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New Avenues for Promoting Mindfulness in Adolescence using mHealth

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Abstract

There is a large evidence base supporting the efficacy of mindfulness interventions in adulthood, and growing support for the efficacy of these interventions in adolescence. Historically mindfulness interventions have been delivered in person and in groups, with recommendations for home practice being a critical part of the intervention. However, compliance with these practice recommendations in adolescence is very poor. Past studies indicate that using mobile technology to promote skill transfer to real life can be an effective strategy, particularly when used as a supplement to an in-person intervention strategy. To date, however, mobile technology has largely been used to create stand-alone mindfulness interventions. The goals of the current paper are to discuss the potential opportunities and challenges with a mobile-technology-enhanced mindfulness intervention, and to present the rationale that such an approach is not only theoretical and empirically sound but also a critical next step to increase the efficacy and developmental appropriateness of mindfulness interventions for adolescents. This discussion is grounded in a specific example of a mindfulness intervention supplemented by momentary interventions we are developing.

Keywords

mindfulness interventions; adolescence; mHealth; ecological momentary intervention

Mindfulness can refer to a psychological state of awareness and attention (particularly on the present moment with non-judgment), a trait-like pattern of processing sensory information, or a practice of cultivating attention to the present-moment with self-compassion (Germer,

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Siegel, & Fulton, 2005). There is increasing recognition that interventions that focus on the practice of mindfulness can produce quite meaningful change in health and well-being (e.g., Eberth & Sedlmeier, 2012; Grossman, Niemann, Schmidt, & Walach, 2004; Khoury et al., 2013). Mindfulness interventions also appear to target mental health and regulatory problems that are particularly difficult to treat during adolescence. Although several studies have begun to explore brief and online implementations of mindfulness interventions (e.g., Lindsay, Young, Smyth, Brown, & Creswell, 2018), to our knowledge there have been no empirical investigations of an in-person mindfulness intervention that is enhanced by an ecological momentary intervention (e.g., using mobile technology to deliver intervention content in the moment; see Heron & Smyth, 2010). Our goals are to discuss the challenges and opportunities of incorporating a mobile-technology-enhanced supplement into a mindfulness intervention for adolescents, and explicate that a critical next step in the implementation of mindfulness interventions is the use of such a mobile-technology-enhanced mindfulness intervention, particularly for adolescents exposed to chronic stress.

The Benefits of Increasing Mindfulness in Adulthood

Although mindfulness practices have ancient roots in Buddhist traditions, work in the West to promote psychological well-being through mindfulness did not begin to flourish until the late 1970s (Kabat-Zinn, 1982; Keng, Smoski, & Robins, 2011). Since then, empirical and clinical interest in mindfulness has surged, leading to what some argue is a “third wave” treatment approach that emphasizes individuals’ relationships to their thoughts and feelings in creating therapeutic change (following the first two waves of therapeutic approaches focusing on applying classic learning theories to change behavior and next focusing on changing maladaptive thoughts) (e.g., Hayes, Follette, & Linehan, 2004; Hayes & Hofmann, 2017). Meta-analytic evidence from implementations with both clinical and non-clinical samples of adults suggests that mindfulness interventions improve health and well-being (Eberth & Sedlmeier, 2012; Grossman et al., 2004; Khoury et al., 2013), and anxiety and depression in particular (Hofmann, Sawyer, Witt, & Oh, 2010; Vollestad, Nielsen, & Nielsen, 2012). Furthermore, one recent meta-analysis suggests that effects of mindfulness interventions on mental health and well-being are evident at follow-up periods that range from 1–34 months (de Vibe, Bjorndal, Tipton, Hammerstrom, & Kowalski, 2017). Meta-analytic analyses of potential mechanisms by which mindfulness interventions improve clinical outcomes suggest that increases in mindfulness as well as reductions in cognitive/emotional reactivity, rumination, and worry may be mediators of these effects (Gu, Strauss, Bond, & Cavanagh, 2015). Other empirical work has highlighted changes in body awareness as important in accounting for differences between mediators and non-mediators (Cebolla et al., 2017). In line with the mindfulness stress buffering account (Creswell & Lindsay, 2014), there is evidence from meta-analyses that mindfulness interventions reduce stress (Chiesa & Serretti, 2009). Supportive evidence for this account also comes from individual studies (many of which are randomized controlled trials) that these interventions improve coping (Weinstein, Brown, & Ryan, 2009), emotion regulation (for a review, see Davis & Hayes, 2011) and physiological stress regulation (Brewer et al., 2009; Delgado et al., 2010; Lindsay et al., 2018). In addition, multiple studies suggest that mindfulness training changes brain structure and function in areas key for emotion regulation, attention allocation, self-

