momentary level, but not when these outcomes were reported retrospectively (Moore et al., 2016). Moreover, when daily dairy reports of emotional expression and flexibility, which are central to emotion regulation (Aldao et al., 2015; Gross, 2014), were compared to momentary-level reports, momentary-level reports were significantly associated with anxiety and depression diagnoses and daily diary reports were not associated with these diagnoses (Shin et al., 2022a). Taken together, we know that stressors may degrade adolescent mindfulness at the daily level (Lucas-Thompson et al., 2021) and given the consistent associations between momentary mindfulness and emotion regulation and processes central to mental health (Aguilar-Raab et al., 2021; Brown & Ryan, 2003; Chin, Slutsky, et al., 2019; Keng & Tong, 2016; Shin et al., 2022a), it is important to extend our understanding of this relationship to the momentary-state level. By understanding these relationships at the momentary-state level, we may have greater insight into the protective qualities of momentary-state mindfulness and emotion regulation for adolescent health.

The Need for Ecological Momentary Assessments

This question of how momentary, state-levels of mindfulness and emotion regulation difficulties operate within the context of life stressors is a question that inherently relies on momentary level data. Most current behavioral research relies on retrospective reports of feelings, behaviors, and life experiences that are subject to recall bias and limited ecological validity (Schwarz, 2007). These forms of bias can result in inaccurate data, results, and conclusions about dynamic socio-emotional/behavioral processes as well as difficulties translating findings into real-world settings (Raphael, 1987; Schwarz, 2007; Shiffman et al., 2008). When measuring subjective experiences like the severity of stressors, it is particularly important to use real-time data that can capture an individual's experience within the same

moment an event occurs (Schwarz, 2007). These subjective experiences are often inadequately represented in memory: once the experience ends, it can be difficult to report on the qualities of that experience like the severity or intensity (Schwarz, 2007). The impacts of the stressors, in contrast, may have lingering effects on emotional and behavioral processes throughout the day (i.e., outside of the same moment that the stressor was reported). Although less clear, momentary assessments of stressors indeed have been found to precede and later be associated with negative affect and symptoms of psychological disorders (Gerritsen et al., 2019). In addition, stress is known to have immediate and delayed effects on physiological processes related to cognitive control and emotion regulation (Langer et al., 2021); therefore, it is important to also investigate the effects of stressors outside of the same moment that it occurs.

Taken together, there is a need for research that utilizes ecological momentary assessments (EMA) of behavioral and emotional processes. EMA involves real-time repeated sampling of an individual's experiences within their natural environment (Shiffman et al., 2008). These repeated measurements can reduce recall bias, maximize ecological validity, and answer questions that rely on momentary-level data (Shiffman et al., 2008). Although EMA is ideally suited for investigating how mindfulness and emotion regulation can operate within moments of stress and this methodology can be successfully implemented with adolescents (Goodman et al., 2017; Heron et al., 2017), the implementation of EMA within adolescent MBIs is extremely limited.

The Current Study

The current study aims to fill an important gap in the literature by characterizing the real-time, dynamic relationship between life stressors measured throughout the day at the momentary level, momentary-state mindfulness, and momentary-state emotion regulation difficulties among

adolescents exposed to chronic stressors. Although real-time assessments of the associations among life stressors, mindfulness, and emotion regulation within daily life have been limited (Lucas-Thompson et al., 2021), I hypothesized that life stressors would be associated with mindfulness and emotion regulation difficulties during the same momentary assessments that the stressor was reported. The presence (vs. absence) of life stressors as well as stressor severity (measured continuously) were expected to be associated with lower mindfulness and greater emotion regulation difficulties. Based on literature that suggests that more prolonged and more severe stressors can contribute to greater negative consequences (Yaribeygi et al., 2017), I explored both the presence and absence of a stressor as well as the severity of the stressors. In line with literature that suggests that EMA measurements of stress can have a lagged-effect on emotional processes (Gerritsen et al., 2019; Langer et al., 2021), I also expected for stressors to impact mindfulness and emotion regulation difficulties outside of the moment that it was reported. More specifically, the presence of life stressors compared to the absence as well as greater severity of stressors were hypothesized to be associated with less mindfulness and greater emotion regulation difficulties reported at the next momentary assessment. Importantly, all hypotheses were focused on the momentary-state level, which is also known as the within-person level, as opposed to the aggregated individual level (between-person level). Hypotheses were focused on the momentary-state level because existing literature suggests that understanding momentary-state mindfulness and emotion regulation can provide important insight into bettering mental health (Aguilar-Raab et al., 2021; Brown & Ryan, 2003; Chin, Slutsky, et al., 2019; Keng & Tong, 2016; Shin et al., 2022a). In addition, subjective experiences are often inadequately represented in memory (Schwarz, 2007), and it is important to include momentary assessments of life stressors, mindfulness, and emotion regulation in order to gain a more

accurate picture of true characteristics and process-oriented changes that may occur after experiencing life stressors. Overall, understanding the relationships between life stressors experienced throughout the day, mindfulness, and emotion regulation at the momentary level can provide greater insight into the benefits and buffering effects of mindfulness for adolescents exposed to chronic stressors.

Method

Participants

Participants were a convenience sample of adolescents referred to a community-based mentoring program for exhibiting indicators of risk for not reaching their full potential (e.g., Department of Human Services [DHS]/juvenile-justice involvement, behavioral/emotional problems). A total of N=81 adolescents consented to participate in the research study and completed at least one EMA survey. Adolescents ranged in age from 10-18 years (M_{age}=13.75 years, SD=2.17 years); 56% identified as male (n=45), while 37% identified as female (n=30) and 7% identified as another gender (n=6). A little over half of the adolescents identified as non-Hispanic White (n=46, 57%); 24% identified as Hispanic/Latino (n=19); 7% identified as Native American (n=6); 7% identified as more than race (n=6); and 5% identified as Asian or Pacific Islander or Black/African American (n=4). Three adolescents (4%) dropped out or withdrew from the study at baseline and before the intervention. There were no significant differences in age, income, race, or gender between those who dropped out of the study at baseline (n=3) and those who remained in the study (n=78; ps>.46).

Of those who provided information on a baseline risk assessment (Herrera et al., 2013) (n=76), which assessed environment (e.g., economic adversity, family risk/stress and peer difficulties) and individual (e.g., problem behaviors and mental/health concerns) risk factors,

96% (n=73) reported at least one indicator of risk. Many indicators of individual and environmental risk are also considered to be chronic stressors because they cause stress and persist over time; chronic stressors within this sample include poverty, financial instability, and interpersonal violence (American Psychological Association, 2012; Kim et al., 2013; Thoresen & Eagleston, 1983). Over half of participants' parents/guardians (n=41, 54%) reported that within the last 12 months, their family had experienced difficulties paying bills. Fifty-six percent (n=44) reported that their child had ever been diagnosed with a mental health diagnosis by a therapist or mental health professional. Fifty percent (n=37) reported making less than $40,000 a year and the median household income was in the range of $40,000 to $59,999. Twenty-five percent of families (n=19) reported that their child had seen or experienced many fights within the home over the past 12 months.

Procedure

All procedures were approved by the Colorado State University Institutional Review Board. Adolescents and their parents provided assent and consent, respectively, at their intake meeting with the mentoring program. At baseline and before the mentoring program began, adolescents completed a research visit where they answered baseline survey questions and installed an application called TigerAware (Morrison et al., 2018) onto their cell phones, which was used to collect EMA data. Adolescents without cell phones (n = 16; 20%) were provided with cell phones with parental permission. During the research visit, adolescents were trained in: 1) how to use the application, and 2) how to answer the survey questions. EMA surveys began the day after the research visit. Participants received three surveys per day for a total of seven days, and at each administration, they had up to 30 minutes to answer the survey for that momentary interval. Each survey had the same 13 questions and was estimated to take five

minutes or less to complete. Depending upon how early the participant started and ended school, weekday surveys arrived at random times between after-school hours of 3:00pm-9:00pm, or between before-school hours of 7:00am-8:15am and after-school hours of 4:15pm-9:00pm. On the weekends, surveys arrived at random times between 9:00am-9:00pm. Participants were paid one dollar for each survey completed and if they answered at least 76% of all surveys (i.e., 16 out of 21 surveys), they received a five-dollar bonus. EMA study design and payment were designed to be in line with standard protocols for EMA administration with school-age youth (Heron et al., 2017; Wen et al., 2017).

Measures

Life stressors

To assess for life stressors, participants responded to the question, "In the last hour, has at least one negative event occurred?" Examples of negative events such as getting a bad grade on a test or fighting with their parents/guardians were provided during the baseline visit. If this question was endorsed, adolescents were then asked to rate the event's severity on a scale from 1 ('not at all severe') to 10 ('extremely severe'). In the absence of a life stressor, severity was coded as 0 'not present.' This question is in line with the procedures outlined by Hankin and colleagues (2005). Life stressors were measured dichotomously as presence (1) or absence (0) and continuously (0-10) with higher scores indicating greater severity of life stressors.

Mindfulness

Two key dimensions of mindfulness were assessed: mindful attention or awareness and mindful non-judgment. These two dimensions of mindfulness were selected based upon prior research of daily reports of mindfulness among adolescents (Galla, 2016). Items were drawn from reliable and valid survey measurements of mindfulness and modified to correspond to the

momentary assessment timeframe (Brown & Ryan, 2003; Neff, 2003; Neff et al., 2021). Participants completed the five-item Mindful Attention and Awareness Scale (Brown & Ryan, 2003) to assess for mindful attention/awareness. Participants rated the extent to which they were currently (i.e., at the moment of data collection) experiencing a statement (e.g., "I am preoccupied with the past or future") on a 7-point Likert scale from 1 ('not at all') to 7 ('very much'). Items were revere scored and then averaged. Participants also completed two items from the Self-Compassion Scale for Children-Short Form (Sutton et al., 2018) to assess mindful non-judgment. Participants rated how much each statement (e.g., "I feel understanding and patient with myself") currently applied to them on a 7-point Likert scale from 1 ('not at all') to 7 ('very much'). One item was reverse scored and then the two items were averaged. Higher scores indicate greater (more positive valence) levels of mindful attention/awareness and mindful non-judgment, respectively.

Emotion regulation difficulties

Participants completed four items from the State-Difficulties in Emotion Regulation Scale (S-DERS; Gratz & Roemer, 2004; Lavender et al., 2017). Items with the highest factor loadings on each subscale (i.e., non-acceptance, awareness, modulate, and clarity) from the S-DERS were selected (Lavender et al., 2017). The S-DERS is a valid and reliable measure intended to capture state-based emotion regulation difficulties (Lavender et al., 2017) and it was adapted from the DERS questionnaire (Kaufman et al., 2016), which has been validated for use among adolescents. Participants responded to how much a statement (e.g., "I feel embarrassed for feeling how I feel") currently applied to their emotions. The awareness item was reverse scored, and then an average score was calculated. Higher scores indicate greater (more negative valence) difficulties with emotion regulation.

Data Analysis

Prior to analyses, a lagged variable for mindfulness and emotion regulation difficulties was created such that life stressors reported in one moment predicted mindfulness and emotion regulation difficulties in the next moment. Next, variables were checked for non-normality; mindfulness, difficulties with emotion regulation, and severity of life stressors were all significantly skewed and, therefore, a Bayesian estimator was used within all analyses because it is robust to non-normality (Asparouhov & Muthén, 2010).

After checking for non-normality, I investigated the intraclass correlations (ICC) with an intercept only, unconditional random effects model to determine if multilevel modeling was appropriate. ICCs describe the proportion of variance in a variable that can be explained by the grouping variable, in this case, by participant. The ICCs were all above .05 (Table 1) and the assumption of independence was likely violated; therefore, multilevel modeling was used to account for the dependency in the nested data (Kreft & De Leeuw, 1998). As such, multilevel structural equation modeling (MSEM) was used to investigate the associations among life stressors, mindfulness, and emotion regulation difficulties at the momentary-state level (Figure 1). MSEM is extremely flexible and capable of handling missing data and intensive repeated measurements across multiple levels of data (Curran, 2003; Hox, 2013; Mehta & Neale, 2005). MSEM also allows for the disaggregation of between and within-person level effects (Curran, 2003), which is important because it allows for investigations of the momentary level effects (at the within-person level) as opposed to the average trait level effects at the individual (between-person) level (Figure 2). More specifically, the study design is a two-level random effects MSEM model with momentary assessment as level one (within-person) and individual as level two (between-person), which is in line with past EMA research (Curran, 2003; Prince et al.,

2019). Analyses of processes that occur within the same moment (concurrent) and the next moment (prospective) were conducted separately. Although all hypotheses are about the momentary state level, which is also known as the within-person level, all variables were allowed to vary at the momentary (within-person; level 1) and individual level (between-person; level 2) because past research suggests that mindfulness and emotion regulation difficulties can vary between people and within people (Lucas-Thompson et al., 2021; Shin et al., 2022).

