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The Impact of Peer Supportive Accountability on Use of a Mindfulness App in Depressed College Students: A Mixed Methods Study

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THE IMPACT OF PEER SUPPORTIVE ACCOUNTABILITY ON USE OF A MINDFULNESS APP IN DEPRESSED COLLEGE STUDENTS: A MIXED METHODS STUDY

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BIT	Behavioral Intervention Technology
CBT	Cognitive-Behavioral Therapy
CLPM	Cross-Lag Panel Model
MHapp	Mental Health App
PHQ	Patient Health Questionnaire
PSA	Peer Supportive Accountability
SA	Supportive Accountability
SAQ	Supportive Accountability Questionnaire
TA	Thematic Analysis

ABSTRACT

There are high rates of mental health concerns on college campuses, but students face barriers to treatment. Mental health apps (MHapps) are a promising way to improve access to evidence-based interventions such as mindfulness. MHapps improve outcomes such as depression, anxiety, and stress, but adherence to MHapps is low. Supportive accountability (SA), a model for incorporating human support in tech-based interventions, improves adherence and can be provided by peers. Greater engagement with SA features is generally associated with higher adherence, but the directionality of this relationship is unclear and findings are mixed on whether and how peers provide SA. This study examined, in a two-month trial of a mindfulness MHapp (Headspace), how college students utilized peer SA (PSA) features, including an online forum and face-to-face meetings. Comparing groups with and without PSA features, this study also examined how engagement with PSA impacted adherence. A thematic analysis revealed 6 themes related to the content of peer interactions and 2 themes related to the process. Participants valued certain PSA features more highly than others and their sense of SA decreased over time. Patterns of adherence to Headspace differed between the two groups, and Headspace-with-PSA participants tended to use the app more around the days of PSA meetings. No significant relationship was found between quantity of engagement with various PSA features and app adherence. However, there was a relationship between quality/content of engagement and app adherence. Implications for the implementation of MHapp-based interventions with PSA on college campuses, as well as directions for future research, are discussed.

CHAPTER ONE

INTRODUCTION

Rates of mental health concerns have been rising on college campuses over the past two decades (CCMH, 2022). This population is particularly at-risk because the college years typically coincide with emerging adulthood, a developmental period marked by increased vulnerability for the emergence of psychopathology (Kessler et al., 2007; McGorry et al., 2011; Schulenberg & Zarrett, 2006). Adequately addressing college student mental health is imperative given the strong links between student well-being and outcomes such as academic performance and retention (Eisenberg et al., 2009) and career and life satisfaction (Howard et al., 2010). However, the majority of college students with mental health problems do not receive treatment (Blanco et al., 2008; Healthy Minds Network, 2019) due to a variety of barriers including perceived time constraints (Czyz et al., 2013), skepticism about the effectiveness of psychotherapy (Eisenberg et al., 2011), long waitlists at counseling centers (Kadison & Digeronimo, 2004), and a preference for self-management or utilization of informal sources of support such as friends (Czyz et al., 2013; Salaheddin & Mason, 2016; Wilson et al., 2011).

Technology-based mental health interventions are a promising way to improve access to effective mental health treatment in college students. Behavioral intervention technologies (BITs) including mental health mobile apps (MHapps) address many of the barriers faced when seeking in-person services (Mohr et al., 2014), and successfully implementing BITs has become particularly important in light of the COVID-19 pandemic (Smith et al., 2020). MHapps are

well-suited to college students given the ubiquity of smartphone use in the emerging adult population (Lattie et al., 2019). MHapps demonstrate efficacy in improving mental health outcomes such as depression, anxiety, and stress (Cuijpers et al., 2010; Linardon et al., 2019; Oliveira et al., 2021; Sommers-Spijkerman et al., 2021) and they are generally described as convenient and easy to use (Chittaro & Vianello, 2016; Kubo et al., 2018).

Mindfulness-based interventions have a substantial body of research demonstrating their positive impact on a wide variety of physical and mental health outcomes. Research on mindfulness-based MHapps has largely replicated the positive effects seen with face-to-face mindfulness interventions (e.g., Cavanagh et al., 2013; Lee & Jung, 2018). Headspace is one of the most popular mindfulness-based MHapps, and research trials have found that Headspace use leads to improvements in stress, depression symptoms, irritability, burnout, college adjustment, well-being, and quality of life (e.g., Economides et al., 2018; Flett et al., 2019; Kubo et al., 2018; Yang et al., 2018).

Unfortunately, MHapps suffer from low rates of adherence and engagement (Lattie et al., 2019; Mohr, Burns et al., 2013). One recommendation to improve adherence to MHapps is the addition of human support. Supportive accountability (SA; Mohr et al., 2011) is one model for how human support can be effectively incorporated into BITs to improve adherence and treatment outcomes. SA involves a reciprocal relationship between an individual and a coach who provides accountability and supportive performance monitoring, and collaboratively sets expectations and goals (Mohr et al., 2011). SA has been successfully implemented in a number of BIT trials and is associated with increased adherence to the interventions (e.g., Dennison et al., 2014; Lepore et al., 2021; Mohr, Duffecy, et al., 2013).

Outcomes do not differ based on whether SA is provided by licensed mental health professionals or lay individuals (Baumeister et al., 2014), and peers are a particularly good candidate to provide SA in the college student population given the crucial role of peer support in emerging adulthood (Michelmore & Hindley, 2012; Swenson et al., 2008). Peers can effectively provide SA (Fortuna et al., 2020; Possemato et al., 2022), but intervention trials of BITs with peer supportive accountability (PSA) are mixed, with some finding a similar impact on adherence as those using SA with professional coaches (Ho et al., 2016) and others finding no relationship between PSA and adherence (Duffecy, Sanford, et al., 2013).

Quantitative studies have provided evidence that engagement with SA features is associated with increased adherence to MHapps, and qualitative studies have provided additional information about the content of SA engagement. The present study used mixed methods to build on both of these areas of research. While SA engagement and MHapp adherence are clearly correlated, the directionality of this relationship remains unclear. Further, more research is needed into PSA specifically, as findings are mixed on its impact on adherence and whether peers provide true supportive accountability versus simply providing support. The present study aimed to examine these questions using data from a two-month trial of Headspace in college students with depression. Specifically, the study aimed to (1) Describe the thematic content of participant engagement with PSA features, (2) Examine the impact of PSA features on adherence patterns, and (3) Analyze the interplay of PSA engagement and MHapp adherence over time to clarify the directionality of this relationship.

CHAPTER TWO

REVIEW OF THE RELEVANT LITERATURE

Emerging Adulthood, College Students, and the Campus Mental Health Crisis

Emerging adulthood refers to the developmental stage from age 18-29, when individuals tend to feel as though they are between stages, identifying as neither adolescents nor adults (Arnett et al., 2014). This period is characterized by increased independence and identity exploration as individuals clarify their values and develop skills (Arnett, 2000; 2004). Emerging adults experience many environmental changes, such as enrolling in college, beginning long-term romantic relationships, moving out of their parents' home, and entering the workforce (Arnett et al., 2014). The instability and uncertainty of this period makes it a particularly vulnerable time for the development of psychopathology (Kessler et al., 2007; McGorry et al., 2011; Schulenberg & Zarrett, 2006). Major transitions during emerging adulthood, such as the transition to college, can overwhelm one's coping capacity and activate underlying mental health vulnerabilities (Schulenberg & Zarrett, 2006). Indeed, rates of most major mental disorders (e.g., depression and bipolar disorders) increase during this developmental period (McGorry et al., 2011). Further, national surveys indicate that mental health concerns among this age group are becoming more prevalent and more severe (Mojtabai et al, 2016; SAMHSA, 2018).

With about 70% of high school graduates in the U.S. enrolling in postsecondary education (U.S. Department of Education, 2019), there are more emerging adults in college than at any other time in history (Arnett, 2016). Consistent with the rising rates of mental health

concerns among emerging adults, college campuses have seen an alarming increase in reported psychological distress among students over the last two decades (CCMH, 2022; Duffy et al., 2019) leading many to conclude that U.S. colleges are experiencing a nationwide "mental health crisis" (Kadison & DiGeronimo, 2004, p. i). Between 2009 and 2015, average utilization of counseling centers increased by about 30% while university enrollment grew by only 5% (CCMH, 2022). Almost half of college students meet diagnostic criteria for a psychological disorder (Blanco et al., 2008) and about one third of college students report being diagnosed or treated for a mental health condition in the past year (ACHA, 2019). Depression is one of the most common mental health concerns among college students, with about half of students who seek campus mental health services citing depression as a presenting concern (CCMH, 2022; LeViness et al., 2019). About one fifth (18%) of college students score in the severe range on a screening measure for depression, with another 18% scoring in the moderate range; this suggests that over a third of college students meet criteria for major depressive disorder (Healthy Minds Network, 2019).

College student mental health is strongly linked to academic performance and retention (Bruffaerts et al., 2018; De Luca et al., 2016; Eisenberg et al., 2009) and students with a psychological disorder withdraw from college at almost twice the rate of the general student population (Salzer, 2012). A diagnosis of depression is associated with a 0.49 point (half a letter grade) decrease in grade point average, while treatment is associated with a 0.44 point increase (Hysenbegasi et al., 2005). Mental health problems during this period also predict long-term, post-college outcomes such as quality of relationships (Salmela-Aro et al., 2008), workplace productivity (Wang et al., 2007), and career and life satisfaction (Howard et al., 2010). Thus,

adequately addressing college student mental health can improve students' well-being, long-term functioning, and academic performance. Indeed, students who receive counseling services overwhelmingly report that treatment had a positive impact on their academic functioning (LeViness et al., 2019). However, a majority of college students with mental health problems do not receive treatment (Blanco et al., 2008; Healthy Minds Network, 2019), and students from traditionally underrepresented groups, such as first-generation college students and students of color, are particularly unlikely to seek mental health services (Lipson et al., 2018).

College students face a variety of barriers to seeking mental health treatment. First, emerging adulthood is a developmental period marked by increasing autonomy and independence, which can impact the perceived need for formal mental health support (Wilson et al., 2011). Many emerging adults prefer to utilize informal sources of support, such as their friends or family (Healthy Minds Network, 2019; Wilson et al., 2011), and many express a preference for self-management of mental health problems (Czyz et al., 2013; Gulliver et al., 2010; Salaheddin & Mason, 2016). In one survey, 66% of college students at elevated suicide risk who did not seek help cited a belief that professional treatment was not needed (Czyz et al., 2013), while another survey found that 67% of college students with suicidal thoughts tell a friend before telling anyone else (Active Minds, 2020). Students may avoid seeking treatment due to perceived stigma (Gulliver et al., 2010; Salaheddin & Mason, 2016) or skepticism about the effectiveness of psychotherapy (Eisenberg et al., 2011). Even among those who are interested in treatment, perceived time constraints (Czyz et al., 2013) and uncertainty about what services are available on campus (Eisenberg et al., 2007) are additional barriers. Further, students who seek treatment often face under-resourced counseling centers with long waitlists (LeViness et al.,

2019; Kadison & Digeronimo, 2004); in 2018, the average ratio of university counseling staff to students at the university was 1 counselor for every 1,411 students (LeViness et al., 2019). Many of these barriers to treatment disproportionately impact students already at higher risk for adverse academic and psychological outcomes (Lipson et al., 2018). To address these disparities and improve college student well-being, it is necessary to explore alternative strategies to mental health intervention with this population.

Addressing the Treatment Gap with Mental Health Technologies

One promising way to improve access to effective mental health intervention for college students is through the use of technology. Advancements in technology over the past few decades have drastically changed how health care, including psychological treatment, can be delivered (Kazdin & Blase, 2011; Patrick et al., 2016). Effectively implementing technology-based health care has become particularly important in light of the COVID-19 pandemic, which limits the possibility of in-person treatment (Smith et al., 2020). In addition to addressing barriers caused by COVID-19, technology-based mental health interventions have the potential to address ongoing barriers related to transportation, time constraints, and cost of treatment, as well as concerns about stigma and privacy (Bakker et al., 2016; Burns et al., 2009; Kazdin, 2015; Mohr et al., 2014). This ideally allows more vulnerable populations, who disproportionately face barriers to mental health care, to access convenient and affordable treatment (Kazdin, 2015; Kempf et al., 2015).

Behavioral intervention technologies (BITs) are web-based programs delivered via computers and mobile phones that aim to promote physical, behavioral, and mental health through changing cognitions and behaviors (Mohr, Burns, et al., 2013). The term *BITs* refers

specifically to psychological interventions that target physical and mental well-being, and is distinct from *eHealth*, which refers to all health-related uses of information and communication technology (e.g., electronic medical records). Further, the term BITs encompasses a wide range of technological modalities and is distinct from *mHealth*, which refers exclusively to mobile-based health interventions and applications (Mohr, Cheung, et al., 2013; Schueller et al., 2013). As technology has evolved, BITs also have evolved from more telephone- and software-based interventions to more website- and mobile application-based interventions (Luxton et al., 2011; Mohr, Cheung, et al., 2013). BITs have demonstrated acceptability and effectiveness in treating a range of mental health problems in a range of populations and age groups (e.g., Hollis et al., 2017; Kazdin, 2015; Mohr, Burns, et al., 2013; Oliveira et al., 2021; Struthers et al., 2015).

BITs delivered via mental health-focused mobile phone applications (MHapps) are particularly well suited to college students given the ubiquity of smartphone use in this population (Lattie et al., 2019). Over 90% of emerging adults in the U.S. own a smartphone (Hitlin, 2018) and the average college-aged American looks at their phone at least 80 times per day (Bratu, 2018). A review of 17 articles concluded that MHapps are a promising way to deliver psychological interventions to youth due to MHapps' flexibility and interactivity (Seko et al., 2014). The flexible, self-delivered format of MHapps fits especially well with emerging adults' developmental desire for autonomy (Wilson et al., 2011) and preference for self-management of mental health problems (Czyz et al., 2013; Gulliver et al., 2010; Salaheddin & Mason, 2016). A recent meta-analysis of 26 studies demonstrated that college students benefit from self-guided programs to improve stress management (Amanvermez et al., 2022), providing support for the self-guided nature of MHapps. In a survey of 741 college students randomly selected from the

population at a large public university, one in ten reported that if they had a mental health condition, they would prefer MHapps over face-to-face treatment (Kern et al., 2018). Notably, this preference for MHapps was significantly more common in non-white students compared to white students, highlighting the role MHapps can play in addressing disparities in access to treatment. The most commonly endorsed reasons for preferring MHapps over face-to-face treatment were convenience, confidentiality/anonymity, and immediate availability (Kern et al., 2018). Indeed, MHapps have been provided to college students currently on the waitlist for a campus counseling center, in order to provide more immediate access to intervention while they wait for face-to-face treatment (Levin et al., 2020). Overall, 26% of students surveyed were open to using MHapps; of those who were not open to using MHapps, about half reported that it was because they did not have current mental health concerns (Kern et al., 2018). In a survey of 1,300 teens and emerging adults (age 14-22), 64% had used health-related mobile apps (Rideout & Fox, 2018). Among those with moderate to severe depression symptoms, 76% had used health-related apps and 38% had used MHapps, with the majority (67%) reporting that the apps they had used were helpful (Rideout & Fox, 2018).

MHapps demonstrate similar efficacy to computer-based BITs (Watts et al., 2013) and face-to-face treatment (Cuijpers et al., 2010; Linardon et al., 2019). Reviews of the MHapp literature generally conclude that MHapps have the potential to improve access to treatment for underserved groups, are well-suited to adolescents and emerging adults, and show promising effects on psychological outcomes but more research is needed to understand their effectiveness (Bakker et al., 2016; Bush et al., 2019; Lattie et al., 2019; Linardon et al., 2019; Luxton et al., 2011; Rubeis, 2020). In research trials with adults, MHapps have led to significant reductions in

depression symptoms, anxiety symptoms, and substance use (Burns et al., 2011; Rizvi et al., 2011; Watts et al., 2013; Wright et al., 2019). With college students specifically, a systematic review of MHapp interventions with college students found efficacy in reducing depression, anxiety, stress, and alcohol and tobacco abuse (Oliveira et al., 2021). For example, one trial of a MHapp demonstrated reductions in anxiety and improvements in emotional well-being, energy, and general health (Lee & Jung, 2018). In a randomized controlled trial of a different MHapp, the intervention significantly improved stress, anxiety, depression, and academic productivity in college students with elevated stress levels (Harrer et al., 2018). Further, these gains were maintained 3 months after the intervention (Harrer et al., 2018). Given this evidence, developmental considerations of emerging adulthood, and college students' overall openness to MHapps and familiarity with mobile technology, college campuses are ideal environments to implement MHapp-based psychological interventions (Kern et al., 2018; Lattie et al., 2019).

Mindfulness, Mindfulness-based MHapps, and Headspace

Mindfulness is defined as paying attention in the present moment purposefully and without judgement (Kabat-Zinn, 1994). Mindfulness practice has been increasingly incorporated into psychotherapy, both as the primary focus of treatment (e.g., in mindfulness-based cognitive therapy and mindfulness-based stress reduction) and as a skill that is integrated into other approaches (e.g., in dialectical behavioral therapy and acceptance and commitment therapy; Creswell, 2017; Keng et al., 2011). Mindfulness-based interventions are proposed to improve psychological outcomes by cultivating intentionality, present-focused attention, and attitudes of curiosity and acceptance (Shapiro et al., 2006). Mindfulness is an evidence-based practice with a substantial body of research demonstrating its positive impact on both physical and mental health

outcomes in adults, including chronic pain (Morone et al., 2008; Zautra et al., 2008), immune functioning (Davidson et al., 2003), blood pressure and heart rate (Ditto et al., 2006), self-efficacy (Waelde et al., 2004), empathy and self-compassion (Chiesa & Serretti, 2009), post-traumatic stress disorder (King et al., 2013), depression and anxiety (Foley et al., 2010; Waelde et al., 2004; Chiesa & Serretti, 2011; Goldberg et al., 2019), and overall psychological distress and well-being (Eberth & Sedlmeier, 2012; Foley et al., 2010). In college students specifically, mindfulness practice has been associated with significant reductions in stress, anxiety, and depression (Astin, 1997; Bamber & Morpeth, 2018; Bamber & Schneider, 2016; Call et al., 2014; Dvořáková et al., 2017; Gallego et al., 2014; Lynch et al., 2011; McIndoo et al., 2016; Oman et al., 2008; Taylor et al., 2014), as well as increases in life satisfaction, self-compassion, forgiveness, self-control, and hope (Canby et al., 2015; Dvořáková et al., 2017; Oman et al., 2008; Sears & Kraus, 2009; Taylor et al., 2014). Face-to-face mindfulness interventions are often delivered in group settings, which can normalize the experience and validate participants' challenges and reactions (Finucane & Mercer, 2006). Notably, several studies found a dose-response effect such that minutes of meditation practice or number of sessions completed at home was significantly associated with stronger effects on intervention outcomes such as depression (Bamber & Morpeth, 2018; Collard et al., 2008; Huberty et al., 2021; Parsons et al., 2017; Waelde et al., 2004), though others have not found this dose-response effect (e.g., Lahtinen et al., 2021).

Mindfulness-based interventions are particularly well-suited to a mobile app format because meditation content can be recorded and played through the app whenever is most convenient for the individual (Cavanagh et al., 2013). MHapp-based mindfulness interventions

have the same effectiveness as face-to-face mindfulness interventions (Orosa-Duarte et al., 2021). A systematic and meta-analytic review of 27 randomized trials of MHapp-based mindfulness interventions found that principles of mindfulness, acceptance, and self-compassion can be learned effectively through smartphone apps (Linardon, 2020). Further, because mindfulness-based MHapps can record how many sessions were completed and when, researchers and clinicians do not have to rely solely on self-report measures to determine adherence (Cavanagh et al., 2013; van Emmerik et al., 2018). A thematic analysis of interviews with participants who had recently used a mindfulness-based MHapp revealed that users found the app to be useful, pleasant, and easy to use (Chittaro & Vianello, 2016). Overall, research on mindfulness-based MHapps has replicated the positive effects seen with face-to-face mindfulness interventions. For example, mindfulness-based MHapps have been associated with improved psychological well-being, increased empathy and self-compassion, and reductions in depression, anxiety, and stress in college students (Cavanagh et al., 2013; Lee & Jung, 2018; Orosa-Duarte et al., 2021; Sun et al., 2021), improvements in quality of life and reductions in psychological distress (van Emmerik et al., 2018), reductions in work-related stress (Bostock et al., 2019), improved sleep quality (Huberty et al., 2021), reduced risk of compassion fatigue and burnout in nurses (Wylde et al., 2017), and reductions in irritability and stress (Economides et al., 2018). A recent meta-analytic review including 97 trials of mindfulness-based BITs found significant effects on depression, anxiety, stress, and mindfulness (Sommers-Spijkerman et al., 2021). Similarly, a meta-analysis examining mindfulness-based MHapps specifically (including 34 trials) similarly found significant effects on depression, anxiety, stress, and psychological well-being (Gál et al., 2021). Mindfulness-based MHapps also show promise reducing pandemic-related distress in college

students (Sun et al., 2021), an important area to explore as the world enters the third year of the COVID-19 pandemic. While it is clear that mindfulness can be successfully delivered via mobile app and mindfulness-based MHapps can have positive effects on psychological outcomes, clinicians and individual users must determine which app, of the thousands available, is the one to download or recommend (Lau et al., 2020; Torous & Roberts, 2017; Van Amerigen et al., 2017). Thus, more research into individual apps is required to establish which apps are evidence-based (Mohr, Cheung, et al., 2013; Lau et al., 2020).

Headspace is one of the most popular mindfulness-based MHapps, with millions of users across over 190 countries (Headspace, Inc., 2022). Headspace offers hundreds of guided meditations as well as informational videos and articles about mindfulness and related topics (Headspace, Inc., 2022). The app has been described by users as engaging, convenient, and easy to use (Kubo et al., 2018; Mistler et al., 2017). After using Headspace for only 7-10 days, the majority of users report that they would recommend it to others (Mistler et al., 2017; Taylor et al., 2016). A recent systematic review examining over one thousand MHapps found that Headspace has more research evidence than any other MHapp (Lau et al., 2020). Research trials have found that Headspace use leads to improvements in stress (Economides et al., 2018; Flett et al., 2019; Yang et al., 2018), depression symptoms (Flett et al., 2019; Howells et al., 2016), distress (Bostock et al., 2019; Kubo et al., 2018), irritability and affect (Economides et al., 2018), job strain and burnout (Bostock et al., 2019; Wylde et al., 2017), general well-being (Bostock et al., 2019; Yang et al., 2018), quality of life (Kubo et al., 2018), and college adjustment (Flett et al., 2019). Notably, while many trials compare Headspace to a waitlist control group (Bostock et al., 2018; Kobu et al., 2018; Lim et al., 2015; Rosen et al., 2018), several have found significant

effects when comparing guided mindfulness meditations in Headspace to active control conditions, including other Headspace content (psychoeducation about mindfulness, Economides et al., 2018; breathing exercises, Noone & Hogan, 2018), other mindfulness apps (Flett et al., 2019), brain training apps (Bennike et al., 2017), and in-person mindfulness interventions (Wylde et al., 2017). Most research trials of Headspace have been 4-8 weeks, but some studies demonstrate that Headspace can lead to benefits after only 10 days of use (Economides et al., 2018; Flett et al., 2019; Howells et al., 2016). Further, several studies have demonstrated a dose-response effect wherein more Headspace use leads to greater benefits (Bennike et al., 2017; Flett et al., 2019), emphasizing the importance of adherence.