representation, and coping (for reviews, see Davis & Hayes, 2011; Keng et al., 2011; see also, Tang, 2018).

The Benefits of Increasing Mindfulness in Adolescence

Problems with stress and anxiety are increasingly common in adolescence, with levels of stress in adolescence that are now comparable to levels of stress in adulthood (American Psychological Association, 2014; Collishaw, Maughan, Goodman, & Pickles, 2004). Mental health problems are also particularly difficult to treat during the second decade of life, particularly because many past treatment strategies for adolescents rely on “downward extensions” of treatments for adults that neglect many of the unique developmental characteristics of adolescence (Hammen, Rudolph, Weisz, Rao, & Burge, 1999).

Although the work evaluating the effects of mindfulness interventions during adolescence is more-limited, research suggests that mindfulness-based interventions can be successful in targeting these difficult to treat symptoms in adolescence. A recent meta-analysis found that mindfulness training in adolescence resulted in significant, small-to-moderate improvement in psychological symptoms relative to active controls for both clinical and non-clinical samples (Zoogman, Goldberg, Hoyt, & Miller, 2014). These effects are evident for studies using both pretest-posttest and randomized controlled trial designs, with effects that are larger at follow-up relative to post-test (Klingbeil et al., 2017). In addition, analyses specifically examining the effects of mindfulness interventions in schools suggests that they are effective at improving cognitive performance, mental health, and wellbeing as well as reducing stress (Carsley, Khoury, & Heath, 2017; Zenner, Herrnleben-Kurz, & Walach, 2014). Overall, these programs are well-liked by adolescents, and also result in increases in both emotion-regulation and self-regulation as well as reductions in stress, depression, externalizing behaviors, and sleep problems (Bluth et al., 2016; Broderick & Metz, 2009; Dvorakova et al., 2017; Eva & Thayer, 2017; Fung, Guo, Jin, Bear, & Lau, 2016; Fung et al., 2018; Metz et al., 2013; Shomaker et al., 2017).

Mindfulness training may be effective for adolescents because of its dual focus on top-down regulatory functions as well as bottom-up arousal processes. More specifically, the mental training in a mindfulness intervention fosters self-regulation of both attention (e.g., cultivating attention to the present moment) and emotion (e.g., fostering self-compassion and non-judgment) (Zelazo & Lyons, 2012). In addition, mindfulness training may improve functioning across a variety of domains because of reductions in bottom-up contributors to regulation including arousal, stress, and anxiety (Zelazo & Lyons, 2012). Because of this dual focus, mindfulness training may be a powerful and developmentally appropriate intervention strategy for adolescents.

Benefits of Ecological Momentary Interventions

One of the goals of interventions that aim to help clients improve functioning is skill transfer from the treatment setting into clients’ daily life. Along those lines are arguments that “home practice is the program” (Berkel, et al., 2018, p. 663), and therefore a critical challenge for interventionists is assisting participants to use outside of the intervention

