ASSESSING THE FEASIBILITY, ACCEPTABILITY, PRELIMINARY EFFICACY, AND ANTICIPATED CLINICAL PRACTICE IMPLEMENTATION OF A MINDFUL EATING SMARTPHONE APPLICATION: A MIXED METHODS ANALYSIS AMONG UNDERGRADUATE WOMEN WITH BINGE EATING AND CLINICAL EXPERTS

by

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A dissertation submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in
Health Psychology

Charlotte

2020

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ABSTRACT

NADIA JAFARI. Assessing the Feasibility, Acceptability, Preliminary Efficacy, and Anticipated Clinical Practice Implementation of a Mindful Eating Smartphone Application: A Mixed Methods Analysis Among Undergraduate Women with Binge Eating and Clinical Experts. (Under the direction of DR. JENNIFER B. WEBB)

Mental health applications (mHealth apps) are developed to bolster the utility and convenience of smartphones to stimulate behavior change, although many mHealth apps lack strong empirical support. Undergraduate women are daily app users and a high risk group for binge eating (BE). The app "Am I Hungry?" Mindful Eating Virtual Coach was developed from Dr. Michelle May's mindful eating (ME) self-help program and companion book *Eat What You Love, Love What You Eat for Binge Eating*. The app is designed to treat BE using ME decision making strategies but has not been empirically evaluated. The present study assessed early stage facets using a mixed methods approach among undergraduate women who binge eat and clinical experts in the field of disordered eating and nutrition. Preliminary results show that users experienced significant decreases in BE, increases in intuitive eating, and to a small degree, increases in ME. The intervention demonstrated good feasibility with a 92% retention rate. Participants used the app for an average of 23.8 ± 5.7 days over the course of 4 weeks. Qualitative findings contribute to understanding users' motivation to engage in ME app-based treatment, how the app can foster behavioral change related to BE, barriers to students' app use, and opinions of clinical experts regarding practice implementation. Suggested improvements from both user and provider perspectives extend our knowledge of the strengths and limitations of apps and how these technologies can provide a complementary, educational component to clinical practice.

DEDICATION

This dissertation is dedicated to my parents, Wanda and Jamshid. Your immeasurable sacrifices and unconditional love are the reasons I could pursue my dream of completing a doctorate in psychology. I would never have been able to do any of this without you. I promise to use this privilege to create positive changes in the world. Mami, te quiero. Dad, dooset daram.

ACKNOWLEDGEMENTS

It is with sincere and overwhelming gratitude that I acknowledge the people who contributed to my professional development throughout graduate school. To my advisor, Dr. Jennifer B. Webb, I cannot thank you enough for inviting me to work with you. You have challenged me to grow in ways I never thought possible. Because of your compassionate and strengths-based approach to mentorship, I have become more well-rounded, organized, considerate, and principled as a researcher and clinician. Thank you for the numerous opportunities to collaborate on manuscripts and present my research, and for allowing me the freedom to develop my own ideas. I hope to continue my work with the same integrity, modesty, and curiosity that you have demonstrated as a mentor. I am also incredibly grateful for the other members of my dissertation committee: Dr. Erika Montanaro, Dr. Erin Basinger, and Dr. Margaret Quinlan-Carbone. Thank you for each of your unique contributions to this project throughout its development.

To the brilliant members of the MIND-BATCH lab, it has been a tremendous honor to work with each one of you over the years. I want to extend my sincerest gratitude and appreciation to the lab members who provided me with thoughtful contributions on this project and assisted me with recruitment, data collection, and analysis: Jodie Lisenbee, Jan Mooney, Rachel Uri, Brianna Cullins, Lia Bauert, and Jordan Carelock.

This research would not exist without the Health Psychology PhD program, which funded a portion of this study. The program went above and beyond my expectations in terms of didactic, clinical, and research experiences. I would like to thank Dr. Amy Peterman for her guidance in my clinical work and Dr. Virginia Gil-Rivas for her leadership. I would also like to acknowledge the colleagues in my graduate program who have supported me throughout this

process in various ways. To Dr. Ana Orejuela-Davila, I would be lost without late our night writing sessions. Your determination is truly motivating. To Dr. Linda McWhorter, another commendable study buddy turned lifelong friend. Thank you both for your unwavering friendship, kindness, and support throughout our graduate school years.

Finally, this project would not be possible without the participation of undergraduate women and clinical experts who were willing to devote their time and share their personal and professional experiences. I hope to integrate their unique experiences with integrity into eating disorder research.

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LIST OF ABBREVIATIONS

BE	Binge eating
ME	Mindful eating
IE	Intuitive eating
EDs	Eating disorders
TPB	Theory of Planned Behavior
TAM	Technology Acceptance Model
CBT	Cognitive Behavioral Therapy
MBIs	Mindfulness Based Interventions

Chapter 1: Introduction

Overview & Scope

The universal availability of smartphones shows great potential in tackling the lack of accessible self-help and in-person treatments for binge eating (BE). A smartphone is an innovative mobile phone that also functions as a handheld computer. These devices are capable of sending and receiving text messages, accessing the Internet, and running software applications (i.e., "mobile apps"). Between 81% (Jesse, 2015) and 99.8% of college students own smartphones (Post, 2011), and "83% of smartphone users don't leave home without their device" (Google, 2013). On average, smartphone users have 33 apps installed on their device and use 12 apps over the course of a month (Google, 2013). Among a sample of 395 undergraduate students with smartphones, Jesse (2015) found that students used their primary app (typically social media) 11 times per day on average.

In 2015, the World Health Organization (WHO) surveyed 15,000 mHealth apps and found that 29% focus on mental health diagnosis, treatment, or support (Anthes, 2016). Chandrashekar (2018) argues that the ubiquity of smartphone apps could be well-suited to address the lack of access to mental health treatments as well as mental health provider shortages. An increasing number of apps are designed as therapeutic aids, either as a stand-alone platform (Free et al., 2013; Vandelanotte, Spathonis, Eakin, & Owen, 2007) or in combination with traditional therapy (Bauer & Moessner, 2012; Chan, Torous, Hinton, Yellowlees, 2014; Donker, Petrie, Proudfoot, Clarke, Birch, Christensen, 2013; Newman, Szkodny, Llera, & Prezworski, 2011; Juarascio, Manasse, Goldstein, Forman, & Butryn, 2015; Musiat, Goldstone, Tarrier, 2014). Standalone technologies do not require any clinician assistance (e.g., computer-based interventions, web-guided treatments, self-guided mobile applications; Anton & Jones, 2017). In contrast, technology-enhanced interventions depend on some clinician involvement in

conjunction with technology (e.g., telephone support, video conference, face-to-face sessions combined with between-session text messages, videos, reminders; Anton & Jones, 2017). Whether standalone or technology-enhanced, mHealth apps can provide an important role in the future of mental health care because they leverage the utility and practicality of smartphones for behavior change. However, since many of these applications lack trial-based evidence, their effectiveness remains unclear.

It is possible that smartphone apps can widen access to evidence-based treatment for subclinical college-aged individuals and may address limitations of current treatment delivery in this population (Juarascio et al 2015). An area of much needed empirical attention in terms of how mHealth might be clinically applied is in the context of BE among undergraduate women. According to the DSM 5, binge eating disorder (BED) is defined as recurring episodes of consuming significantly more food in a short period of time than most people would eat under similar circumstances, with episodes marked by feelings of lack of control and typically not driven by hunger (APA, 2013). BE is characterized as recurrent episodes of uncontrollable overeating, in the absence of extreme weight control behaviors as seen in anorexia nervosa and bulimia nervosa. To be clinically diagnosable, most symptoms of BED occur on average at least once a week over three months. BED is a chronic and stable condition (Pope, Lalonde, Pindyck, et al., 2006), with sufferers experiencing distress and guilt about their eating behaviors yet struggling greatly with regulating these behaviors despite long-term medical concerns such as diabetes and hypertension (Carter & Davis, 2011; Colles, Dixon, O'Brien, 2008).