Adherence and Engagement with Mental Health Apps

Clinicians and intervention researchers alike have long struggled with how to increase adherence to mental health treatment programs. Research on adherence has traditionally focused on the crucial role of the therapeutic alliance, or emotional bond, between the clinician and the patient (Thompson & McCabe, 2012). This bond is widely acknowledged as one of the most important, if not the most important, factor predicting adherence and effectiveness in face-to-face mental health treatment, and some argue that this is true for eHealth interventions as well (Santarossa et al., 2018). However, MHapps do not inherently have this critical component of human support, and thus face a unique barrier to adherence even as their format eliminates others (Mohr et al., 2011). Although some individuals (e.g., those with social anxiety) may choose MHapps specifically for the lack of human interaction (Werntz et al., 2021) and the self-guided nature of MHapps affords flexibility and independence, it also contributes to low rates of adherence and engagement (Lattie et al., 2019; Mohr, Burns, et al., 2013). BITs in general tend

to have low engagement and high dropout rates (Donkin et al., 2011; Eysenbach, 2005; Mohr, Burns, et al., 2013), even more so than face-to-face psychological interventions (Christensen et al., 2009). In a systematic review of BITs for depression and anxiety, Christensen and colleagues (2009) found completion rates were typically 50-70% and predictors of increased adherence included milder baseline symptoms and younger age. A meta-analytic review of mindfulness BITs found adherence rates ranging from 35% to 92%, but the authors note that most studies lacked clear definitions of adherence (Sommers-Spijkerman et al., 2021). Various other factors impacting attrition include time constraints, low motivation, technical problems (i.e., difficulty accessing a computer), skepticism about the effectiveness of the treatment, and the lack of human contact (Christensen et al., 2009). Another systematic review looking at BITs for children, adolescents, and young adults concluded that, while BITs are acceptable and beneficial for this population, adherence and engagement remain crucial challenges to address (Struthers et al., 2015).

MHapps are frequently downloaded, but only a small percentage of people continue to use the same MHapp for more than a few weeks (Baumel et al., 2019b; Torous et al., 2019). Outside of research settings, over 90% of people who download a MHapp stop using it within thirty days (Neura, 2020). Even within research trials, adherence is low. Linardon and Fuller-Tyszkiewicz (2020) conducted a systematic and meta-analytic review of adherence to MHapps and found that low adherence and high attrition are common in research trials of MHapps. They suggest that this may undermine research on MHapp effectiveness (Linardon & Fuller-Tyszkiewicz, 2020). Predictors of retention included contact with researchers, regular reminders, and acceptance-based (e.g., mindfulness) interventions (Linardon & Fuller-Tyszkiewicz, 2020).

Baumel and colleagues (2019b) similarly found higher adherence rates with mindfulness/meditation MHapps, as well as peer support MHapps, compared to other types of interventions. However, trials of mindfulness-based MHapps report high dropout rates as well, particularly during follow-up periods of self-guided use (Economides et al., 2018; van Emmerik et al., 2018). Other factors that predict adherence include perceived usefulness of the app, rewards, feedback, and a sense of agency (Schueller et al., 2013). It is critical to improve adherence to MHapps because certain measures of adherence (e.g., number of activities completed) predict psychological outcomes such as depression or anxiety symptoms (Donkin et al., 2011; Mohr, Burns, et al., 2013). However, other measures of adherence (e.g., number of logins) do not consistently impact psychological outcomes, so more research is needed to understand the best methods of measuring adherence as well as how to improve it (Donkin et al., 2011; Eysenbach, 2005; Ng et al., 2019).

Experts have provided several recommendations and suggestions for improving adherence to MHapps. Schueller and colleagues (2017) identified several areas that can be targeted, including usability of the program, motivation to engage, fit with the person's needs, knowledge about how to use the app or why it will help, implementation into daily life, and technical issues. Enhancing the usability of the technology itself (e.g., creating a more user-friendly interface) and incorporating game-like elements would make MHapps more engaging, particularly for youth and emerging adults (Mohr, Burns, et al., 2013). Text message reminders are well-accepted, but it is unclear if this significantly improves adherence (Moffitt-Carney & Duncan, 2021). Providing incentives such as monetary compensation predicts lower attrition in research trials (Linardon & Fuller-Tyszkiewicz, 2020; Mohr, Burns, et al., 2013), but this has

little applicability to real-world implementation of MHapps. The most common recommendation is the addition of human support that promotes adherence. Notably, although one-tenth of college students would prefer using a MHapp to face-to-face treatment if they had a mental health problem (Kern et al., 2018), focus groups with teen and emerging adult mental health advocates (age 16-25) suggest that most young people would prefer that technology *complement* face-to-face components of treatment, not replace them altogether (Montague et al., 2015). Thus, a hybrid model that utilizes both MHapp content and in-person or online human support may be the best approach. Indeed, MHapp interventions that incorporate human support or guidance demonstrate stronger effects on psychological outcomes than interventions with entirely self-directed MHapp use (Andersson & Cuijpers, 2009; Musiat et al., 2021; Wright et al., 2019).

Improving Adherence with Supportive Accountability

Several models have been proposed to incorporate human support into BITs. In the Swedish Model (Andersson et al., 2008), individuals engaging in self-directed online treatment send questions and summaries of lessons to a mental health professional. The therapist, usually via email, then provides brief feedback, answers questions about the material, and provides encouragement (Andersson et al., 2008). In the Macquarie University Model (MUM; Titov et al., 2015), a mental health professional regularly provides encouragement and reminders aimed at increasing skills practice via phone calls, emails, and other electronic messaging. Both of these models rely on support provided by trained therapists, and the Swedish Model utilizes primarily asynchronous communication (e.g., email) while the MUM utilizes synchronous communication (e.g., phone calls and instant messaging) in addition to email (Schueller et al., 2017).

A third model guiding how human support can be effectively incorporated into BITs is referred to as "supportive accountability" (SA; Mohr et al., 2011). This approach involves a reciprocal relationship between the patient and a coach who is viewed as trustworthy, benevolent, and legitimate (i.e., having relevant expertise). The coach works to enhance adherence to BITs through accountability, supportive performance monitoring, and clear process-focused expectations and goals. A crucial way SA differs from the models above is that the human support is not necessarily provided by mental health professionals; instead, coaches can be professionals, students, or lay people such as peers (Mohr et al., 2011).

"Supportive accountability" is a relatively new term, but incorporating supportive accountability into mental health treatment, often from peers, is not a new concept (Repper & Carter, 2011; Solomon, 2004). There is significant precedent for this approach, particularly in telephone crisis lines and substance abuse treatment programs utilizing a mentor/sponsor model such as Alcoholics Anonymous (AA), where perceived support from sponsors and fellow group members significantly predicts better adherence to treatment and treatment outcomes (Groh et al., 2008). Similarly, in an in-person intervention targeting medication adherence for HIV-positive individuals, more interaction with peer coaches predicted higher self-reported adherence (Simoni et al., 2007).

Supportive accountability has been implemented with a variety of BITs targeting mental and physical health outcomes. An online intervention aimed at increasing physical activity in individuals with multiple sclerosis incorporated SA-based video coaching with a doctoral student (Dlugonski et al., 2012). While the intervention demonstrated efficacy compared to a waitlist control group, the RCT did not include an intervention condition with no SA, so the added

benefit of SA is difficult to assess. In a pilot study examining the effect of MHapps delivering CBT-based treatment on depression (Stiles-Shields et al., 2019), brief weekly SA-based coaching sessions were incorporated with both intervention groups (a cognitive app and a behavioral app). The combination of the MHapps and SA significantly reduced depression scores compared to a waitlist control, but there was again no condition where participants used the MHapps without SA. Similarly, Graham and colleagues (2020) examined the effect of CBT-based MHapps with SA coach support on depression and anxiety outcomes, utilizing a waitlist control group but no comparison to a self-guided intervention group. While these studies successfully demonstrate the feasibility of incorporating SA-based human support with BITs, they do not demonstrate its added benefit.

Other research has specifically examined whether SA improves BIT adherence and targeted health outcomes. In a trial targeting depression symptoms, participants were randomly assigned to a web-based intervention, the web-based intervention plus telephone coaching aimed at increasing adherence, or a waitlist control group (Mohr, Duffecy, et al., 2013). Participants in the group with SA had significantly greater adherence to the intervention compared to those in the group with self-directed use, suggesting that SA improves adherence. However, the SA group did not significantly differ from the self-directed group in depression outcomes (Mohr, Duffecy, et al., 2013). A trial targeting weight management found similar results; participants who received brief SA-based telephone coaching demonstrated greater retention and adherence to an online intervention for weight management (Dennison et al., 2014). However, weight loss outcomes were not significantly greater in the SA group. Notably, these results were based on intent-to-treat analyses and many participants randomized to receive SA did not engage with it;

in an as-treated analysis, participants who engaged with the coaching had significantly greater weight loss than those randomized to the SA group who did not engage with the coaching (Dennison et al., 2014). In a trial targeting smoking cessation using a mobile app, there was a positive relation between engagement with SA coaches and use of the app in the 24 hours after that engagement, and this relation was stronger for those with lower motivation to quit (Lepore et al., 2021). Overall, SA appears to improve adherence to BITs, but findings remain mixed on whether this effect is strong enough to impact treatment outcomes such as depression. Further, it appears that level of engagement with SA features may determine the impact it can have on adherence and treatment outcomes.

Peer Supportive Accountability

The studies described above incorporate SA from coaches who have a high level of expertise (e.g., mental health professionals). However, the SA model is designed such that either professionals or lay people can provide the support, and a systematic review of BITs with human support found no difference in treatment outcomes based on the qualification level of coaches (Baumeister et al., 2014). Coaching delivered by paraprofessionals (Titov et al., 2010), doctoral students (Andersson et al., 2012), and peers (Lattie et al., 2017) is just as effective as coaching delivered by licensed clinicians. Titov and colleagues (2010) compared clinician-assisted and technician (i.e., paraprofessional)-assisted web-based CBT and found that both groups exhibited clinically significant reductions in depression comparable to effects of face-to-face treatment. Similarly, treatment outcomes in another web-based CBT intervention were not impacted by whether guidance was provided by a licensed clinical psychologist or a clinical psychology doctoral student (Andersson et al., 2012). Lattie and colleagues (2017) examined an online

intervention aimed at preventing depression in adolescents and found no difference in adherence or psychological outcomes between a clinician-led group and a peer-led group.

When taking developmental considerations into account, peers may be particularly good candidates to provide SA in the college student population. Emerging adulthood is a developmental period when peers largely take over from parents as the primary attachment figures (Swenson et al., 2008). Peers are the most commonly utilized source of informal support for mental health needs in youth (Michelmore & Hindley, 2012) and 67% of college students with suicidal thoughts tell a friend before telling anyone else (Active Minds, 2020). In a survey of over one thousand young people (age 16-24 years), when asked how they would respond to a friend in need, individuals in this age group were more likely to suggest talking to friends than talking to a counselor or doctor (Ellis et al., 2012). In college students, social support from peers decreases risk for depression and predicts higher quality of life (Alsubaie et al., 2019), increases self-esteem (Armsden & Greenberg, 1987; Bum & Jeon, 2016), and buffers the impact of psychological stress (Lee & Goldstein, 2016). Peer support also has well-established benefits for those with mental illness more generally (e.g., Davidson & Guy, 2012). Peers would therefore be ideal to provide the emotional bond required for SA, but SA also requires performance monitoring and accountability. Can peers provide this as well? A recent systematic review of peer-supported digital mental health interventions (Fortuna et al., 2020) suggests that they can. The authors identified 30 studies reporting results from 24 digital mental health interventions using peer support networks and/or peer-delivered components. Fortuna and colleagues (2020) conclude that utilizing peer support to deliver or supplement mental health-focused BITs is

feasible, acceptable, and effective at improving adherence and psychological functioning, but they also emphasize that this area of research is very new and more clinical trials are needed.

Intervention trials of BITs with peer supportive accountability (PSA) have found results similar to those using SA with professional coaches. An online preventive intervention for depression in adolescents integrated SA-based peer networking features where fellow adolescent participants could monitor others' engagement with the site, set adherence-related goals, and hold each other accountable for those goals (Ho et al., 2016). Although there was no comparison group without PSA, higher engagement with the PSA features (measured by number of exchanged comments) was positively correlated with adherence (measured by time spent on the intervention website; Ho et al., 2016). These results suggest that PSA improves adherence, but it is possible that those who are more engaged in the intervention were also more engaged in the PSA features. More research is needed into the directionality of this relation between PSA engagement and BIT adherence. Notably, engagement with PSA components, and with the intervention site overall, decreased over the 10-week trial, dropping off significantly after week 3, which is consistent with other BIT research (Ho et al., 2016; Mohr, Duffecy, et al., 2013). Based on qualitative interviews with participants, Ho and colleagues (2016) suggest that seeing peers' intervention activity motivates participants when others' usage is high, but it can also demotivate participants when they see others' usage declining. Another PSA-based preventive intervention for depression with adolescents similarly demonstrates that peers are capable of providing supportive accountability. Participants completed an 8-week CBT-based online program with SA features led by either a licensed clinician or a trained peer (Lattie et al., 2017). Both groups demonstrated significant decreases in depressive symptoms, with no differences in outcomes or

program adherence between the peer-led group and the clinician-led group (Lattie et al., 2017). In qualitative interviews, participants expressed a desire for more reminders to engage with the PSA components of the program (Lattie et al., 2017). It is important to note that both of these interventions were universal prevention programs, not targeted treatment for adolescents with elevated depression. However, the age of participants (14-19 years) is closer to the college student population than the majority of SA research focused on adults, making these important studies to consider when adapting PSA for college students.

In older populations, PSA findings are more mixed. For example, in an intervention for adult cancer survivors (age 27-68 years), participants were randomly assigned to an online distress management training program with or without an SA-based peer support component (Duffecy, Sanford, et al., 2013). There were no differences in adherence or depression outcomes between the two groups, suggesting no significant benefit from the addition of PSA. However, the study was not powered to detect differences between the groups due to a small sample size, so no clear conclusion can be drawn (Duffecy, Sanford, et al., 2013). A CBT-based intervention for older adults (age 65+ years) with depression similarly assigned participants to a self-delivered online intervention or to the same intervention with peer support features (Tomasino et al., 2017). Both groups demonstrated a decline in depression symptoms compared to a waitlist control and there was no significant difference in depression outcomes between the two intervention groups. However, the group with peer support required significantly less coaching with the intervention, suggesting feasibility-related benefits of the addition of PSA (Tomasino et al., 2017). Comparing results from these two PSA-based interventions with older adult samples to results from the two interventions above with adolescent participants (Ho et al., 2016; Lattie et

al., 2017) suggests that PSA can be implemented with all ages but may be particularly effective at increasing adherence in young people. It may also be particularly effective in populations with a high level of shared experience and pre-existing community bond, such as military veterans. In a web-based intervention for veterans with mental health needs (age 30-77), those randomized to receive PSA had more log-ins than those with self-directed use, and those who received PSA (as-treated) had greater improvements in depression symptoms (Possemato et al., 2022).

Several studies examining PSA-based or peer support-based interventions have utilized qualitative methods to describe the content of peer-to-peer interactions in order to better understand how PSA may impact adherence and treatment outcomes. For example, a thematic analysis of text messages exchanged between trained peer SA coaches and older adults with mental illness identified four themes, including engagement with the targeted BIT, health-related behavior change, self-management techniques, and peer support (Fortuna et al., 2019). Windler and colleagues (2019) utilized thematic analysis to assess blog posts and comments, as well as interviews with blog moderators, in an online peer support intervention for adolescents with depression or anxiety. Blog posts were also coded for different elements of supportive accountability (Windler et al., 2019). Bambina (2007) coded blog posts in an online cancer support group for different types of social support being offered or requested. Marino and colleagues (2007) analyzed dialogue in a peer-based intervention to improve medication adherence for people with HIV/AIDS. Using a grounded theory approach, the authors identified four themes in the peer interactions, including reciprocal support, personal growth and empowerment, social acceptance, and resistance and challenges (Marino et al., 2007). Finally, Chittaro & Vianello (2016) conducted a thematic analysis of interviews with participants after a

5-week trial of a mindfulness-based MHapp, identifying themes related to patterns of use, usability, and mindfulness concepts.

Predictive studies have demonstrated that PSA has the potential to improve adherence to MHapps, and descriptive studies provide a deeper understanding into what PSA looks like and why supportive peer interactions might impact adherence to mental health interventions. Thus, a mixed methods approach has the potential to build on both areas of research and examine PSA engagement through a descriptive and predictive lens.

Present Study

Prior research demonstrates a positive association between engagement with supportive accountability features and adherence to BITs such as MHapps. The assumption of the supportive accountability model is that more engagement with SA predicts better adherence, but the directionality of this relationship is unclear, particularly for PSA. Peers are a good candidate for providing SA in college students due to the developmental context of emerging adulthood. However, findings are mixed on whether and how peers provide supportive accountability versus simply providing support. The present study examined the use of PSA in a two-month trial of the mindfulness-based MHapp Headspace. The broader trial (Conley et al., 2019) randomized college students with elevated depression symptoms to self-directed Headspace use, self-directed Headspace use with PSA features, or a waitlist control. The PSA condition included an online forum and three face-to-face meetings with other participants. The proposed study aimed to understand how college students utilized the PSA features and how engagement with these features impacted adherence to the MHapp. Qualitative analyses explored how college students

engaged with PSA features and quantitative analyses examined the extent to which PSA engagement impacted adherence over time.

Aim 1: Describe Engagement with PSA Features.

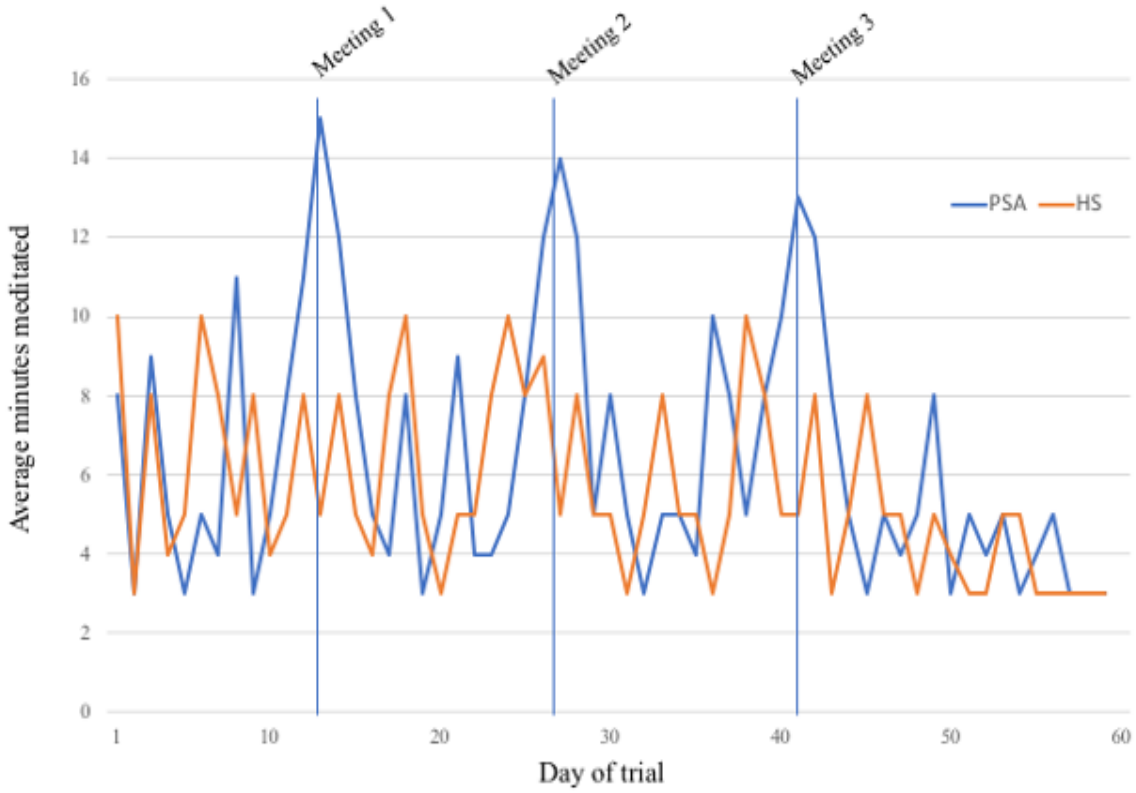
The first aim was to describe the thematic content of participant engagement with PSA features. Specifically, the present study aimed to identify themes across participant posts in the online PSA forum and transcripts from face-to-face PSA meetings. Prior studies using peer supportive accountability or other peer support-based interventions have utilized qualitative methods to identify and analyze themes in peer text messages (Fortuna et al., 2019), blog posts (Bambina, 2007; Windler, et al., 2019), and group meeting transcripts (Marino, et al., 2007). Following this precedent, the proposed study aimed to describe how college students engage with PSA features by analyzing the thematic content of their contributions to the online forum and face-to-face meetings. Themes identified through qualitative analysis were then used to quantitatively code posts in the online forum to explore how often certain themes were discussed. Further, to explore participants' experience of PSA, the present study presents participants' own subjective evaluation of different PSA components as well as their subjective experience of supportive accountability from their peer group. Observations based on visual inspection of descriptive statistics were then tested for statistical significance. These analyses were exploratory and there were no hypotheses for Aim 1.

Aim 2: Visualize and Compare Adherence Patterns.

The second aim was to examine the impact of PSA features on adherence patterns. Specifically, the present study used data visualization to understand adherence patterns over time and aimed to examine how patterns of adherence to Headspace map onto the occurrence of face-

to-face PSA meetings. Adherence was hypothesized to spike before and after face-to-face PSA meetings, with PSA participants using Headspace significantly more in the two days before and after meetings than during other periods of the trial (Hypothesis 1; see Figure 1). Further, adherence patterns for the group with PSA were compared to adherence patterns for the group with self-directed MHapp use only. Headspace-with-PSA group adherence was predicted to differ from Headspace-as-Usual group adherence, particularly around the occurrence of face-to-face PSA meetings (Hypothesis 2).

Figure 1. Predicted Graph of Group Adherence Relative to PSA Meetings

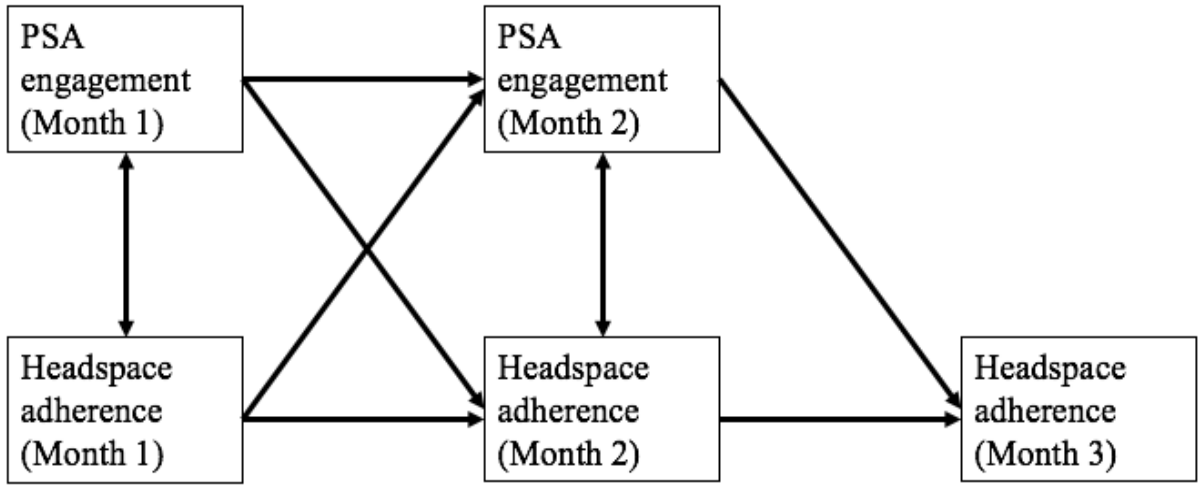


Aim 3: Analyze Interplay of PSA Engagement and App Adherence.