It is also important to note that within all models, cohort (online vs. in-person) was added as a control variable. In addition, under the assumption that data were missing at random (Rubin, 1976), missing data were handled by using Bayesian estimation. Bayesian estimation uses full information from all observations as non-informative priors and is robust to non-normality (Asparouhov & Muthén, 2010), but given the creation of a random slope, model fit statistics were not provided (Muthén, L.K. and Muthén, 2017). In addition, 95% Bayesian Credible Intervals (95% CI) were calculated to determine the true value of a parameter with 95% probability. All analyses were conducted within Mplus version 8.9 (Muthén, L.K. and Muthén, 2017).

Results

Eighty-one participants provided a total of 1,186 total data points at baseline. The average cluster size was 14.64, which indicates that the average number of surveys completed was approximately 70% or 14 out of 21 total surveys. The number of completed EMA surveys at baseline was not associated with age, race/ethnicity, income or gender identity (ps>.59).

Same Moment

At the momentary (within-person) level, the presence compared to the absence of life stressors was significantly and inversely associated with mindful attention/awareness (B = -.14,

SE = .04, p <.001, 95% CI [-.22, -.07]) and mindful non-judgment (B = -.18, SE = .03 , p <.001, 95% CI [-.25, -.11]) and positively associated with emotion regulation difficulties (B = .22, SE = .03, p <.001, 95% CI [.15, .28]) concurrently when controlling for cohort (online vs. in-person). In other words, in moments when adolescents reported stressors, they also reported lower mindful attention and mindful non-judgment as well as higher emotion regulation difficulties relative to when adolescents did not report momentary stressors.

The severity of life stressors also was significantly and inversely associated with mindful attention/awareness (B = -.15, SE = .05, p <.001, 95% CI [-.25,-.06]) and mindful non-judgment (B = -.23, SE = .04, p <.001, 95% CI [-.31,-.15]) and positively associated with emotion regulation difficulties (B =.26, SE = .04, p <.001, 95% CI [.17, .34]) concurrently when controlling for cohort. In moments where there were stressors with greater severity compared to less severity, adolescents reported lower mindful attention/awareness and lower mindful non-judgment as well as greater emotion regulation difficulties.

Next Moment

The presence compared to the absence of life stressors was not significantly prospectively, from one moment to the next, associated with mindful attention/awareness (B = -.04, SE = .03, p =.077, 95% CI [-.11, .02]), mindful non-judgment (B = -.02, SE = .04, p = .323 , 95% CI [-.09, .05]), or emotion regulation difficulties (B = .05, SE = .04, p = .101, 95% CI [-.03, .11]) when controlling for cohort. The severity of life stressors also was not significantly prospectively associated with mindful attention/awareness (B = -.05, SE = .04, p =.113 , 95% CI [-.14, .03]), mindful non-judgment (B = -.004, SE = .04, p = .47, 95% CI [-.08, .09]), or emotion regulation difficulties (B = .07, SE = .05, p =.058, 95% CI [-.02, .16]) when controlling for cohort. In other words, there were no significant associations between life stressors reported

within one moment and mindfulness or emotion regulation difficulties reported within the next moment.

Discussion

The goal of this study was to understand the dynamic relationships of momentary life stressors with momentary mindfulness and emotion regulation difficulties among adolescents exposed to chronic stressors. Previous research suggests that chronic stress may profoundly impact an adolescent's regulatory capacities (Sheth et al., 2017) and that greater mindfulness may help to buffer against these negative impacts of stress (Creswell & Lindsay, 2014). However, a relatively untested assumption of the mindfulness stress buffering hypothesis is that adolescents can maintain mindfulness during moments of stress (Lucas-Thompson et al., 2021). Results within this paper, which are focused on momentary level effects, revealed that this buffering assumption may, in part, be unsupported when mindfulness is untrained. Findings instead suggest that momentary stressors relate to lower mindfulness and greater emotion regulation difficulties concurrently, but not prospectively from one moment to the next moment in adolescents' daily lives. Results of this study provide important knowledge related to the stress buffering effects of mindfulness as they highlight that adolescents may have difficulty practicing mindfulness within moments of stress. This study also provides insight into the acute effects of life stressors for adolescents exposed to chronic stressors.

In line with my hypotheses, both the presence as compared to the absence of life stressors as well as stressors with greater severity related to significantly lower mindful attention and mindful non-judgment as well as greater emotion regulation difficulties, concurrently within the same moment. In other words, it may be particularly difficult for adolescents to remain mindful and regulate their emotions while experiencing a life stressor. These findings are supported by

research which suggests that the brain regions that support mindfulness and emotion regulation such as the prefrontal cortex are still developing (Dahl, 2004; Steinberg, 2014) and under situations of high affective arousal, adolescents' cognitive abilities and executive functioning can be highly influenced by emotionality and situational factors (Steinberg, 2005; Zelazo & Carlson, 2012). As such, during more stressful situations, adolescents may have a diminished ability to maintain mindfulness and regulate their emotions. These findings also extend existing literature that identified similar relationships between life stressors and mindfulness at the daily level (Lucas-Thompson et al., 2021) by highlighting how these relationships can exist at the momentary level among not just mindfulness, but also with emotion regulation. Importantly, mindfulness and emotion regulation vary from moment-to-moment (Bai et al., 2020; Kabat-Zinn, 2003) and influence key dimensions of mental health such as affective dynamics (Keng & Tong, 2016), stress reactivity (Aguilar-Raab et al., 2021; Chin, Slutsky, et al., 2019), and mental health diagnoses (Moore et al., 2016; Shin et al., 2022). Given the associations between momentary mindfulness and emotion regulation with mental health as well as research that suggests stress can degrade health (for a review see: Thoits, 2010), results of this study add essential information by demonstrating that greater levels of stress are associated with lower momentary mindfulness and emotion regulation. Additional tests which investigate associations among these variables using mediation (i.e., exploring how life stressors may ultimately contribute to negative health outcomes through lower mindfulness and greater emotion regulation difficulties) will be necessary within future research in order to understand causal processes.

There are several important potential takeaways of these results. First, these results highlight how functional mindfulness, or mindfulness applied within everyday contexts, may require some element of training in order to be beneficial or helpful within moments of stress.

More specifically, adolescents within this study did not receive any training in mindfulness practices before providing EMA surveys. Given literature that suggests that the regions of the brain that support mindfulness and emotion regulation are still developing during adolescence as well as existing evidence which also found that mindfulness may not be sufficiently developed to effectively buffer adolescents from the impacts of life stressors at the daily level (Lucas-Thompson et al., 2021), training may be particularly necessary. Theoretically, training can improve stress management (Johnston & Cannon-Bowers, 1996) and the application of new skills during stressful circumstances (Collyer & Malecki, 1998; Salas et al., 2012). Therefore, training in mindfulness may help to improve the application of functional mindfulness during moments of stress.

Second, findings from this study provide preliminary evidence for one way that health disparities may develop at the micro level, which can help to inform future intervention efforts. A robust body of literature suggests that the negative effects of stress on health may be particularly pronounced for those from lower socioeconomic backgrounds given disproportionate experiences of social, economic, and political stressors that can ultimately contribute to preventable differences in mental and physical health problems (e.g., Bradley & Corwyn, 2002; Pampel et al., 2010; Thoits, 2010). The findings of this study add to this literature as they display how momentary level life stressors may be a functional antecedent to mental and physical health problems given the associations among life stressors, lower mindfulness, and greater emotion regulation among adolescent participants from predominately lower socioeconomic backgrounds. Interventions aimed at alleviating health disparities may benefit from incorporating this knowledge into intervention planning and design in order to ensure that intervention components target momentary-level antecedents. Taken together, it will be important to test

these potential implications by investigating if an intervention such as mindfulness training may alter the relationships between life stressors, mindfulness, and emotion regulation difficulties at the momentary-state level (see Study 2).

Unexpectedly, life stressors were not associated with mindfulness or difficulties with emotion regulation prospectively, such that life stressor presence nor severity reported in one moment was not associated with mindfulness/emotion regulation reported within the next moment. These findings are in contrast with existing research that suggests stressors can have delayed effects on emotional and physiological processes (Gerritsen et al., 2019; Langer et al., 2021). Given the significant concurrent associations, life stressors may have a more immediate effect on mindfulness and emotion regulation rather than a delayed effect. In addition, previous literature has focused on the delayed effects of stress on negative affect, symptoms of psychological disorders, and physiological markers of stress such as increases in diurnal cortisol (Gerritsen et al., 2019; Langer et al., 2021). Although mindfulness and emotion regulation are related to these constructs (Brockman et al., 2017; Langer et al., 2021), they are distinct emotional/behavioral processes and, therefore, life stressors may influence mindfulness and emotion regulation differentially. Importantly, however, greater trait and momentary-state mindfulness and emotion regulation are associated with mental health (Enkema et al., 2020; Shin et al., 2022); as a result, this finding may help to explain the delayed effects of life stressors on symptoms of psychological disorders. In other words, there may be an indirect effect of life stressors on health outcomes through more acute, momentary changes in mindfulness and emotion regulation. Another possibility that immediate effects, but not short-term, delayed effects, were observed may relate to the fact that adolescents within this sample were exposed to chronic stressors. Given the reoccurring nature of chronic stressors, it may make the current

moment stressor most predictive of lower mindfulness and greater emotion regulation difficulties as opposed to a stressor that occurred hours before. Alternatively, more advanced modeling of these processes may be necessary to understand the delayed effects of life stress on mindfulness and emotion regulation. For example, dynamic structural equation modeling (DSEM), which combines multi-level modeling, time series analysis, and time-varying effects modeling to appropriately model repeated measurements across a week may more accurately portray these relationships given its strength in modeling autoregressive parameters of how a current state is predicted by previous states or time points (Asparouhov et al., 2018) and ability to overcome Nickell bias (i.e., a correlation between regressor and error, which can be created when lagging a dependent variable; Nickell, 1981). Within future work, it will be helpful to investigate these questions by comparing the effects of life stressors on different emotional/behavioral processes and by modeling these relationships using more advanced analytical approaches that take time across the entire week into account.

Limitations and Additional Future Directions

Although this study contributes valuable information about the relationships of momentary stressors with mindfulness and emotion regulation among adolescents within daily life, there are several important limitations to consider. First, this study did not include 'time' as a predictor in the models and, therefore, dynamic processes that occurred across a week could not be investigated. Although the current analytic approach is appropriate to understand momentary level processes (Curran, 2003; Hox, 2013; Mehta & Neale, 2005), it will be important to explore how these dynamic relationships change across the course of a week given research which suggests that stress and stress reporting may be experienced differently across a week (i.e., there can be higher and more frequent reports of stress on weekdays compared to

weekends; Zawadzki et al., 2019). Second, this was a sample of adolescents from predominately lower socioeconomic backgrounds who have experienced self-identified environmental and individual risk factors such as economic adversity, family risk/stress, peer difficulties and mental/health concerns. Given the characteristics of the current sample, results may not be generalizable to samples with higher socioeconomic status and lower risk factors. Third, previous experience with mindfulness was not included as a control variable within analyses and hypotheses about trained versus untrained mindfulness may be speculative. Moreover, given the fact that most significant results were concurrent or occurring within the same moment, casual claims cannot be made. A lack of prospective findings highlight potential issues with directionality as mindfulness may shape appraisals of whether or not something is stressful (Garland et al., 2011). Within future work, it may be important to test these potential bi-directional relationships in order to clarify any questions related to directionality.

Conclusion

In the current study, the presence of life stressors and stressors with greater severity were related to less mindfulness and greater emotion regulation concurrently, but not prospectively among a sample of adolescents facing chronic stressors. The results of this study help to test an assumption of the mindfulness stress buffering and provide evidence that it may be difficult for adolescents to remain mindful and regulated within moments of stress. The findings highlight how mindfulness training may be necessary in order to change the function and accessibility of mindfulness for adolescents within moments of stress, particularly for those youth who are facing high levels of chronic stress. The results also point to specific mechanisms such as lower mindfulness and greater emotion regulation difficulties by which life stressors can degrade health at the micro-level. This knowledge can help to inform intervention planning, design, and analysis

of effects as it highlights how intervention effects will need to target and investigate micro-level processes. For example, within the current study, stressors with greater severity were related to lower mindfulness and greater emotion regulation difficulties at the momentary level; it will be important to test whether or not interventions can alter these momentary relationships. Within future work, it will also be important to model these relationships using additional advanced analytic approaches like DSEM and explore whether or not mindfulness training may help to alleviate the effect of life stressors on mindfulness and emotion regulation.