sessions what they have learned. A particularly important tool to support this goal is the use of ecological momentary interventions (EMIs). These EMIs can take a variety of forms, and can be stand-alone treatments or supplements to existing treatments (Heron & Smyth, 2010). The defining feature of EMIs is ecologically valid delivery of structured or unstructured intervention content in people's daily lives and settings (Heron & Smyth, 2010). Given the ubiquity of mobile phones across socioeconomic and educational strata (Pew Research Center, 2018), they are becoming valuable tools by which to deliver EMIs (e.g., through text-messages). In addition, EMIs can be delivered on a pre-programmed schedule or 'just-in-time' in response to real-time data from participants (e.g., through ecological momentary assessments) (Smyth & Heron, 2016), and can be tailored to individual characteristics of participants (Heron & Smyth, 2010). EMIs can be delivered on devices that are provided to participants, or on devices that participants already own. EMIs provide real-world support, especially at moments of particular need/risk, which can help intervention participants feel empowered to use newly acquired behaviors. In addition, because participants receive EMI content in real-life settings, they may be more likely to apply those newly acquired behaviors (Heron & Smyth, 2010). There is strong evidence that EMIs can increase treatment efficacy, particularly when combined with other treatment elements, such as in-person and/or group treatment (Heron & Smyth, 2010).

The Argument for an EMI supplement to a Mindfulness Intervention for Adolescents

Although mindfulness interventions produce meaningful improvements in important outcomes for adolescents, the average effect sizes are small-to-moderate and are also heterogeneous (Bluth et al., 2016; Zoogman et al., 2014). One possibility is that effects are small because of relatively limited "uptake" of mindfulness into daily life, and that new ways to make sure the program is practiced and incorporated into real life would increase the strength of these programs. As discussed in the following paragraphs, an EMI supplement may be a particularly useful strategy to pursue when aiming to increase mindfulness among adolescents and has several important characteristics that may increase the efficacy of mindfulness interventions directed at this age group.

The most effective strategies for prevention/intervention with adolescents are 1) age-specific (in terms of content *and* delivery) and 2) facilitate learning how to apply skills in daily life (Weissberg, Kumpfer, & Seligman, 2003): developing an EMI mindfulness supplement should improve these programs in these two important ways. In terms of age specificity, many mindfulness interventions for adolescents currently provide age-appropriate content, but incorporating EMI as a means for delivering supplemental mindfulness content may further increase the developmental appropriateness of the intervention delivery strategies. As noted, EMIs are currently most frequently delivered via mobile phones (Heron & Smyth, 2010). Mobile technology has become an important part of life for adolescents (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013): more than 78% of adolescents own mobile phones (Madden et al., 2013), and most teens use text messaging (with an average of 60 messages sent and/or received per day) (Lenhart, Ling, Campbell, & Purcell, 2010). By early adolescence, 52% of youth in the United States own mobile phones (Lenhart, 2009), and

there are dramatic increases in mobile phone ownership as adolescents transition into high school (Lenhart, Hitlin, & Madden, 2005). In addition, mobile phone ownership and use is relatively equally distributed across ethnic and socioeconomic groups (Blair & Fletcher, 2011; Madden et al., 2013), with adolescents from lower socioeconomic backgrounds sometimes more likely than those from higher socioeconomic backgrounds to rely on their mobile phone to access the internet (Madden et al., 2013). Therefore, importantly, EMI supplements not only do not create health disparities because of differences in access to mobile technology but may hold unique promise to more equitably deliver treatment supplements. EMI components are highly acceptable to adolescents (Franklin, Waller, Pagliari, & Greene, 2006; Heron, Everhart, McHale, & Smyth, 2017; Obermayer, Riley, Asif, & Jean-Mary, 2004), and interventions that incorporate an EMI may be more likely to result in lasting change for adolescents than more traditional treatments because technology is so easily incorporated into adolescents' lives and also so well-liked (Heron et al., 2017; Heron & Smyth, 2010). Therefore, incorporating an EMI into mindfulness interventions should make the intervention more appealing and age-appropriate for adolescents.