Whereas a small proportion of college women are diagnosed with clinical eating disorders, prevalence studies indicate that 61% report disordered eating behaviors more generally (Anderson et al., 2003; Heron, 2011). Although overeating tends to remit over time, BE and

BED have shown higher rates of continuation or worsening of symptoms during the transition from late adolescence to early/middle young adulthood (Goldschmidt et al., 2016). Thus, problematic eating is persistent for a subset of individuals. The average age of BED onset is between ages 18 and 25 years (Beck, 2016; Stice, Marti, & Rohde, 2013). Within college samples, the prevalence of severe BE symptoms has been projected to be as high as 44%, placing them at higher risk for developing BED (Beck, 2016; Goldschmidt et al., 2016; Lloyd-Richardson, Bailey, Fava, & Wing, 2009; Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). Therefore, it is important to address eating concerns earlier along on the continuum before overeating turns into BE to promote better long-term outcomes.

Traditional cognitive-behavioral treatment approaches for BE focus on the reduction of symptoms by teaching individuals alternative ways of coping (e.g., distraction). Acceptance-based therapeutic approaches, such as dialectical behavior therapy (DBT) and acceptance and commitment therapy (ACT), conceptualize BE symptoms as efforts to escape intense or distressing emotional states, and therefore, the treatment aims are to reduce BE through increasing emotional acceptance and tolerance. However, in addition to increasing awareness of and reducing BE behaviors, what is lacking in traditional CBT and acceptance-based approaches is the focus on increasing mindful eating processes. More recent mindfulness-based approaches have demonstrated promising outcomes for treating BE symptoms through enhancing adaptive eating skills (e.g., interoceptive awareness; Kristeller et al., 2014; Warren, Smith, & Ashwell, 2017).

Although mindfulness-based eating interventions may prove helpful for college students with BE in the context of an efficacy trial, there are multiple barriers to successful treatment that apps have the potential to alleviate. Apps can provide basic psychoeducation and initial

screening to support students who are unable to receive treatment due to costs or time constraints and can reach individuals who avoid seeking treatment due to stigma and/or shame associated with BE. mHealth apps are not only a convenient and affordable way to receive evidence-based concepts, they also present a unique method of treatment delivery for mental health concerns such as BE. In-person psychotherapeutic treatments encourage individuals to practice self-monitoring and learned skills daily; however, patients often show poor compliance with and adherence to these traditional self-guided tools (Edelman & Chambless, 1995; Schmidt & Woolaway-Bickel, 2000). Apps may also be a potential remedy to individuals' lack of adherence and compliance by prompting users to practice "in-the-moment" mindfulness skills and decision-making at any desired time interval. For individuals with BE, this feature may be particularly salient before, during, or after a BE episode.

An app called "Am I Hungry?" Mindful Eating Virtual Coach has been developed from Michelle May's, M.D. mindful eating self-help program and book *Eat What You Love, Love What You Eat for Binge Eating*. The app is designed to treat BE behaviors using mindful-eating decision making strategies but has not been empirically evaluated. The app provides users with psychoeducation regarding aspects of the cycle of BE (e.g., emotional, environmental, physical triggers), mindfulness practices (e.g., mind-body-heart scan, self-care) and the mindful-eating cycle (e.g., "When I want to eat, I ask myself 'am I hungry?'"; May & Anderson, 2014). Since binge eating usually takes place when a person is home or alone (Goldschmidt, Crosby et al., 2014; Stein et al., 2007), having an app-based treatment may be perceived as a useful and practical approach for this population. This application is self-guided and thus would be considered a stand-alone intervention.

Assessing early stage facets is important in furthering knowledge of what motivates users to engage in app-based treatment, as well as potential barriers to their use. To date, there have been a few studies exploring the development, use, feasibility, and preliminary evaluation of the acceptability of self-help mobile app interventions specifically for disordered eating behaviors, weight, and stress (Ambwani, Cardi, & Treasure, 2014; Boh, Lemmens, Jansen et al., 2016; Cardi, Clarke, & Treasure, 2013; Fairburn & Rothwell, 2015; Darcy & Lock, 2017; Nitsch, Dimopoulos, Flaschberger et al., 2016; Forman, Goldstein, Zhang, et al., 2018; Heron & Smyth, 2010; Heron, 2011; Hildebrandt, et al., 2017; Juarascio, Goldstein, Mannasse et al., 2015; Juarascio, Manasse, Goldstein et al., 2015; Levinson, Sala, Fewell et al., 2018; Lyzwinski et al., 2018; Mason, Jhaveri, Cohn, & Brewer, 2018; Rodgers, 2016; Rodgers, Pernal, Shiyko et al., 2016; Tregarthen, Lock, & Darcy, 2015); however, none of these studies examines mindfulness-based app interventions for BE.

Providing an empirical foundation of early factors is important prior to conducting a high-powered randomized controlled trial (RCT). Essentially, clarification is needed to know whether users are motivated to use the app before testing it for clinically significant outcomes. First, the treatment app must be perceived as practical for individuals to use, for providers to implement and users must demonstrate ongoing engagement with the app (feasibility). Second, users must find that the app is suitable and sustainable to their needs and providers must find components of the app agreeable to treatment evidence-base (acceptability). Lastly, users must find that the app provides a desired change in behavioral and symptomatic outcomes (preliminary efficacy).

Chapter 2: Theoretical Frameworks

Overview

In this section, I will focus on the theoretical constructs that are key factors in explaining individuals' decisions to utilize smartphone technology for making health behavior changes. Given the growth in the advancement and adoption of mHealth apps, an emerging research arena has explored health app practices from several viewpoints (West, Hall, Hanson, Barnes, Giraud-Carrier, & Barret, 2012). Overall, prior research on health apps has focused in the following areas: first, studies have concentrated on the general features of numerous smartphone health apps, such as design and functional elements, and thus, these apps have been categorized based on their main functions using content analysis (Bender, Yue, Jason, Deacken, & Jada, 2013; Middleweerd, Mollee, Wal, Brug, & Velde, 2014; West et al., 2012) and have proved useful for summarizing health apps into manageable categories (Cho, 2016). A second cluster of studies has explored the relationships between app functions and health-related behaviors with the aim to develop more effective apps based on actual behavioral patterns (Brannon & Cushing, 2014; Cho, 2016; Kharrazi, Chisholm, VanNasdale, & Thompson, 2012; West, Hall, Arredondo, Berrett, Guerra, & Farrell, 2014). Whereas the first group of studies mainly characterized apps based on purposes and functions, the second group evaluated the design of apps depending on theories of behavior change (Cho, 2016). Although these studies have helped to explain the design elements of health apps, they are limited in their lack of emphasis on the ways in which health apps are actually being used. In other words, these studies rarely collected and examined actual attitudes towards health apps and their behaviors in using those technologies (Cho, 2016). Regardless of applied and theoretical contributions to developing better functions and more efficient apps, these studies have not assessed the factors that govern the adoption and

acceptability of apps by individuals. It is difficult for these findings to lead researchers and practitioners to actively encourage patients to adopt and use apps (Cho, 2016).