Chapter 2: Investigating the Role of Mindfulness Training Using Ecological Momentary Assessment Among Adolescents Exposed to Chronic Stressors

Adolescents embedded in communities with high exposure to chronic stressors (e.g., financial instability, interpersonal/community violence) are at high risk for developing mental and physical health problems (Sheth et al., 2017). Exposure to chronic stressors is a well-documented risk factor for the development of elevated anxiety and depression symptoms (Grant et al., 2004; Thoresen & Eagleston, 1983). Research suggests that chronic stressors can induce changes in neurobiological and behavioral constructs such as impairments in emotion regulation, which contribute to the development of anxiety and depression (Sheth et al., 2017). The capacity for emotion regulation and broader self-regulation increases across adolescence, corresponding with the development of the prefrontal cortex of the brain (Sheth et al., 2017; Steinberg, 2014). Exposure to chronic stressors can have negative impacts on this developing neural circuitry, which may then contribute to the onset of mental health problems and ensuing physical health concerns (Sheth et al., 2017; Suglia et al., 2016). Despite knowledge about risk factors and the long-term consequences of adolescent mental health problems (Lancefield et al., 2016), rates of adolescent anxiety and depression have continued to increase over the past decade (Bitsko et al., 2018; Perou et al., 2013). This pattern highlights that there is an unmet need for additional research on ways of protecting adolescents from the negative impacts of chronic stressors. Extant research suggests that mindfulness-based interventions (MBIs) may be an effective approach for improving coping and mental health among adolescents exposed to adversities and at-risk for poor future outcomes such as not graduating from high school (Rawlett & Scrandis, 2015). Despite strong theoretical underpinnings (Kabat-Zinn, 2003; Rawlett & Scrandis, 2015), this work is in the early stages and the data that do exist have not fully elucidated how MBIs may

alter the impact of stressors in one's daily life (Bai et al., 2020; Rawlett & Scrandis, 2015). The current study aims to fill these gaps in the literature by incorporating real-time assessment of life experiences and behaviors in order to understand the potential benefits of MBIs for adolescents exposed to chronic stressors.

Mindfulness, Stressors, and Emotion Regulation

According to the mindfulness stress buffering hypothesis, mindfulness is most beneficial under conditions of high stress; therefore, populations that experience chronic stressors may benefit most from mindfulness (Creswell & Lindsay, 2014). Greater dispositional mindfulness, a trait-like characteristic of paying attention, on purpose, to the present moment with non-judgment (Brown & Ryan, 2003), has been shown to reduce one's reactivity to stressors (Creswell & Lindsay, 2014) and buffer against the harmful effects of stressors (Cortazar & Calvete, 2019; Lucas-Thompson et al., 2021). Mindfulness is expected to have these buffering effects by mitigating stress reactivity and by altering stress-related pathways that are associated with emotion regulation (Creswell & Lindsay, 2014).

Emotion regulation is central to stress processes and mental health because it is the process through which individuals effectively manage and express their emotions (Gross, 2014). Individuals who experience difficulties effectively regulating their emotions often experience distress in the form of anxiety and depression over time (Aldao et al., 2010). Furthermore, exposure to high levels of prolonged stress or chronic stressors can result in neural changes that contribute to emotion regulation difficulties (Sheth et al., 2017). Greater emotion regulation difficulties then contribute to the development and exacerbation of mental health problems (Aldao et al., 2010; Zeman et al., 2006). In theory, practicing mindfulness interrupts these processes by increasing the recruitment and activation of prefrontal regulatory regions of the

brain that control emotion regulation (Creswell & Lindsay, 2014). The activation of adaptive emotion regulation has then been shown to contribute to clinical improvements in anxiety and depression (Chambers et al., 2009; Pepping et al., 2016). As such, mindfulness may provide adolescents exposed to chronic stressors with an important buffer during times of stress.

Although mindfulness may be particularly well suited to help adolescents exposed to chronic stressors, several lines of theoretical and observational evidence suggest that adolescents may not always be capable of remaining mindful and regulated during life stressors without mindfulness training (Bai et al., 2020; Lucas-Thompson et al., 2021; Steinberg, 2005). Life stressors can degrade meta-cognitive processes associated with mindfulness and emotion regulation (Sheth et al., 2017; Shields et al., 2016). Within situations of high emotional arousal, adolescents' cognitive abilities and executive functioning can also be significantly influenced by emotionality and situational factors (Steinberg, 2005; Zelazo & Carlson, 2012). As such, stressors characterized by high levels of perceived stress may uniquely degrade adolescents' mindfulness and emotion regulation. Furthermore, adolescents are still developing the cognitive capacity for mindfulness (Jankowski & Holas, 2014; Steinberg, 2014) and without training, mindfulness may not be sufficiently developed to effectively buffer adolescents from the impacts of stressors. Recent evidence from an observational cohort of adolescents supports this notion; daily stressors were found to degrade adolescent daily mindfulness (when mindfulness was untrained) and contribute to greater daily psychological distress (Lucas-Thompson et al., 2021). In addition, when the severity of life stressors was greater than usual for college students, college students reported more negative emotions and poorer state emotion regulation within daily life (Bai et al., 2020). Thus, in contrast to adults (Bergin & Pakenham, 2016; Bränström et al., 2011; Cole et al., 2015; Dixon & Overall, 2016; van Son et al., 2015), adolescents may not be typically,

developmentally capable of remaining mindful and regulated during more severe life stressors without mindfulness training.

Mindfulness-Based Interventions (MBIs)

Training may be essential to alter the effects that life stressors can have on adolescent mindfulness and emotion regulation difficulties. In general, practice can be an important element of stress management (Johnston & Cannon-Bowers, 1996) and as individuals learn how to effectively use and apply new skills, they can theoretically become more effective at using them under stressful circumstances (Collyer & Malecki, 1998; Salas et al., 2012). Likewise, training in mindfulness may be necessary for adolescents to utilize the benefits of mindfulness (i.e., greater mindful awareness and emotion regulation) when faced with life stressors that are typically experienced throughout the day. MBIs were designed to provide individuals with training in mindfulness through formal practices such as mindful movement, body scans, and sitting meditations (Cullen, 2011; Kabat-Zinn, 2003). Through these experiences, individuals are provided with opportunities to practice and cultivate mindfulness through different activities related to daily life including during daily life stressors (Cullen, 2011). In other words, MBIs provide explicit training and practice related to remaining mindful during life stressors that may be experienced throughout the day, which may be beneficial for adolescents.

MBIs have been shown to produce a wide range of health benefits for adolescents (Dunning et al., 2019; Kostova et al., 2019; Lin et al., 2019). They are thought to exert such benefits on health through the enhancement of mindfulness and one's regulatory abilities, such as improvements in emotion regulation (Kostova et al., 2019). Research supports this notion as MBIs for adolescents result in reductions in adolescents' trait-levels of emotion regulation difficulties (Lin et al., 2019), increases in dispositional mindfulness (Bluth et al., 2016; Dunning

et al., 2019), and ultimately improvements in mental and physical health (Bluth et al., 2016; Dunning et al., 2019; Kallapiran et al., 2015; Shomaker et al., 2019). For adolescents experiencing problem behaviors, delinquency, mental health problems, and poor academic achievement, similar findings have been observed (Rawlett & Scrandis, 2015). A review of the literature on the use of MBIs with adolescents at-risk for poor future outcomes such as poor academic achievement suggests that MBIs can be effective at reducing stress and increasing mindfulness (Rawlett & Scrandis, 2015). Furthermore, MBIs appear to be influential in reducing emotion regulation difficulties (Miller et al., 2021) and depression symptoms (Bluth et al., 2015; Sibinga et al., 2016) as well as improving coping skills (Sibinga et al., 2013, 2016) among adolescents at-risk for behavioral, emotional, and academic concerns. However, extant work on adolescent MBIs have limited utilization of randomized designs or active controls (Dunning et al., 2019; Rawlett & Scrandis, 2015). Without a randomized design, the reliability and effectiveness of these interventions remains unclear. When investigating the benefits of MBIs, an active control where participants receive a known effective treatment is also important to identify the efficacy of the intervention (Dunning et al., 2019). Taken together, initial studies suggest that mindfulness training results in improvements in mindfulness and emotion regulation for adolescents exposed to various difficulties, but additional work utilizing randomized controlled designs with an active control is necessary.

Traditional Assessment Techniques

In addition, most of the evidence on MBI effects among adolescents utilizes traditional assessment techniques and retrospective self-reports that are reported before and after an intervention (Bai et al., 2020; Galla, 2016). These measures are helpful in characterizing average, trait-like levels of emotional and behavioral factors, but they are subject to limited ecological

validity and high recall bias, and as such, they may miss valuable information about multi-faceted, dynamic processes like mindfulness and emotion regulation in real life experiences (Raphael, 1987; Schwarz, 2007; Shiffman et al., 2008). Furthermore, data provided from traditional assessment techniques do not allow for investigations of process-oriented changes that can occur in response to stimuli like life stressors (e.g., fighting with parents or getting a bad grade on a test) as most current data can only assess average levels of change over time. It is important to understand responses to stimuli like life stressors because changes in emotions, thoughts, and feelings can occur after stressful events and sometimes impact mental health (Bai et al., 2020; Lucas-Thompson et al., 2021; Steinberg, 2005; Zelazo & Carlson, 2012). In order to investigate how mindfulness training can alter responses to life stressors that individuals can experience throughout the day, it is necessary to go beyond these traditional assessment techniques.

Innovative Alternatives: Ecological Momentary Assessments Within MBIs

Assessment techniques that allow for measurements of behavioral and emotional processes in individuals' daily lives such as ecological momentary assessments (EMA) offer an alternative to traditional assessment techniques. EMA can minimize recall bias, maximize ecological validity, and help to investigate responses to stimuli like life stressors (Bai et al., 2020; Schwarz, 2007). Responses to stressors often occur at the momentary, state-level as opposed to at the overall trait-level. Both emotion regulation and mindfulness can change from moment-to-moment (Bai et al., 2020; Kabat-Zinn, 2003; Lavender et al., 2017) and once a subjective experience ends, it can in difficult to fully report weeks or months later on all of the qualities of that experience (Schwarz, 2007). Therefore, it is important to incorporate momentary assessments of these processes. EMA has indeed been used to identify that mindfulness training

helps to improve the depletion of state emotion regulation among college students when experiencing various daily life stressors as compared to a wait-list control (Bai et al., 2020). Within three randomized controlled trials, mindfulness training for stressed community adults (Chin, Lindsay, et al., 2019; Lindsay et al., 2018; Moore et al., 2016) and emotionally distressed older adults (Chin, Lindsay, et al., 2019; Lindsay et al., 2018; Moore et al., 2016) was also shown to improve momentary reports of depression, anxiety, positive and negative affect, and mindfulness. Although EMA has been successfully implemented with adolescents (Heron et al., 2017) and there has been a call to use EMA within investigations of adolescent MBIs (Goodman et al., 2017), the incorporation of EMA within adolescent MBIs has been limited. Taken together, it is necessary to apply EMA to understand how mindfulness training may alter the effects of life stressors on mindfulness and emotion regulation difficulties.

The Current Study

The current study utilized EMA to identify how mindfulness training may alter the associations of life stressors (measured throughout the day) with mindfulness and emotion regulation difficulties at the momentary-state level within the context of a randomized controlled trial for adolescents exposed to chronic stressors. Adolescent participants were randomized to receive mindfulness training or an active control. Mindfulness training was offered for 30 minutes within the context of a youth mentoring program; those assigned to the active control condition received the mentoring program as usual (without the 30-minute MBI). In line with existing literature that suggests the MBIs can improve trait levels of mindfulness and emotion regulation (Bluth et al., 2015; Cotton et al., 2016; Miller et al., 2021) as well as ameliorate the depletion of state emotion regulation difficulties during life stressors (Bai et al., 2020), I hypothesized that there would be weaker associations between 1) life stressors and state

mindfulness and 2) life stressors and state emotion regulation difficulties measured at mid-intervention and at post-intervention (compared to pre-intervention) as well as at post-intervention when compared to mid-intervention, among adolescents who received the MBI (MBI+mentoring) compared to the active control (mentoring-alone). For those in the active control group of mentoring-alone, I expected for these associations to remain strong. In other words, for those who do not receive mindfulness training, stressors would degrade state mindfulness and emotion regulation. For those who received mindfulness training, stressors would not degrade state mindfulness and emotion regulation to the same extent. All hypotheses were focused on the momentary-state level (within-person) as opposed to the individual level (between-person) based on literature which suggests that both mindfulness and emotion regulation change from moment-to-moment (Bai et al., 2020; Kabat-Zinn, 2003; Lavender et al., 2017) and that mindfulness training can alter these state-level processes (Bai et al., 2020; Chin, Lindsay, et al., 2019; Lindsay et al., 2018; Moore et al., 2016). Taken together, this study aims to clarify how mindfulness training may alter the impacts that life stressors (experienced throughout the day) may have on momentary-state mindfulness and emotion regulation difficulties in order to determine the benefits of mindfulness training for adolescents exposed to chronic stressors.