In terms of facilitating application, a key benefit of EMIs is its incorporation of intervention content or practices into real-life. As with mindfulness intervention programs for adults (e.g., Kabat-Zinn, 1990), in mindfulness interventions for adolescents there is typically explicit discussion that regular practice at home between group meetings is necessary for increasing mindfulness (and, therefore, experiencing any benefits that accompany increased mindfulness). Adolescents are encouraged to engage in formal practice (intentional time set aside for practice; practices similar to those included as home practice in programs for adults such as a body scan, but often of a shorter length, as is more developmentally appropriate) as well as informal practice (e.g., noticing thoughts and breathing throughout the day). Although not all studies support the link between home practice and outcomes (Astin, 1997; Davidson et al., 2003; Lloyd, White, Eames, & Crane, 2018), among adult participants in Mindfulness-Based Stress Reduction (MBSR) programs, time spent practicing mindfulness between sessions predicts improvements in mindfulness, wellbeing, and mental health; links between practice time and psychological outcomes are mediated by increases in mindfulness (Carmody & Baer, 2008). There is even some evidence that the best predictor of improvements as a result of mindfulness training is amount of time spent engaging in mindfulness practices (Ott, Norris, & Bauer-Wu, 2006). In addition, the frequency – although not the duration – of informal mindfulness practice at home is predictive of well-being (Birtwell, Williams, van Marwijk, Armitage, & Sheffield, 2018). With this said, however, compliance with home practice recommendations is generally very poor in mindfulness interventions with adolescents, with an average of only 5.66 out of 21 days of home practice (Quach, Gibler, & Mano, 2017). There is a clear need for a tool to increase home practice in adolescents, and an EMI mindfulness supplement is intended to do just that: increase adolescent engagement in formal and informal mindfulness practice between sessions, and, as a result, improve outcomes.

Potential Challenges of an EMI supplement to a Mindfulness Intervention

Despite the ubiquity of mobile technology, there is somewhat of a “backlash” to the general public's perceptions of the benefits of mobile phones (Detwiler, 2018). This changing

attitude is reflected most notably in the popular press, with claims that mobile phones ruin relationships, sleep, health, work, and brains (Oaklander, 2016; Paul, 2017; Strimpel, 2018). Although this concern is widespread, it is also heightened when it comes to perceptions about the effects of mobile technology and internet use on adolescents. In 2010, youth aged 8–18 spent an average of 7 hours and 38 minutes per day using mobile technology and the internet (Kaiser Family Foundation, 2010). There are concerns that the time-trends we observe of increases in adolescent mental health problems (Collishaw et al., 2004) and suicide rates (Twenge, Joiner, Rogers, & Martin, 2018) are attributable to “dangerous” levels of mobile technology and internet use in this age group (Scott, Valley, & Simecka, 2017; Ungar, 2018). In support of this argument is evidence that adolescents who engage in more screen time report lower psychological well-being, and similarly that in years in which adolescents engage in more screen time, average psychological well-being is lower (Twenge, Martin, & Campbell, 2018). Many youth and young adults share these concerns reflected in the popular press, with about half of those in the ‘millennial’ generation reporting worry that social media use negatively affects their physical and mental health (American Psychological Association, 2017). The root of these concerns about mental health effects of mobile technology use is often concerns about the effects on our (in)ability to allocate attention *away* from technology (Scott et al., 2017). Essentially, there are concerns that mobile technology use causes mindlessness: “Thumbs are stronger, attention shorter, temptation everywhere: We can always be, mentally, digitally, someplace other than where we are” (Gibbs, 2012, para. 2). Therefore, it is reasonable to raise questions about whether utilizing mobile technology to increase mindfulness could actually cause iatrogenic effects.

There is empirical evidence supporting negative effects of using mobile technology on attention and, as a result, behavior, in some contexts. For instance, talking on a mobile phone while driving dramatically increases the likelihood of making dangerous driving errors (Sanbonmatsu, Strayer, Biondi, Behrends, & Moore, 2016), with driving performance affected as much as when drivers are legally drunk (Strayer, Drews, & Crouch, 2006). In addition, driving while using a mobile phone also decreases accuracy of perceptions about driving safety (Sanbonmatsu et al., 2016). People even walk differently while using mobile phones, with behavior that indicates an attentional blindness to surroundings (Hyman, Boss, Wise, McKenzie, & Caggiano, 2010). Furthermore, mobile phone notifications create distractions significant enough to impair performance even if users do not engage with the phone; the effects of these notifications are similar to the effects when people do actively engage with their phones (Stothart, Mitchum, & Yehnert, 2015). Similarly, the mere presence of mobile phones predicts greater distraction, reduced enjoyment and closeness during interactions with friends and family (Dwyer, Kushlev, & Dunn, 2017; Przybylski & Weinstein, 2013), as well as impaired performance on challenging cognitive tasks (Thornton, Faires, Robbins, & Rollins, 2014).