Lui and colleagues (2017) conducted a review on the use of mHealth apps in a psychotherapy context that focused on efficacy or effectiveness. Out of 21 studies included in their review, there were no studies on apps for eating disorders or samples with disordered eating. Although empirical evidence was lacking for the present study's target sample, Lui et al (2017) found that most apps appeared to have a strong theoretical basis and were adaptations of empirically supported approaches; however, these findings were not confirmed by expert opinion. Clinician perspectives about novel practices have been shown to be essential in implementation decisions and the frequency with which new practices are adopted in routine health care (Greenhalgh et al., 2004). The perceptions of mental health clinicians regarding the use of smartphone applications have received some empirical attention (Kuhn, Eftekhari, Hoffman, Crowley, Ramsey, et al., 2014). Further inquiry is needed to narrow the dearth of findings for clinician opinions and implementation practices.

This chapter provides a health behavior change framework for understanding users' attitudes on using a mindful eating smartphone app and clinicians' perspectives on implementing this technology into practice. First, an introduction to the theory of planned behavior will be provided and then applied to the adoption of mHealth smartphone applications, the use of guided self-help in changing eating behaviors (i.e., binge eating, mindful eating), and clinical practice implementation. A discussion on the advantages and appropriateness of using an action research mixed methods approach to examining these constructs is provided.

Theory of Planned Behavior

The theory of planned behavior (TPB; Ajzen, 1991) is a continuum model of health behavior change where individuals are positioned along a range that reflects the likelihood of action (Schwarzer, 2011). This model assumes that an individual's behavior (i.e., increase in adaptive eating behaviors) is the outcome of an intention (e.g., "I intend to use this app at least 3 times a day."). Forming an intention is viewed as being influenced by beliefs and attitudes (Fishbein & Azjen, 1975). This model implicitly assumes there are two distinct processes of behavior change: a motivational one that produces an intention, and a volitional one that produces effective performance of the desired behavior change (Schwarzer, 2011). The model consists of the following eight variables: behavior, intention, attitudes towards behavior, subjective norm, perceived behavioral control, behavioral beliefs, normative beliefs, and control beliefs. Intention represents a person's readiness to perform a health behavior (in this case, using a smartphone app for BE), is based on attitude toward the behavior, subjective norm, and perceived behavioral control, and mediates between these three components and the behavior (Schwarzer, 2011). Attitude toward a behavior is indicative of the positive or negative value linked to the behavior; thus, attitude is determined by a set of behavioral beliefs (Schwarzer, 2011). Subjective norm is the perceived social pressure to engage or not engage in a behavior and is predicated on a set of normative beliefs. Perceived behavioral control pertains to an individual's confidence in their ability to perform a particular health behavior, is determined by a set of control beliefs, and is considered to be the same as perceived self-efficacy (Bandura, 1997; Schwarzer, 2011). Behavioral beliefs reflect the likelihood that a behavior (i.e., using a smartphone app) will lead to an expected outcome (i.e., decreases in binge eating and increases

in mindful eating). Attitudes toward a behavior are a product of behavioral beliefs and subjective values about the expected outcome (Schwarzer, 2011).

A typical feature of continuum models is that they are better at capturing differences in intentions than differences in behavior (Schwarzer, 2011). However, there are two disputed characteristics of continuum models. First, using a single set of predictors for describing behavior change suggests that attitudinal and behavioral changes occur in a linear fashion and that a "one-size-fits-all" intervention approach is appropriate for all individuals engaging in maladaptive behaviors (Schwarzer, 2011). As a result, it excludes qualitative changes over time, such as attitude changes or moving backward and forward, and it is not significant if an intervention is targeted for changing a predictor (e.g., attitudes). Second, continuum models do not explain the post-intention phase, in which individuals' behavior change goals are put into action (Schwarzer, 2011). Since people's behaviors do not always align with their intentions, the space between intentions and behaviors is referred to as the "intention-behavior gap" (Sheeran, 2002). Thus, the TPB is mainly an intention theory, which will be useful in guiding this investigation on assessing both users' and clinicians' perceptions about the uptake of a smartphone application for BE. Potential gaps related to post-intention use may also be addressed in interviews with participants.

Theory of Planned Behavior and Technology Acceptance Model to Explain Adoption of mHealth

The potential of smartphones "to influence human behavior is due to the strong attachment people have to their mobile devices, the multi-use capability of such devices, and the fact that they are carried wherever they go" (Fogg & Eckles, 2007; Glynn et al., 2015; p. 2). Smartphone owners check their devices regularly and this recurrent "checking habit" is

reinforced by instantly visible information, rewards, and in some cases “gamified” (Oulasvirta, Rattenbury, Ma, & Raita, 2012; Glynn et al., 2015, p. 2). In comparison to laptops, smartphone use takes significantly less time, is spread more evenly throughout the day, is nearly twice as frequent, and the frequency of these brief “checks” increases with the use of a few applications (Oulasvirta, et al., 2012). This, in addition to the capability to produce “reminders”, most apps are likely to encourage and enable an individual to use their smartphone to improve, manage, and regulate their eating behavior on a daily basis.

Dennison et al (2013) explored young adults’ attitudes towards apps related to health behavior change. They found that the attraction and usefulness of apps depends on whether a user was already motivated to change their lifestyle and health behaviors. If the user was committed to changing, features such as self-monitoring tools, reminders, and prompts were thought to be useful, but in the absence of motivation these features were viewed as unnecessary and irritating (Dennison, Morrison, Conway, & Yardley, 2013). Additionally, participants believed their smartphones were “valuable because they make things quicker, easier, and more pleasurable to do; however, many health-related apps that they tried or heard about were time-consuming, burdensome, or difficult to set up and interact with, and participants showed little patience for using these apps” (Dennison et al., 2013; p. 6). Participants also expressed apprehension about whether apps they used were from trustworthy and valid sources. It will be important to note whether women in the present study have similar and/or different attitudes towards the ME app.

The acceptance of a new technology is not just reliant on motivation to change a lifestyle or behavior (Glynn, et al., 2015). Factors such as prior experience, peer support, and perceived usefulness meaningfully influence whether a user uses a technology (Davis, Bagozzi, &

Warshaw, 1989; Venkatesh & Davis, 2000). People will not necessarily perceive a technology to be useful if you simply tell them it is, which is mostly accurate if they have limited (or undesirable) experiences or do not receive support from peers when learning (Glynn et al., 2015;Venkatesh, Morris, Davis, & Davis, 2003). Perceived ease of use and perceived complexity both have a larger influence on technology acceptance (Bagozzi, 2007). Given that college students are a cohort in which technology use is normative and generally accepted, the acceptance of mobile apps for health behavior change may be highest in this population.

Technology Acceptance Model

Within mHealth, the technology acceptance model (TAM) represents the dominant theoretical lens through which mHealth adoption has been examined. The technology acceptance model (TAM) is a widely used perspective to examine the implementation of new technology (Davis, Bagozzi, & Warshaw, 1989). Drawing from the theories of reasoned action (TRA; Fishbein, 1975) and planned behavior (Ajzen, 1991), Davis and colleagues (1989) originally asserted that an individual's acceptance of a new technology is primarily influenced by their attitudes towards the technology and that these attitudes are determined by two factors: perceived usefulness (PU) and perceived ease of use (PEOU). PU is the extent to which a person proficiently accomplishes a given task with a new technology (Egea & Gonzalez, 2011; Venkatesh & Davis, 2000; Yarbrough & Smith, 2007). PEOU is determined by the amount of effort required to learn and use the novel technology (Venkatesh & Davis, 2000).