Method

Participants

A convenience sample of adolescents referred to a community-based mentoring program for exhibiting indicators of risk for not reaching their full potential (e.g., Department of Human Services [DHS]/juvenile-justice involvement, behavioral/emotional problems) were invited to participate in a larger randomized control trial (Miller et al., 2021). Inclusion criteria for the larger study were enrollment in the mentoring program, being between the ages of 10-18 years

old and being English-speaking (in order to participate in group programming with peers that was facilitated in English). A total of N=81 adolescents (M_{age}=13.75 years, SD=2.17 years) consented and provided at least one EMA data point. Slightly fewer females (37%, n=30) than males participated in the study; 7% identified as another gender (n=6). Adolescents identified as non-Hispanic White (n=46, 57%), Hispanic/Latino (n=19; 24%), Native American (n=6; 7%), Asian/Pacific Islander or Black/African American (n=4; 5%), or more than race (n=6; 7%). Five adolescents (6%) dropped out or withdrew from the study. There were no significant differences in age, income, race, or sex between those who completed the study (n=76) versus those who dropped out of the study (n=5; ps>.16).

This sample demonstrated significant socio-emotional and behavioral vulnerabilities, which were also considered to be indicators of chronic stressors (American Psychological Association, 2012; Kim et al., 2013; Thoresen & Eagleston, 1983) through completion of a baseline risk assessment (Herrera et al., 2013). The baseline risk assessment measured environmental and individual risk factors that have been associated with an increased likelihood of future problems such as crime and unemployment (Herrera et al., 2013). Of those who provided information (n=76), the majority (n=73; 96%) reported at least one indicator of risk. Most participants indicated that within the past 12 months, their family had experienced difficulties paying bills (n=41; 54%). Many also reported being diagnosed with a mental health diagnosis by a therapist or mental health professional (n=44; 56%). Similarly, 50% of families (n=37) reported making less than $20,000 a year and the median household income was in the range of $40,000 to $59,999. Twenty-five percent (n=19) reported that their child had seen or experienced many fights within the home over the past 12 months.

Procedure

All procedures were approved by the Colorado State University Institutional Review Board. Adolescents and their parents provided assent and consent, respectively, at their intake meeting with the mentoring program. The mentoring program occurred across two nights in the Fall semester of Fall 2021 and three nights in the Spring semester of 2022. Different adolescents were served on different nights of the program such that adolescents participated in only one night of activities. One of the nights was randomized to receive an MBI embedded within the mentoring program (n=38) and the other night(s) received mentoring-alone, which was used as the active control (n=43). Before participating in the program, participants completed a baseline survey as well as one week of EMA. EMA was completed over the course of seven days during which participants received three EMA surveys a day. Each EMA survey had the same 13 questions and was estimated to take five minutes or less to complete. Depending upon how early the participant started and ended school, weekday surveys arrived at random times during after-school hours between 3:00pm-9:00pm or before school-hours between 7:00am-8:15am and after-school hours between 4:15pm-9:00pm. On the weekends, surveys arrived at random times between 9:00am-9:00pm. Once the participant received a notification to complete the survey, they had 30 minutes to respond. Adolescents received one dollar per survey and if they answered at least 76% (i.e., 16 out of 21 surveys), they received a five-dollar bonus. This same EMA procedure was again utilized at mid-intervention, and post-intervention. All EMA procedures were selected to be in line with previous EMA studies with children and adolescents (Heron et al., 2017; Wen et al., 2017).

Participants randomized to receive the MBI participated in nine, 30-minute sessions of Learning 2 Breathe (L2B; Broderick, 2013). L2B is an evidence-based adolescent mindfulness

curriculum intended to enhance emotion regulation with group sessions and activities focused on body awareness, thought awareness, emotion awareness, attention to the body, thoughts and emotions, and tenderness or non-judgment. L2B was offered during a mentoring program by trained facilitators. To fit within the context of the mentoring program, modifications to timing and activities were made by individuals certified as L2B trainers and approved by individuals certified as master trainers of L2B. Although all adolescents participated in mentor–mentee activities to build positive relationships, support academic success, and explore prosocial interests (for a full description, see Haddock et al., 2013; Weiler et al., 2013), the mentoring-alone group received an extra 30 minutes of this program as opposed to the 30-minute L2B program. One cohort of adolescents (n=44) participated in activities online while the other cohort (n=37) participated in-person. This was an unplanned adjustment due to COVID-19, a global pandemic that forced many schools, workplaces, and interventions online. The average number of attended sessions was 7.61 (85%) out of a total of 9 sessions. In addition, 62 adolescents (77%) participated in at least 7 sessions, which suggests that there were adequate rates of attendance.

Measures

Life stressors

In line with procedures outlined by Hankin and colleagues (2005), participants responded to the question, “In the last hour, has at least one negative event occurred?” Examples of negative events such as getting a bad grade on a test or fighting with parents were provided during the baseline visit. If this question was endorsed, adolescents then rated the event’s severity on a scale from 1 (‘not at all severe’) to 10 (‘extremely severe’). In the absence of a life stressor, severity was coded as 0 ‘not present.’ Life stressors were measured dichotomously as

the presence (1) and absence (0) of a life stressor as well as continuously with the severity ratings of each stressor; higher scores indicate greater severity of life stressors.

Mindfulness

In line with existing research on daily reports of adolescent mindfulness (Galla, 2016), two key dimensions of mindfulness were assessed: mindful attention/awareness and mindful non-judgment. To assess for mindful attention/awareness, participants completed the five-item Mindful Attention and Awareness Scale (Brown & Ryan, 2003). Participants rated the extent to which they currently (i.e., at the moment of data collection) experienced a statement (e.g., "I am preoccupied with the past or future") on a 7-point Likert scale from 1 ('not at all') to 7 ('very much'). Items were revere scored and then an average score was calculated. To assess for mindful non-judgment, participants completed two items from the Self-Compassion Scale for Children-Short Form (Sutton et al., 2018). Participants rated how much each statement (e.g., "I feel understanding and patient with myself") currently applied to them on a 7-point Likert scale from 1 ('not at all') to 7 ('very much'). One item was reverse scored and then averaged. Higher scores (more positive valence) indicate greater levels of mindful attention/awareness and mindful non-judgment, respectively.

Emotion regulation difficulties

To assess for emotion regulation difficulties, participants completed four items from the State-Difficulties in Emotion Regulation Scale (S-DERS; Gratz & Roemer, 2004; Lavender et al., 2017). Items with the highest factor loadings on each subscale (i.e., non-acceptance, awareness, modulate, and clarity) from the S-DERS were selected (Lavender et al., 2017). The S-DERS is a valid and reliable measure of state-based emotion regulation difficulties (Lavender et al., 2017) and it was adapted from the DERS (Kaufman et al., 2016), which has been validated

for use among adolescents. Participants responded to how much a statement (e.g., "I feel embarrassed for feeling how I feel") currently applied to their emotions. Relevant items were reverse scored, and an average score was calculated with higher scores (negative valence) indicating greater difficulties with emotion regulation.

Data Analysis

Prior to analyses, variables were checked for non-normality; mindfulness, difficulties with emotion regulation, and severity of life stressors were all significantly skewed and, therefore, a Bayesian estimator was used within all analyses to account for non-normality (Asparouhov & Muthén, 2010).

After checking for non-normality, I analyzed intraclass correlations (ICCs) with an intercept only, unconditional random effects model to determine if multilevel modeling was appropriate. The grouping or cluster variable involved in primary analyses was subject. The ICCs were all above .05 (Table 1) and, therefore, the assumption of independence was likely violated (Kreft & De Leeuw, 1998). To account for nesting, multilevel structural equation modeling (MSEM) was used to test the impact of intervention arm [an MBI (i.e., MBI+mentoring) vs. a control (i.e., mentoring-alone)] at 1) mid-intervention and 2) post-intervention compared to baseline in influencing the relationship of life stressors with mindfulness and emotion regulation difficulties (Figure 3 and Figure 4). Mid-intervention was also compared to post-intervention. To make these comparisons, burst was dummy coded (see Table 2 for more information on dummy coded variables) and each model was run twice to analyze all pairwise comparisons. In each model, I tested an interaction term that was created for intervention arm x burst to determine if this predicts the concurrent relationship between life stressors, mindfulness and emotion regulation difficulties at the momentary-state level.

To probe significant interaction terms, simple slopes were analyzed using MSEM with a Bayesian estimator to understand how an MBI compared to a control influenced the relationship between concurrent life stressors, mindfulness, and emotion regulation at baseline, mid-intervention and post-intervention. In addition, an online calculator (Soper, 2023), which relies on t-tests, was used to determine if significant differences existed between two slopes. For example, the calculator was used to understand if the associations between life stressors and mindfulness for those involved in MBI+mentoring at mid-intervention were significantly different from those in the mentoring-alone group at mid-intervention. Of note, Study 1 displayed baseline effects and, therefore, the primary focus of this study was on mid-intervention and post-intervention effects.

Importantly, MSEM is extremely flexible as it allows for nesting, which occurs with repeated measures, and it can handle both dichotomous and continuous predictor variables (Curran, 2003). MSEM also allows for the modeling of measurement error, which is an advantage over traditional multilevel modeling (MLM) because MLM assumes that variables are measured without error (Curran, 2003). The estimation and removal of measurement error from latent variables then allows for unbiased estimates of regression coefficients (Curran, 2003). In addition, MSEM allows for the decomposition of momentary-state level processes from the average individual level processes (Curran, 2003), which is essential because all hypotheses are at the momentary level. Within this study, the study design was a two-level random effects MSEM model with momentary assessment as level one and individual as level two. Missing data were handled by using Bayesian estimation. Bayesian estimation uses full information from all observations as non-informative priors and is robust to non-normality (Asparouhov & Muthén, 2010), but given the fact that this model includes random slopes, model fit statistics were not

available (Muthén, L.K. and Muthén, 2017). In addition, 95% Bayesian Credible Intervals (95% CIs) were calculated to determine the true value of a parameter with 95% probability. All analyses were conducted within Mplus version 8.9 (Muthén, L.K. and Muthén, 2017) and included cohort (online vs. in-person) to control for any potential differences between the two cohorts. However, cohort was not included as a grouping variable because ICCs that included cohort as the grouping variable were below .05.

Results

Eighty-one participants provided a total of 3,178 total data points. The average cluster size was 14.64 at baseline, 14.96 at mid-intervention, and 14.28 at post-intervention, which indicates that adolescents completed approximately 68%-71% of surveys (out of 21) at each time point. In addition, the number of completed EMA surveys across the entire study was not associated with age, race/ethnicity, income or gender identity (ps>.23).

Presence vs. Absence of Life Stressors and Mindfulness

Within-person main effects

When controlling for arm, burst, and cohort, the presence vs. the absence of life stressors was inversely associated with mindfulness attention/awareness (B = -.18, SE = .02, p <.001, 95% CI [-.22, -.13]) and mindful non-judgment (B = -.20, SE = .02, p <.001, 95% CI [-.24, -.16]).

Between-person main effects

Burst (when mid-intervention was compared to baseline) was significantly and positively associated with the random slope of life stressors predicting mindful attention (B = .70, SE = .12, p <.001, 95% CI [.42, .89]) and mindful non-judgment (B = .56, SE = .19, p =.010, 95% CI [.10, .84]). Burst (when mid-intervention was compared to post-intervention) was also significantly and negatively associated with the random slope of life stressors predicting mindful attention (B

= -.54, SE = .11, p =.001, 95% CI [-.71, -.10]) and mindful non-judgment (B = -.55, SE = .17, p =.011, 95% CI [-.77, -.10]). However, arm was not significantly associated with mindful attention or mindful non-judgment (p's >.35). This suggests that across both arms, the slope between life stressors and mindfulness may be steeper (i.e., suggesting more of an influence of life stressors) at mid-intervention compared to baseline. However, at post-intervention, this slope may be less steep compared to mid-intervention.

Burst x arm as a moderator of the association between life stressors and mindful attention

The random slope of life stressors predicting mindful attention was significantly predicted by the interaction term of burst (baseline, mid-intervention or post-intervention) X arm (MBI+mentoring vs. mentoring-alone) when baseline was compared to post-intervention (B = -.60, SE = .17, p = .009, 95% CI [-.77, -.12]) and when mid-intervention was compared to post-intervention (B = -.63, SE = .06, p <.001, 95% CI [-.74, -.50]). However, the random slope of life stressors predicting mindful attention was not significantly associated with the interaction term of burst X arm when baseline was compared to mid-intervention (B = .15, SE = .23, p = .268, 95% CI [-.31, .57]).