However, these negative interpersonal effects appear to be explained not by mobile phone *use* but by psychological reliance on the device (Lapierre & Lewis, 2016). It also appears to be problematic phone use that resembles addiction that is most strongly related to cognitive functioning (Hadlington, 2015) and mental health (Babadi-Akashe, Zamani, Abedini, Akbari, & Hedayati, 2014). Overall, there are clear negative potential effects of mobile technology use and overuse. Thus, it becomes important to consider these risks and

challenges when designing and implementing EMI based on mobile phone use, particularly in adolescents.

Arguing for a Mindfulness EMI Despite These Challenges

Why, then, are we arguing that it will likely be beneficial to incorporate mobile technology into mindfulness interventions? First, increasing mindfulness may reduce problematic relationships with mobile technology, with some positing that increasing mindfulness may help people reduce their over-reliance on technology (Kabat-Zinn, 2005). In line with this argument is evidence that college students who report greater mindfulness are significantly less likely to report risky driving, such as texting while driving (Feldman, Greeson, Renna, & Robbins-Monteith, 2011; Terry & Terry, 2015). Second, because problematic technology use may be motivated by urges to distract from unpleasant emotions (Kabat-Zinn, 2005), mindfulness interventions may also reduce problematic relationships with technology by promoting emotion regulation. Consistent with this hypothesis is evidence that associations between mindfulness and texting while driving are mediated by desires to reduce unpleasant emotions (Feldman et al., 2011). Providing individuals with mindfulness tools may allow them to facilitate emotion regulation without using technology as a distraction.

Third, training in mindfulness, including the practices of non-judgment and self-compassion that are commonly included in mindfulness training, may also help to inoculate adolescents against the negative effects of (over)use. For instance, social media provides frequent opportunities for upward social comparisons, which have been observationally and experimentally found to explain the effects of social media use on reduced self-esteem (Vogel, Rose, Roberts, & Eckles, 2014). Yet those who report more self-compassion also report lower levels of social comparison (Neff & Vonk, 2009). Therefore, increasing self-compassion through mindfulness training may protect adolescents from many of the negative effects of mobile technology use. Third is the intriguing, although very speculative, possibility that encouraging adolescents to use mobile technology to access mindfulness practices could, through associational learning, condition more mindfulness in the presence of that technology. Because the technology use in this context would be skill-based practice of mindful attention, a new relationship with technology might be forged.

Furthermore, it is unlikely that we will rely less on technology in the coming decades; adolescents especially will have grown up with mobile technology as an integral part of their lives. Although there are costs to an overreliance on technology, mobile phones in particular also serve important developmental functions during adolescence (i.e., facilitating interpersonal relationships as well as adolescent autonomy) (Blair & Fletcher, 2011). Therefore, it seems wise to capitalize on the power of mobile technology while working to avoid its dangers. This argument is in keeping with the rapidly growing e- or M-health movement (Jorm, Morgan, & Malhi, 2013). In addition, there is increasing exploration of mobile technology and the internet as tools to promote mindfulness. For instance, Zindel Segal, a co-founder of Mindfulness-Based Cognitive Therapy, has speculated that online dissemination of this intervention is where its future lies (Segal, 2011).

Most studies that have explored using technology to promote mindfulness have focused on stand-alone interventions. Several online mindfulness interventions have been successfully implemented, with resulting reductions in perceived stress, negative affect, anxiety, and depression (Cavanagh et al., 2013; Fish, Brimson, & Lynch, 2016; Gluck & Maercker, 2011; Krusche, Cyhlarova, King, & Williams, 2012; Shore, Strauss, Cavanagh, Hayward, & Ellett, 2018). In addition, mindfulness interventions have been successfully delivered via smartphone applications (Lim, Condon, & DeSteno, 2015; Lindsay et al., 2018). Overall, there is meta-analytic evidence that “self-help” mindfulness interventions (i.e., implemented by individuals themselves using books, websites, or applications) significantly increase mindfulness and lower symptoms of anxiety and depression relative to control interventions (Cavanagh, Strauss, Forder, & Jones, 2014).