TAM theory explicitly recognizes the TPB attitudes construct as central to user motivations to adopt technology, although the attitudes construct has been defined as perceived usefulness and perceived ease-of-use within the TAM model (Davis et al., 1989). Recent revisions to the model incorporate factors such as subjective norms and perceived risk (Lala,

2014). The TAM model has been applied in previous studies to understand the adoption of health apps (Lim, Xue, Yen et al., 2011; Xue, Yen, Chang et al., 2012) and college students' attitudes toward diet/fitness apps (Cho, Lee, & Quinlan, 2017). Within mHealth, the constructs of PEOU, PU, and subjective norms all emerged as particularly important cognitive influences on adoption intentions from the initial exploration of the TAM theory model (Cho, Quinlan, Park, & Noh, 2014; Shareef et al., 2014).

Given the relatively nascent findings on the technology acceptance model, there are understandably even fewer studies examining the post-adoption behaviors of using apps. Inquiry into the process that leads people to continue using mHealth apps can further address the post-intention gap of the TPB in explaining technology adoption for health behavior change. To address this gap, Cho (2016) created and tested a model to explain which factors sustain intentions to use health apps, drawing from the post-acceptance model (PAM) and the technology acceptance model (TAM). The results demonstrated that PU, PEOU, confirmation, and satisfaction were significantly associated with the continued use of smartphone health apps (Cho, 2016).

Clinician's Perspectives on Implementing mHealth into Practice

Clinicians have faced a longstanding conundrum: how to bring psychotherapy treatment into patients' daily lives by encouraging practice and skill building between sessions (i.e., "homework"; Heron & Smyth, 2011). More generally, the use of mHealth interventions in patients' everyday environment is growing, and clinicians are gradually responding to questions about the value and risks of mobile apps. Although mHealth shows great promise for advancing patient health, "clinicians must standardize their identification, evaluation, and selection to maximize their utility, safety, and impact" (Boudreaux, Waring, Hayes et al., 2014, p. 1).

Aside from barriers to seeking and obtaining mental health services (e.g., time and financial costs, stigma, etc.), another critical barrier is the main model for delivering treatment, or the most common way psychological services are provided to treatment-seeking individuals (Kazdin, Fitzsimmons-Craft, & Wilfley, 2016). The typical mode of delivery has three characteristics: (a) treatment sessions are provided in person and one-to-one with a client (individual, couple, family); (b) treatment is provided by a highly trained (Master's or Doctoral level) mental health professional; and (c) sessions are held at a clinic, private office, or health-care facility (Kazdin et al., 2016). Kazdin and colleagues (2016) argued that using different models of treatment delivery can ensure that people getting treatment receive high quality evidence-based care and reach individuals who are underserved. Only 20% of individuals with eating disorders are receiving any treatment (Eisenberg et al., 2011), whereas a portion of the other 80% of individuals with EDs receiving no treatment at all could be reached through the integration of mHealth applications.

Clinicians appeared to have mostly positive perceptions of using a smartphone app as an aide for prolonged exposure therapy among patients with post-traumatic stress disorder (Kuhn, Eftekhari, Hoffman, Crowley, Ramsey, Reger, & Ruzek, 2014). Clinicians who were younger than 40 years old, possessed a smartphone, and had previously used an app in practice held more positive attitudes than those who were older than 40, did not have a smartphone, and had not used an app in practice (Kuhn, et al., 2014). Owning a smartphone and having favorable attitudes of the apps' advantages and complexity were significant predictors of intentions to use the app in the future (Kuhn et al., 2014). The findings from this study are limited because clinicians did not actually see or use the app and may not have had adequate information to evaluate the app.

Additionally, it is unknown how these findings might align with clinician perceptions of other types of apps (Kuhn et al., 2014).

The American Psychiatric Association has developed the following guidelines for clinicians in selecting mobile apps to recommend to patients: (a) gather relevant background information about the app before evaluating it (e.g., What is the cost? Who is the developer? Does it claim to be medical?), (b) understand the risk, privacy and security concerns regarding user data, (c) evaluate any evidence for potential benefits in clinical studies or through informed decision making (e.g., What does it claim to do vs. what does it actually do? User feedback to support claims? Is there peer-reviewed, published evidence about the tool?), (d) whether the app is easy to use (e.g., Are features customizable? Is it easy to access for the patient? Is it culturally relevant?), and lastly, (e) can the app share data between the client and clinician (i.e., interoperability; APA, 2020).

Hans et al (2018) argues that sustainable adoption of mHealth applications may only occur if providers are willing to restructure their workflow practices and accept the incorporation of technology that will unavoidably change the way they practice. The introduction of new technologies into the healthcare context may to some degree necessitate the reorganization of workflow for providers. After investigating the effect of a mobile application designed to track self-reported measures for self-management (e.g., collaborative goal setting, managing care plans), primary care providers had concerns about liability associated with monitoring, increased time spent documenting “due to a lack of interoperability between the app and the electronic patient record, increased provider anxiety regarding the app’s potential to infringe on appointment time, and increased demands for patient engagement” (Hans, Steele Gray, Gill, & Tiessen, 2018, p. 151). These primary care providers did report that the app helped to target

treatment plans and to begin a collaborative discussion on goal-setting. However, the authors found a high level of provider resistance to adapt their behavior and demonstrated consistent attempts to move the app towards fitting with prevailing workflows, suggesting that resistance to change may be expected and will need to be addressed (Hans et al., 2018).

Regarding factors in favor of implementation, Possemato and colleagues (2017) found that clinicians supported the use of a PTSD Coach app because it was compatible with the clinics' current practices, was easy to implement, was thought to address patient needs, and had strong support from leaders and stakeholders in the field. The authors noted that provider knowledge and beliefs about the intervention may facilitate implementation of mobile app interventions (Possemato, Kuhn, Johnson, Hoffman, & Brooks, 2017).

Binge Eating and Mindful Eating Interventions

In further addressing the cognitive and behavioral processes that motivate users and practitioners to adopt smartphone app technology, it is also important to recognize the cognitive and affective principles that underlie aspects of binge eating, mindful eating, and mindfulness-based self-help approaches for binge eating.

Affect Regulation Model of Binge Eating

Dysregulated affect is involved in largely all psychological disorders in the DSM-5, and an extensive body of literature has assessed the role of maladaptive behaviors in regulating affect (Haedt-Matt & Keel, 2011). One of the most frequently mentioned explanations for BE emphasizes its part in regulating emotional distress or negative affect (Polivy & Herman, 1993). The affect regulation model asserts that escalations in negative emotions trigger BE and that by using food for comfort and distraction, BE functions to relieve negative affect (Hawkins & Clement, 1984). BE in response to negative emotions develops into a conditioned response that

is maintained through negative reinforcement (Polivy & Herman, 1993). Two hypotheses have been tested in relation to the affect regulation model: (a) increases in negative affect precipitate BE, and (b) BE is associated with an immediate decrease in negative affect (Haedt & Keel., 2011).

Several studies have supported the first hypothesis, that negative affect is relatively high or increasing before BE (Abraham & Beumont, 1982; Arnow, Kenardy, & Agras, 1992; Berg et al., 2013; Engel et al., 2013; Davis & Jamieson, 2005; Lynch, Everyingham, Dubitzky, et al., 2000; Hsu, 1990; Kjelsas, Borsting, & Gudde, 2004; Vanderlinden et al., 2004; Agras & Telch, 1998; Chua, Touyz, & Hill, 2004; Telch & Agras, 1996; Haedt-Matt & Keel, 2011; Smyth et al., 2007); however, mixed empirical support has emerged for the second hypothesis (Abraham & Beumont, 1982; Hawkins & Clement, 1984; Hsu, 1990; Agras & Telch, 1998; Tachi et al., 2001), with some evidence suggesting that negative affect decreases after BE (Smyth et al., 2007) and other evidence suggesting that negative affect actually increases after BE (Engel et al., 2013; Haedt-Matt & Keel, 2011). Overall, the evidence regarding the causal relation between negative affect and BE is inconclusive and limited (Parks, Dingemans, & Danner, 2017).