Finally, the third aim was to analyze the interplay of PSA engagement and MHapp adherence over time to clarify the directionality of this relationship. Specifically, the present

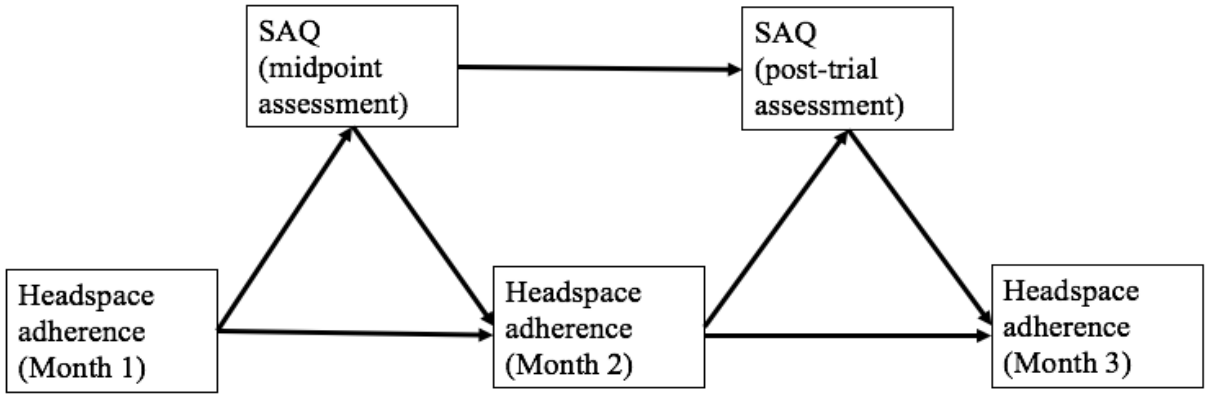
study aimed to examine the relationship between level of engagement with PSA components and adherence to the Headspace app. As this relationship is usually presented as a correlation in the literature, this study aimed to explore the directionality of this relationship over time. A bidirectional relationship was hypothesized; that is, it was hypothesized that more engagement with the PSA group would predict increased adherence to Headspace, and increased adherence to Headspace would predict more engagement with the PSA group (Hypothesis 3; see Figure 2). However, engagement with PSA features was hypothesized to have a stronger effect on adherence than adherence had on engagement with PSA features (Hypothesis 4).

Figure 2. Proposed Model 1 for Aim 3: Headspace Adherence and Engagement With PSA Features



Finally, a separate model included participants' subjective experience of supportive accountability from their peer group, and this was expected to bidirectionally predict adherence to Headspace in the second half of the trial and into the follow-up period (Hypothesis 5; see Figure 3).

Figure 3. Proposed Model 2 for Aim 3: Headspace Adherence and Subjective Experience of Supportive Accountability



CHAPTER THREE

METHODS

This study analyzed data from the Supported Mindful Learning (SMiLe) study, a randomized controlled trial investigating the effectiveness of Headspace, a mindfulness-based MHapp, for improving mental health and well-being in college students with clinically elevated depression symptoms. The SMiLe study began in Fall 2017 and continued for four years (i.e., eight semesters) with data collection ending in Summer 2021.

Procedures

Undergraduate students at a mid-sized urban Midwestern university were recruited via flyers on campus, email listservs, and the psychology research participant pool. Students who expressed interest in the study completed an online screening survey to determine eligibility. As part of the screening survey, participants completed an 8-item version of the Patient Health Questionnaire-9 (PHQ-9; Kroenke & Spitzer, 2002) that excluded the item assessing suicidality. Inclusion criteria for the study included being a current undergraduate student, being at least 18 years old, and scoring 10 or above on the PHQ-8 because this cutoff indicates clinically significant symptoms of depression (Kroenke et al., 2009; see Appendix A). Exclusion criteria included currently participating in individual psychotherapy, a history of neurological conditions or brain injury, regular mindfulness practice in the past six months and/or a high level of prior experience with mindfulness or Headspace, and an unwillingness to participate in the peer group if randomized to the Headspace-with-PSA condition.

Once enrolled in the study, participants were randomized to one of four conditions: Headspace-with-PSA, Headspace-as-Usual With Orientation, Headspace-as-Usual Without Orientation, or Waitlist Control. An unequal allocation procedure was used for randomization to ensure that six participants were assigned to the Headspace-with-PSA condition each semester. Participants in the Headspace-with-PSA and Headspace-as-Usual With Orientation conditions attended an orientation session where researchers reviewed study procedures, briefly described the principles of mindfulness, oriented participants to the features and content of Headspace, and provided recommendations for adherence. Participants were encouraged to engage with Headspace daily and utilize its mental health-focused content, but no specific guidelines or requirements were given and all Headspace use was self-guided throughout the trial. At the orientation session (which was held on Zoom in Fall 2020 and Spring 2021 and in person all prior semesters), participants filled out forms ranking (highest, middle, and lowest priority) their goals for participating in the study (e.g., acceptance, emotion regulation, focus) and their priorities for Headspace content (i.e., which courses they were most interested in). Starting in Fall 2020, participants also were asked to write a response to the question, "What are your goals for how much/often you will use Headspace over the next 8 weeks? (For example, number of minutes per day, number of sessions per week, a certain time of day you hope to meditate...)." Researchers provided participants with a code that provided free access to Headspace for three months. Participants in the Headspace-as-Usual With Orientation group then left the orientation session and did not have additional contact with research staff beyond surveys and compensation. The Headspace-with-PSA participants were then provided with information about the PSA features and given an opportunity to meet one another. During this initial meeting, Headspace-

with-PSA participants were encouraged to share their adherence goals with one another, and to set some group goals for how they would engage with the PSA features. Starting in Spring 2018 (the second PSA cohort), participants were specifically asked about their hopes for the peer support group, their goals for engagement with the Facebook group and, once face-to-face meetings were added in Fall 2018, their goals for engagement with meetings. They were prompted to discuss how they might hold one another accountable, potential barriers to adherence, and potential solutions. A researcher used nondirective motivational interviewing techniques to facilitate this discussion. Headspace-with-PSA participants also added one another as "buddies" within the Headspace app. This feature allowed them to view one another's user statistics within the app. During the course of the trial, Headspace expanded this feature to include "nudges," where buddies could send one another reminders to meditate within the app.

Participants in the Headspace-with-PSA condition joined a private, closed Facebook group that served as an online forum where participants could post about their own mindfulness practice and support others' practice through motivation and encouragement. See Appendix B for de-identified sample participant Facebook posts from the present study. Twice per week, research staff posted user statistics, which included each group member's total number of sessions and minutes of Headspace completed since the start of the trial, which sessions were completed (e.g., stress, self-esteem, acceptance), and how many days in the past week that participant used Headspace. In addition to individual user statistics, research staff posted group user statistics, which included the total number of minutes and sessions completed as a group within the last day, within the last week, and since the start of the trial. Three to five times per week, research staff also posted inspirational quotes that have been used by Headspace to

motivate users, and conversation prompts to encourage participants to share their experiences with mindfulness. Finally, research staff sent participants an email digest twice per week that included the user statistics and quotes from the Facebook group, as well as a brief explanation of research findings demonstrating the benefits of mindfulness. These emails also included links to the Facebook group and to Headspace.

After the first two semesters of the study, a face-to-face component was added to the Headspace-with-PSA condition based on participant feedback in exit interviews. In addition to the online forum and emails described above, Headspace-with-PSA participants attended three face-to-face group meetings where they had the opportunity to discuss their experiences with Headspace and mindfulness, collaboratively set goals, check in with one another about progress, discuss barriers, challenges, and successes with their practice, and foster a sense of social connectedness with one another. During each meeting, a slide with suggested discussion topics (e.g., "Share what keeps you motivated to continue your practice / what helps you to make time for using Headspace, even when it's challenging?" - see Appendix C) was displayed for the group. While research staff were present and began meetings with a brief introduction and reminder of suggested discussion prompts, there was minimal facilitation and participants were free to discuss a variety of topics. Research staff then provided a brief summary of topics discussed at the end. With participants' permission, research staff transcribed the conversation. The method of transcription changed over the course of the study from bullet points summarizing participant statements, to live transcription with the intent to transcribe as accurately as possible, to transcriptions based on audio recordings. See Appendix D for sample excerpts from face-to-face PSA meeting transcripts. Prior to the COVID-19 pandemic, all face-to-face group meetings

took place in person. Starting with the second meeting of the Spring 2020 semester, all subsequent group meetings took place virtually over Zoom.

All participants completed survey batteries at baseline (T1), halfway through the trial (1 month; T2), at post-intervention (2 months; T3), and one month after post-intervention (follow-up; 3 months; T4). After completing the follow-up survey, waitlist participants were invited to complete the trial as Delayed Headspace-as-Usual Without Orientation participants. They were then provided with an access code for Headspace and completed three additional surveys, with their original follow-up survey acting as a pre-intervention baseline. Adherence data for each participant, including which Headspace sessions were completed and when, was provided to the research team by Headspace.

Participant Characteristics

Over 8 semesters, 145 college students were enrolled in the study. Of these 145 participants, 48 (33%) were assigned to Headspace-with-PSA, 38 (26%) to Headspace-as-Usual With Orientation, 18 (12%) to Headspace-as-Usual Without Orientation, and 41 (28%) to Waitlist Control. The present study primarily analyzed data from Headspace-with-PSA participants ($N = 48$; see Aim 1 and Aim 3), but also analyzed data from Headspace-as-Usual with Orientation (hereinafter referred to as "Headspace-as-Usual") participants ($N = 38$; see Aim 2), for a total sample size of 86.

The 86 participants included in the present study ranged in age from 18 to 27 years old ($M = 19.17$; $SD = 1.53$), with the majority of participants being in their first year (54%) or second year (29%) of college. The majority (91%) identified as female, 6% as male, and 4% as transgender or non-binary. In terms of racial and ethnic identity, 1% identified as African-

American, 13% as Asian-American, 14% as Hispanic or Latine, 57% as White/Caucasian, and 15% as another racial or ethnic identity (e.g., Middle Eastern). Six participants (7%) selected more than one racial/ethnic category. Seventy-three percent of participants identified as heterosexual, 16% as bisexual, 5% as gay, and 6% as another sexual orientation (e.g., asexual). Participants reported their religious affiliation/beliefs, with 35% reporting no religious affiliation, 38% identifying as Catholic, 7% as Muslim, 6% as other (e.g., agnostic), 5% as atheist, 4% as Buddhist, 3% as Evangelical or Orthodox Christian, and 2% as Protestant. Participants came from a variety of socioeconomic backgrounds; when reporting their annual family income, 8% reported less than $25,000, 17% between $25,000 and $50,000, 20% between $50,000 and $75,000, 14% between $75,000 and $100,000, 20% between $100,000 and $150,000, 12% between $150,000 and $200,000, and 9% over $200,000.

Measures

Adherence to Headspace

Adherence to technology-based interventions has been measured with a variety of different metrics (Mohr, Burns, et al., 2013). For example, adherence/engagement to BITs has been measured via self-report questionnaires, qualitative interviews, daily diaries, usage data from the BIT, and data from sensors or other physiological measures (Ng et al., 2019). One systematic review examining adherence to BITs identified 11 different approaches to measuring adherence across 69 studies, with the most common metric being number of logins, followed by number of modules/sessions completed and amount of time spent in the program (Donkin et al., 2011). A more recent systematic review on this topic identified 71 indistinct (i.e., “retention in the trial” and “participant retention” were counted separately) measures of user engagement

across 25 studies of MHapps (Ng et al., 2019). Examples include duration of app use, number of logins, number of interactions with coaches, and program completion rate. Other reviews have similarly found that time spent on the site/app, number of logins, and number of exercises completed are commonly used (Christensen et al., 2009; Mohr, Burns, et al., 2013). Following these precedents, and given that prior research shows a dose-response effect such that more mindfulness practice predicts stronger outcomes (e.g., Bamber & Morpeth, 2018; Flett et al., 2018; Huberty et al., 2021; Parsons et al., 2017), adherence to Headspace was measured by the number of minutes spent meditating. Although the number of Headspace sessions completed was also considered as a potential measure of adherence, this has little variability when examining average use per day (i.e., the average number of sessions per day ranges from 0 to 1), making meaningful data visualization difficult. Further, preliminary analyses for the present study as well as the larger trial (Conley et al., manuscript in preparation) found similar patterns in outcomes based on whether adherence was measured by minutes versus sessions. Finally, Headspace sessions can include non-mindfulness content such as sleep sounds. Measuring adherence with minutes of mindfulness practice allows for a focus on the primary "active ingredient" of the intervention (mindfulness). Thus, the present study used minutes of mindfulness practice to measure adherence to Headspace. Objective user data was provided to the research team by Headspace.

PSA Engagement

Level of engagement with online peer support features has generally been measured by number of exchanged comments (e.g., Ho et al., 2016) or number of posts in an online forum (e.g., Bambina, 2007). The online forum in the present study allowed for multiple types of

engagement; participants could write their own posts, comment on peers' posts, "like" peers' posts, comment on posts by the research team, and "like" posts by the research team. Additionally, Facebook indicates who has seen the post, providing a measure of more passive engagement with the forum than posting, commenting, or liking. To create engagement metrics, all participant posts in the online forum were coded for (1) who posted it, (2) who "liked" it, (3) who saw it, (4) who commented on it, and (5) how many comments it generated. Each participant was coded for each post as 1 (yes) or 0 (no) for posting, liking, seeing, and commenting. Two researchers independently coded 6 participant posts (= 180 codes) for engagement with the posts and demonstrated 100% agreement; one of the researchers then coded the remainder of the participant posts. A weighted sum of these variables (4 points for each post made, 3 points for each comment made on a post, 2 points for each "like," and 1 point for each post seen) was calculated to reflect level of engagement with the PSA online forum. In addition to level of engagement, quality/content of engagement with the online forum was measured by coding of Facebook posts using themes identified in the thematic analysis. Each post was coded as containing a theme (1) or not (0) and posts could contain multiple themes. Finally, engagement with PSA features was additionally measured by attendance at face-to-face group meetings (number of meetings attended).

Supportive Accountability

Participants' subjective experience of supportive accountability was assessed using an 11-item version of the Supportive Accountability Questionnaire (SAQ; Duffecy, Kwasny, et al., 2013; Mohr, Duffecy, et al., 2013). The SAQ assesses feelings of accountability toward a coach or group and the items can be adapted to include details relevant to the program being studied. In

the present study, Headspace-with-PSA participants were asked about accountability with respect to using Headspace and using the online forum (see Appendix E for the full version of the SAQ used in the present study). Sample items include "My Loyola SMiLe group is aware of how much I have engaged in Headspace," "I believe that my Loyola SMiLe group is aware of and notices when I use our Facebook group," and "If I use Headspace less frequently than expected, I feel like I need to give my Loyola SMiLe group reasons why." Items are rated on a 7-point scale from "strongly disagree" to "strongly agree." Higher scores indicate stronger feelings of supportive accountability toward the peer group.

Evaluation of PSA Features

Participants' subjective evaluation of PSA features was assessed using a 12-item measure designed for the SMiLe study (see Appendix F). Headspace-with-PSA participants were asked "How valuable (useful, helpful, engaging, motivating, beneficial) did you find the following features of the Loyola SMiLe Group?" and asked to rate various components (e.g., usage stats posted on Facebook, fellow group members posting on Facebook, emails from research staff) on a 5-point scale from -1 (harmful, hindering) to +3 (very valuable). Items were examined separately to assess participants' relative evaluation of different features.

Data Analysis

Aim 1: Describe Engagement with PSA Features

A thematic analysis of participant Facebook posts and face-to-face group meeting transcripts was conducted to describe the content of PSA engagement. Thematic analysis (TA) is a qualitative method used to systematically identify, organize, and interpret themes across a dataset (Aronson, 1995; Braun & Clarke, 2006; Braun & Clarke, 2012). TA is particularly

recommended for researchers with little experience conducting qualitative data analysis (Braun & Clarke, 2012). This method allows the researcher to take an approach that is simultaneously inductive (i.e., bottom-up, data-driven) and deductive (i.e., top-down, theory-driven). TA offers further flexibility in that themes can be identified on a semantic level (i.e., use of certain words or language patterns) or on a latent level (i.e., underlying ideas or assumptions in the data). Additionally, TA can be used to provide a rich thematic description of an entire dataset, or a more in-depth account of one particular piece of a dataset (Braun & Clarke, 2006). The present study sought to identify and interpret themes on a latent level (i.e., the underlying ideas in the participant posts, as opposed to the semantic content) and provide a rich thematic description of the entire dataset (i.e., all participant posts and group meeting transcripts, as opposed to a particular subset).

The present study followed the Braun and Clarke (2006) step-by-step guide to TA. The first step, familiarizing oneself with the data, involved two researchers (the author and an advanced undergraduate research assistant) reading through all participant posts and meeting transcripts, noting initial ideas for common threads in the data. The second step, generating initial codes, involved coding interesting and relevant ideas or features of the data in a systematic fashion. First the two researchers each went through the same few transcripts or posts and developed their own list of codes that captured/described the latent content. Codes were added to transcripts and spreadsheets of Facebook posts using comments in separate files so as not to see one another's codes. Then the two researchers met, talked through the codes each had developed, and agreed upon a combined list. If the researchers had two codes that were similar, they collaboratively picked the one that better captured the concept (e.g., "what motivates to

meditate" and "reasons to meditate" became "what motivates to meditate") or developed a third code that encompassed both (e.g., "recommendations for app improvements" and "limitations of Headspace app" became "limitations/drawbacks of app features"). If one researcher developed a code and the other did not have a similar one, they talked through whether that code should be added to the list or if it was captured by a preexisting code (e.g., "discussing/comparing streaks" was determined to be captured by preexisting codes "discussing/comparing user stats" and "specific features of the app"). Once there was a common list of codes for that subset of data, the two researchers then coded the next subset using the existing list of codes as well as any additional new codes for concepts that had not yet been captured. Then they came back together and repeated the process above to create an updated list of codes. Researchers are encouraged to revisit data coded early in the process as some codes may have developed over time and early codes may need to be modified (Braun & Clarke, 2006). Thus, codes created early in step two were sometimes clarified/adjusted throughout the process to better capture all content within that code. This process (coding the same subtest of data, comparing lists of codes, and creating an updated common list) was repeated several times until all qualitative data had been coded. Codes were related to latent content (e.g., underlying ideas such as motivations, goals, challenges, and experiences) and a single statement could have multiple codes if it was discussing multiple topics/ideas. The unit of analysis varied as sometimes one sentence included multiple ideas/concepts and sometimes a paragraph of text, or multiple exchanges, discussed one idea/concept. The coding approach was primarily data-driven in order to provide a description that best encompassed all content in the dataset. However, due to the focus of the present study, supportive accountability theory was taken into account and particular attention was given to

instances of peers offering or receiving support and engaging in discussion about adherence to Headspace. As the coding process proceeded, two types of codes emerged: those related to content (i.e., what participants were talking about) and those related to process (i.e., what participants were doing). Codes were thereafter divided into "content codes" and "process codes," which then informed how themes were developed.

The third step involved sorting all of the codes generated in step two into potential themes. Each researcher individually grouped conceptually similar codes into initial themes. Then the two researchers met, discussed their ideas, and decided on a common preliminary list of themes. For the content codes, a more data-driven, bottom-up approach to theme development was utilized. For the process codes, a more literature-driven, top-down approach was utilized, given prior knowledge about the actions involved in supportive accountability (i.e., "monitoring" and "bond"; Duffecy, Sanford, et al., 2013). During the fourth step, themes were reviewed for fit with the data. The researchers met several times to discuss themes and preliminary themes were combined together, split up into separate themes, or discarded as the list of themes was refined (e.g., preliminary themes "how to meditate" and "habit-forming techniques" were combined to create the final theme "building mindfulness into daily life."). The final list of themes was then named and defined (step five; see Appendix G). The final step (step six) involved describing the themes in an analytic narrative that includes illustrative examples for each theme (see Results) and relates themes to relevant literature (see Discussion).

In order to bridge qualitative findings with quantitative findings, the identified codes were then used to quantitatively code all participant Facebook posts. The themes were developed through a thematic analysis of both Facebook posts and group meeting transcripts, but meeting

transcripts were not quantitatively coded because the method of transcription varied widely across semesters, from abbreviated notes that sometimes summarized conversations and were often in third person (e.g., "talking about course load and how impacting stress"), to attempted live transcription during meetings, in which certain statements would be missed (e.g., "But teachers don't give you … [Couldn't hear]"), to verbatim transcriptions of audio recordings (e.g., "I'm hoping to kind of destress with it, um, get consistent with it, and then, yeah, um, yeah hopefully just get more present and mindful"). This made it impossible to define consistent codable units of data. For Facebook posts, each participant post was considered a unit of data and coded as containing each theme (1) or not (0). Most posts contained more than one theme. Two researchers (the same two researchers who conducted the thematic analysis and therefore had strong familiarity with the data and the themes) independently coded for the presence of 8 themes across each of the 133 posts (for a total of 1,064 yes/no codes). Both researchers coded all posts and initial agreement was $\kappa = .86$. The two researchers then came together to discuss and resolve all differences in coding decisions.

Finally, in addition to the thematic analysis of participant posts and group meeting transcripts, descriptive statistics are presented from two survey measures assessing participants' experience of the PSA features. First, descriptive statistics from the SAQ (described above; Duffecy, Kwasny, et al., 2013; Mohr, Duffecy, et al., 2013) illustrate participants' subjective experience of supportive accountability to their peer group. Additionally, descriptive statistics from the Evaluation of PSA Features measure are presented to illustrate participants' relative experience of different PSA features included in this study. While Aim 1 was purely descriptive

and exploratory, post-hoc *t*-tests were run to examine whether observed differences in means on these two measures were statistically significant.

Aim 2: Visualize and Compare Adherence Patterns

To visualize adherence patterns over time, data was plotted in line graphs where the x-axis represents time (i.e., day of trial) and the y-axis represents average minutes meditated. Multiple graphs were created to allow for better visual inspection. Outliers were not removed from analyses because, due to the objective nature of the Headspace adherence data, extreme values are the result of true adherence and not the result of random responding. Vertical lines were placed on certain graphs to indicate when face-to-face group meetings occurred.

To analyze adherence patterns within the Headspace-with-PSA group, and to specifically examine the impact of face-to-face meetings on adherence, a repeated-measures analysis of variance (ANOVA) was run. The within-group design of a repeated-measures ANOVA allows for the comparison of the same participants to themselves under three or more different conditions. In this case, there were 7 conditions: (1) before the first meeting, (2) around the first meeting, (3) between the first and second meetings, (4) around the second meeting, (5) between the second and third meeting, (6) around the third meeting, and (7) after the third meeting. The repeated-measures ANOVA compared adherence within the Headspace-with-PSA group across the seven conditions to examine within-group differences in adherence over time. An intent-to-treat analysis included all Headspace-with-PSA participants from semesters that included face-to-face meetings ($N = 36$), and an as-treated analysis included only those who attended at least two out of the three meetings ($N = 31$), as there were only 21 participants who attended all three.