For some people (e.g., individuals from rural areas or families with a lower income), stand-alone mindfulness interventions delivered online or through smartphone applications may be preferable, given the limited access to trained facilitators in some areas as well as the intensive and often expensive nature of these in-person interventions (Cavanagh et al., 2014). There may be a unique opportunity to merge stand-alone treatment (online or in person) with mobile supplements; the evidence most consistently supports the efficacy of EMIs when they are combined with other intervention strategies rather than implemented as a stand-alone intervention (Heron & Smyth, 2010). Therefore, in terms of promoting mindfulness, an EMI that is incorporated into an existing intervention may be particularly likely to be effective. Developers of mindfulness interventions (e.g., Kabat-Zinn, 1990) have traditionally suggested that the interpersonal, group dynamic of the in-person meetings is an important part of the intervention. Incorporating an EMI into an in-person mindfulness intervention can, through the in-person group meetings, capitalize on the benefits of having an experienced teacher guide the development of mindfulness skills as well as the benefits of the group experience, while the EMI between sessions facilitates skill transfer into participants’ daily lives.

Future Directions and Conclusions

In sum, we argue that incorporating an ecological momentary intervention into mindfulness training is not only a reasonable, but potentially critical, next step in implementation, particularly with adolescents. We will be developing and testing such an approach, using a mindfulness program supplemented by developmentally and clinically appropriate EMI. Many mindfulness programs for adolescents have adapted interventions developed for adults. Alternatively, some programs have been developed specifically for adolescents. For example, there is building evidence for the success of Learning to BREATHE (L2B) (Broderick & Metz, 2009), a program built for adolescents and rooted in the philosophy of mindfulness-based stress reduction (MBSR) (Kabat-Zinn, 1990) which can be implemented at school or in the community. This program is derived from the same meditative training tradition approach used in MBSR, which focuses on practicing cultivating attention that is purposeful, present-focused, open and non-reactive. As with MBSR, the three families of practices that are taught are focused attention (e.g., awareness of breath), open awareness (i.e., awareness of bodily sensations, thoughts, and feelings as they occur), and compassion (i.e., loving kindness and compassion for self and others). L2B, however, was specifically

tailored to meet the developmental needs of adolescents (i.e., supporting empowerment, autonomy, and self-efficacy in the face of stress; building skills for emotion regulation; encouraging group cohesion by focusing on the common experiences of adolescence; reducing tendencies for social comparison and self-judgment; and encouraging peer acceptance and support via shared practice and activities). This program is very well-liked by adolescents, increases mindfulness, and promotes emotion regulation as well as reduces stress, depression, and externalizing behaviors (Bluth et al., 2016; Broderick & Metz, 2009; Dvorakova et al., 2017; Eva & Thayer, 2017; Fung et al., 2016; Fung et al., 2018; Metz et al., 2013; Shomaker et al., 2017). Therefore, our team has selected L2B as the mindfulness program to use as the foundation for an EMI supplement.

L2B is highly acceptable to adolescents and is effective for improving a range of outcomes; as noted, however, to experience the benefits of such an intervention, it is necessary for participants to incorporate what they learn during sessions into their daily lives. Unfortunately, however, adolescents generally exhibit very low compliance with home practice recommendations. By encouraging the application of skills in real lives and contexts using a tool that is well-integrated into adolescents' lives, an EMI supplement to L2B is likely to increase the practice of mindfulness between sessions and therefore better promote mindfulness and its accompanying benefits. In the future, it is critical to empirically examine the implementation, acceptability, and efficacy of such an intervention approach, but we argue that this approach will better equip adolescents to address, in real time, the challenges that they are increasingly experiencing.

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