Ecological momentary assessment (EMA) is a commonly used method in research examining the relationship between negative affect and BE because it can assess variables of interest immediately and in natural environments (Berg, et al., 2017). EMA enhances ecological validity and minimizes retrospective recall bias (Shiffman, Stone, & Hufford, 2008; Stone & Shiffman, 1994). Results from a meta-analysis of studies using EMA demonstrated that negative affect increases after BE episodes in participants with binge eating disorder (BED; Haedt-Matt & Keel, 2011). One possible explanation for the contradiction between the prediction from the affect regulation model and EMA results is that BE may result in an immediate but brief

reduction in negative affect that is rapidly exchanged with an increase in negative affect as the consequences of BE become more obvious (Haedt-Matt & Keel, 2011). Thus, it seems improbable that BE would be sustained by decreases in negative affect.

Alternatively, BE may be maintained through shifts in affect during BE episodes that are not sustained after a binge (Haedt-Matt & Keel, 2011). One study found that negative affect decreased significantly from pre-binge to during the binge episode (Deaver et al., 2003), whereas another study found no significant changes in negative affect from before to during BE in participants with BED (Hilbert & Tuschen-Caffier, 2007), and lastly, affect was found to worsen during BE compared to before BE in two studies (Johnson & Larson, 1982; Stickney & Miltenberger, 1999). Thus, these preliminary investigations indicate no clear support for reductions in negative affect during BE (Haedt-Matt & Keel., 2011).

Kenardy and colleagues (1996) have argued for a "trade-off" theory of affect regulation where a binge episode serves to trade one kind of negative affect (e.g., anger as an antecedent) for a less unpleasant type of negative affect (e.g., guilt following BE). Thus, BE may be maintained by reducing the unpleasantness of the emotions experienced rather than by generating an overall reduction in negative affect (Haedt-Matt & Keel, 2011). Four EMA studies found that anxiety decreased from pre- to post- BE (Elmore & de Castro, 1990; Hetherington et al., 1994; Kaye et al., 1986; Redlin et al., 2002), whereas depression (Elmore & de Castro, 1990; Hetherington et al., 1994; Kaye et al., 1986) and guilt (Redlin et al., 2002) increased, and another study showed that anger and irritability decreased, whereas sadness and shame increased post-BE (Johnson & Larson, 1982). Other studies have demonstrated reliable post-binge increases in anxiety, depression, and hostility (Powell & Thelen, 1996); anxiety and shame/guilt (Corstorphine et al., 2006); or anger, guilt, and depression (Wegner et al., 2002), signifying that a

trade-off in aspects of negative affect has not been consistently detected (Haedt-Matt & Keel, 2011).

Although BE does not appear to be maintained by post-binge decreases in negative affect, it is possible that BE is positively reinforced by increases in positive affect related to the pleasurable aspects of eating desired foods (e.g., Small, Jones-Gotman, & Dagher, 2003; Haedt-Matt & Keel., 2011). This positive reinforcement has not been a major focus of the affect regulation model for BE, and the results from these few studies suggested that positive affect decreased after BE; however, this result does not eliminate the likelihood that positive affect increases during a binge episode (Haedt-Matt & Keel., 2011; p. 674).

An experimental study examined the affect regulation model of BE by comparing the effects of manipulating mood during meal intake of individuals with BE versus individuals without BE (Russell, Haynos, Crow & Fruzzetti, 2017). In the stressful condition, the authors found that individuals with BE did not consume significantly more than the control group (i.e., individuals without BE), but a larger subset of the BE group (nine out of 26) engaged in extreme intake compared to controls (two out of 26; Russell, et al., 2017). This might mean that both BE and dietary restriction may function as strategies to manage reactions to stress. Although research and theory in BE samples have fixated on BE as a response to stressful experiences (Aubie & Jarry, 2009; Laessle & Schulz, 2009; Telch & Agras, 1996; Wonderlich et al., 2008), research shows that individuals who binge eat also frequently restrict (Elran-Barak et al., 2015; Polivy & Herman, 1985; Russell, et al., 2017). Therefore, both dietary restriction and BE may serve to regulate stress or negative affect among individuals who binge eat (Russell et al., 2017).

Mindfulness

Mindfulness has received a monumental rise in popularity in the past decade, both in the popular media and in psychotherapy research (Didonna, 2009; Shapiro & Carlson, 2009). As a result of the positive outcomes of mindfulness-based stress reduction (MBSR) programs and the role of mindfulness in DBT, as well as ACT, mindfulness has shifted from an obscure Buddhist concept to a conventional treatment construct (Davis & Hayes, 2011). "The term 'mindfulness' has been used to refer to a psychological state of awareness, a practice that promotes this awareness, a mode of processing information, and a characterological trait" (Brown, Ryan, & Creswell, 2007; Davis & Hayes, 2011, p. 198; Germer, Siegel, & Fulton, 2005; Kostanski & Hassed, 2011; Siegel, 2007). Mindfulness can be defined as "moment-by-moment awareness" (Germer et al., 2005, p. 6) or as "a state of psychological freedom that occurs when attention remains quiet and limber, without attachment to any particular point of view" (Martin, 1997, p. 291), or "the awareness that arises when paying attention in the present moment on purpose and nonjudgmentally" (Kabat-Zinn & Hanh, 2009, p. 20). When an individual is "being mindful," the ability to harbor a nonjudgmental attitude and let their experience unfold with interest rather than trying to control it keeps them from being swayed by positive and negative emotional states. Using this definition, mindfulness is understood as a state and not a trait, and although it is associated with certain practices (e.g., meditation, yoga), it is not synonymous with them (Davis & Hayes, 2011).

"Mindful eating" involves focusing on the process of eating through heightened attention to sense of smell and taste as well as the mechanical process of chewing food, while attuning oneself with one's internal hunger and satiety cues by stopping to eat immediately when full (Lyzwinkski, Caffery, Bambling, Edirippulige, 2018). ME thus consists of making sensible food

choices, fostering an awareness of physical versus psychological (emotional) hunger and satiety cues (Dalen, Smith, Shelley et al., 2010), and eating appropriately in response to those cues (Miller, Kristeller, Headings, et al., 2014). Body dissatisfaction and negative body image can change an individual's relationship with food, often leading to restriction-binge cycles. ME focuses on the process of eating, not what is eaten, and there are no rules to be followed. Becoming aware of the physical and emotional sensations while eating reacquaints individuals with natural physiological processes of appetite and eating regulation. Practicing this awareness with non-judgment also helps individuals notice the negative self-talk that may accompany eating or judgments made about food choices. Becoming aware of the various factors that influence eating behavior may allow an individual to make different choices. It is expected that a ME practice will lead to decreases in binge behaviors because it can assist individuals in tuning back into emotional and physical states as well as the motivation to manage distressing emotions through eating in a non-judgmental, accepting manner.