To probe the significant interaction terms, simple slopes revealed that at baseline, life stressors were significantly associated with mindful attention for those in MBI+mentoring (B = -.21, SE = .05, p <.001, 95% CI [-.30, -.10]), but not for those in mentoring-alone (B = -.08, SE = .05, p =.065, 95% CI [-.19, -.02]; Figure 5). At mid-intervention, life stressors were significantly associated with mindful attention for those in the MBI+mentoring group (B = -.18, SE = .06, p =.003, 95% CI [-.29, -.06]) and for those in the mentoring group (B = -.15, SE = .05, p =.002, 95% CI [-.26, -.04]). At post-intervention, however, this relationship was only significant for those in the mentoring-alone group (B = -.18, SE = .08, p =.016, 95% CI [-.33, -.01]), but not for

those in the MBI+mentoring group (B = -.10, SE = .07, p =.10, 95% CI [-.24, .05]; Figure 6). Taken together, this pattern of findings suggests that the presence of life stressors was significantly associated with lower mindful attention at mid-intervention for individuals in both arms. However, at post-intervention, for those who received mindfulness training, life stressors were no longer significantly associated with mindful attention.

Burst x arm as a moderator of life stressors and mindful non-judgment

The random slope of life stressors predicting mindful non-judgment was only associated with the interaction term of burst X arm when baseline was compared to mid-intervention (B = -.58, SE = .18, p =.016, 95% CI [-.78, -.08]). These associations were not significant when baseline was compared to post-intervention (B = -.11, SE = .27, p = .33, 95% CI [-.60, .43]) or when mid-intervention was compared to post-intervention (B = -.34, SE = .27, p = .14, 95% CI [-.74, .19]).

In probing the significant interaction term, results revealed that at baseline, life stressors were negatively associated with mindful non-judgment for those in the MBI+mentoring group (B = -.18, SE = .05, p < .001, 95% CI [-.27, -.09]) and mentoring group (B = -.18, SE = .05, p < .001, 95% CI [-.27, -.08]). Similar trends were observed at mid-intervention. At mid-intervention, life stressors were negatively associated with mindful non-judgment for those in the MBI+mentoring group (B = -.18, SE = .06, p =.003, 95% CI [-.29, -.06]) and mentoring-alone group (B = -.15, SE = .05, p = .002, 95% CI [-.26, -.04])(Figure 7). Although life stressors continued to be negatively and significantly associated with mindful non-judgment in both conditions, the slope for those in mentoring-alone was not as steep at mid-intervention compared to those in MBI+mentoring, which suggests potential buffering effects of mentoring at mid-intervention.

Presence vs. Absence of Life Stressors and Difficulties with Emotion Regulation

Within-person main effects

When controlling for arm, burst, and cohort, the presence vs. absence of life stressors was positively associated with difficulties with emotion regulation (B = .21, SE = .02, p <.001, 95% CI [.17, .24]).

Between-person main effects

Burst (when mid-intervention was compared to baseline) was significantly and negatively associated with the random slope of life stressors predicting difficulties with emotion regulation (B = -.84, SE = .10, p <.001, 95% CI [-.96, -.57]). Arm was also significantly and negatively associated with the random slope of life stressors predicting difficulties with emotion regulation (B = -.25, SE = .01, p =.004, 95% CI [-.44, -.06]).

When comparing mid-intervention to post-intervention, burst was significantly and positively associated with the random slope of life stressors predicting difficulties with emotion regulation (B = .62, SE = .09, p < .001, 95% CI [.41, .78]). Arm was also significantly and negatively associated with the random slope of life stressors predicting difficulties with emotion regulation (B = -.18, SE = .07, p = .002, 95% CI [-.33, -.06]). Collectively, these findings suggest that both arm and burst may significantly and differentially influence the random slope of life stressors predicting difficulties with emotion regulation at mid- and post-intervention.

Burst x arm as a moderator of life stressors and difficulties with emotion regulation

The random slope of life stressors predicting difficulties with emotion regulation was only associated with the interaction term of burst X arm when mid-intervention was compared to post-intervention (B = .65, SE = .07, p < .001, 95% CI [.49, .76]). These associations were not

significant when baseline was compared to mid-intervention (B = .29, SE = .20, p = .08, 95% CI [-.18, .60]) or post-intervention (B = .39, SE = .21, p = .05, 95% CI [-.10, .69]).

To probe the significant interaction term, main effects revealed that at mid-intervention, life stressors were significantly associated with difficulties with emotion regulation for those in mentoring-alone (B = .21, SE = .06, p = .001, 95% CI [.09, .32]), but not for those in MBI+mentoring (B = .09, SE = .05, p = .068, 95% CI [-.03, .18]). Similar relationships existed at post-intervention. At post-intervention, life stressors were significantly associated with difficulties with emotion regulation for those in the mentoring-alone group (B = .20, SE = .07, p = .004, 95% CI [.06, .32]), but not for those in the MBI+mentoring group (B = -.003, SE = .06, p = .45, 95% CI [-.12,.11]; Figure 8). This pattern of findings suggests that at mid-intervention and post-intervention, mindfulness training (compared to mentoring-alone) reduced the "effect" or coupling of life stressors with difficulties with emotion regulation.

Severity of Life Stressors and Mindfulness

Within-person main effects

When controlling for arm, burst, and cohort, the severity of life stressors was negatively associated with mindfulness attention (B = -.22, SE = .03, p < .001, 95% CI [-.28, -.16]) and mindful non-judgment (B = -.25, SE = .03, p < .001, 95% CI [-.31, -.20]).

Between-person main effects

Burst (when mid-intervention was compared to baseline) was significantly and positively associated with the random slope of life stressors predicting mindful attention (B = .78, SE = .1, p < .001, 95% CI [.49, .94]) and mindful non-judgment (B = .62, SE = .20, p = .006, 95% CI [.15, .91]). Burst (when mid-intervention was compared to post-intervention) was also significantly and negatively associated with the random slope of life stressors predicting mindful

attention (B = -.22, SE = .03, p < .001, 95% CI [-.28, -.15]) and mindful non-judgment (B = -.25, SE = .03, p < .001, 95% CI [-.30, -.19]). However, arm was not significantly associated with mindful attention and mindful non-judgment (p's > .28). This pattern of results suggests that across both arms, the slope may be steeper at mid-intervention compared to baseline. However, at post-intervention, this slope may be less steep compared to mid-intervention.

Burst x arm as a moderator of life stressors and mindful attention

The random slope of the severity of life stressors predicting mindful attention was only associated with the interaction term of burst X arm when mid-intervention was compared to post-intervention (B = -2.14, SE = .53, p < .001, 95% CI [3.21, -1.12]). These associations were not significant when baseline was compared to mid-intervention (B = -.15, SE = .25, p = .30, 95% CI [-.57, .39]) or post-intervention (B = -.46, SE = .25, p = .08, 95% CI [-.74, .22]).

Simple slopes used to probe significant interactions revealed that at mid-intervention, life stressors were significantly associated with mindful attention for those in the MBI+mentoring group (B = -.18, SE = .06, p =.003, 95% CI [-.30, -.06]) and for those in the mentoring-alone group (B = -.18, SE = .08, p =.013, 95% CI [-.33, -.03]). At post-intervention, however, this relationship was only significant for those in the mentoring-alone group (B = -.26, SE = .10, p =.004, 95% CI [-.47, -.06]), but not for those in the MBI+mentoring group (B = -.12, SE = .09, p =.093, 95% CI [-.30, .06]; Figure 9). These patterns suggest that adolescents in the MBI+mentoring group may have benefitted at post-intervention as life stressors no longer contributed to significantly lower mindful attention/awareness, whereas those in the mentoring-alone group did not receive such benefits.

Burst x arm as a moderator of life stressors and mindful non-judgment

The random slope of the severity of life stressors predicting mindful non-judgment was not significantly associated with the interaction term of burst X arm, (baseline compared to post-intervention, B = -.51, SE = .26, p =.095, 95% CI [-.76, .20]; baseline compared to mid-intervention, B = -.24, SE = .31, p = .24, 95% CI [-.73, .43]; mid-intervention compared to post-intervention, B = -.50, SE = .20, p = .03, 95% CI [-.73, .01]).

Severity of Life Stressors and Difficulties with Emotion Regulations

Within-person main effects

When controlling for arm, burst, and cohort, the severity of life stressors was positively associated with difficulties with emotion regulation (B = .26, SE = .03, p < .001, 95% CI [.20, .31]).

Between-person main effects

Burst (when mid-intervention was compared to baseline) was significantly and negatively associated with the random slope of life stressors predicting difficulties with emotion regulation (B = -.85, SE = .10, p < .001, 95% CI [-.98, -.58]). Arm was also significantly and negatively associated with the random slope of life stressors predicting difficulties with emotion regulation (B = -.23, SE = .11, p = .02, 95% CI [-.44, -.01]).

When comparing mid-intervention to post-intervention, burst was significantly and positively associated with the random slope of life stressors predicting difficulties with emotion regulation (B = .62, SE = .09, p < .001, 95% CI [.41, .78]). Arm was also significantly and negatively associated with the random slope of life stressors predicting difficulties with emotion regulation (B = -.18, SE = .07, p =.002, 95% CI [-.33, -.06]). Together, these results suggest that

both arm and burst may significantly influence the random slope of life stressors predicting difficulties with emotion regulation at mid- and post-intervention.

Burst x arm as a moderator of life stressors and difficulties with emotion regulation

The random slope of the severity of life stressors predicting difficulties with emotion regulation was only associated with the interaction term of burst X arm when mid-intervention was compared to post-intervention (B = 1.45, SE = .42, p <.001, 95% CI [.68, 2.31]). These associations were not significant when baseline was compared to mid-intervention (B = .45, SE = .18, p = .095, 95% CI [-.76, .20]) or post-intervention (B = .31, SE = .21, p = .09, 95% CI [-.13, .65]).

To probe the significant interaction terms, main effects revealed that at mid-intervention, life stressors were significantly associated with difficulties with emotion regulation for those in the mentoring-alone group (B = .23, SE = .09, p = .008, 95% CI [.03, .40]), but not for those in the MBI+mentoring group (B = .11, SE = .07, p = .062, 95% CI [-.03, .23]). Similarly at post-intervention, life stressors with greater severity were significantly associated with difficulties with emotion regulation for those in the mentoring-alone group (B = .22, SE = .08, p = .007, 95% CI [-.05, .38]), but not for those in the MBI+mentoring group (B = .04, SE = .06, p = .30, 95% CI [-.09, .15]; Figure 10). These patterns suggest that there are potential differences between mindfulness training and mentoring-alone at mid-intervention and post-intervention when investigating the influence of the severity of life stressors on difficulties with emotion regulation.

Discussion

The overarching objective of the current study was to understand how mindfulness training may alter the associations of life stressors with mindfulness and emotion regulation

difficulties at the momentary-state level within the context of a randomized controlled trial for adolescents exposed to chronic stressors. Existing evidence supports the notion that adolescents may have difficulty remaining mindful and regulated during life stressors without formal mindfulness training (Bai et al., 2020; Lucas-Thompson et al., 2021; Steinberg, 2005). Results from the current study suggest that compared to an active control, mindfulness training delivered within a mentoring program does appear to ameliorate the adverse effects of life stressors on mindfulness and difficulties with emotion regulation, particularly at post-intervention. More specifically, at post-intervention, life stressors were not significantly associated with concurrent mindful attention or difficulties with emotion regulation for those who received mindfulness training, but these associations remained significant for those who received mentoring-alone. These findings are meaningful as they demonstrate the possible protective buffering effects of mindfulness training for mindfulness and emotion regulation at the momentary level in youth facing high levels of chronic stress and social adversity.

As supported by existing evidence (Bai et al., 2020; Chin, Lindsay, et al., 2019; Lindsay et al., 2018; Lucas-Thompson et al., 2021; Moore et al., 2016; Steinberg, 2005) and in line with current hypotheses, mindfulness training compared to an active control at mid-intervention and post-intervention significantly influenced the relationships between life stressors, mindfulness, and emotion regulation difficulties. In exploring the influence of mindfulness training on life stressors and mindfulness, the presence as compared to the absence of life stressors as well as the greater severity of stressors were associated with lower mindful attention/awareness for both conditions at mid-intervention. However, at post-intervention, these relationships changed for those who received mindfulness training. At post-intervention, life stressors were no longer

significantly tied to mindful attention for those who received mindfulness training, but for those who received mentoring-alone, life stressors continued to degrade concurrent mindfulness.