To compare adherence patterns between the Headspace-with-PSA group and the Headspace-as-Usual group, a mixed ANOVA was run in which the between-groups factor was group (Headspace-with-PSA vs. Headspace-as-Usual) and the within-groups factor is time, using the 7 conditions described above in the one-way ANOVA. In addition to this 2x7 design, a 2x2 version was run in which the within-groups factor was whether a PSA meeting occurred (the 96 hour period around the three meetings versus all other days of the trial). Based on the 7 conditions described above, adherence across conditions 1, 3, 5, and 7 was averaged to determine adherence within each group when a PSA meeting was not proximal, and adherence across conditions 2, 4, and 6 was averaged to determine adherence within each group around the occurrence of PSA meetings. This allowed for a 2x2 design with adherence as the dependent variable, and improved the power of the analysis.

Aim 3: Analyze Interplay of PSA Engagement and App Adherence

To examine the relationship between adherence to Headspace and engagement with PSA features over time, cross-lagged panel models (CLPM), a structural equation modeling (SEM) approach, was utilized. In CLPM, cross-lagged correlations represent causal relationships between two or more variables over time (Cole & Maxwell, 2003; Kearney, 2017; Selig & Preacher, 2009) and coefficients reveal the relative strength of different directional longitudinal pathways (Kearney, 2017). Thus while prior studies have reported a cross-sectional correlation between adherence and SA engagement (e.g., Ho et al., 2016), this approach allows the present study to examine the directionality of this relationship. In CLPM, each variable predicts its own subsequent occurrence at each later time point (e.g., adherence in the first half of the trial predicts adherence in the second half of the trial, which predicts adherence during the follow-up

period), which controls for the effect of previous time points (Cole & Maxwell, 2003; Selig & Preacher, 2009).

The first two models included longitudinal relationships among PSA engagement (measured by the weighted composite of posts made, posts seen, comments, and likes in the Facebook group in the first model, and by participation at face-to-face meetings in the second model) in the first and second halves of the trial, and Headspace adherence (measured by minutes meditated and sessions completed) in the first and second halves of the trial, as well as in the follow-up period. In the third model, PSA engagement was measured by participants' subjective reporting of experienced supportive accountability on the SAQ. The model included SAQ scores at the midpoint assessment (T2) and post-intervention assessment (T3), and Headspace adherence in the first and second halves of the trial, as well as in the follow-up period.

The fit of each model was evaluated using goodness-of-fit statistics, including incremental fit indices (comparative fit index, CFI, and Tucker-Lewis index, TLI) and absolute fit indices (standardized root mean square residual, SRMR, and root mean square error of approximation, RMSEA). Incremental fit indices measure whether modified models are a better fit than the proposed model, and values closer to 1 indicate a better fit to the data. Absolute fit indices measure how far the proposed model is from a perfect fit, and values closer to 0 indicate a better fit to the data (Lee et al., 2014).

With the addition of quantitative coding of themes in Facebook posts, regressions were run to examine the relation between quality/content of PSA engagement and Headspace adherence. These regressions tested whether the proportion of posts containing certain SA-

related themes within a PSA group's online forum predicted Headspace adherence for members of that group.

Power Analysis

For Aim 1, there are no specific guidelines for how many data excerpts are required to generate codes and themes when conducting a thematic analysis (Braun & Clarke, 2012). Given the qualitative nature of the aim, no power analysis is indicated. However, descriptions of datasets used in prior PSA-related thematic analyses (e.g., 59 participants answering 6 open-ended questions in Chittaro & Vianello, 2016; 356 text messages sent between 11 participants in Fortuna et al., 2019; 110 blog posts in Windler et al., 2019) suggest that the present study, with 133 participant Facebook posts and transcripts from 18 face-to-face meetings, had ample data to produce meaningful results with this approach.

For Aim 2, a sensitivity power analysis was conducted using G*Power 3.1 (Faul et al., 2009) to determine the minimal detectable effect for the present study, given the current sample size. An effect size was calculated using partial $\eta 2$, where .01 is considered a small effect, .06 a medium effect, and .14 a large effect (Cohen, 1988). For the first analysis (repeated-measures within-factors ANOVA with 7 conditions), the sample includes all Headspace-with-PSA participants who attended at least two in-person groups ($N = 31$; as-treated analysis) or had the opportunity to attend groups ($N = 36$; intent-to-treat analysis). If alpha = 0.05 and power = 0.80, with 1 group and 7 measurements, the present study is powered to detect an $\eta 2$ of .28 with 36 participants and .31 with 31 participants (large effects).

For the second analysis in Aim 2, (ANOVA with within-between interaction), the sample includes all Headspace-with-PSA participants who had the opportunity to attend groups ($N = 36$)

plus all Headspace-as-Usual participants during semesters with PSA groups ($N = 22$) for a sample size of 58. If alpha = 0.05 and power = 0.80, with 2 groups and 7 measurements, the present study is powered to detect an $\eta 2$ of .19 (large effect). When the conditions are combined into 2 measurements (around meetings vs. not around meetings), the present study is powered to detect an $\eta 2$ of .12 (medium to large effect).

For Aim 3, Bentler (2006) emphasizes that determining *a priori* power in structural equation modeling is not straightforward and depends on many factors. Whereas some have suggested guidelines such as 5 or 10 participants per estimated parameter (Bentler & Chou, 1987) or 10 participants per variable (Nunnally, 1967), Wolf and colleagues (2013) argue that broad rules of thumb are problematic and often inaccurate because they are too general and not model-specific. Bentler (2006) notes that models are less likely to be rejected with smaller samples, and Muthen (2019) notes that fit statistics are considered "not trustworthy" with small sample sizes, so it is preferable to use methods where multiple models are tested when dealing with small samples. If a proposed model is only tested against a perfect fit and is found to be acceptable, it is unclear whether there was adequate power to reject the model. Therefore, a risk with a small sample is that a poorly fitting model will be accepted erroneously. In contrast, if the model is compared to multiple alternatives, then some alternatives being rejected indicates there was sufficient power (Bentler, 2006). Thus, the incremental fit indices (CFI and TLI), which compare the proposed model to modified models, as opposed to the absolute fit indices (SRMR and RMSEA) provide more useful information in the present study given the small sample size.

CHAPTER FOUR

RESULTS

Aim 1 Results: Describe Engagement with PSA Features

Thematic analysis

The thematic analysis of PSA group meeting transcripts and Facebook posts yielded six content-related themes (building mindfulness into daily life; goal-setting, motivation, and barriers; benefits and limitations experienced; specific intervention features; mindfulness outside of study; non-mindfulness topics) and two process-related themes (monitoring/accountability; bonding). While the content themes (Themes 1-6) were defined using a bottom-up, data-driven approach and described what participants were *talking about*, the process themes (Themes 7 and 8) were defined using a more top-down, theory-driven approach and described what participants were *doing*. See Appendix G for the full list of codes within each theme. Sample quotes below are taken both from group meeting transcripts and from participant Facebook posts.

Theme 1: Building Mindfulness Into Daily Life

Participants discussed strategies for building mindfulness/Headspace practice into their routine (e.g., "...I've also realized that trying to do your meditation in the same place kind of helps because your brain starts to connect it to that area I guess.") In discussing how to build mindfulness into their daily life, participants discussed when ("I always do it at night."; "...I try to do it in the morning, like, I'll get out of bed and make my bed and go eat breakfast and then, like, come back to my room and do it."), where ("Yeah I do mine in my room as well."; "I still

haven't found the best place to do it when it's cold outside, have you guys tried anywhere new?"), physically how ("I tried meditating while sitting on the ground a few times…"; "Yeah I definitely use my headphones."), and for how long ("I started trying 10 minute long meditations…"; "I usually only do the 10 min ones…") to meditate. Discussion of when to meditate also included examples of meditating "as needed" rather than meditating at the same time each day (e.g., "...I did it in reaction to a meltdown yesterday and that helped so much… doing it as it was happening was more impactful than doing it at night when I'm less stressed anyway."; "I finished my first app. calc exam earlier today and I felt like I needed a boost, so I did the first Happiness meditation…"). These topics were discussed in the context of simply sharing one's own experience ("I meditated for a few minutes while drinking my morning coffee and sitting outside…"), giving recommendations or suggestions to group members for improving adherence and consistency ("Instead of pushing it until the end of the night, try to do it earlier in the day."), and asking group members for advice regarding building mindfulness into a daily routine ("Though I still haven't found the best place to do it when it's cold outside, have you guys tried anywhere new?").

Theme 2: Goal-setting, Motivation, and Barriers

Goals, as well as barriers to meeting goals, were a major focus of the conversations among PSA participants. Group members primarily set goals related to consistency of Headspace use but also around engagement with the Facebook group. There were individual goals ("I just still want to work on consistency. I want to try and do it, I'd say, at least five days a week."; "I want to finish the pack that I'm working on, self-esteem.") and group goals ("As a group, we can post during Thanksgiving to remind each other to push hard…"; "As discussed last time, let's

stick to our goal of posting two times before the end of this month."). Discussion of goals included setting goals ("I am going to try and do it at least once a day.") and reviewing progress toward previously stated goals ("...one of my goals from the last session was to try the regret pack… but I think I listened to 3 sessions since then…"; "Hi guys, I just thought I'd share that my personal goal is going well so far! I officially have a 3 day streak."). In addition to progress in adherence, participants shared progress toward building mindfulness as a skill ("I wasn't sure I was getting the hang of the noting technique, but I think that now I'm starting to learn how to use it."). When setting goals, participants often discussed what motivates them to use Headspace in the moment ("...whenever I get a message/quote/reminder from Headspace, I try to utilize them and actually go in at that moment (as I'm reminded and aware) to play at least one session."; "I feel like it motivates me more to want to be doing the exercises more knowing that I want to make sure my group members are proud as well…"). When reviewing prior goals, participants often discussed barriers they faced to implementing mindfulness practice ("I think the issue I had was that I did not have peace and quiet when I was home… So I did not do the goals and I feel like if I didn't have the spring break, it would have been easier."; "...it's hard to incorporate into my schedule because between school and work sometimes it just slips out of my mind.") and barriers to engagement that they faced once meditating ("I live in an apartment with roommates and they're always, everybody's like, it's really small so it seems really easy to get distracted in like the living room."; I tried the whole sitting cross legged but my back hurt and I had to focus so much on my posture that I wasn't thinking about the meditation."). Finally, this theme also included goals related to future mindfulness practice after the study was over ("...so I think I would practice mindfulness in the future just because it helps me handle school and just like life

stuff in general."), including barriers to future use ("...it's going to be hard to have that consistency when we don't technically like have to do it…"; "It's weird I am stressed out about wanting to try half the app later when it's done but it's so expensive and I'm like ahh I'm trying to build this habit but it's a lot of money to spend.").

Theme 3: Benefits and Limitations Experienced

Participants frequently discussed benefits they had experienced, or were experiencing, as a result of their mindfulness practice. This included benefits during the meditation exercises ("...it felt really good to relax and notice my breathing!"; "It was soothing and it helped me relax enough to go to sleep."), short-term benefits immediately following meditation ("I really struggled getting up this morning because I went to bed super late, but once I did my meditation, I definitely felt more motivated to start getting things done."; "I was feeling irritated today and I tried the "frustrated" module. It actually helped me relax a lot and I am feeling focused enough to do homework tonight before the weekend hits!"), and longer-term benefits or changes in oneself as a result of regular mindfulness practice ("I feel like I'm a little bit more forgiving towards myself…"; "I definitely feel like doing it has made me more self-aware of my emotions and, like, I know how to deal better."; "I noticed I am more aware of everything, like my surroundings."; "It's definitely made me feel much more relaxed and just happier overall…"). Participants identified challenges in their lives, including mental health challenges, that benefited from mindfulness practice ("I have, like, a chronic pain medical condition…I've just noticed lately that I've been experiencing less pain when I'm conscious of what I'm thinking about, which is great because now I can, like, I went hiking a few days ago and I felt fine. Usually that would put me in bed rest for like a couple days."; "I've always struggled with classes and just like

managing that with life and everything else, even my own mental health. It's just helped me to really feel okay with relaxing and knowing there's going to be days that are unproductive and it's okay…"). Early in the trial, participants discussed expected benefits of engagement in the study ("I chose to participate in Headspace to improve my focus and mental wellbeing. I'm fully aware of the beneficial effects of meditation, but I never had the motivation or push to get a start on it until now."; "I was looking for ways to deal with stress and negative emotions…"). In addition to benefits of mindfulness practice, participants identified benefits they experienced from engagement with their PSA group ("I love seeing you guys post and your tips really help so thank you so much for those!"). Discussions and posts usually focused on benefits, but participants also shared limitations of their mindfulness practice ("I found the exercise to be really peaceful but after it was over I started getting anxious and stressed almost instantly."; "I tried the wakeup one and I feel like it didn't do anything.") as well as limitations of the Headspace app itself ("I wish the app had a search bar or something." "It'd be easier to find ones that pertain to how you're feeling in a specific time." "Definitely agree with that, probably why I spend 20 minutes trying to find one.").

Theme 4: Specific Intervention Features

Discussions and posts often included references to specific features of the Headspace app. Participants frequently shared which modules/courses they had tried within Headspace ("I've started the productivity pack, so I'm hoping that will get me in the mood for studying."; "I just completed the second session of the basics course." "I was feeling irritated today and I tried the frustrated module.") and their reactions to or thoughts about them ("I think this is my favorite module so far because it actually helps me get better sleep!"; "I've started to move away from

the sleep stuff… It's repetitive and annoying to listen to every night."; "The focus pack is one of my favorites because I genuinely feel like it helps me concentrate better on the tasks that I have for that day!"; "I've been doing the managing anxiety one, and that's been helping me a lot just like noticing anxiety a lot more in my day-to-day life and how to better manage it…"). They also discussed techniques, skills, or lessons that are taught within the app ("I like the noting skill"; "...it's just like deep breathing, just like really taking a minute and just actually, like, feeling your breath, like, leave your lungs..."; "It's been helpful to be reminded in these meditations that we are not our thoughts or feelings and we can let them pass without fixating on them."; "Yeah he loves sunlight, liquid sunlight going through your head."). Conversations about Headspace included logistical information about where to find content in the app ("Since the packs can be repetitive I like the Everyday Headspace ones because it changes each day and is less repetitive. They are very specified for that day." "Do they tell you what it's about?" "You'll see on the first page it's below the packs…"; "...I think there's an option, it's called SOS, and if you go there, there's small ones like 3-minute ones for like if you're feeling overwhelmed or stressful."), characteristics of the meditations ("It is so relaxing with the voice"; "I struggle with, because the long pauses, I check to see if it is still on, it just feels too long."), and features that the app offers such as run streaks and daily reminders ("I was upset with myself because one day I completely forgot to do Headspace and lost my streak and so then I had to start over." "Did you get the notification?" "Like the daily thing? I did but it doesn't make much noise and I get so many notifications that I don't even notice them."; "Yay! *[Screenshot of 10-day run streak]*"). In addition to features of the Headspace app, participants discussed other specific intervention features such as discussing the Facebook forum during face-to-face meetings ("But yeah, it's

hard to figure out like what to write sometimes"; "Yeah I'm really awful at being on Facebook, I really don't like Facebook.") and discussing the meetings in the Facebook forum ("Hello everyone! Do we have a meeting today?"; "It was nice seeing you all for our last meeting.")

Theme 5: Mindfulness Outside of Study

While study inclusion criteria ensured that participants had minimal mindfulness experience prior to beginning the trial, group members sometimes shared about past experiences or challenges with mindfulness ("I tried mindfulness before with a therapist and hated it so I like this better, which is good."; "I've sporadically tried meditation, but I've never been consistent with it…"; "The only time previous to this I ever interacted with meditation was, like, high school gym classes where we had like, 'try meditation for one day.'") as well as outside knowledge about mindfulness or mental health in general ("I read this article about how to sit when meditating because I wasn't sure if I was doing it wrong.."; "We were reading about stress in college, and mental health is a continuum… It's a work in progress. Even Headspace won't cure our problems but it will help us in our progress."). In talking about meditation practice, participants often brought up other mindful activities such as yoga or journaling ("I go to yoga already and that helps"; "I've always meant to start the habit of journaling in order to get my thoughts in order and relieve stress and I've been linking starting the habit of journaling with meditating." "Before Headspace, what inspired the mindfulness, for me it was music." "I would agree, something that allows your mind to wander or restart." "Yeah walks or being in nature in general. Exercise to some extent."). Additionally, many participants observed opportunities to be mindful in their everyday life outside of Headspace use ("I feel like I still did some of the visualizations. I'd wake up and only have 15 seconds before work so I would still try to do the

practice even without the app."; "I was studying at the [library] and my phone was at like 6% and I left the [library] and I needed to go home and charge it. I left the [library] and I decided to go on a walk instead. You know how everyone is just on their phone all the time? And I wasn't looking at my phone or listening to music, and it felt like meditating, but it wasn't. I felt present."; "It's kind of weird because I never felt super mindful unless I was in yoga classes because you have to be mindful, but it's weird to see you don't have to be doing that to be mindful. You can be mindful doing your daily stuff.").

Theme 6: Non-Mindfulness Topics

Group discussions were mostly unfacilitated and conversation frequently veered off-topic from Headspace and mindfulness. Participants often shared stressors related to college, work, and life ("I have a lot of projects and papers and all of the tests that are happening…"; "I just have a lot of midterms. I had two exams this week, I have two more next week, and then a whole bunch of quizzes and stuff."; "Freshman 15 is real." "My job has been starting to get more stressful. I work at the UPS store and we are starting to come into the holiday season…"; "...coming to college in a different country, I struggle with the culture and the language."). They discussed and recommended non-mindfulness activities that promote mental and physical health ("If you drink a ton of water in the morning, hydrating immediately in the morning wakes me up."; "I've been trying to get on a more consistent bedtime too…"; "I've been trying to eat healthy"; "I'm trying to balance out my stress levels by being physically active in [gym]."; "I feel like a lot of people say not to get on your phone first thing in the morning.") as well as other non-mindfulness activities for fun, such as podcasts ("For me, I watch Anime"; "I'm weird and listen to a murder podcast… Listen to My Favorite Murder, it's not scary."; "I've gotten really

into audiobooks, and I can do a jigsaw puzzle while I listen."; "The Moth Radio Hour is a really good one. It's a bunch of various speakers telling true stories and every week it's a new subject."). As all participants were undergraduate students at the same institution, they also shared about specific resources and opportunities available on campus ("I also had success coaching at the tutoring center for an hour one-on-one appointment. Highly recommend!"; "Here I've been trying a lot of the group fitness classes…" "And those are free, I'm like this is crazy!"; "Also, remember how we were talking about how transfer students have a hard time? There is a group for transfer students!"). Notably, the 2018 midterm election, the onset of the COVID-19 pandemic, and the 2020 presidential election occurred during the trial in Fall 2018, Spring 2020, and Fall 2020 respectively. During all semesters, but particularly during these three, participants discussed global/political events ("Since midterm elections and all that… are you guys old enough to vote?"; "Yeah there's been a little tension in my friend group because of it."; "For me, the elections were frustrating because I like politics and I was texting my friends from home but none of my friends here don't care."; "We just had the first official case of COVID-19 and that was the first one in my county and there was one right across the river in Iowa and I think it's crazy how quickly it can travel."; "Everything's just kind of surreal right now, like I can't believe a full week of being booted out of school already went by."; "...and cases have exploded exponentially in my state, so it's scary."). Discussion of mindfulness sometimes led to discussion of spirituality and religion ("I also feel like, meditating, it puts me in touch with my spiritual side without going to a church service. I used to go with my parents in high school, but I always want to be spiritual…" "I totally agree with that. Like I was never someone who super went to church or anything but I'm definitely very interested in it"; "I feel like a lot of spirituality is about being

mindful and present."; "...one of my favorite Bible verses, it's Matthew 6:34. It's basically something along the lines of, 'Therefore, don't worry about tomorrow, for tomorrow will worry about itself. Each day has enough worry of its own.' That's something that I've tried to make the focus of my life for the past two years."). Finally, participants also used group meetings and Facebook to clarify study logistics ("How many Sona credits is the study?"; "Hey guys we don't have a session tomorrow right?").

(Note: Themes 1-6 were defined using a bottom-up, data-driven approach and described what participants were *talking about*; Themes 7 and 8 were defined using a more top-down, theory-driven approach and described what participants were *doing*.)

Theme 7: Monitoring/Accountability

This process theme included the accountability-focused actions that the PSA components were designed to facilitate. Participants asked about others' Headspace use ("Are you all starting with one pack or jumping around?"; "Has anyone had a meditation sesh yet that just was really hard for them?"; "Do y'all find it easier to meditate in a chair or on the ground?"), including asking about others' experienced benefits or changes ("What changes have you noticed since using Headspace?"; "...did anybody's family or friends notice any difference??"; "Have you noticed any improvement in your sleep?"). They elicited goal-setting from others ("Do you guys have any new goals for the remainder of the time?"; "So we are going to start [the] change [course], right? How about you guys? What do you want to try?"; "How are you guys going to maintain mindful habits after the study is over?? I would love some inspiration.") and checked in on others' prior goals, including prior group goals ("Comment below and let me know how your individual goals are going so far this week!"; "I think you guys wanted to start the cravings

pack…"; "Group goal was post once a week for the two weeks and I feel like we've done that…"). Participants often requested or gave recommendations about specific Headspace content ("Is there any packs or singles and stuff that you guys really like that you would recommend at all?"; "I just finished the happiness pack last night! I really enjoyed the advice and techniques in there, highly recommend! Anyone have suggestions for what I should try next?") or about improving adherence ("Honestly, I had a really rough time focusing on one thing and I kept thinking about all the stuff I have to do for school this week. Anyone have any tips for focusing?"; "How do you guys adapt to schedule changes that throw off your meditation time?? I wanted to meditate first thing this morning but these last few days have been hectic and I've been having trouble getting it done. Any tips or ideas?"). When conversation veered off topic, certain group members brought it back to the topic of mindfulness/Headspace ("Back to meditation…"). Similarly, some participants would pull less engaged group members into discussion to encourage engagement ("How's it been going for you? [directed at a group member who hadn't spoken yet]"; "Haven't heard from some of you guys… how are you handling everything this week?"). Finally, participants also provided general encouragement of one another's Headspace use ("Also day 3 let's keep it going you, we got this!"; "It's hard to stay focused for so long but we can do it!"; "Hopefully this Sunday brings everyone the chill vibes they need… Don't forget to meditate, too!!!!").

Theme 8: Bonding

Participants in PSA groups bonded with one another by showing interest in fellow group members ("So how is your semester now? Is it stressful?"; "I hope everyone has a wonderful weekend! …Does anyone have any exciting plans?"; "What's your major?") and expressing

empathy/support toward fellow group members (“Hey all! Way to go making it to break! I hope everyone has a great (and mindful) break and rest well!! You deserve it!”; “I’m sorry that was so stressful for you.”; “That’s okay, sometimes you have to treat yourself.”; “I like that you pointed that out.”). They shared information about themselves unrelated to mindfulness practice, in order to get to know one another as people (“I’m a freshman math major and I’m involved with Wind Ensemble and Advocate on campus.”; “...I have some actually good news to come out of being home! I got a job as an ER scribe at a hospital nearby and I'm excited because I want to go to medical school and this will be great clinical experience.”; “I’m going to have a very busy weekend filled with lots of homework and studying.”; “I want to study abroad in Rome.”). They connected over shared interests and stressors (“Everyone is just losing. This semester is just about, like, casualties, and lowering my GPA.” “Very much so. I completely agree.”; “Wishing everyone luck on midterms, I know this is definitely a stressful time.”) and gave advice about non-mindfulness topics (“...my knee really hurts whenever I bend it.” “You should get it checked by NovaCare, they can do a quick check. It’s right behind [pizza place] but they close early like 5 or 7.”; “...my professor puts all the notes online and I know that I have all the notes. So I found that it is helpful to just listen in class. Like if you are taking notes and listening and writing you are not comprehending.” “Maybe I should try that.”). Finally, participants often used joking to build companionship and camaraderie with one another (“Let’s see, what keeps you motivated? I would say…” “The money. Haha, I’m kidding.”; “He’s like ‘sit comfortably’ and I’m, like, hunched over like, ‘let’s do this’ [all laugh].”; “...sometimes I'll text my boyfriend and be like this was cool, I don't want to strangle my roommate anymore [laugh].”). For a few cohorts, joking included creating and sharing memes in the online forum ([Picture that shows a person

labeled "phone notifications" passing a note to a person labeled "me waiting for a text from a boy"] [Picture that shows the person looking angry and opening up the note that shows Headspace notifications]).