Chapter 3: Literature Review

Psychological and Behavioral Risk Factors for Binge Eating Among College Women

In a 10-year longitudinal study, Goldschmidt and colleagues (2016) assessed predictors of eating behaviors (BE vs. no overeating, overeating vs. no overeating, BE vs. overeating) at three time points: in early/middle adolescence, late adolescence/early young adulthood, and early/middle young adulthood. Increased psychosocial difficulties (i.e., depressive symptoms, body dissatisfaction, lower self-esteem) in late adolescence and early young adulthood predicted higher risk for BE compared to overeating in early/middle young adulthood women, signifying that poorer psychosocial functioning during this developmental stage predicts more extreme eating-related symptoms later in life (Goldschmidt et al., 2016). Transitioning from high school to college is thought to be linked to an increased risk for health concerns because it usually occurs with reduced physical activity (Butler et al., 2004) and increased intake of high-fat foods and alcohol (Anderson et al., 2003; Greene et al., 2011). Lloyd-Richardson et al (2008) found that after half of their drinking episodes, freshmen engaged in frequent late-night eating and experienced the “drunk munchies” (disinhibition leading to the consumption of large quantities of typically high-fat foods, p. 4).

Eating behaviors can be theorized as falling on a continuum with EDs (e.g., binge eating disorder) at one end and intuitive eating habits at the other (Levine & Smolak, 2006a; Shisslak, Crago, & Estes, 1995; Striegel-Moore, Silberstein & Riodin, 1986). Supporters of this continuum model argue for the need to consider eating behaviors that occur between these two poles. Disordered eating is the presence of some symptoms of eating pathology, such as BE, but does not meet the full criteria for a diagnosable eating disorder (e.g., according to the Diagnostic and Statistical Manual criteria; APA, 2013; Heron, 2011). Within the continuum model, disordered

eating behaviors (e.g., restricting intake, binge eating) often co-occur with body image dissatisfaction and concerns about weight and shape, which altogether places an individual at risk for developing an ED (Heron, 2011; Levine & Smolak, 2006a).

There are substantial differences between BE and the more common phenomenon of overeating (also referred to as stress eating or emotional eating). Overeating consists of an objectively large amount of food intake, and BE is characterized by overeating in addition to a sense of loss of control (LOC; APA, 2013). Persistent BE is much less common, far more severe, and is associated with significant physical and psychological problems (APA, 2013). Binge and emotional eating are not necessarily two separate distinct processes. Rather, they are one process that occurs along a continuum, where at one end, it is a diagnosable eating disorder. Without treatment, BE might remain constant or advance into a fully diagnosable syndrome (Stice, Marti, Shaw, & Jaconis, 2009), while overeating (with or without LOC) might be expected to lessen over time (Goldschmidt, Wall, Zhang, Loth & Neumark-Sztainer, 2016).

Dieting

The risk factor for BE that has received the most empirical attention is dieting (Lowe, 1994; Lowe & Levine, 2005). Dieting has been criticized on many grounds, including being a significant contributor to the development of BE and eating disorders (Keys, Brozek, Henschell, Mickelson, & Taylor, 1950; Lowe & Levine, 2005; Polivy & Herman, 1985). Dieting can increase the likelihood that an individual will overindulge to counter the effects of deprivation and may actually encourage BE because disinhibited eating can be the result of transgressing strict dietary rules (Christensen, 2011; Marlatt & Gordon, 1985). Dieting can also exponentially slow down metabolic rate when weight is lost, making weight regain more likely (Ravussin & Swinburn, 1992) and has cumulative negative effects on physiological (Brownell, Greenwood,

Stellar, & Shrager, 1986) and psychological functioning (Polivy & Herman, 1985; Polivy & Herman, 2002), such as disrupting one's ability to process information efficiently (Jones & Rogers, 2003). In addition to being physiologically taxing, dieting is psychologically ill-advised for women because it encourages unrealistic expectations about the changeability of body weight and shape (Brownell, 1991; Striegel-Moore, Silberstein, & Rodin, 1986). Other variables that increase the likelihood of dieting include higher weights, body dissatisfaction, appearance overvaluation, perceived pressure to be thin, and modeling of eating disturbances (Stice & Agras, 1998). Stice, Presnell, and Spangler (2002) replicated these findings, and additionally assert that BE may be deeply affixed to pressures to conform to the current thin ideal because logically, body dissatisfaction would promote dieting behavior.

Moreover, dieting causes a shift from relying on innate hunger cues to asserting cognitive control overeating behavior, which leads to disinhibited eating when these sustained cognitive efforts are interrupted (Lowe, 1994; Stice, et al., 2002). Disinhibition (i.e., lack of restraint), an antecedent for binge eating, has been shown to foster increases in the tendency to eat, especially when combined with perceived deprivation (Bryant, King, & Blundell, 2008). Dietary restrictions can create a sense of deprivation, which interferes with interoceptivity, or the ability to recognize and identify emotional states and/or physiological states (i.e., hunger). Individuals who have difficulty distinguishing their emotional states may use eating as a way to cope with a negative and uncertain emotional event (Leon, Fulkerson, Perry, & Early-Zald, 1995; Sim & Zeman, 2005). This creates an environment where, for individuals who overeat, LOC is more likely to occur, especially in the presence of uncertainty or negative emotions, food cues, and deprivation (Mailloux, Bergeron, Meilleur, D'Antono, & Dube, 2014). Disinhibition has been

strongly linked to all types of overeating, one-and-a-half to almost threefold increase in overeating and BE (Maillouux et al., 2014).

There is also research to suggest that emotional eating, which is the propensity to eat in response to negative emotions, predicts BE (Bardone-Cone, et al., 2012; Stice, Presnell, Spangler, 2002), confirming past evidence that negative affect promotes BE (Stice & Agras, 1998). Repeated demonstrations have shown that psychological distress typically suppresses eating in non-dieters (unrestrained eaters), yet distress increases eating in chronic dieters/restrained eaters (Baucom & Aiken, 1981; Polivy & Herman, 1999; Ruderman, 1985;). Results from an experimental study suggest that distress-induced overeating in restrained eaters may serve as a coping function for the individual, allowing for distraction from the distress or concealing the source of distress (Polivy & Herman, 1999). Restriction of fatty and sugary foods in particular can cause distress-induced overeating (Polivy & Herman, 1999; Ruderman, Belzer, & Halperin, 1985), and these foods are typically selected by consumers during an episode of overeating because they tend to lift mood by releasing neuropeptides, thus reinforcing their selection (Kelley, Baldo, Pratt, & Will, 2005).

Mailloux and colleagues (2014) examined correlates of overeating in a nonclinical sample of young women (aged 18 to 21 years) and found that overeating behaviors are rather common. Over 40% of their sample (*N*= 1447) reported at least one episode of overeating in the last 28 days, with almost 21% of participants reporting objectively overeating and an additional 20% reporting objectively BE (Mailloux et al, 2014). Findings from this study also confirmed that weight and shape concerns, negative affect, dietary restraint, disinhibition, and hunger were significantly associated with BE and overeating, but not interoceptive awareness. Given the substantial impact that BE has on multiple areas of an individual's well-being (i.e.,

psychological, physiological, social, etc.), it is imperative that empirical inquiry consider prevention and intervention strategies that address these concerns during critical periods in life (e.g., college aged groups).

Stress

A predominant factor contributing to disordered eating behaviors among college students is their increasing level of stress (Kristeller & Hallet, 1999; Lloyd-Richardson et al., 2008; Bahl, Milne, Ross, & Chan, 2013). In the 2017 American College Health Association National College Health Assessment survey, students most frequently cited stress, anxiety and depression as impediments to academic performance. Coping with stress frequently results in unsuccessful attempts to maintain self-control concerning excessive smoking, drinking, and eating (Baumeister, Heatherton, and Tice, 1994). Greene et al. (2011) identified clusters of college students at elevated health risk based on eating and exercise behaviors and psychosocial determinants of body weight. As compared to men and women identified as “psychosocially secure” and “behaviorally competent”, men and women identified as “high risk” desired the greatest amount of weight loss, had higher emotional eating scores, and had the highest level of psychological distress (Greene et al., 2011).