Similar findings emerged when exploring the benefits of mindfulness training for difficulties with emotion regulation, but the positive effects were noticed sooner than they were for mindful attention. More specifically, at mid-intervention and at post-intervention, mindfulness training was protective against the negative impacts of life stressors on difficulties with emotion regulation. For those who received mentoring-alone, however, life stressors were associated with greater emotion regulation difficulties at mid-intervention and post-intervention. One explanation for why MBI produced faster results for difficulties with emotion regulation as compared to mindful attention/awareness may be related to the notion that the capacities that support adolescent mindfulness are not fully developed (Dahl, 2004; Steinberg, 2014) and it may take the entire intervention program to truly bolster adolescents' functional mindfulness, mindfulness applied within everyday life. In addition, more immediate effects of mindfulness training for difficulties with emotion regulation supports existing evidence that emotion regulation may be a core underlying mechanism of MBI program effects (Arch & Craske, 2006; Guendelman et al., 2017; Shapiro et al., 2006). More immediate improvements in emotion regulation may help to explain temporal changes in mental and physical health following an MBI. This finding may also be explained by literature which suggests that cultivating and practicing mindfulness can alter how individuals report on their own mindfulness (Goodman et al., 2017); individuals with mindfulness training may be more aware of their "wandering mind" and rate themselves lower in mindfulness (Grossman, 2011). Going forward, it will be helpful to test to what extent improvements in momentary emotion regulation give rise to changes in

mental and physical health outcomes within the context of an MBI and to incorporate more objective measurements of mindfulness to explore this potential explanation.

In interpreting these results, it is also important to note that when comparing baseline to mid-intervention, the interaction between burst and arm was not significantly associated with difficulties with emotion regulation. This finding was contrary to hypotheses as it suggests that positive changes in difficulties with emotion regulation at mid-intervention were not distinct from baseline when comparing the MBI to an active control. It also highlights how positive and more immediate benefits of MBIs for difficulties with emotion regulation (when compared to mindfulness as a mechanism) may be most relevant within the second half of the intervention. This finding is in line with research that found more significant buffering effects of an adolescent MBI within the second half of the program when compared to the first half of the program (Lucas-Thompson et al., 2023). However, it is currently unclear how many sessions of an MBI are necessary in order to produce beneficial results for difficulties with emotion regulation and mindfulness within the context of life stressors. Given this finding, exploring dosage effects within future research may be helpful in order to clarify the question of exactly when MBIs may benefit momentary-level mindfulness and difficulties with emotion regulation.

Unexpectedly, mindfulness training compared to an active control at mid-intervention and post-intervention did not significantly alter the associations between life stressors and mindful non-judgment. Instead, those who received the active control (mentoring-alone) seemed to fair better at mid-intervention as there was a weaker association between life stressors and mindful non-judgment for those in the mentoring-alone group compared to those who received mindfulness training (MBI+mentoring). This result is surprising because mindful non-judgment is a core component of dispositional mindfulness (Brown & Ryan, 2003; Lindsay & Creswell,

2017). In addition, one of the primary topics of the MBI was tenderness/non-judgment; as such, the MBI curriculum includes several activities designed to enhance mindful non-judgment (Broderick, 2013). However, this finding is in line with recent research suggesting that mindfulness training may strengthen the buffering effects of an adolescent MBI for mindful attention, but not for mindful non-judgment (Lucas-Thompson et al., 2023). One possibility for these seemingly disparate results is that practicing non-judgment and self-compassion can be particularly difficult for adolescents exposed to chronic stressors and adversities. This possible explanation is partially supported by literature which suggests that individuals exposed to trauma and adversities can "self-attack" with shame and self-criticism (Lee et al., 2001). Furthermore, shame is associated with judging oneself harshly or negatively (Tangney et al., 1996; Wicker et al., 1983) and even with training, it may feel unnatural or uncomfortable for adolescents to show themselves compassion in situations that feel upsetting and stressful. Another explanation may be related to the fact that there was not sufficient training in mindful non-judgment. Tenderness/non-judgment is one of six topics of L2B that is taught at the end of the MBI, and it might be necessary to incorporate additional activities related to mindful non-judgment sooner in MBI programming in order to notice positive effects. Within future investigations, it would be beneficial to incorporate qualitative research to explore barriers to practicing mindful non-judgment for adolescents exposed to adversities and investigate if additional and earlier activities related to mindful non-judgment would alter an adolescent's ability to practice mindful non-judgment within moments of stress.

Collectively, however, these findings suggest possible positive and protective qualities of mindfulness training. More specifically, these results demonstrate that mindfulness training may help adolescents within moments of stress by ameliorating the negative impacts of moment-to-

moment life stressors on mindfulness and emotion regulation and that these benefits are evident within adolescents' daily lives. They also highlight how skills and concepts taught during MBIs can be functionally applied within stressful circumstances among adolescents exposed to high degrees of chronic social stressors. In addition, these results suggest that MBIs may target the intended mechanisms of change such as mindfulness and emotion regulation (Chiesa et al., 2014; Lindsay & Creswell, 2017).

Taken together, the implications of this work have applied and theoretical significance as they demonstrate that the benefits of mindfulness training can be observed in real-world contexts (i.e., outside of a research laboratory) and provide support for theoretical models on how and why mindfulness training helps to improve mental and physical health. In line with this notion, existing evidence suggests that MBIs improve health through the mechanisms of mindfulness and emotion regulation (Arch & Craske, 2006; Guendelman et al., 2017; Nyklíček & Kuijpers, 2008; Sauer & Baer, 2010). However, most data on mechanisms of change for adolescent MBIs utilize between-subjects and cross-sectional designs that are subject to low ecological validity (Galla, 2016) and the active components that underlie desired changes in health outcomes are not fully understood. Findings from this study, which utilized ecologically valid, intensive repeated measurements, highlight how an MBI, even relative to a conversative, active control, can alter the relationships between momentary life stressors and mindfulness as well as emotion regulation difficulties. These results provide preliminary evidence that MBIs can target the theorized mechanisms of change at the momentary level. Although this may have long-term implications for health, it will be essential to explore the relationship between momentary-levels processes and health outcomes using meditation within future research to determine the true benefits of mindfulness training for health at the momentary level.

Limitations

Although this study has many notable strengths including the use of EMA among adolescents exposed to chronic stressors in the context of a rigorous randomized controlled design and active comparison group, there are several important limitations to consider when interpreting these results. First, EMA was designed to be collected within bursts (e.g., baseline, mid-intervention, and post-intervention) throughout the study. Although burst designs are commonly used within developmental and social health research to reduce participant burden (Cho et al., 2019; Sliwinski, 2008), there may be important processes to capture between bursts that were not captured within this study. Second, this was a small sample of adolescents. Although we had adequate power to detect significant effects given the repeated-measurement design (Arend & Schäfer, 2019), simple slopes used to probe the interaction terms were conducted separately and, therefore, the sample size was reduced within simple slopes analyses. This limitation may also help to explain why life stressors were not significantly associated with mindful attention for those in the mentoring-alone group at baseline; it will be essential to replicate results of this study among a larger sample of adolescents to further vet the benefits of mindfulness training for adolescents within moments of stress. Moreover, this study did not include longer periods of follow-up in that study procedures ended after post-intervention. Although research suggests that there are enduring long-term benefits of MBIs for various aspects of mental and physical health (Kanen et al., 2015; Kostova et al., 2019; Solhaug et al., 2019) and in some cases, even stronger effects at long-term follow-up (Bögels et al., 2021), it is currently unknown how long the buffering effects observed within this study may last. Future investigations would benefit from including longer periods of follow-up and additional measurements between bursts among a larger sample of adolescents.

Conclusions

This study contributes meaningful information related to the positive buffering effects of mindfulness training for adolescents within moments of stress. Results suggest that mindfulness training targets the proposed mechanisms of change, mindful attention/awareness and emotion regulation, by ameliorating the negative effects of life stressors on both mindful attention/awareness and emotion regulation. Interestingly, these buffering effects were not evident for mindful non-judgment; additional mixed-methods work may be necessary to understand the barriers to practicing mindful non-judgment during moments of stress. Taken together, the findings of this study provide meaningful evidence for how and why MBIs can be beneficial for adolescent health within daily life among adolescents who may be particularly vulnerable to the impacts of life stressors.

Table 1

Intraclass Correlations (ICCs) for Study 1 and Study 2

	ICCs for Study 1	ICCs for Study 2
Mindful Attention	.58	.56
Mindful Non-judgment	.71	.65
Difficulties with Emotion Regulation	.70	.65
Presence vs. Absence of Life Stressors	.47	.17
Severity of Life Stressors	.58	.14

Note. The grouping variable within these analyses was subject.

Table 2

Dummy Coding within Study 2

Burst	D1	D2	D3
Baseline	0	0	1
Mid-Intervention	1	0	0
Post-Intervention	0	1	0

Note. The three dummy codes that were created were D1, D2, and D3. Models were run two times. The first model had D1 and D2 and that reflected how mid-intervention and post-intervention differed from baseline because baseline was the reference group. The second model had D2 and D3 and that provided additional information on how post-intervention differed from mid-intervention because mid-intervention was the reference group.

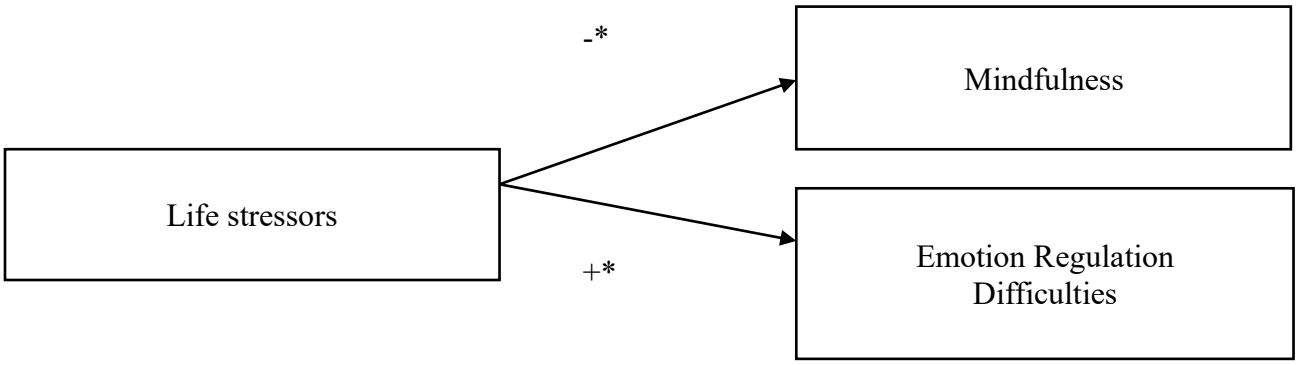

Figure 1. Conceptual model of presence and severity of life stressors contributing to significantly (*) worse mindfulness and greater emotion regulation difficulties. This relationship was tested at the momentary level twice; once where all variables are reported during the same moment ("concurrent") and again for the next moment where mindfulness and emotion regulation difficulties are lagged ("prospective"). Of note, mindfulness contains two dimensions (mindful attention and mindful non-judgment) that were tested separately within the same model.

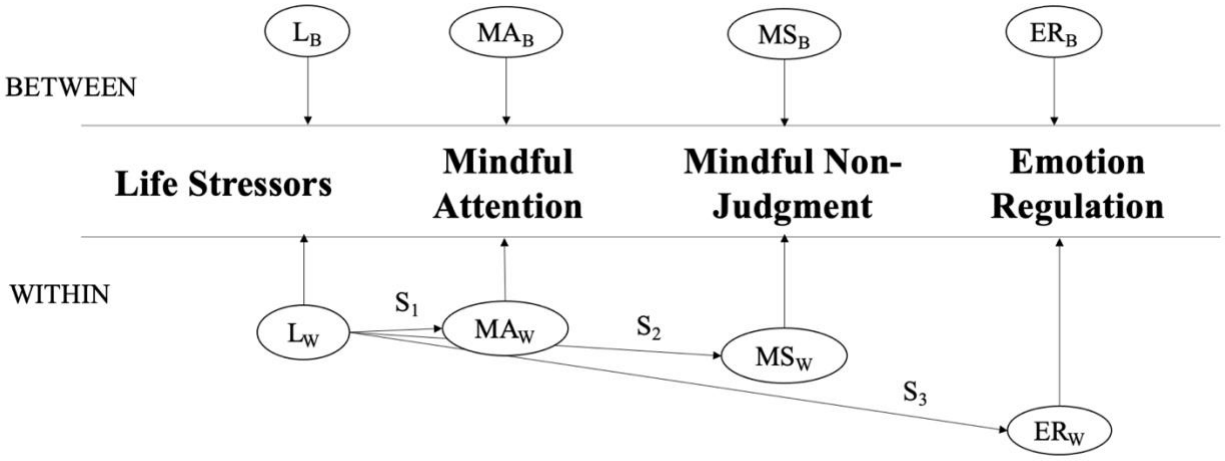

Figure 2. Figure is a path model of study 1. These relationships were tested at the momentary level twice; once where all variables are reported during the same moment (concurrently) and again for the next moment where mindfulness and emotion regulation difficulties are lagged (prospectively).