Quantitative Coding of Facebook Posts

The qualitative findings from the thematic analysis were used to quantitatively code the content of participant Facebook posts, in order to understand how often certain themes were discussed (and to examine whether SA themes predict more Headspace use; see Aim 3). While themes were determined through a thematic analysis of both Facebook posts and group meeting transcripts, meeting transcripts were not quantitatively coded because the method of transcription varied widely across semesters, making it impossible to define consistent codable units of data that could be compared to one another. For Facebook posts, each participant post was considered a unit of data and was coded as containing each theme or not. Across 8 PSA cohorts, participants made 133 Facebook posts. The number of posts per cohort ranged from 5 to 42. Each post contained between 1 and 8 themes (only one post contained all 8 themes), with an average of 3.8 themes present in each post.

Table 1 shows how often each theme was expressed in participant Facebook posts, ordered from most to least frequent for content themes, then process themes. The most commonly discussed theme in the online forum was goal-setting, motivation, and barriers (61.7% of posts), with monitoring/accountability as the second most common (58.6%). Thus, participants most commonly used the Facebook group to state their goals, review progress toward their goals, check in on others' goals, and provide reminders and encouragement to others to meditate. Approximately half of the posts included non-mindfulness topics, indicating that

participants also commonly used the Facebook group to share about themselves and discuss college-related stressors and other non-intervention topics. Seven out of 8 themes came up in at least 40% of posts, but only a small proportion of posts (13.5%) addressed mindfulness outside of the study.

Table 1. Number and Percent of Facebook Posts Containing Each Theme

Theme	Number of Posts	% of Total Posts
Content Themes		
Goal-setting, motivation, and barriers	82	61.7
Benefits and limitations experienced	70	52.6
Non-mindfulness topics	69	51.9
Discussion of specific intervention features	63	47.4
Building mindfulness into daily life	57	42.9
Mindfulness outside of study	18	13.5
Process Themes		
Monitoring/Accountability	78	58.6
Bonding	69	51.9

Participant Experience of PSA Features

Descriptive statistics from the SAQ and the Evaluation of PSA Features revealed participants' subjective experience of supportive accountability as well as their beliefs about how valuable or helpful each PSA feature was. Table 2 displays descriptive statistics for the SAQ, including means for the monitoring subscale (items 1-6), the bond subscale (items 7-11) and the total scale. Items were ranked from 1 (strongly disagree) to 7 (strongly agree).

Table 2. SAQ Descriptive Statistics and T2-T3 Change

Item	T2 (Midpoint Assessment)		T3 (Post-Trial Assessment)		T2-T3 Change	
	Mean	SD	Mean	SD	*t*(45)	*p*
1. I believe that my Loyola SMiLe group is aware of and notices when I use Headspace.	5.53	1.38	5.23	1.46	1.53	.133
2. I believe that my Loyola SMiLe group is aware of and notices when I use our Facebook group.	6.02	0.97	5.19	1.81	3.45	.001**
3. My Loyola SMiLe group is aware of how much I have engaged in Headspace.	5.68	1.25	5.47	1.33	1.38	.175
4. My Loyola SMiLe group is aware of how much I have engaged in our Facebook group.	5.87	1.10	5.49	1.41	1.85	.071
5. I think that my Loyola SMiLe group expects that I will be very consistent in using Headspace every day, or nearly every day.	5.02	1.54	4.26	1.73	3.38	.001**
6. I think that my Loyola SMiLe group expects that I will be very consistent in logging in and using our Facebook group every day, or nearly every day.	4.34	1.88	3.70	1.86	2.53	.015*
Monitoring Subscale Mean (Item 1-6)	5.41	1.08	4.89	1.35	3.56	<.001***
7. I believe my Loyola SMiLe group will think less of me if I don't use Headspace as frequently as is expected.	3.83	1.96	2.96	1.98	2.85	.007**
8. I believe my Loyola SMiLe group will think less of me	3.55	1.89	2.64	1.73	3.35	.002**

if I don't use our Facebook group as frequently as is expected.						
9. It would bother me if my Loyola SMiLe group thought less of me.	4.85	1.68	4.45	1.84	2.43	.019*
10. If I use Headspace less frequently than expected, I feel like I need to give my Loyola SMiLe group reasons why.	5.00	1.69	3.96	1.98	4.52	<.001***
11. If I participate in our Facebook group less frequently than expected, I feel like I need to give my Loyola SMiLe group reasons why.	4.51	1.87	3.68	2.01	3.86	<.001***
Bond Subscale Mean (Item 7-11)	4.34	1.42	3.54	1.58	4.24	<.001***
SAQ Mean Score	4.93	1.01	4.27	1.31	4.45	<.001***
SAQ Total Score	54.21	11.08	47.02	14.46	4.45	<.001***

Note. Items were rated from 1 (strongly disagree) to 7 (strongly agree).
*p<.05; **p<.01; ***p<.001

Although this aim was purely exploratory and descriptive, without specific or directional hypotheses, select observations based on visual inspection of means were then tested for statistical significance. First, visual inspection of the means revealed that mean scores decrease between T2 and T3 for every item, reflecting an overall decrease in subjectively experienced PSA between the midpoint and post-trial timepoints. Paired-sample *t*-tests (see Table 2) confirmed that this represents a statistically significant decrease for the overall scale, for both subscales, and for 8 of the 11 individual items. Visual inspection of means also revealed that items beginning with "I believe my Loyola SMiLe group will think less of me if…" were rated lower than all other items. Paired-sample *t*-tests confirmed that item 7 ("I believe my Loyola SMiLe group will think less of me if I don't use Headspace as frequently as is expected") was rated significantly lower than item 1 (t=4.95; p<.001), item 2 (t=7.11, p<.001), item 3 (t=5.65, p<.001), item 4 (t=6.13, p<.001), item 5 (t=3.79, p<.001), item 9 (t=3.23, p=.002), item 10 (t=4.14, p<.001), and item 11 (t=2.37, p=.022) at T2. Similarly, item 8 ("I believe my Loyola SMiLe group will think less of me if I don't use our Facebook group as frequently as is expected") was rated significantly lower than item 1 (t=6.08; p<.001), item 2 (t=8.47, p<.001), item 3 (t=7.01, p<.001), item 4 (t=7.40, p<.001), item 5 (t=5.06, p<.001), item 6 (t=2.64, p=.011), item 9 (t=4.29, p<.001), item 10 (t=5.54, p<.001), and item 11 (t=3.88, p<.001) at T2. Finally, visual inspection of the two subscale means revealed that participants reported higher feelings of monitoring than feelings of bond. Paired-sample *t*-tests confirmed that the monitoring subscale mean is significantly higher than the bond subscale mean at T2 (t=4.96, p<.001) and at T3 (t=7.23, p<.001).

Table 3 displays descriptive statistics for Evaluation of PSA Features. Participants were prompted to consider "how valuable (useful, helpful, engaging, motivating, beneficial)" they

found each of the PSA features listed below. Items were ranked from -1 ("harmful, hindering") to 3 ("very valuable"), with 0 representing "neutral, didn't help or hurt." Participants could also select "N/A: I didn't notice or experience this" and these responses were excluded when calculating descriptives. Items are listed in Table 3 from most valuable to least valuable, per participant ratings at T2. Footnotes indicate how many participants rated each item "N/A: I didn't notice or experience this" (no footnote indicates zero N/A responses for that item).

Overall, most PSA features were rated between "1: A little bit valuable" and "2: Moderately valuable" on average. As with the SAQ above, select observations based on visual inspection were tested for statistical significance using *t*-tests. Visual inspection of means suggested that meeting face-to-face was widely considered more valuable than engaging with the online forum in any way. Indeed, paired sample *t*-tests confirmed that "meeting with my group members every other week" was rated as significantly more valuable than "group members' progress stats posted on Facebook" (t=2.94, p=.006), "mindful inspiration images/quotes posted on Facebook" (t=3.45, p=.002), and "group members replying to the admin postings" (t=3.05, p=.005) at T2, but not significantly more valuable than other items. Within the Facebook-related items, visual inspection of means suggested that seeing fellow group members post content was considered more valuable than posting one's own content and these differences were not significant (t=2.01, p=.051). Seeing one's own progress stats appeared to be rated as more valuable than seeing group members' progress stats, but this was not a significant difference (t=.651, p=.519).

Table 3. Evaluation of PSA Features Descriptive Statistics

Item	T2 (Midpoint Assessment)		T3 (Post-Trial Assessment)	
	Mean	SD	Mean	SD
Meeting with my group members every other week	2.06[a]	0.98	1.94[a]	1.10
Emails from Loyola SMiLe Project - in general as a reminder	1.79	1.06	1.55	1.19
Group members replying to my own posts	1.70[b]	1.13	1.63[c]	1.22
Group members posting their own content (articles, questions, discussion threads)	1.68[d]	1.07	1.71[e]	1.13
Facebook push notifications and/or email alerts when someone posted in the group	1.64	1.05	1.49[d]	1.08
Posting my own content or replies	1.50[b]	1.13	1.37[c]	1.20
Emails from Loyola SMiLe Project - specifically research about mindfulness benefits	1.45	1.21	1.34[b]	1.24
My progress stats posted on Facebook	1.38	1.24	1.33	1.25
Group members' progress stats posted on Facebook	1.32	1.12	1.15	1.23
Mindful Inspiration images/quotes posted on Facebook	1.15	1.10	1.00	1.10
Group members replying to the admin postings	1.00[f]	1.10	1.13[g]	1.13

Note. Items are listed from most valuable to least valuable, per participant ratings at T2. Items were ranked from -1 ("harmful, hindering") to 3 ("very valuable"), with 0 representing "neutral, didn't help or hurt." Participants could also select "N/A: I didn't notice or experience this" and these responses were excluded when calculating descriptives. The following superscripts indicate the number of N/A responses for that item: [a]1; [b]3; [c]4; [d]2; [e]5; [f]6; [g]7.

Aim 2 Results: Visualize and Compare Adherence Patterns

Data Visualization

Several graphs were generated to visually depict patterns of Headspace use over time for Headspace-as-Usual and Headspace-with-PSA participants. Headspace use was measured by the number of minutes meditated per day. Because the focus of Aim 2 was to examine the impact of PSA group meetings, data from the first two semesters (when there were no meetings) and the last semester of the trial (when there was no PSA group) were excluded. Additionally, one PSA participant was missing user data, due to a technical glitch with the provided access code, and was therefore excluded from Aim 2 analyses. This left a sample of 35 Headspace-with-PSA participants and 22 Headspace-as-Usual participants for Aim 2.

First, graphs were created to examine individual participants' pattern of use over the trial, with separate graphs for Headspace-with-PSA (Figure 4) Headspace-as-Usual (Figure 5).

Figure 4. Headspace-with-PSA Daily Adherence

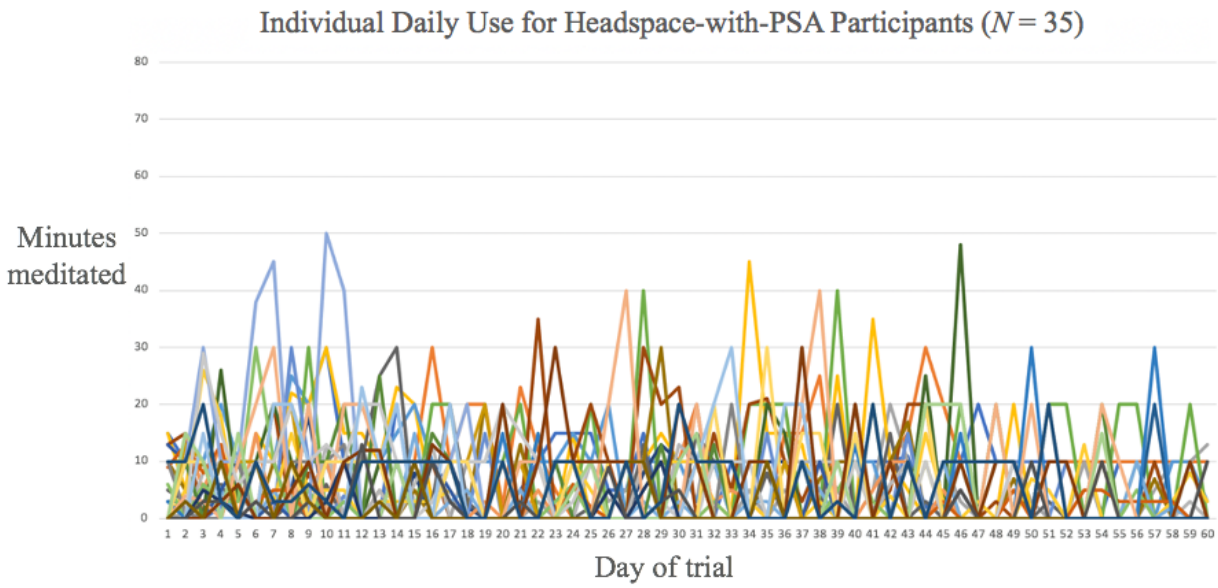
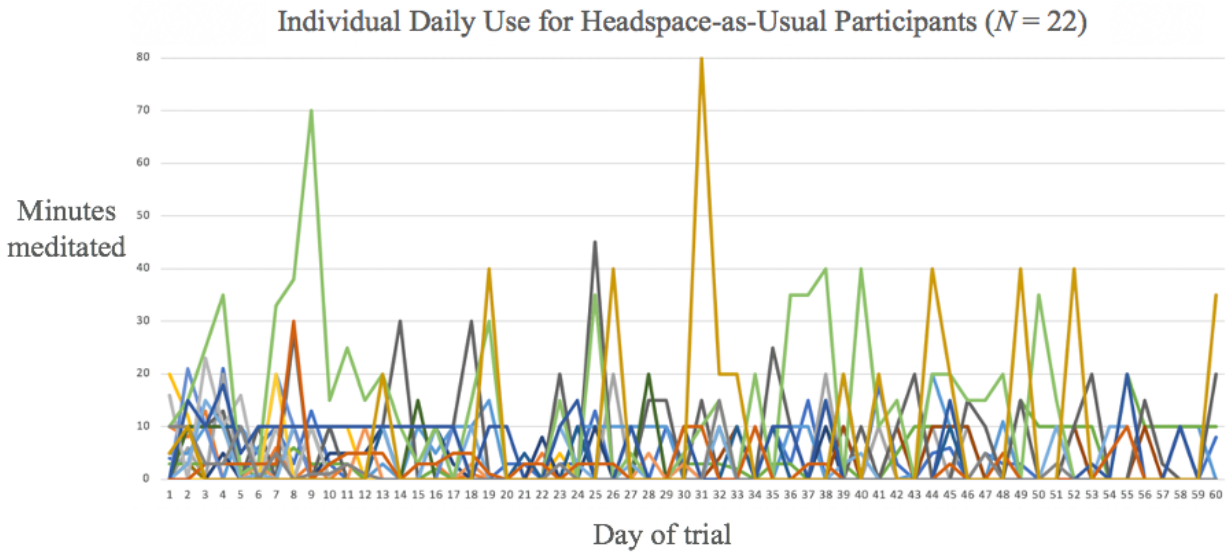


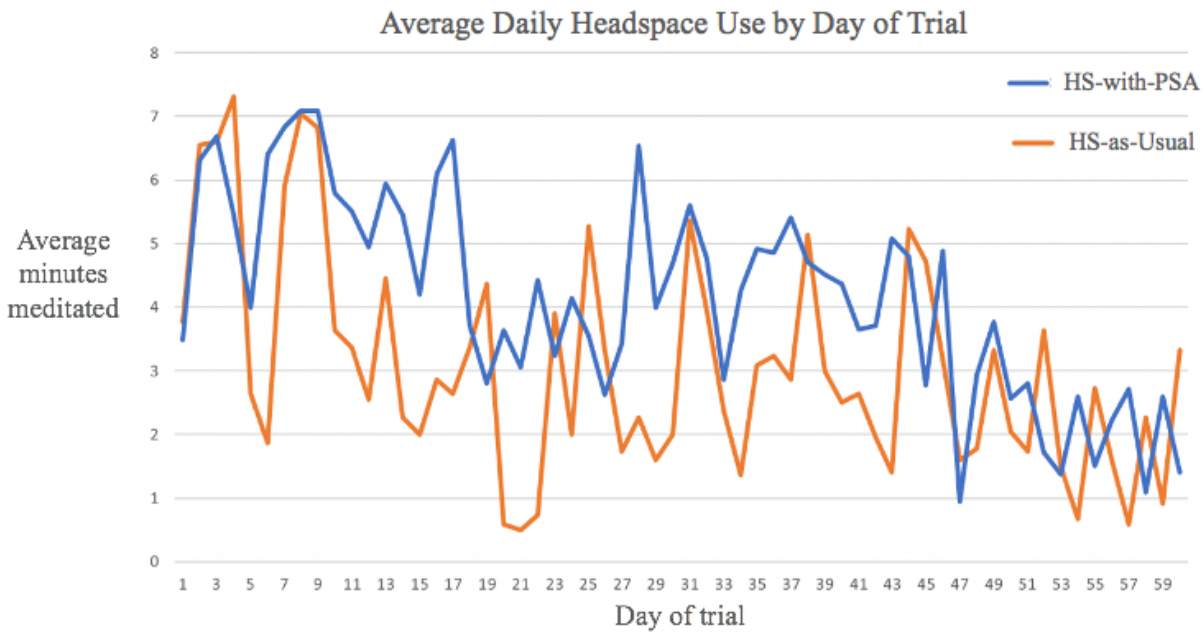
Figure 5. Headspace-as-Usual Daily Adherence



Visual inspection of these graphs indicates two clear outlier data points (individual days for individual participants) in the Headspace-as-Usual group. These data points were examined and determined to reflect true Headspace use (e.g., multiple sessions throughout the day, based on timestamps). Additionally, survey responses for these two participants were examined. When asked how much they had practiced Headspace since the start of the trial on a 1-5 scale from "None: Not at all" to "A lot: Daily practice," one participant selected 4 ("Much: A few times each week") and the other selected 5 ("A lot: Daily practice") at both the midpoint and post-assessment timepoints. Additionally, in qualitative responses about what Headspace content they had listened to and found most helpful, what skills they had learned from their Headspace use, and how they had applied those skills in everyday life, both participants discussed their experience at length and mentioned specific courses that match their objective user data. Based on their survey responses, they seem to have had genuinely high engagement with the intervention. Thus, these outliers were not removed from analyses.

Next, minutes each day were averaged within each group to display the overall pattern of adherence for each group over time (Figure 6). The blue line represents Headspace-with-PSA and the orange line represents Headspace-as-Usual.

Figure 6. Adherence for Both Groups by Day of Trial



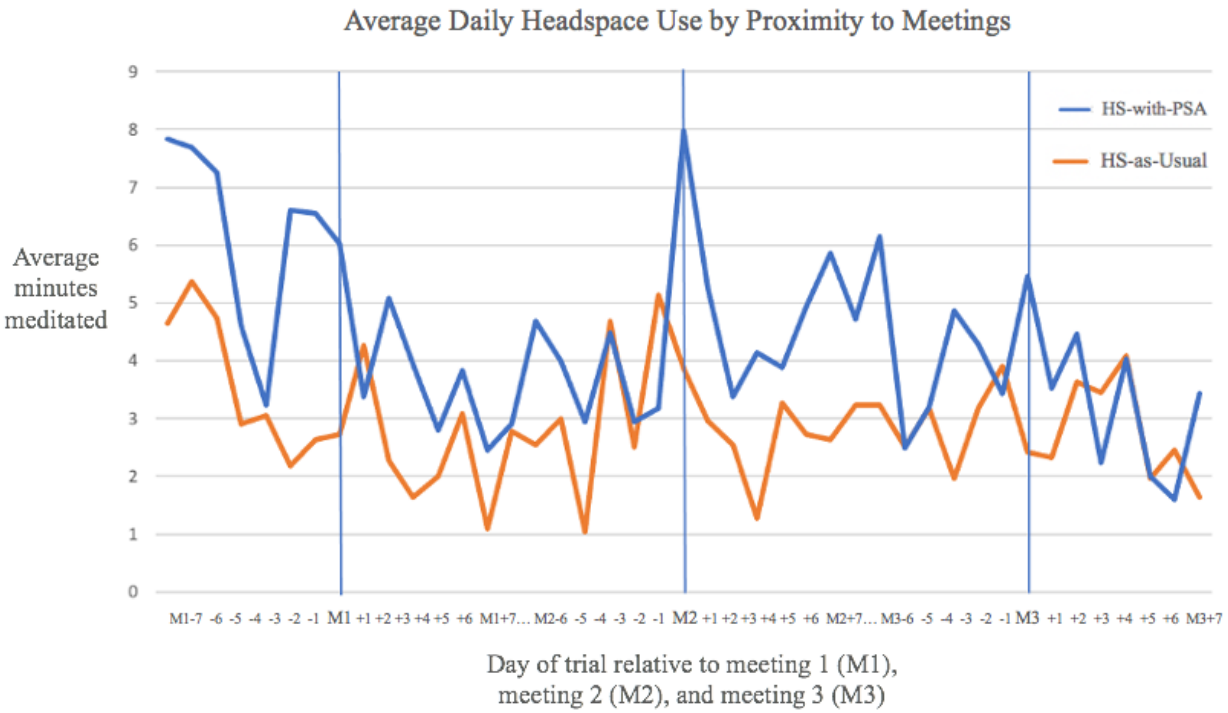
Due to various scheduling factors (e.g., participants' weekly schedules, timing of holidays), group meetings were not consistently held on the same day or even week of the trial each semester. Table 4 shows which day of the trial each meeting was held each semester.

Table 4. Timing of PSA Meetings Across Semesters (By Day of Trial)

Semester	Day of Meeting 1	Day of Meeting 2	Day of Meeting 3
Fall 2018	14	28	42
Spring 2019	14	28	42
Fall 2019	9	30	44
Spring 2020	22	36	50
Fall 2020	17	31	45

For this reason, a second graph was created to line up meeting days across cohorts (Figure 7). As the fewest number of days between meetings (non-inclusive of meeting days) was 13, points on the graph were created to reflect: the 7 days before meeting 1, the day of meeting 1, the 7 days after meeting 1 and the 6 days before meeting 2, the day of meeting 2, the 7 days after meeting 2 and the 6 days before meeting 3, the day of meeting 3, and the 7 days after meeting 3. This approach ensured that the same day was not counted twice. While this excluded some days between meetings for certain cohorts (e.g., the 8th day after meeting 1, if there was longer than 13 days between meeting 1 and 2), it allowed for a much clearer picture of how meetings may have impacted the pattern of Headspace use. Figure 7 displays this pattern of use centered on meeting days, with meeting days indicated by vertical lines.

Figure 7. Adherence for Both Groups by Proximity to PSA Group Meetings



Visual inspection of this graph supports the hypothesis that Headspace use increased on the day of PSA meetings, and in the 1-2 days prior to the meeting in the case of meeting 1, for the Headspace-with-PSA group but not the Headspace-as-Usual group. This hypothesis was then tested with ANOVAs.