Bardone-Cone et al. (2012) longitudinally measured stress (academic, interpersonal, body weight), perfectionism (self-oriented and socially prescribed), and overeating and drinking in response to negative affect in 406 undergraduate women. Interestingly, perfectionism stemming from the belief that others expect perfection from oneself, not from personal striving for perfection, interacted with academic stress to predict the greatest difficulties regulating overeating and drinking in response to negative affect (Bardone-Cone, Brownstone, Higgins, Harney, Fitzsimmons-Craft, 2012). In a college environment, social pressures to perform

academically are prevalent and great value is placed on academic outcomes. The authors theorize that the combination of socially prescribed perfectionism and academic stress predicting difficulties among these eating and drinking domains may occur especially for individuals with lower distress tolerance (Bardone-Cone, et al., 2012).

Recently, evidence suggested that in certain individuals, many different cues aside from negative emotions will lead to overeating. Bongers, de Graff, & Jansen (2016) aimed to experimentally investigate food intake of emotional eaters in response to a variety of food cues among college women. Over the course of two sessions, they found strong correlations between food intake after all four conditions: negative mood manipulation, positive mood manipulation, food exposure, and a control group. The authors concluded that individuals identified as emotional eaters who show increased food intake when in a negative emotional state also overeat when experiencing other food cues. Thus, the term "emotional eating" may not accurately depict the eating behavior of individuals named "emotional eaters" given that they overeat after a variety cues (i.e., positive and negative mood states) that are not limited to negative emotions (Bongers, de Graff, & Jansen, 2016).

Body Dissatisfaction

Body image is a complex mental picture of the body that an individual forms in their mind (Pruzinski & Cash, 2002). According to this conceptualization, body image is not about actual external appearance, but rather the internalized representation of one's physical features. There are many other facets that are important in developing an internal representation of the body aside from physical attributes, specifically cognitive, affective, and behavioral components (Cash & Deagle, 1997; Thompson, 1996). Body image dissatisfaction is defined as a psychological disturbance with one's appearance, which occurs when there are discrepancies

between perceptions of one's actual physical appearance and those one desires or thinks one should obtain (Rosen et al., 1992; Tiggemann & Pickering, 1996). This construct can be understood using a continuum model, with levels of discontent ranging from none to extreme. Most people are within the middle range, experiencing mild to moderate body distress (Heron, 2011). People with increased levels of body image dissatisfaction are more likely to experience problems in social and psychological functioning, including lower self-esteem, greater depression and anxiety (Heron, 2011; Thompson et al., 1999).

College-aged women are a group that are particularly vulnerable to experience stressors related to their weight, appearance, and food, and report high thin-ideal internalization and body dissatisfaction rates (Dakanalis, Carra, Clerici, & Riva, 2015). Body dissatisfaction, thin-ideal internalization, negative affectivity, and low self-esteem are commonly known as risk factors for the onset of EDs (Stice, 2002) and these variables are likely to maintain EDs (Goldschmidt, Wall, Zhang, Loth & Neumark-Sztainer, 2016; Stice & Agras, 1998). Several studies with predominately first year college women emphasized negative affectivity, body dissatisfaction with weight and/or shape, and poor self-esteem as reliable predictors of increased behavioral symptoms of EDs (i.e., BE and inappropriate weight compensatory behaviors [IWC]; Arigo, Schumacher, & Martin, 2014; Berg, Frazier, & Sherr, 2009; Dakanalis, Timko, Serino, Riva, Clerici, Carra, 2016; Striegel-Moore, Silberstein, Frensch, & Rodin, 1989).

Body dissatisfaction is related to BE (Cooley & Toray, 2001; Dunkley & Grilo, 2007; Stice & Agras, 1998) and this relationship is not only driven by shared association with other eating disorder symptoms (Fichter, Quadflieg, & Brandl, 1993; Marcus, Wing, Ewing, et al., 1990). As stated previously, the act of bingeing typically occurs amid an effort to restrict eating through dieting to achieve weight loss. Holmes and colleagues (2015) tested the effectiveness of

the dual pathway, objectification theory, and escape from awareness models as potential mediators for the relationship between body dissatisfaction and BE. Their findings offered support for these models when tested separately; yet a combined model suggested that the dual pathway model was superior in accounting for this relationship (Holmes et al., 2015).

Negative affect has also been associated with overeating and problem drinking in undergraduate women (Bardone-Cone, Brownstone, Higgins, Harney, & Fitzsimmons-Craft, 2012; Fox & Froom, 2009). These behaviors are understood as attempts to escape from or modify intense emotions, which is generally considered maladaptive. The dual pathway model suggests that body dissatisfaction causes generalized and intense states of negative affect or depressed mood, which are reconciled through distraction and/or comfort through consuming food (Stice, 1994; Stice, 2001). People who experience difficulties regulating this mood state may binge eat as a means to distract or comfort themselves (Holmes, et al., 2015). Alternatively, dietary restriction may be used in attempts to reduce body dissatisfaction, but this also leads to BE as sustained restraint increases hunger cues and responses to food, resulting in an increased likelihood that over-eating will occur due to the body's attempts to restore energy and nutrient levels (Polivy & Herman, 1985).

The two pathways of negative affect resulting from body dissatisfaction and dietary restraint have received widespread support in both clinical and non-clinical samples of women with EDs. In non-clinical populations, mood disturbances that stem from body dissatisfaction are positively associated with the severity of BE symptomology (Hayes & Napolitano, 2012; Holmes, et al., 2015; Johnson & Wardle, 2005; Skinner, Haines, Austin, & Field, 2012; Stice, 2001; Stice & Agras, 1998; Stice, Presnell, & Spangler, 2002). However, the link between dietary restraint and BE has been inconsistent within the literature; not all binge episodes are a

result of food deprivation, and some individuals with BED are just as likely to binge eat on days when food intake is restricted as when it is not (Yanovski, Gormally, Leser, et al., 1994).

Between 69% and 100% of participants with BED and bulimia nervosa (BN) retrospectively reported negative mood as an antecedent of BE when asked open-ended questions regarding why they engaged in the behavior (Abraham & Beumont, 1982; Arnow, Kenardy, & Agras, 1992; Lynch, Everyingham, Dubitzky, et al., 2000) and when asked to complete questionnaires of factors that may trigger BE (Davis & Jamieson, 2005; Hsu, 1990; Kjelsas, Borsting, & Gudde, 2004; Vanderlinden et al., 2004). In three studies of BED (Agras & Telch, 1998; Chua, Touyz, & Hill, 2004; Telch & Agras, 1996), participants were randomly assigned to a negative or neutral mood induction followed by a measure of food intake. Participants in the negative mood condition consumed significantly more food during the ensuing taste test (Chua et al., 2004) and experienced more binge episodes (40%) compared to those in the neutral condition (17%; Agras & Telch, 1998; Telch & Agras, 1996). There were no differences in baseline measures of negative mood between those who did and did not binge eat; thus, increases in negative mood appeared to serve as a trigger for BE.