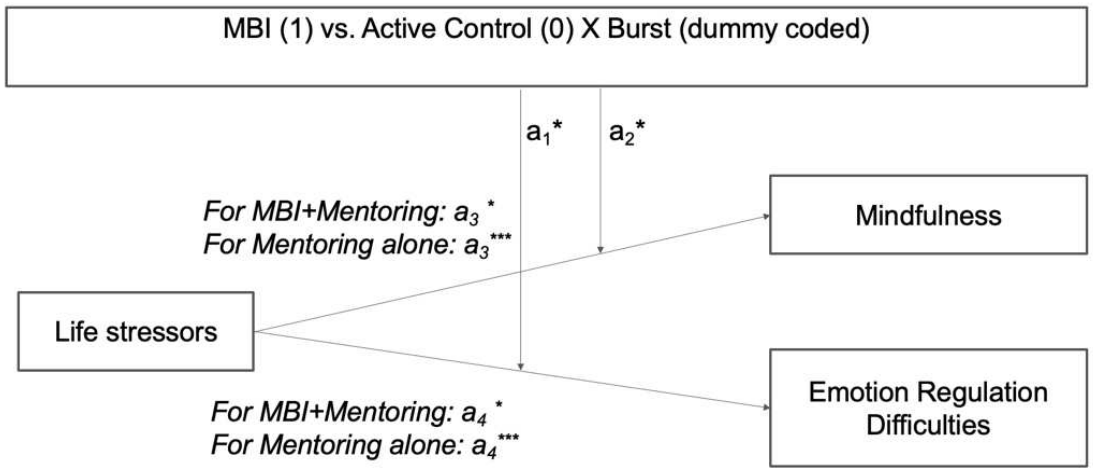

Figure 3. Figure is a conceptual model of study 2. An MBI was hypothesized to ameliorate the impacts of life stressors on momentary, state-levels of mindfulness (a_2^*), and emotion regulation difficulties (a_1^*). It was expected that the relationships may remain significant, but that there would be weaker associations for those in MBI+mentoring group (a_3^*, a_4^*) when compared to those in the mentoring-alone group. For the active control, relationships between the variables were expected to remain strong and significant (a_3^{***}, a_4^{***}). Burst was dummy coded and represents baseline, mid-intervention, and post-intervention EMA measurements.

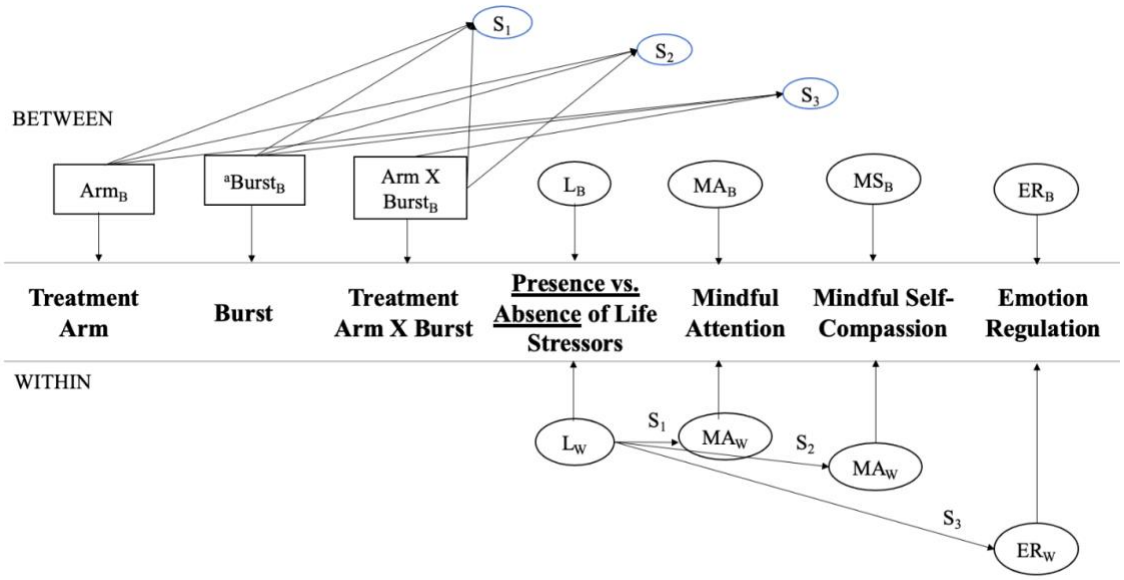

Figure 4. Figure is a path model of study 2. Arm represents the MBI+mentoring intervention (coded as 1) and the active control of mentoring-along (coded as 0). [a]Burst was dummy coded into three variables to parse out the differences between baseline, mid-intervention, and post-intervention. In order to test all pairwise comparisons, the model was run twice. Interaction terms were also created between treatment arm and each dummy coded variable to understand how changes occurred across time within each arm of the study.

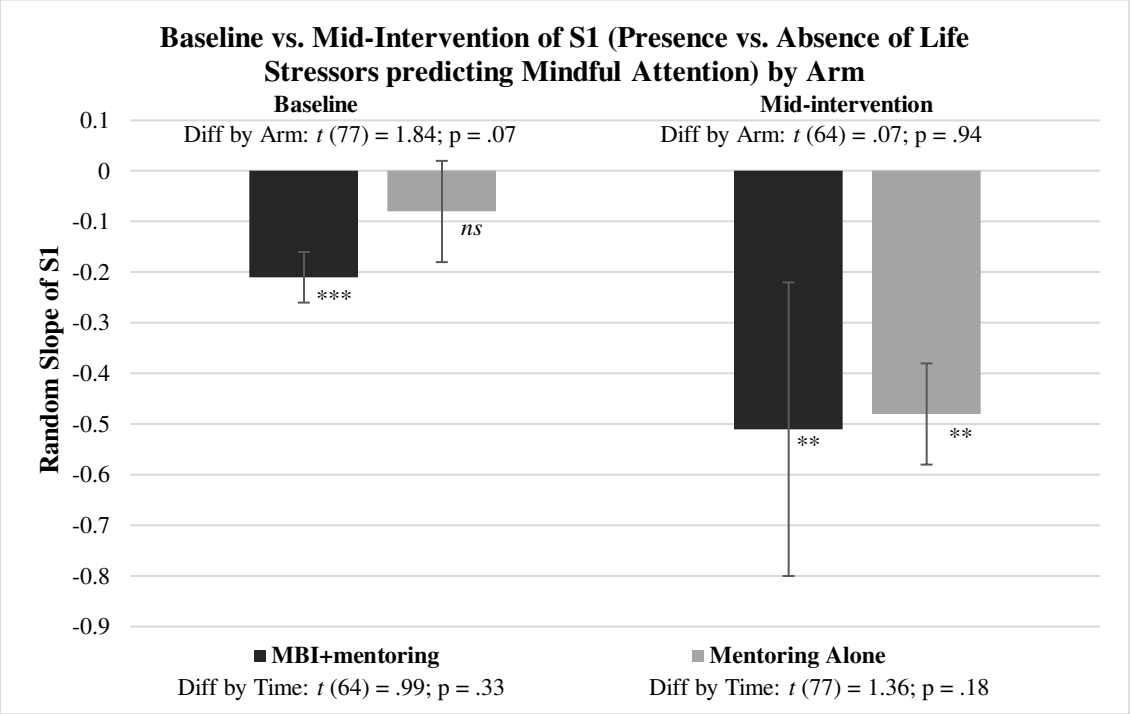

Figure 5. The figure represents the random slope of presence vs. absence of life stressors predicting mindful attention by arm at baseline and mid-intervention. *NS* represents a non-significant slope; *** represents p <.001; ** represents p < .05. The bars above represent the unstandardized estimates of the slope of the presence vs. absence of life stressors predicting mindful attention (S1) by arm at baseline and mid-intervention. Error bars represent standard error. Diff by arm represents the differences in slopes at each time point by arm (MBI+mentoring vs. mentoring-alone). Diff by Time represents the differences in each arm by time (e.g., MBI+mentoring at baseline vs. MBI+mentoring at mid-intervention). In addition, S1 for those in MBI+mentoring at baseline was not significantly different from S1 for those in mentoring-alone at mid-intervention t (72) = .92; p = .36. S1 for those in MBI+mentoring at mid-intervention was also not significantly different from S1 for those in mentoring-alone at baseline t (69) = 1.41; p = .16.

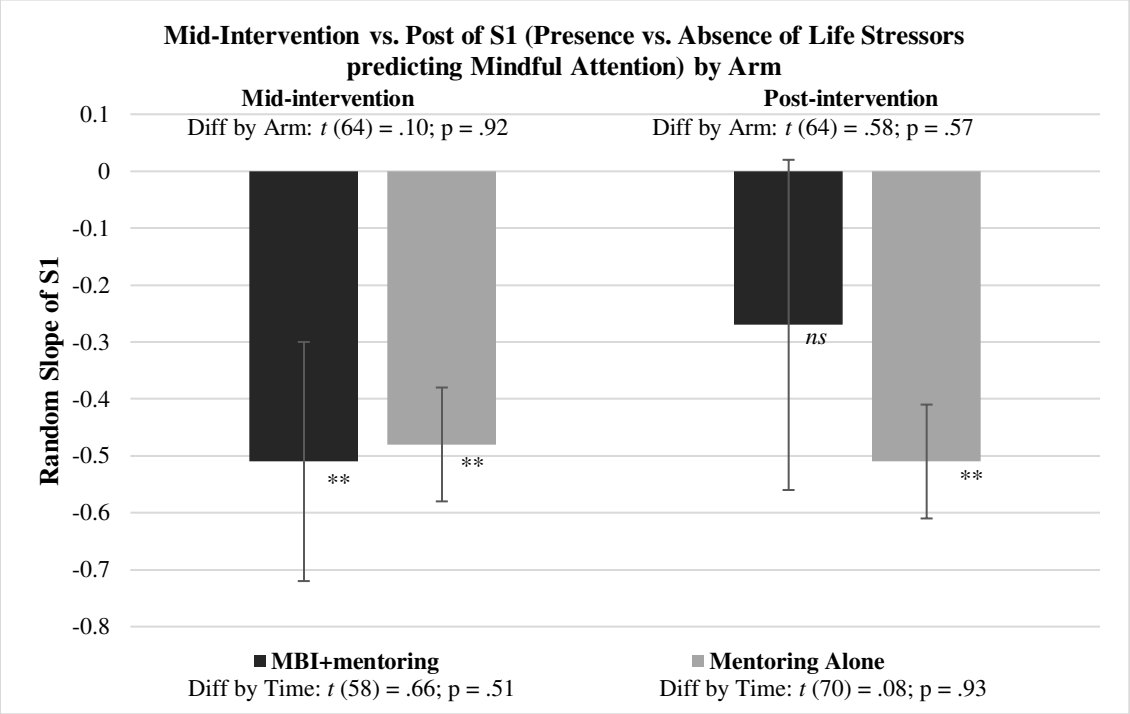

Figure 6. The figure represents the random slope of presence vs. absence of life stressors predicting mindful attention by arm at mid-intervention and post-intervention. *NS* represents a non-significant slope; ** represents p <.05. The bars above represent the unstandardized estimates of slope of the presence vs. absence of life stressors predicting mindful attention (S1) by arm at mid-intervention and at post-intervention. Error bars represent standard error. Diff by arm represents the differences in slopes at each time point by arm (MBI+mentoring vs. mentoring-alone). Diff by time represents the differences in each arm by time (e.g., MBI+mentoring at mid-intervention vs. MBI+mentoring at post-intervention). In addition, S1 for those in MBI+mentoring at mid-intervention was not significantly different from S1 for those in mentoring-alone at post-intervention t (62) = 0.00; p = .99. S1 for those in MBI+mentoring at post-intervention was also not significantly different from S1 for those in mentoring-alone at mid-intervention t (66) = .57; p = .57.