ANOVAs

First, a repeated measures within-group ANOVA was run to compare average minutes meditated by members of the Headspace-with-PSA group across the seven time conditions: (1) before the first meeting (on average, 13 days), (2) around the first meeting (5 days), (3) between the first and second meetings (on average, 10 days), (4) around the second meeting (5 days), (5) between the second and third meeting (on average, 9 days), (6) around the third meeting (5 days), and (7) after the third meeting (on average, 13 days). Conditions 2, 4, and 6, included the two days before and two days after each meeting (thus, a total of 5 days including the day of the meeting). For the intent-to-treat analysis (includes all Headspace-with-PSA participants who had the opportunity to attend groups and had user data available; $N = 35$; see Figure 8), results indicate a large, significant effect of time on adherence for the PSA participants, $F(6,29) = 6.675$, $p < .001$, $\eta_p^2 = .580$. Results were similar, with an even larger effect size, for the as-treated analysis (includes Headspace-with-PSA participants who attended at least two of the three group meetings and had user data available; $N = 30$; see Figure 9), $F(6,24) = 6.774$, $p < .001$, $\eta_p^2 = .629$.

Figure 8. Within-Group ANOVA for Headspace-with-PSA (intent-to-treat): Daily Meditation in Relation to Meetings (M)

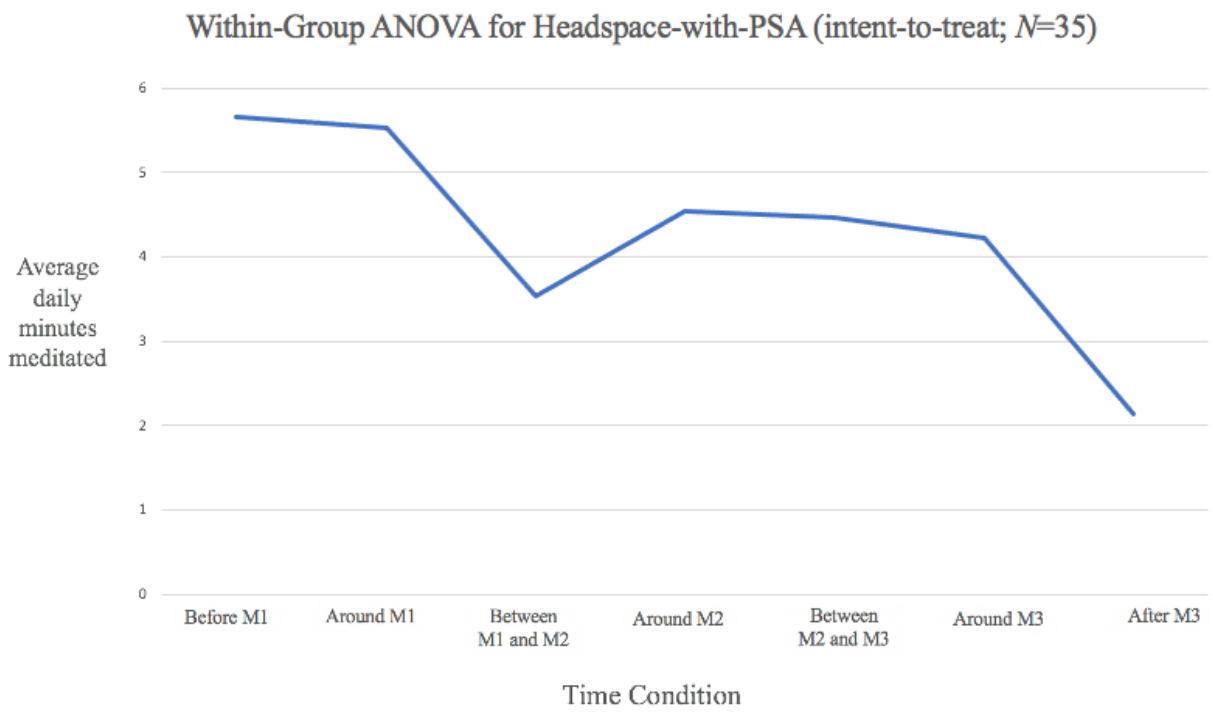
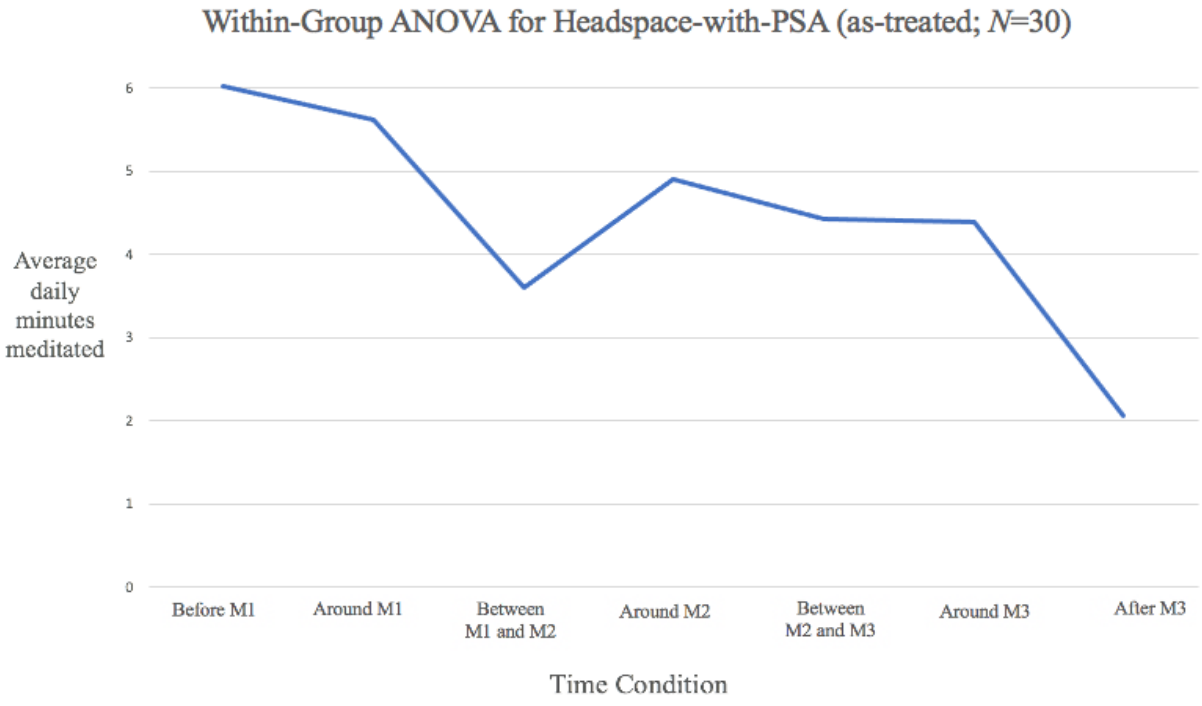


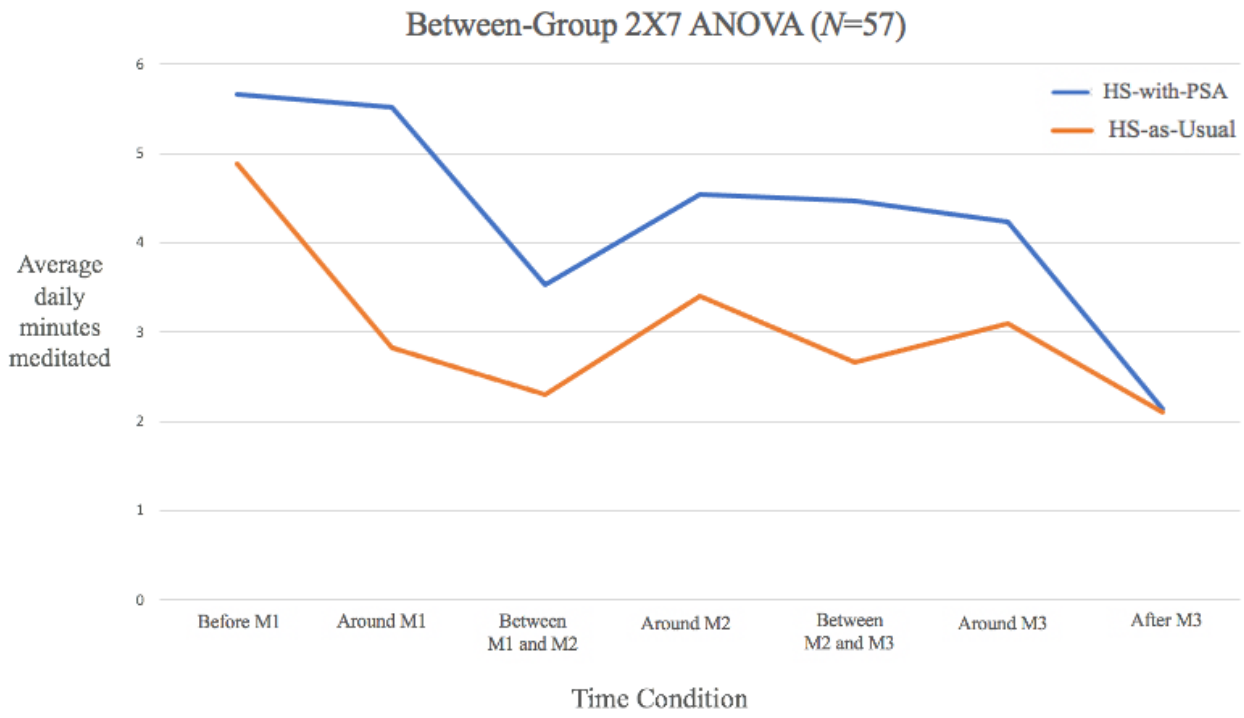
Figure 9. Within-Group ANOVA for Headspace-with-PSA (as-treated):Daily Meditation in Relation to Meetings (M)



Post-hoc pairwise comparisons for the intent-to-treat analysis probed which time periods were significantly different from one another. As depicted in Figure 8, Headspace use during the final time period (after the third meeting) was significantly lower than Headspace use during all other 6 conditions (ps < .045), indicating a decline in use after the final meeting. Additionally, use around meeting 1 (condition 2) was significantly higher than between meeting 1 and 2 (condition 3; p = .011), providing partial support for Hypothesis 1, that Headspace use would be higher around meetings compared to between meetings. For the as-treated analysis, the same post-hoc comparisons were statistically significant: as depicted in Figure 9, Headspace use after the third meeting was significantly lower than during all other 6 conditions (ps < .036), and use around meeting 1 was significantly higher than between meeting 1 and 2 (p = .035). No other pairwise comparisons were significant for the Headspace-with-PSA within-group ANOVAs. Because there were no meaningful differences between the pattern of adherence for the intent-to-treat and as-treated samples, the intent-to-treat sample for Headspace-with-PSA (N = 35) was used in the between-group ANOVAs to improve power.

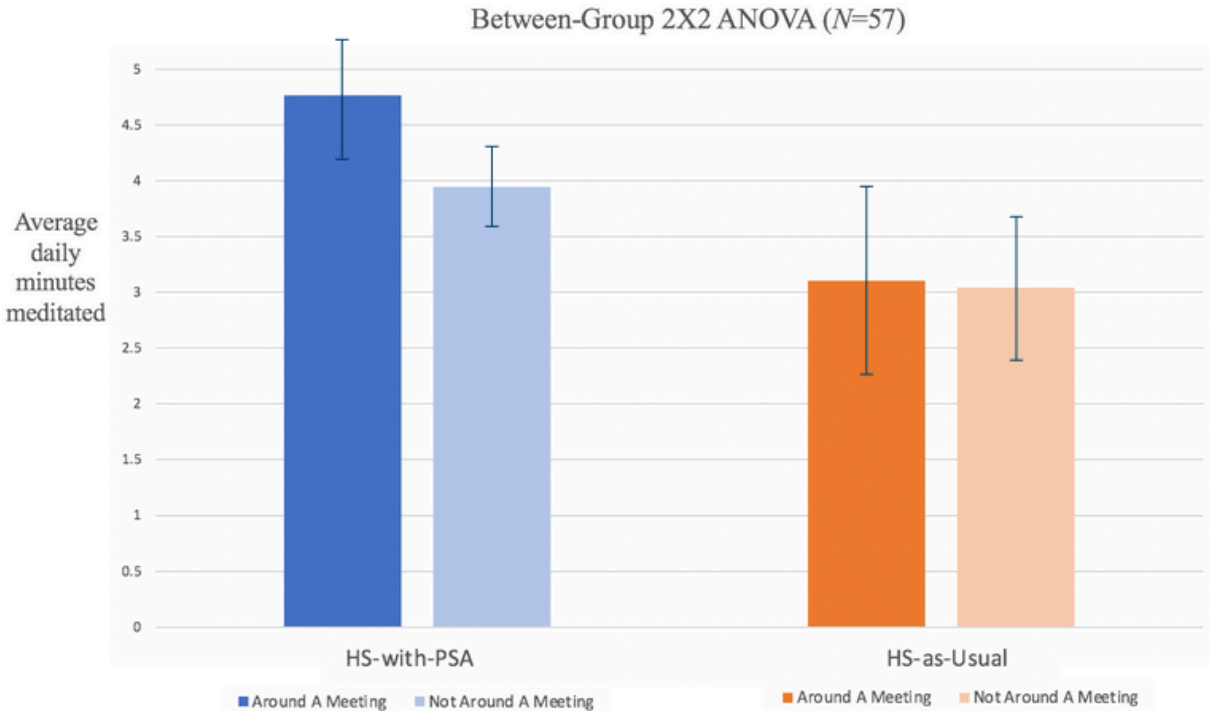
Next a 2x7 repeated measures between-group ANOVA was run to examine whether the pattern of adherence differed significantly between the two groups (Figure 10). Results indicated a group by time interaction with a large effect size that the present study is not powered to detect with significance testing (power analyses indicated the power to detect an effect size of .19 for this analysis), $F(6,50) = 1.727$, $p = .134$, $\eta_p^2 = .172$.

Figure 10. Between-Group 2X7 ANOVA: Daily Meditation in Relation to Meetings (M)



To improve power and to specifically examine differences between "around a meeting" and "not around a meeting," a 2x2 between-group ANOVA was then run to compare minutes meditated by the two groups in the time around meetings versus not around meetings. As "around a meeting" versus "not around a meeting" is a nominal, not an ordinal, variable, results for the 2x2 ANOVA are depicted using a bar graph, rather than a line graph as above. Results indicated a group by time interaction with a small-to-medium effect size that the present study is not powered to detect with significance testing (power analyses indicated the power to detect an effect size of .12 for this analysis), $F(1,55) = 1.715$, $p = .196$, $\eta_p^2 = .030$.

Figure 11. Between-Group 2X2 ANOVA: Daily Meditation in Relation to Meetings



Taken together, these results suggest that differences in adherence patterns between the two groups can be partially attributed to the presence of PSA meetings. To further confirm that differences between the two groups could be attributed to the presence of PSA meetings, an exploratory within-group ANOVA was run for the Headspace-as-Usual group across the 7 time conditions (see HS-as-Usual line in Figure 10). If similar differences between time conditions existed for the Headspace-as-Usual group as for the Headspace-with-PSA group, then the within-group effects for Headspace-with-PSA could not be attributed confidently to PSA features and would more likely be attributed to factors that both groups experienced. There was a significant within-group effect of time for the Headspace-as-Usual group, $F(6,16) = 3.986$, $p = .012$, $\eta_p^2 = .599$. However, post-hoc pairwise comparisons revealed that this was driven by a significant difference between condition 1 (before the first meeting) and condition 5 (between meetings 2 and 3; $p = .033$). No other pairwise comparisons were significant. This is distinct from the

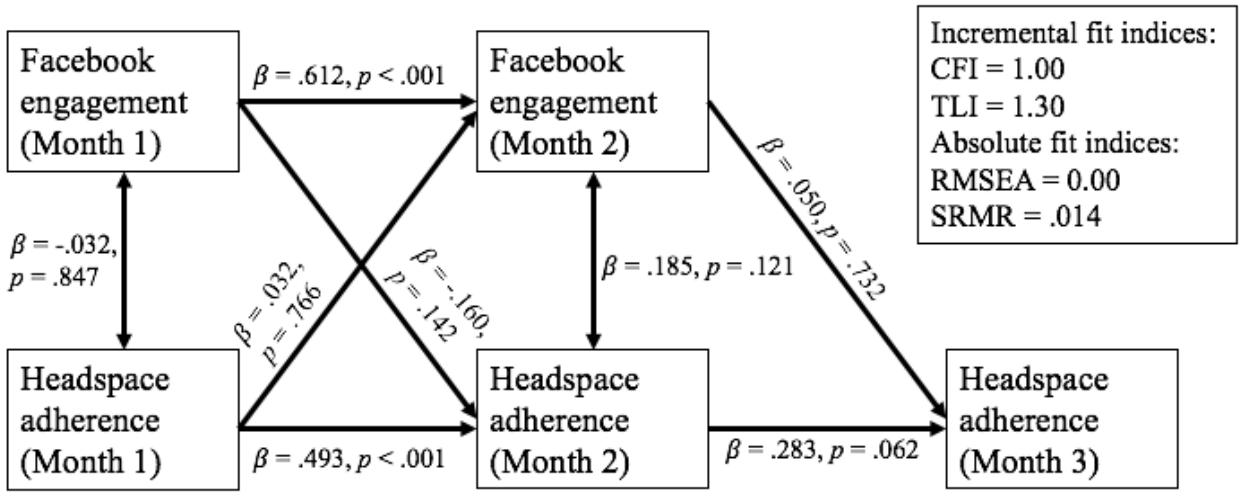
within-group pattern for Headspace-with-PSA, which had significant differences between condition 7 (after the third meeting) and the other 6 conditions, and between condition 2 (around meeting 1) and condition 3 (between meeting 1 and 2). This suggests that the within-group time effect for the Headspace-as-Usual group was distinct from that of the Headspace-with-PSA group (which appears to be more, though not exclusively, driven by meeting times). Overall, the effect of time for the Headspace-as-Usual group appears to reflect a more general decrease in use over time, which does not map onto PSA meetings. The large effect for the between-group 2x7 ANOVA supports the hypothesis that adherence patterns would differ between the two groups, and the small-to-medium effect for the between-group 2x2 ANOVA supports the hypothesis that the groups' adherence patterns would differ specifically based on meeting times (Hypothesis 2).

Aim 3 Results: Analyze Interplay of PSA Engagement and App Adherence

PSA Engagement and Headspace Use

The bidirectional cross-lagged panel model (CLPM) with Headspace use (minutes meditated) and Facebook engagement (weighted sum of posts made, commented on, liked, and seen) by month (see Figure 12) demonstrated poor fit using the chi-square test of model fit, $\chi 2$ (2) = .253, p = .881. Other fit indices indicated excellent fit, including the root mean square error of approximation (RMSEA = 0.00), standardized root mean square residual (SRMR = .014), comparative fit index (CFI = 1.00), and Tucker-Lewis index (TLI = 1.30).

Figure 12. CLPM Results for Headspace Adherence and PSA Engagement (*N*=46)



However, the sample size for this analysis (46) makes the power to reject the model "extremely low" and the fit statistics are considered "not trustworthy at such a small N" (Muthen, 2019). For this reason, several exploratory regressions were run to examine these relationships further. No regressions revealed significant relationships. Specifically, across the entire trial and follow-up period, the total Facebook engagement score (across 2 months) did not significantly predict Headspace use (cumulative minutes meditated across 3 months), β = -.014, R^2 = .000, p = .927. Additionally, Facebook engagement during month 1 did not predict Headspace use in month 1 (β = .054, R^2 = .003, p = .722) or in month 2 (β = -.107, R^2 = .011, p = .475). Facebook engagement during month 2 did not predict Headspace use in month 2 (β = .026, R^2 = .001, p = .864) or in month 3 (β = .059, R^2 = .003, p = .697). Examining these relationships in the other direction (i.e., Headspace adherence predicting Facebook engagement), Headspace use in month 1 did not predict Facebook engagement in month 2 (β = -.027, R^2 = .001, p = .860). (Cross-sectional relationships were not reexamined in the other direction.) The β and p values in Figure 12 were provided by MPlus and reflect the strength of each relation when examining the model overall, whereas the values listed here reflect individual exploratory regressions that do not

account for the entire cross-lagged model. Overall, these results reflect no significant relationship between level of engagement with the Facebook group (as measured in the present study) and app adherence, providing no support for the hypothesis that these variables would be reciprocally related over time.

The present study additionally aimed to test the bidirectional model in Figure 12 using attendance at face-to-face group meetings in place of engagement with the Facebook group. However, this sample was limited to Headspace-with-PSA participants who had the opportunity to attend group meetings ($N = 35$), which is an even smaller sample size than in the model above. MPlus was unable to calculate fit statistics for the model given this sample size. Instead, exploratory regressions were run to examine the relationship between group attendance and Headspace use. No regressions revealed significant relationships. Specifically, cumulative attendance at PSA group meetings did not significantly predict Headspace use during month 2 ($\beta = -.094$, $R^2 = .009$, $p = .589$), Headspace use during month 3 ($\beta = -.084$, $R^2 = .007$, $p = .637$), or cumulative Headspace use across all 3 months ($\beta = .054$, $R^2 = .003$, $p = .764$). Overall, these results similarly reflect no significant relationship between level of engagement with the PSA group (measured by attendance) and app adherence.

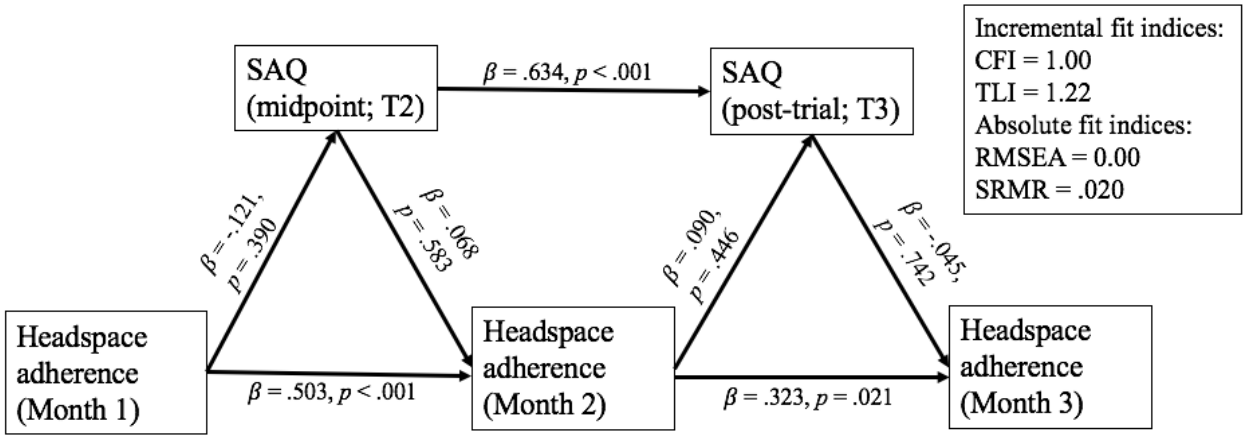
To examine the relationship between Headspace use and *quality* of PSA engagement, rather than *quantity*, results from the quantitative thematic coding of Facebook posts from Aim 1 was used. Specifically, exploratory regressions examined whether the proportion of posts coded as "monitoring" and as "bond" within a cohort's Facebook forum predicted adherence for participants in that cohort. Both p values and effect sizes using R^2 are reported (for R^2, .10-.30 is small to medium, .30-.50 is medium to large, and >.50 is large to very large; Cohen, 1988). When these variables were examined separately, proportion of posts coded as monitoring (across

the 2 months of Facebook use) did not significantly predict total cumulative Headspace use (across 3 months), $\beta = .216$, $R^2 = .047$, $p = .149$. Proportion of posts coded as bond (across the 2 months of Facebook use) did not significantly predict total cumulative Headspace use (across 3 months), $\beta = .215$, $R^2 = .046$, $p = .151$. However, when these two variables were entered into a regression model together to predict total cumulative Headspace use, the overall impact of both monitoring and bond within Facebook posts was nonsignificant with a small effect size, $F(2,43) = 3.049$, $R^2 = .124$, $p = .058$.