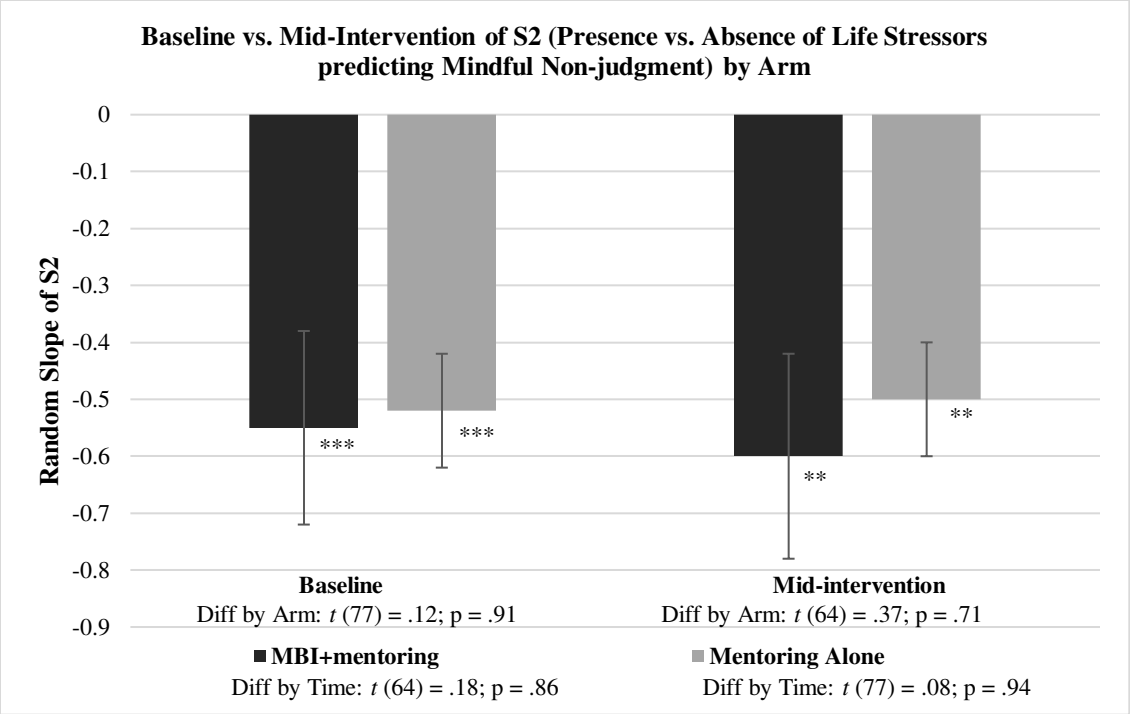

Figure 7. The figure represents the random slope of presence vs. absence of life stressors predicting mindful non-judgment by arm at baseline and mid-intervention. *** represents p <.001; ** p <.01. The bars represent the unstandardized estimates of slope of the presence vs. absence of life stressors predicting mindful non-judgment (S2) by arm at baseline and mid-intervention. Error bars represent standard error. Diff by arm represents the differences in slopes at each time point by arm (MBI+mentoring vs. mentoring-alone). Diff by Time represents the differences in each arm by time (e.g., MBI+mentoring at baseline vs. MBI+mentoring at mid-intervention). In addition, S1 for those in MBI+mentoring at baseline was not significantly different from S1 for those in mentoring-alone at mid-intervention t (72) = .92; p = .36. S1 for those in MBI+mentoring at mid-intervention was also not significantly different from S3 for those in mentoring-alone at baseline t (69) = 1.41; p = .16.

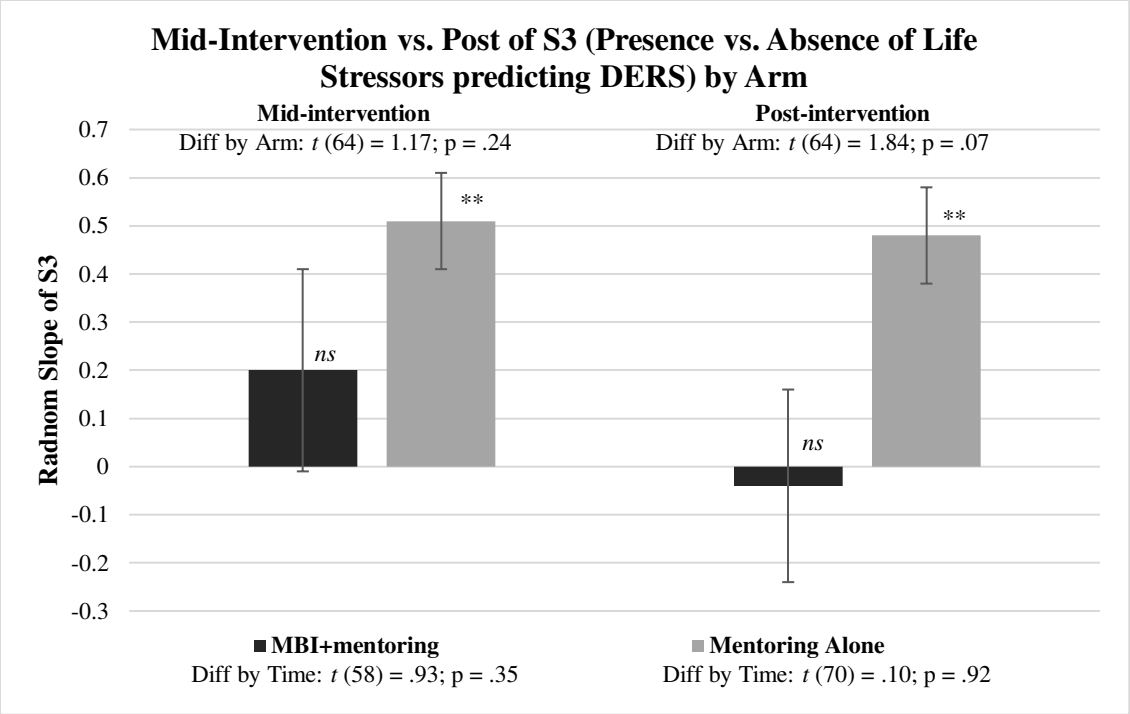

Figure 8. The figure represents the random slope of presence vs. absence of life stressors predicting difficulties with emotion regulation (DERS) by arm mid-intervention and post-intervention. *NS* represents a non-significant slope; ** represents $p < .05$. The bars above represent the unstandardized estimates of slope of the presence vs. the absence of life stressors predicting DERS (difficulties with emotion regulation; S3) by arm at mid-intervention and at post-intervention. Error bars represent standard error. Diff by arm represents the differences in slopes at each time point by arm (MBI+mentoring vs. mentoring-alone). Diff by Time represents the differences in each arm by time (e.g., MBI+mentoring at mid-intervention vs. MBI+mentoring at post-intervention). In addition, S3 for those in MBI+mentoring at mid-intervention was not significantly different from S3 for those in mentoring-alone at post-intervention t (62) = 1.09; p = .28. S3 for those in MBI+mentoring at post-intervention was also not significantly different from S3 for those in mentoring-alone at mid-intervention t (66) = 1.90; p = .06.

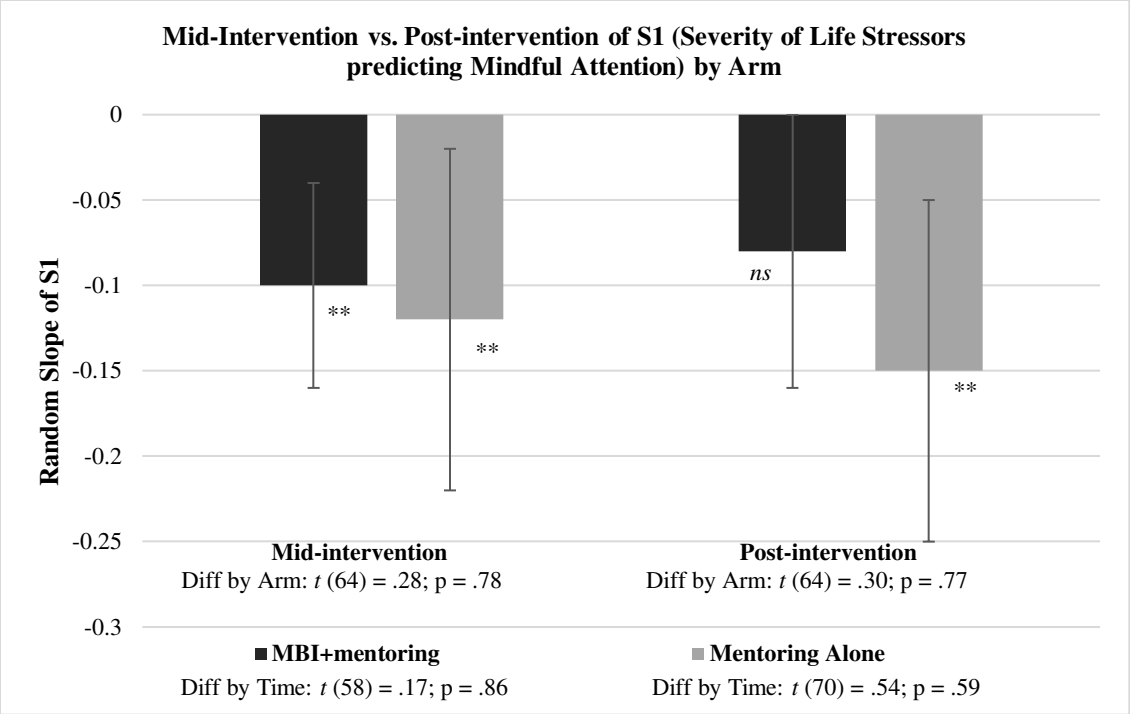

Figure 9. The figure represents the random slope of the severity of life stressors predicting mindful attention by arm at mid-intervention and post-intervention. *NS* represents a non-significant slope; ** represents $p < .05$. The bars above represent the unstandardized estimates of the random slope of the severity of life stressors predicting mindful attention (S1) by arm (MBI+mentoring vs. mentoring-alone) at mid-intervention and at post-intervention. Error bars represent standard error. Diff by arm represents the differences in slopes at each time point by arm Diff by Time represents the differences in each arm at by time (e.g., MBI+mentoring at mid-intervention vs. MBI+mentoring at post-intervention). In addition, S1 for those in MBI+mentoring at mid-intervention was not significantly different from S1 for those in mentoring-alone at post-intervention t (62) = .56; p = .58. S1 for those in MBI+mentoring at post-intervention was also not significantly different from S1 for those in mentoring-alone at mid-intervention t (66) = .40; p = .69.

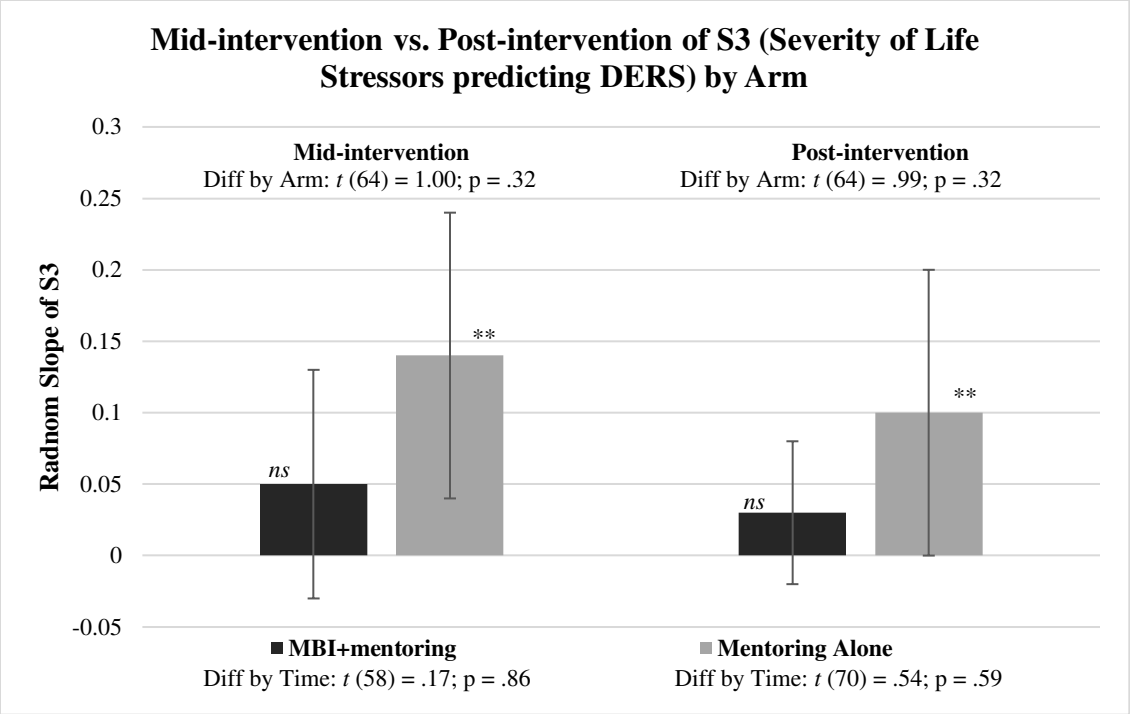

Figure 10. The figure represents the random slope of the severity of life stressors predicting difficulties with emotion regulation (DERS) by arm mid-intervention and post-intervention. *NS* represents a non-significant slope; ** represents p <.05. The bars above represent the unstandardized estimates of slope of the severity of life stressors predicting DERS (difficulties with emotion regulation; S3) by arm at mid-intervention and at post-intervention. Error bars represent standard error. Diff by arm represents the differences in slopes at each time point by arm (MBI+mentoring vs. mentoring-alone). Diff by Time represents the differences in each arm by time (e.g., MBI+mentoring at mid-intervention vs. MBI+mentoring at post-intervention). In addition, S3 for those in MBI+mentoring at mid-intervention was not significantly different from S3 for those in mentoring-alone at post-intervention t (62) = .78; p = .44. S3 for those in MBI+mentoring at post-intervention was also not significantly different from S3 for those in mentoring-alone at mid-intervention t (66) = 1.17; p = .24.

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