Supportive Accountability and Headspace Use

The bidirectional cross-lag panel model (CLPM) with Headspace use (minutes meditated) and SAQ scores by month demonstrated similar results: $\chi 2$ (3) = .949, $p = .814$; RMSEA = 0.00; SRMR = .020; CFI = 1.00; TLI = 1.22. Given the small sample size, these fit statistics are considered "not trustworthy." Fit indices were identical when using the monitoring and bond subscales of the SAQ, rather than the total scale.

Figure 13. CLPM Results for Headspace Adherence and Subjective Experience of Supportive Accountability (SAQ)



Given that the fit indices must be interpreted with extreme caution with the present study's sample size, exploratory regressions were run to further examine the relationship

between SAQ and Headspace use. No regressions revealed significant relationships. Specifically, SAQ scores at T2 did not significantly predict Headspace use in month 2 for the total scale (β = -.012 R^2 = .000, p = .938), the monitoring subscale (β = .045, R^2 = .002, p = .767), or the bond subscale (β = -.059, R^2 = .004, p = .695). SAQ scores at T2 also did not significantly predict Headspace use in month 3 for the total scale (β = .052 R^2 = .003, p = .737), the monitoring subscale (β = .129, R^2 = .017, p = .397), or the bond subscale (β = -.038, R^2 = .001, p = .805). Further, SAQ scores at T2 did not significantly predict total Headspace use (cumulative minutes meditated across 3 months) for the total scale (β = -.076, R^2 = .006, p = .618), the monitoring subscale (β = .039, R^2 = .002, p = .799), or the bond subscale (β = -.156, R^2 = .024, p = .306). Similarly, SAQ scores at T3 did not significantly predict Headspace use in month 3 for the total scale (β = -.020, R^2 = .000, p = .896), the monitoring subscale (β = .085, R^2 = .007, p = .579), or the bond subscale (β = -.126, R^2 = .016, p = .410). Examining these relationships in the other direction (i.e., Headspace adherence predicting SAQ scores), Headspace use in month 1 did not predict SAQ scores at T2 for the total scale (β = -.850, R^2 = .017, p = .400), the monitoring subscale (β = .001, R^2 = .000, p = .996), or the bond subscale (β = -.203, R^2 = .041, p = .181), and Headspace use in month 2 did not predict SAQ scores at T3 for the total scale (β = .092, R^2 = .009, p = .542), the monitoring subscale (β = .179, R^2 = .032, p = .234), or the bond subscale (β = -.015, R^2 = .015, p = .921). (Cross-sectional relationships were not reexamined in the other direction.) Overall, these results reflect no significant relationship between subjectively experienced supportive accountability (as measured by the SAQ) and app adherence, providing no support for the hypothesis that these variables would be reciprocally related over time.

Taken together, results from Aim 3 do not provide support for the hypothesis that PSA engagement (measured by level of Facebook engagement and attendance at group meetings)

would be reciprocally related to Headspace adherence over time (Hypothesis 3) with engagement having a stronger effect on adherence than vice versa (Hypothesis 4). Results also do not provide support for the hypothesis that SAQ scores would be reciprocally related to Headspace adherence over time (Hypothesis 5). As they were measured in the present study, these variables do not seem to be significantly related. The one exception is that the extent to which participants in a group were engaging in supportive accountability (monitoring and bond), appears to predict Headspace adherence for that whole cohort, with a small effect. This suggests that *quality* of engagement is more important than *quantity* in impacting adherence. It also suggests that engagement of one's group as a whole may be more important than individual engagement. This is a unique consideration for group-based PSA interventions, where participants are both receiving and providing SA.

CHAPTER FIVE

DISCUSSION

This study examined, in a two-month trial of Headspace, how college students utilized peer supportive accountability (PSA) and how engagement with PSA features impacted adherence to the app. Prior research has demonstrated that BITs, including MHapps, are a promising way to improve access to evidence-based interventions (Bakker et al., 2016; Lattie et al., 2019; Mohr et al., 2014) and demonstrate efficacy in improving mental health outcomes such as depression, anxiety, and stress (Oliveira et al., 2021; Sommers-Spijkerman et al., 2021). Supportive accountability improves adherence to BITs (Dennison et al., 2014; Lepore et al., 2021; Mohr, Duffecy, et al., 2013) and can be effectively provided by peers (Fortuna et al., 2020; Ho et al., 2016; Lattie et al., 2017; Possemato et al., 2022). Greater engagement with PSA is generally associated with higher adherence and better treatment outcomes (Ho et al., 2016; Possemato et al., 2022), but the directionality of this relationship is unclear and findings are mixed on whether and how peers provide SA effectively.

The present study builds on prior qualitative and quantitative research examining the use of PSA to improve adherence to MHapps. The mixed methods approach allowed for a descriptive exploration of PSA engagement as well as a quantitative examination of the relationship between PSA and Headspace app use. Given low rates of adherence to MHapps (Baumel, Muench, et al., 2019; Linardon & Fuller-Tyszkiewicz, 2020; Neura, 2020), it is imperative to understand how best to implement strategies such as PSA. Additionally, given the

high rates of mental health challenges in college students specifically (CCMH, 2022; Duffy et al., 2019), findings from the present study can guide effective implementation and dissemination of MHapp-based interventions with this population.

Aim 1 Findings

The thematic analysis of group meeting transcripts and Facebook posts revealed that Headspace-with-PSA participants used these forums to discuss how to build mindfulness into daily life; their goals, barriers, and motivation for using Headspace; benefits experienced from mindfulness practice; specific intervention content and features; experiences with mindfulness outside of the study; and non-mindfulness topics. Additionally, participants engaged in both monitoring/accountability actions and bonding. Several of the identified themes are similar to those identified in other qualitative studies of PSA-based interventions. For example, "providing informational support" (Windler et al., 2019), and "informational support" (Bambina, 2007) included discussion and recommendations about specific intervention content and features. Participants in other PSA-based studies also discussed benefits experienced from the intervention (e.g., "health-related behavior change," Fortuna et al., 2019; "personal growth and empowerment," Marino et al., 2007), goals, motivation, and barriers to adherence (e.g., "resistance and challenges," Marino et al., 2007; "engagement in health technology," Fortuna et al., 2019), and strategies for habit-forming (e.g., "self-management techniques," Fortuna et al., 2019). Further, Windler and colleagues (2019) similarly coded interactions for "monitoring" and "bond," drawing on the supportive accountability literature.

Prior research typically has not identified an "unrelated topics" theme similar to "non-mindfulness topics." In the present study, the thematic analysis and the quantitative coding of

Facebook posts revealed that Headspace-with-PSA participants spent a substantial amount of time "off-topic" (i.e., discussing non-mindfulness topics), as 52% of participant posts included this theme. However, this off-topic conversation was not without value, as posts and conversation coded as "non-mindfulness topics" often overlapped with those coded as "bonding." Students used their PSA forums, particularly the face-to-face meetings, as an opportunity to get to know one another and build connections. This sense of connection likely led to increased feelings of supportive accountability toward one another (e.g., in the SA model, the "relational factor" includes the coach being viewed as trustworthy and benevolent; Mohr et al., 2011). Other thematic analyses of PSA interactions have similarly found a theme of "reciprocal support" (Marino et al., 2007) or "peer support" (Fortuna et al., 2019) that encompasses shared experience, connection, and empathy. However, these "bonding"-like themes in other thematic analyses often still relate to the intervention content (e.g., providing empathy around difficulties with adherence, or discussing shared experience related to the targeted symptoms). In studies where peers were more formally trained as SA coaches (e.g., Fortuna et al., 2019), interactions appear to have included far less conversation unrelated to intervention topics. The present study did not include formal SA training for the Headspace-with-PSA group. They were provided with suggested discussion topics for the online forum and meetings and, starting in the second semester of the study, they were prompted at orientation to discuss how they might hold one another accountable. However, these discussions were participant-driven and participants were not provided with specific guidance (i.e., they were not instructed or trained in how to effectively hold one another accountable). This was an intentional decision to make the intervention as self-guided, and therefore generalizable, as possible. This

approach also allowed the present study to explore how college students utilize PSA features on their own. However, more training, guidance, and/or facilitation by researchers may have been beneficial in increasing intervention- and adherence-related conversation. Additionally, the particular setting and population in this study (college students who all attend the same university) may have led to more of this type of conversation, given that the participants had more shared experience unrelated to intervention content than adult participants in other studies where the only obvious shared experience was a diagnosis (e.g., HIV/AIDS in Marino et al., 2007). Notably, despite a lack of training in SA, participants engaged in monitoring/accountability actions in over half (58.6%) of their Facebook posts. This would suggest that peers *do* provide supportive accountability without much training, guidance, or facilitation. The present study did not have a comparison group with mental health professionals providing SA, but prior research has demonstrated no differences in outcomes when SA is provided by peers (Baumeister et al., 2014; Lattie et al., 2017). The amount of conversation/posts in the present study where participants discussed goals, barriers, motivation, and habit-forming, as well as where they engaged in monitoring, would suggest that peers are a viable option to provide SA.

Descriptive statistics and exploratory *t*-tests from the supportive accountability questionnaire (SAQ) revealed an overall decrease in participants' feelings of SA over time (from midpoint assessment, T2, to post-trial assessment, T3). This decrease in subjectively experienced SA from T2 to T3 is consistent with the decrease in Headspace use seen in Aim 2. Although CLPM and regression findings in Aim 3 do not support a predictive relationship between SAQ scores and app adherence, it is notable that both decrease over time. Thus, these SAQ findings

may reflect an overall decrease in engagement with the intervention as the two-month trial came to an end. Indeed, overall engagement in BITs tends to decrease after the first few weeks. Outside of research settings, over 90% of people who download a MHapp stop using it within thirty days (Neura, 2020). Even within research trials of MHapps, adherence is low (Fuller-Tyszkiewicz, 2020), particularly during follow-up periods and periods of self-guided use (Economides et al., 2018; van Emmerik et al., 2018). This was certainly observed in the present study, with app use in the Headspace-with-PSA group decreasing following the final meeting as the trial was winding down and the follow-up period was beginning. On average, there were 15 days between the final meeting and the start of the follow-up period. As discovered in Aim 2, app use in the Headspace-with-PSA group declined during this period, and this decrease in Headspace use after the final meeting was statistically significant (that is, Headspace use after the final meeting was significantly lower than in the other 6 time conditions for the within-group ANOVA; see Aim 2 discussion below).

In examining SAQ scores, it is also notable that SAQ items beginning with "I believe my Loyola SMiLe group will think less of me if…" were rated significantly lower than almost all other items. This likely contributed to the "bond" subscale mean being significantly lower than the "monitoring" subscale mean. Based on how the measure is scored, lower scores on these items are meant to reflect a lack of accountability toward fellow group members. However, this more likely reflects a belief that group members will be unconditionally supportive and will not judge one another. It is possible that lower ratings on these two items actually reflect a stronger, more trusting bond with one's PSA group. This may be a limitation of this measure, which was originally designed for use with an SA coach, not a group of peers, and future research should

examine whether these two items truly reflect "bond" in the same way as other items on the SAQ Bond subscale. Additionally, future research should examine how to assess the subjective experience of *providing* SA to others. The SAQ, given that it was designed for use with a coach, only assessed experienced SA received from others. However, with PSA, the SA is both given and received reciprocally among peers. For example, in addition to rating items such as "I believe that my Loyola SMiLe group is aware of and notices when I use Headspace," peer participants could rate items such as "I am aware of and notice when fellow members of my Loyola SMiLe group use Headspace."

Descriptive statistics and exploratory *t*-tests from the Evaluation of PSA Features questionnaire revealed that the face-to-face meetings were generally viewed by participants as more beneficial than the online forum. While face-to-face meetings are more difficult to implement outside of a research setting, the use of virtual meeting spaces (e.g., Zoom) makes this easier. Seeing one's own progress stats was rated as slightly more valuable than seeing group members' progress stats, but this was not a significant difference. Notably, qualitative findings in prior research suggest that seeing peers' stats is motivating when others' use is high, but it can have the opposite effect and demoviate participants when they see others' use declining (Ho et al., 2016). Thus, posting user stats may have both positive and negative effects. The twice-weekly emails appear to have been helpful as a general reminder to engage with the intervention ("Emails from Loyola SMiLe Project - in general as a reminder" had the second highest average rating), but participants did not highly value research findings on the benefits of mindfulness in the emails ("Email from Loyola SMiLe Project - specifically research about mindfulness benefits" had the 7th highest rating out of 11 items). "Group members replying to the Admin

postings" had the highest number of "N/A" responses (6 at T2 and 7 at T3) in addition to having the lowest average rating out of all features, and inspirational quotes/images about mindfulness posted by researchers was the next lowest valued. In general, although participants often interacted with fellow group members' posts, they rarely interacted with admin posts. In prior studies using PSA with an online forum, some have included similar researcher participation such as posting discussion questions to prompt discussion among participants (Duffecy, Sanford, et al., 2013). In others, researchers did not post or participate in the online forum beyond monitoring it for safety (Ho et al., 2016) or serving as the coach in a clinician-provided SA comparison group (Lattie et al., 2017). Studies both with and without researcher participation in the PSA forum demonstrate positive impacts of PSA. Taken together, these findings suggest that researchers posting regularly in the online forum may not be a necessary component to include in similar interventions, as interactions among participants were experienced as more beneficial. Participants in a similar study did express a desire for more reminders to engage with PSA components (Lattie et al., 2017). However, these reminders could be automated and not provided specifically by researchers, to improve scalability. Considerations around the use of "researcher-provided accountability" in the present study is further discussed below under Strengths, Limitations, and Future Directions.

Aim 2 Findings

Visual inspection of adherence patterns over time indicated that the Headspace-with-PSA group generally had more engagement with the app than the Headspace-as-Usual group, as well as different patterns of use over time. This study did not aim to examine specifically whether there was a significant difference in overall use between the two groups; thus, while visual

inspection indicates more app use by the Headspace-with-PSA group (consistent with prior research finding higher adherence in participants with SA/PSA compared to participants with self-guided use, e.g., Dennison et al., 2014; Ho et al., 2016; Lepore et al., 2021; Mohr, Duffecy, et al., 2013), this may not be a statistically significant difference. This study did aim to examine whether the groups displayed different *patterns* of use, and whether the face-to-face PSA meetings impacted the pattern of use for the Headspace-with-PSA group. The within-group ANOVA for the Headspace-with-PSA group indicated that Headspace use during the final time period (after the third meeting) was significantly lower than Headspace use during all other 6 conditions, indicating a decline in use after the final meeting (even prior to the follow-up period). The fact that adherence was significantly lower after the final meeting, compared to all prior time conditions, suggests that PSA participants may have relied on the external structure of regular meetings for motivation. Visual inspection of daily use by group (Figure 6) indicates that, on average, participants in the PSA condition tended to use the app less frequently during the final 10 days of the trial period; specifically, average daily use for the Headspace-with-PSA group is below 3 minutes for the final 10 days of the trial, and above 3 minutes for almost every day before that. The ANOVAs in the present study did not include adherence into the follow-up period due to a focus on the timing of PSA meetings, but findings from the larger trial (Conley et al., manuscript in preparation) reveal that app use for the Headspace-with-PSA group continued to decline into the follow-up period (month 3), even falling below average app use for the Headspace-as-Usual group. This is consistent with prior research suggesting that use of mindfulness-based MHapps tends to decrease during the course of a trial and into follow-up periods of self-guided use (Economides et al., 2018; Ho et al., 2016; van Emmerik et al., 2018).

Additionally, Headspace use around meeting 1 was significantly higher than between meeting 1 and 2, providing partial support for the hypothesis that Headspace use would be higher around meetings compared to between meetings. This hypothesis only held true for meeting 1; meeting 2 and 3 did not have a significant effect. This indicates that the second two face-to-face meetings did not have a *proximal* impact on Headspace use, but it does not suggest that they had no impact. In fact, it is preferable for the meetings to increase adherence overall across time and not just for a day or two before and after the meetings. Indeed, based on both visual inspection and post-hoc comparisons from the within-group ANOVA, it appears that the impact of meeting 2 held until meeting 3 (there is no significant dip in use between meeting 2 and 3). This finding suggests that meeting 2 provided a "boost" that lasted longer than just 48 hours. It is important to examine whether these patterns (specifically, higher use around meeting 1 compared to between meeting 1 and 2, and no dip between meeting 2 and 3) were truly related to PSA features. If the Headspace-as-Usual group had a similar pattern of use, these findings could be attributed to other non-PSA factors (e.g., time in the semester). However, the Headspace-as-Usual group displayed different patterns. The between-group 2x7 ANOVA revealed a large interaction, suggesting that the two groups had different patterns of adherence overall. Further, the within-group ANOVA for the Headspace-as-Usual group revealed a distinct pattern of use that does not include either of the post-hoc comparison findings for the Headspace-with-PSA group. It can be concluded, then, that this pattern is specific to the Headspace-with-PSA group.

To further examine whether differences in adherence patterns could be attributed to PSA group meetings specifically, the between-group 2x2 ANOVA compared "around meetings" to "not around meetings" between the two groups. Though not significant due to insufficient power,

there was a small-to-medium sized interaction, providing support for Hypothesis 2, that app use would be higher around meeting dates than non-meeting dates for the Headspace-with-PSA group but not for the Headspace-as-Usual group (see Figure 11). Overall, participants in the Headspace-with-PSA group did use Headspace more around the meetings compared to other times in the trial. Of course, as noted above, a global increase in adherence (rather than a proximal increase around meetings) arguably would be preferable. These findings have important implications for the implementation of PSA features, particularly regarding how to improve adherence at the end of trials and into follow-up periods, given consistent findings that app use declines (e.g., Economides et al., 2018; Ho et al., 2016). For example, a "booster" session during the follow-up period would have likely improved adherence for the Headspace-with-PSA group following the end of the two-month trial. Given that meeting with their PSA group was associated with proximal higher adherence, occasional check-ins with group members (either via synchronous meetings or via asynchronous virtual interactions) could increase the likelihood of continued use of the app.

Aim 3 Findings

Aim 3 examined the relation between app adherence and PSA engagement. In general, *quantity* of engagement with the PSA group, as measured and modeled in the present study, does not seem to be related to Headspace use. There was no support for the hypothesis that level of PSA engagement (measured by amount of Facebook engagement and attendance at group meetings) would be reciprocally related to Headspace adherence over time. Both PSA engagement variables were unrelated to Headspace use in cross-lagged panel models and exploratory regression analyses. This finding is inconsistent with prior research demonstrating

that higher engagement with PSA features predicts greater adherence to a tech-based intervention (Ho et al., 2016; Lepore et al., 2021). Of course, this finding could be impacted by how quantity of engagement was measured in the present study. In prior studies, level of engagement has been measured by number of exchanged comments (e.g., Ho et al., 2016) or number of posts in an online forum (e.g., Bambina, 2007), without giving different weight to different types of engagement. In the present study's Facebook engagement score, posting or commenting in the forum was given more weight than liking or seeing other participants' posts. However, participants rated seeing other participants' posts as more valuable than posting themselves, so this approach may not have reflected the true value of each type of engagement (i.e., posting, liking, seeing). Additionally, attendance at group meetings had little variability (0-3, with 31/36 participants attending 2 or 3 meetings) and does not capture how engaged a participant was during the meeting.

Though more research is needed on how to optimally assess or measure *quantity* of PSA engagement, it appears that *quality* of engagement is more important in predicting Headspace use. The proportion of Facebook posts that included monitoring or bond content had a small effect on adherence when entered into a model together. Interestingly, the proportion of posts for each theme did not separately have an effect on adherence when examined individually. This suggests that both monitoring and bond must be present for peer supportive accountability to impact adherence. This finding will be important to emphasize when training individuals in how to effectively provide SA: both monitoring and bond are critical pieces of SA and one without the other is not necessarily sufficient. This finding also suggests that engagement of one's group as a

whole may be more important than individual engagement in predicting adherence. This has implications for how to measure PSA engagement in future research.

The SA model is based on the assumption that experienced SA will lead to increased adherence. However, subjectively experienced SA (measured by the SAQ) was also unrelated to Headspace use in the cross-lagged panel model and exploratory regression analyses. This is inconsistent with prior research finding a significant relationship between SAQ scores and adherence to a tech-based intervention with SA features (Duffecy, Kwasny, et al., 2013). As noted in Aim 1, both Headspace use and SAQ scores decreased from month 1 to month 2, but these results suggest no causal relationship between them. Thus, while Aim 2 findings are consistent with prior studies in which PSA features impacted patterns of adherence to the MHapp (e.g., Dennison et al., 2014; Ho et al., 2016; Lepore et al., 2021; Mohr, Duffecy, et al., 2013), it remains unclear which components of PSA are driving this and how.

Strengths, Limitations, and Future Directions

This study employed a rigorous research design including randomized allocation to study condition, a longitudinal design with data collected at multiple timepoints, and use of objective measures of adherence. The mixed methods approach of the present study allowed for both an exploration of how participants engaged with PSA features and an examination of the relationship between PSA engagement and Headspace use. Additionally, the implementation of PSA through an online forum and face-to-face meetings provided multiple opportunities for participants to engage with PSA features in different ways.

There are several important limitations to the present study. First, the small sample size restricted the present study's power to detect statistically significant effects. The small sample

size was particularly limiting for CLPM analyses, as the fit statistics are considered "not trustworthy at such a small *N*" (Muthen, 2019). Further, the sample was overwhelmingly female (91%) and majority white (57%), limiting the generalizability of findings to other populations. The generalizability of the present study is also limited by the college context. Many of these findings (particularly qualitative findings about what participants discussed at meetings and in Facebook posts) are specific to the population of undergraduate students at one particular university. A non-college emerging adult population would not spend so much time talking about college stressors such as midterm exams, and might stay more on topic in meetings. Additionally, face-to-face group meetings (particularly in-person, but even virtual) could be difficult to coordinate outside of the college context where most participants all live on the same campus and have similar schedules.

Overall, there is a lack of generalizability to self-guided app use in the "real world" outside the research study context. Several PSA participants noted during group meetings that one of the things that motivated them to use Headspace was the knowledge that they were doing it for a research study, that researchers were tracking their engagement with the app, or that they were being compensated for their participation (e.g., "...it's going to be hard to have that consistency when we don't technically like have to do it…"; "Let's see, what keeps you motivated? I would say…" "The money. Haha, I'm kidding."). In general, the research/trial setting has been found to have a large impact on engagement with mental health apps, and app use in research participants is not representative of app use in the real world (Baumel et al., 2019a). Thus, even with PSA, app adherence would likely be lower if this intervention were implemented in a non-research setting. These comments from participants also raise the issue of

researcher-provided SA in the present study. Although fellow participants definitively provided SA (as evidenced by results in Aim 1), a substantial amount of the "PSA features" in this study were actually provided by the researchers. In fact, about half (5/11) of the items in the Evaluation of PSA Features measure are researcher-provided features (e.g., emails from Loyola SMiLe Project, progress stats posted on Facebook, images/quotes posted on Facebook). It is notable that, of the top 6 most highly rated items on this measure, only 1 is a researcher-provided feature (Emails from Loyola SMiLe Project - in general as a reminder). In other words, researcher-provided SA was generally viewed as less valuable than peer-provided SA. As discussed above under Aim 1 Findings, researcher posts may not be a necessary component to include in similar interventions, as interactions among participants were experienced as more beneficial. However, it is impossible to tease apart which had a greater impact (or if they had a differential impact at all) on app use in the present study, and some research indicates that facilitator-led strategies for increasing engagement with BITs are beneficial (Winter et al., 2022). Future research should more intentionally compare researcher-provided SA to peer-provided SA. Of course, there is also some accountability inherent in participating in a research study. It could be argued that the Headspace-as-Usual group experienced some researcher-provided SA as well, in the form of the orientation and monthly surveys. This makes it difficult to generalize research findings to completely self-guided app use, where this baseline accountability is not present.

The present study also lacked a clear definition of "adherence" to the Headspace app. Supportive accountability, by definition, helps individuals work toward clear process-focused goals (Mohr et al., 2011). Participants were encouraged at the orientation session to use the app every day, but this was presented as a suggestion to maximize benefit and was not a defined or

prescribed amount of Headspace use that constituted adherence to the intervention. Starting in Spring 2018, Headspace-with-PSA participants were prompted to discuss their goals for engagement with the PSA group and how they might hold one another accountable, but were not specifically asked to set goals related to app adherence. Starting in Fall 2020, participants were asked at orientation to write a response to the question, "What are your goals for how much/often you will use Headspace over the next 8 weeks? (For example, number of minutes per day, number of sessions per week, a certain time of day you hope to meditate...)." This ideally provided a more specific adherence goal for fellow participants to monitor through PSA. However, as seen in the thematic analysis, participants regularly set new goals or intentions throughout the trial, and their own definitions of adherence likely changed over time. Thus, although the term "adherence" is used in the present study, "engagement" may more accurately reflect what was truly measured. Future studies examining adherence to a MHapp should be sure to clearly define what accounts as "adherence" to the app. Others have noted that adherence is often poorly defined or not defined at all (Ng et al., 2019). When it is defined, the definition varies widely across the literature, making it difficult to synthesize research findings (Donkin et al., 2011; Mohr et al., 2013). Graham and colleagues (2021) argue for the value of subjective experience as an important supplement to objective measures when examining engagement with MHapps. They found that participants who perceived a MHapp as more useful, easy to learn and use, and satisfying demonstrated greater improvements in mental health outcomes (Graham et al., 2021). This provides support for the present study's use of the SAQ and Evaluation of PSA Features as measures of subjectively experienced engagement with the intervention, paired with an objective measure of engagement (Headspace user data). Given that the present study did not

find a significant relationship between (subjective) SAQ score and (objective) Headspace use, using only one without the other to measure engagement with the intervention would provide an incomplete picture. Thus, future research should, whenever possible, include both objective measures of engagement (e.g., data from an app, physiological data) and subjective measures of engagement (e.g., survey responses from participants, interviews about their experience).

There were several changes to the study design over the course of this trial that are pertinent to the present study. This can be interpreted as a strength, as many of these changes were made to improve the experience of participants and the efficacy of the intervention. Further, testing different treatment approaches sequentially with the same group of participants can help determine which treatment approach is best for whom or compare different treatment approaches for the same group of participants. Although this type of analysis is beyond the scope of the present study, it is a possible future direction for the larger SMiLe trial. Other research has intentionally incorporated this as a strength, including the microrandomized trial approach that has been successfully utilized in other mobile health app research (Li et al., 2020) and design-based research methods in education and learning sciences (Anderson & Shattuck, 2012). Both of these approaches involve making iterative adjustments to an intervention during the course of data collection to continually improve the study design, and to compare effectiveness of different versions of the intervention with the same group of participants. Of course, changes in study design during the trial can also be interpreted as a limitation because they complicate the ability to combine data across cohorts, to analyze data that were collected differently, to state that the entire sample participated in the same intervention, and to truly test the relative impact of each element of the intervention. In the present study, specific changes and their impact include: (1)

The three face-to-face PSA group meetings were added in the third semester of the study in response to participant feedback (and accordingly, only certain cohorts were included in Aim 2 analyses); (2) The style of transcription of PSA group meetings changed over time from abbreviated notes to live transcription during meetings to verbatim transcription of audio recordings (making it impossible to quantitatively code meetings transcripts in the same way Facebook posts were); (3) In response to the COVID-19 pandemic, PSA group meetings (starting with the 2nd meeting of Spring 2020) and orientation meetings (starting with Fall 2020) moved from an in-person format to a virtual format (making results less generalizable and creating inconsistency in study design); (4) Starting in Spring 2018, participants were asked to discuss goals related to engagement with PSA features; and (5) Participants were more explicitly asked to state their adherence goals at orientation starting in Fall 2020 (providing more specific goals to target with PSA, but only for the final two PSA cohorts). There were also many changes to the content and features of the Headspace app over the four years of this study, which was outside the control of the research team. For example, Headspace added many new courses, changed the names of certain courses, added a "nudge" feature where "buddies" in the app can send one another reminders to meditate, added more non-meditation content, and changed various aspects of the interface/look of the app.

Another limitation involves the use of Facebook as the platform for the PSA online forum. Overall, Facebook is becoming less popular with the emerging adult population. While 87% of Internet users aged 18-29 reported using Facebook in 2014, that number fell to 70% in 2021, according to Pew Research Center (Auxier & Anderson, 2021). Prospective participants for this RCT were asked in the screening survey to rank their experience with 1. Facebook on

computer, 2. Facebook on phone, and 3. Facebook groups, from "None: never use" to "A lot: daily use." Across all semesters of the study, of the 790 students who completed these three screening questions, 22%, 13%, and 21% selected "None: never use" to these three questions about Facebook, respectively. When asked to elaborate on their answers, common responses included, for example, "I no longer use Facebook," "I deactivated my account," "I still have an account, but don't use it very often," "I only have it to keep in contact with extended family," and "I only check Facebook when I get a notification on my phone." These responses suggest that Facebook may not be the ideal platform to use for online PSA forums with this age group, and lack of engagement with Facebook may have negatively impacted some participants' engagement with the PSA forum in this study. However, other popular social media platforms (e.g., Instagram, Snapchat, and TikTok) do not offer the same group/forum features that Facebook offers. Future studies of PSA interventions with college students should explore alternative platforms for online interaction among participants. An ideal option would be a similar platform that is integrated into the mindfulness app, instead of having the intervention content and PSA forum split across two different platforms. Headspace itself has certain SA features integrated, including the "buddy" feature, where app users can see friends' use and "nudge" one another.

Finally, more research is needed into how to effectively train peers to deliver supportive accountability. As mentioned above, the present study included minimal training or guidance in how to engage in SA. Although a slide was displayed during group sessions with suggested discussion topics, the Headspace-with-PSA group often discussed unrelated topics and sometimes required prompting from a researcher about what to discuss. Although these

conversations were valuable in facilitating bond/support, and participants still engaged in a fair amount of monitoring/accountability actions, more training may have improved outcomes for this group. It is unknown how additional training and guidance could have impacted the level of engagement with PSA features, participants' subjective experience of SA, participants' evaluation of PSA features, and Headspace use. One way to examine this would be the inclusion of a comparison group with comprehensive training in how to deliver SA to fellow group members. The two Headspace-with-PSA groups (one with structured SA training/guidance and one largely untrained and unfacilitated like in the present study) could then be compared across these different metrics of engagement with PSA and adherence to the app.

Conclusions and Implications

This study demonstrates the feasibility of implementing PSA into a MHapp-based intervention in a college campus setting. Given the high rates of mental health challenges in this population, the present study provides a promising way to disseminate evidence-based interventions to emerging adults while promoting increased engagement through SA. The present study also demonstrates that PSA can be implemented in many different formats, including online forums/message boards, email, and face-to-face meetings. To improve future implementation and increase usability and ease of engagement, PSA should ideally be built into the MHapp, with automated reminders to engage with PSA features. PSA features could be optional, as some individuals may choose MHapps specifically due to the lack of human interaction required. Additionally, incorporating regular face-to-face meetings with the peer(s) providing SA appears to add significant value for participants (based on participant ratings of PSA features) and improve adherence (based on the finding that use is higher around meeting

times), and the present study demonstrates that these meetings can occur virtually. More training and guidance in effectively providing SA may improve the impact of PSA on adherence, but the present study demonstrates that peers use PSA features to engage in accountability actions even with minimal training. Findings also indicate that both monitoring and bond should be present in peer interactions for PSA to meaningfully impact adherence. An emphasis on content and quality of peer interactions is key, as this appears to have a stronger impact on adherence than quantity of interactions. It is important to note that Headspace use declined after the final meeting, indicating a need to consider how this can be prevented. Given that meetings seemed to provide a "boost" in app use for Headspace-with-PSA participants, occasional check-ins or "booster" sessions with one's PSA group could help prevent the decline in app adherence often seen in both research and real-world settings.

APPENDIX A

PATIENT HEALTH QUESTIONNAIRE-8

Patient Health Questionnaire-8 (Screening Tool)

Over the last *2 weeks*, how often have you been bothered by any of the following problems?

0 = Not at all

1 = Several days

2 = More than half the days

3 = Nearly every day

1. Little interest or pleasure in doing things

2. Feeling down, depressed, or hopeless

3. Trouble falling or staying asleep, or sleeping too much

4. Feeling tired or having little energy

5. Poor appetite or overeating

6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down

7. Trouble concentrating on things, such as reading the newspaper or watching television

8. Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual

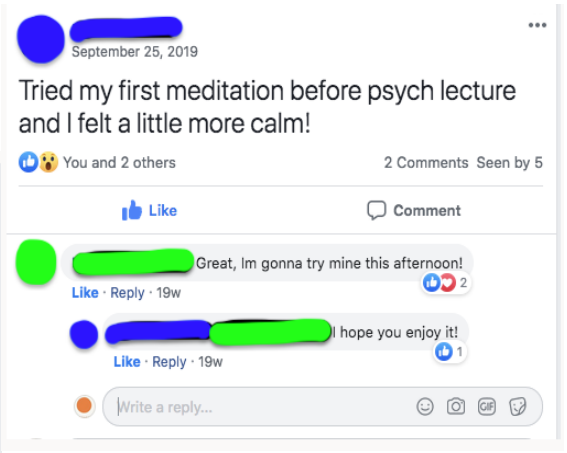
APPENDIX B

SAMPLE FACEBOOK POSTS


[redacted]
October 6, 2017
It's my 3rd day today and my second time where I sort of fell asleep during meditation (his voice is really soothing!). I did it on one of those couches to in the IC so I wasn't even on my bed. Anyways I think I'll work on being more mindful during meditation. But I do feel myself becoming more mindful in my life in general which helps a lot in controlling my overthinking.
Like
You and 1 other
Seen by everyone
[redacted] Yes!! I'm noticing myself thinking about that things he says throughout the day!
Unlike · 13w
1


[redacted]
October 11, 2019
I tried meditating while sitting on the ground a few times and I don't like it. Do y'all find it easier to meditate in a chair or the ground?
You and 1 other
5 Comments Seen by everyone
Like
Comment
[redacted] Chair
Like · Reply · 17w
2
[redacted] A chair is definitely easier for your body to relax in!
Like · Reply · 16w
2
[redacted] Whenever I'm sitting cross legged on the ground or on a bench I get weirdly uncomfortable with my feet positions?? That's why id say chair haha
Like · Reply · 15w
1
[redacted] my feet fall asleep easily when crossed, but I tend to prefer it to sitting normally (as long as I have a back rest)
Like · Reply · 15w
Write a reply...
[redacted] I like sitting on the ground but I think it has just become my habit lol!
Like · Reply · 15w
2
Write a comment...


[redacted]
November 4, 2018
Hi everyone! No one has posted in a little while so I thought I would say something. I have been a lot better about sticking to my goal this week, and I've really started to appreciate the ten minutes I get to myself each day with headspace. I hope this coming week isn't too stressful for anyone! Treat yourself to a reward for all your hard studying!!!
You and 1 other
1 Comment Seen by 5
Like
Comment
[redacted] That's great girl! 10 minutes (esp to ourselves) isn't all that much to me now Keep up the good work
Like · Reply · 18w
1
Write a comment...


[redacted]
September 25, 2019
Tried my first meditation before psych lecture and I felt a little more calm!
You and 2 others
2 Comments Seen by 5
Like
Comment
[redacted] Great, Im gonna try mine this afternoon!
Like · Reply · 19w
2
[redacted] I hope you enjoy it!
Like · Reply · 19w
1
Write a reply...


[redacted]
October 11, 2019
Hey y'all! Im still having trouble finding my groove in meditation, have any of y'all found any sessions that can be done while on the go or walking to class or something? Thanks, beautiful gals!
You and 1 other
1 Comment Seen by 4
Like
Comment
[redacted] If you search for "walk" there are some that will come up
Like · Reply · 17w
1
Write a comment...

APPENDIX C

DISCUSSION TOPIC PROMPTS PROVIDED

AT FACE-TO-FACE PSA MEETINGS

Slide 1

Three Small-Group Check-Ins: Topic Ideas

- What were your goals? How did it go?
- What did you try? What do you recommend?
    - Mindfulness exercises (some are sleep-focused) vs sleep sounds
- Challenges and suggestions for building a mindfulness practice
- Getting the most of the peer group - Facebook, etc.
- Weekly discussing topic (next slide)?
- What are your goals for the next week or two?

Slide 2

Consider: Weekly Discussion Topics?

1. **Introduce yourself** to your group! What interested you in this project, and what are you hoping to get out of it?
2. How did your first week go? Share your **successes, struggles, and support** / advice for others!
3. Share a story of how you have used **mindfulness in your everyday life**. What other mindfulness skills do you think you could try in your everyday life?
4. What packs, sessions, singles, and/or minis are your **favorites so far**? What do you particularly like about them?
5. Share **what keeps you motivated** to continue your practice / what helps you to make time for using Headspace, even when it's challenging?
6. What **changes have you noticed** since using Headspace?
7. Share a news article, a quote, a piece of art - something that **inspires mindfulness** in you!
8. How will you **keep up your mindfulness practice** in the future?

APPENDIX D

SAMPLE EXCERPTS FROM GROUP MEETINGS

A: So I thought the most challenging thing about it was finding a time where it fit in my schedule. But some days I have class early at like 8 or 8:30 and I just didn't want to do it. And other times I felt really tired, but I did notice that when I did do it, I felt really calm and more content with everything. With all of them I felt more calm just in general.
B: I agree.
C: I know we were told not to listen to them before we sleep because we might miss it, but I find it easier to calm down before I sleep. It's a nice way to get my brain ready for sleep. Sleep did take so much for me, so if I get a good sleep, it influences the next day so much.
D: I agree I think I also noticed I thought I was getting better at staying focused during it but I never really meditated before this. When I had more time I decided to do the 20 minute one.They allow for more time when they tell you to sit and the thing added ten minutes to the whole video. That freaked me out.
A: Yeah that makes sense.
C: It is easy to get convinced that your phone turned off.
B: It's so silent. Umm for me and I'm like a very big procrastinator and I know they said during orientation to add it into the routine you already had and I started doing that. The first week I had a streak for 5 or 6 days but then there was a week after where I didn't use it. I felt bad, but whatever. It's like the dentist you know when you don't floss and you floss right before you go.
D: Yeah once I lost the streak it was really hard to get back into it, I just didn't feel as motivated, yeah. (A and E agreeing)

A: Has anyone tried those mini ones when you are freaking out about something? I haven't tried those yet but there were moments when I needed to.
B: No, not yet.C: I haven't tried the urgent ones but I have tried the other 3 minute ones and I liked those as well.
D: The 3 minute ones, I did those in the beginning because I was like "I don't know how to meditate, but I can't sit still 10 min straight," but I found when doing the 3 minute ones, that when I barely started getting in a zone or a calmer headspace it would be over so I realized maybe I should do longer ones. The minimum I do is 5, but I think my ideal is 10-15. Anything longer I get distracted or pulled out, but 10-15 min I can do and just stay present.

A: Today was the first day that I meditated outside and it was actually really nice when the sun was outside because it wasn't that cold. I only had a light jacket and it was warm. It was actually very peaceful. Maybe you guys should try going out there because it was a really pleasant experience.
B: Could you still pay attention to the lake while you were doing the recording?
A: I used my airpods and I could hear the water in the background hitting the rocks and when I listened it was nice.
B: That would be nice.

A: Last time we said daily meditation… How did that go?
B: It got real bad for a while. I had like, two days and then I wouldn't do it for a week. I was so good at the beginning and then there were two weeks when it was really good. But I have a run streak of 4 (others: nice!) , gonna try to keep it going for the next two weeks.

A: The hardest thing for me is I go home at the weekend and I work so it gets hard. Once I start commuting, I don't have time. I don't know where to fit in it. Do you know when to fit it in?
B: That's what's interesting because it's 5-10 min and it's like oh yeah I do have that time but you don't, or if you do it's not the right time or place to do it.
C: I think another thing too -- yeah the place, there aren't many quiet places on campus -- except the chapel like we said.
A: Yeah I may try the chapel, because it's weird to do it with my roommates there.

A: Who has the longest streak right now? I have 0.
B: For sure not me, probably you (to C) (C nodding)
D: I think I have 4. I thought I missed on Tuesday.. I don't remember meditating on Tuesday, but I guess I did. I think I did a monday night meditation which probably counted for Tuesday.
A to E: What's your streak?
E: I got 5, but then I broke it. But I broke it because I forgot. But as someone who has had 5… it was because I finally had a routine and my routine was so good that I finally had a routine for my day so I was like you don't need to meditate, you don't need that anymore, and I was going to the gym but then I was like something's missing… meditation…
B: We talked about that last time!

APPENDIX E

SUPPORTIVE ACCOUNTABILITY QUESTIONNAIRE

Supportive Accountability Questionnaire (Loyola SMiLe Study Version)

The following questions ask for your opinion about being involved in the Loyola SMiLe Facebook group. Please choose the response that best fits your overall experience.

1 = Strongly Disagree 2 3 4 5 6 7 = Strongly Agree

1. I believe that my Loyola SMiLe group is aware of and notices when I use Headspace.
2. I believe that my Loyola SMiLe group is aware of and notices when I use our Facebook group.
3. My Loyola SMiLe group is aware of how much I have engaged in Headspace.
4. My Loyola SMiLe group is aware of how much I have engaged in our Facebook group.
5. I think that my Loyola SMiLe group expects that I will be very consistent in using Headspace every day, or nearly every day.
6. I think that my Loyola SMiLe group expects that I will be very consistent in logging in and using our Facebook group every day, or nearly every day.
7. I believe my Loyola SMiLe group will think less of me if I don't use Headspace as frequently as is expected.
8. I believe my Loyola SMiLe group will think less of me if I don't use our Facebook group as frequently as is expected.
9. It would bother me if my Loyola SMiLe group thought less of me.
10. If I use Headspace less frequently than expected, I feel like I need to give my Loyola SMiLe group reasons why.
11. If I participate in our Facebook group less frequently than expected, I feel like I need to give my Loyola SMiLe group reasons why.

APPENDIX F

EVALUATION OF PSA FEATURES

Evaluation of PSA Features

How valuable (useful, helpful, engaging, motivating, beneficial) did you find the following features of the Loyola SMiLe Group (Facebook, emails):

N/A = I didn't notice or experience this

-1 = Harmful, hindering

0 = Neutral, didn't help or hurt

1 = A little bit valuable

2 = Moderately valuable

3 = Very valuable

1. Group members' progress stats posted on Facebook
2. My progress stats posted on Facebook
3. Mindful Inspiration images/quotes posted on Facebook
4. Group members replying to the Admin (Mindful Ness) postings
5. Group members replying to my own posts
6. Group members posting their own content (articles, questions, discussion threads)
7. Posting my own content or replies
8. Emails from Loyola SMiLe Project - in general as a reminder
9. Emails from Loyola SMiLe Project - specifically the research about mindfulness benefits
10. Facebook push notifications and/or email alerts when someone posted in the group
11. Meeting with my group members after orientation (every other week)*

*Added Fall 2018, when face-to-face meetings were added to the study procedures

APPENDIX G

THEMES AND CODES FROM THEMATIC ANALYSIS

Building mindfulness into daily life

- When to meditate
- Where to meditate
- How to meditate (e.g., physical position to meditate in)
- How long to meditate
- Building mindfulness/HS into routine
- Meditation when needed (versus building mindfulness into routine)
- Habit-forming techniques / routine for everyday life / non-mindfulness/HS

Goal-setting, motivation, and barriers

- Individual goal-setting for self
- Goal-setting as a whole group
- Progress on prior goals
- Goals for future mindfulness (after study)
- Progress in one's mindfulness practice (improving it as a skill)
- Progress in one's adherence to the app
- What motivates to meditate / use HS
- Barriers to adherence/consistency/starting a meditation
- Barriers to successful meditation practice once using the app (e.g., distraction, interruptions)
    - Ways to deal with distraction
- Disinterest in future use / barriers to future use (e.g., cost)

Benefits and limitations experienced (of mindfulness practice, Headspace, PSA group)

- Benefits/changes from mindfulness experienced
    - Benefits during meditation/short-term
    - Long term benefits
- Identifying challenges in one's life that could be helped with mindfulness
    - Reasons for joining study
    - History of mental health challenges, e.g., panic attacks, anxiety
    - Meditation as prevention for potential future challenges
- Connecting with others (outside group, e.g., roommate) over mindfulness
- Limitations/drawbacks of HS use
- Limitation/drawbacks of app features
- Benefits of peer groups (e.g., social connection)

Discussion of specific intervention features (Headspace app, Facebook group)

- Specific packs/courses tried
- Approach to the app (e.g., focusing on one pack vs. trying different categories/packs)
- Specific techniques from HS app (e.g., noting skill, body scan) - not courses
- Specific logistics/content in HS (e.g., where to find different narrators)
- Specific features of the app (e.g., reminders, streaks)
- Reactions to / thoughts about specific HS content or courses
- FB group (barriers to FB engagement, what to post about in the FB group, user stats)

Mindfulness outside of study

- Other mindful activities, not meditating (e.g., journaling, yoga)
- Other meditation apps
- Outside knowledge of mindfulness/mental health (e.g., articles read, knowledge from classes/therapy/others)
- Past experiences with mindfulness before the study
- Mindful moments/techniques in everyday life

Non-mindfulness topics

- Common college/work/life experiences/stressors, including transition to college
- Global/political events - e.g., elections and covid
- Resources/activities/opportunities available on/around campus
- Spirituality
- Other health / mental health promotion activities/tips (e.g., healthy eating, sleep hygiene)
- Other non-mindful activities for fun or stress-reduction (e.g., podcasts, using to-do lists)
- The study / logistical study content (e.g., SONA credits)
- Zoom logistics (e.g., microphones, background noise)

Monitoring/Accountability

- Asking about others' HS use
    - Engaging others in discussion / bringing in specific people
        - Discussion of how to bring in absent group members
    - Eliciting / asking about others' experienced benefits/changes
- Encouragement of mindfulness practice
- Bringing it back on topic to mindfulness/HS
- Eliciting goal-setting from others
- Checking in on others' prior goals or on prior group goals
- Asking for or giving recommendations for specific HS content or logistics
- Asking for or giving recommendations for adherence (e.g., how to be consistent, how to avoid distraction)
- Taking others' ideas/recommendations
- Discussing / comparing user stats

Bonding

- Joking or sharing funny stories
- Showing interest in/empathy/support toward group members
- Sharing about self (e.g., year in school, location, etc.)
- Discussing common college stressors, e.g., midterms
- Giving advice to group members about school/life

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VITA

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