These studies reveal evidence regarding the prevalence of subclinical concerns about stress, body dissatisfaction, negative affect, and BE among university and college students. It appears that BE is more commonly experienced than restrictive forms of disordered eating, and that disordered eating mainly affects women. Influences on BE specific to college women have significant clinical implications, suggesting avenues of intervention that encompass aspects of academic stress, substance use, dieting, etc. Addressing efforts to escape the experience of negative affect is also important to consider when designing and implementing interventions for BE.

Treatment Approaches for Binge Eating

Early research sought to understand the risk factors for BE based on the evidence that BE predicts higher weight (Stice et al., 1999; Stice et al., 2002). Theoretically, episodes of uncontrollable overeating produce a surplus of caloric energy that may eventually lead to weight gain (Stice, Presnell, & Spangler, 2002). Although BE was first recognized as a clinically significant pattern of overeating in individuals with larger bodies by Stunkard in 1959, this research has suggested that traditional weight loss treatments were ineffective for those who struggled with BE (Carter & Davis, 2011). This earlier research is inconsistent with a weight inclusive approach because it implies that avoiding weight gain is the goal. More recent research demonstrates that weight normative approaches to "weight loss" for BE and cyclical dieting fail (Tylka et al., 2014). According to weight inclusive approaches, weight gain or being in a larger body is not inherently problematic, and the goal of these treatments are to increase mindful and intuitive eating.

Overview of Current Treatment Approaches

There are numerous treatments for people with BE, including pharmacological. Currently, Vyvanse is the only medication that has been approved for treatment of BE (McElroy et al., 2015), though a variety of other drugs approved for weight loss treatment are often used to treat BED (Beck, 2016). People with BED comorbid with bipolar disorder may find it difficult to tolerate Vyvanse because stimulants can exacerbate irritability and aggression in those with mood instability and must be cautiously prescribed to people who have heart conditions, high blood pressure, or addictions (Beck, 2016; Epocrates, 2015). Topiramate has also been shown to be superior to placebo and the; however, the recommended dose is up to 600 mg daily, which has been found to cause memory loss and confusion, and thus may not be an ideal choice for

everyone (McElroy et al., 2003). Since there are so few medications found to be effective with few side effects, emphasis should be placed on non-pharmacologic treatments.

The psychotherapeutic treatment that has received the most empirical support to date for adults with disordered eating is Cognitive Behavioral Therapy (CBT), including a transdiagnostic, enhanced version of CBT (CBT-E; Fairburn et al., 2009; Wilson & Zandberg, 2012). A growing body of literature also supports acceptance-based treatments such as Dialectical Behavioral Therapy (DBT) (Safer, Telch, & Agras, 2001a, 2001b; Safer, Robinson, & Jo, 2010; Telch, Agras, Linehan, 2001) and Acceptance and Commitment Therapy (ACT) (Federici & Wisniewski, 2013; Hill, Masuda, Melcher, Morgan, & Twohig, 2015; Juarascio, Manasse, Schumacher, Espel, & Forman, 2017). More recently, therapies that incorporate mindfulness as a core therapeutic element (Kabat-Zinn, 1982) have been used, such as Mindfulness-Based Eating Awareness Training (MB-EAT; Kristeller, Wolever, & Sheets, 2014). A review of the empirically supported psychotherapeutic principles that may be included in a smartphone app for college students with BE follows.

Cognitive Behavioral Therapy

According to Fairburn's (2008) iteration of the cognitive-behavioral model, "poor self-esteem manifests in extreme appearance-related concerns (potentially resulting from having a body type that is not consistent with the 'thin-ideal'"; Goldschmidt, et al., 2016, p. 476; Presnell, Bearman, & Stice, 2004; Stice & Whitenton, 2002), which generates inflexible dieting behaviors intended to change one's shape and weight. Restrictive eating results in BE after breaking a dietary "rule", which is often precipitated by negative mood. Enhanced cognitive behavioral therapy is a form of CBT that is based on transdiagnostic theory of EDs, including a targeted version that addresses only eating pathology and a general version that also addressed external

challenges to change in conjunction with core eating-related symptoms (Cooper & Fairburn, 2011; Fairburn, 2008). The main components of CBT-E are behavioral, including self-monitoring, terminating rigid dieting, and exchanging disordered eating behavior during times of urges for alternate strategies.

A review demonstrated that CBT-E resulted in clinically significant decreases in ED symptoms for most types of EDs with improved relapse rates compared to other treatments (Bulik, Berkman, Brownley, Sedway, & Lohr, 2007; Fairburn et al., 2009; Raykos et al., 2013). At the end of 20 weeks, more than half of the overall sample (*N*= 149) had global Eating Disorder Examination (EDE) scores below 1.74, which is one standard deviation above the community mean, and at 60 weeks follow up, changes were maintained. Although individuals with BN and BED show overall better treatment outcomes than those with AN, only 50-60% of individuals with BN or BED are abstinent from bingeing after a course of CBT (Fairburn, et al., 2009). Thus, CBT is moderately effective in reducing ED symptomatology, especially for BN and BED (Juarascio, et al., 2014). Therefore, much room for additional intervention remains. In a large efficacy trial of outpatient group CBT for BED, only 52% of patients achieved recovery at 4 years post-treatment, and 72% remitted to at least subthreshold symptom severity (Hilbert et al., 2012; Juarascio et al., 2017). A substantial number of people with BED continue to experience full or sub-threshold levels of BE despite receiving the contemporary gold standard treatment approach (Juarascio, et al., 2017).

Federici, Wisniewski, and Ben-Porath (2012) have argued that traditional approaches, specifically psychodynamic therapy (PDT) and CBT, fail to adequately treat the unique emotional needs of individuals with disordered eating, thus leading to a lack of treatment efficacy. PDT and CBT do not place as much emphasis on targeting emotional dysregulation,

impulsivity, self-harm behaviors, and skill deficits that are typically found in those with EDs (Juarascio et al., 2017; Zeeck, Herzog, & Hartman, 2004). Some individuals continue to experience BE after treatment because of the lack of focus on strategies for coping with high levels of negative affect that frequently reinforce BE (Juarascio, et al., 2017). Additionally, the behavioral strategies that make up the central practice of CBT appear effective only when people habitually and consistently use them, but for individuals who find the strategies tedious or difficult to use in moments of discomfort, other strategies may be necessary to encourage behavior change (Juarascio, et al., 2017). Successfully performing the central components of CBT necessitates patients to acquire and utilize several skills (e.g., planning, problem solving, identifying thoughts, physical sensations, and emotions, recognizing precipitants for binge eating and finding an alternative coping strategy; Juarascio, et al., 2018). Poor utilization of CBT strategies may in part be due to the inability to successfully perform a skill learned in treatment and low frequency of practicing skills outside of therapy sessions.

Mindful Eating

The origins of clinical and empirical interest in mindfulness-based interventions (MBIs) date back to Jon Kabat-Zinn (1982), who recognized the advantageous effects of the Stress Reduction and Relaxation Program on pain, mood, and psychiatric symptoms in chronic pain patients (van Emmerik, Berings, & Lancee, 2018). Baer (2003) conducted one of the first empirical reviews of MBIs in a meta-analysis of 21 outcome studies. These treatments were found to be effective across a variety of clinical and nonclinical populations (d= 0.59) and found similar effect sizes for nonclinical populations (students and nonclinical volunteers; d= 0.92) and axis I disorder patients (anxiety, depression, and BED; d= 0.96; Baer, 2003; van Emmerik, et al., 2018).

Mindful eating (ME) is a practice that has shown empirical promise in alleviating BE episodes and can work as an alternative approach to treating BE than other forms of treatment (e.g., CBT, DBT, ACT, weight loss interventions, etc.). In a non-clinical sample of college students, individuals with higher levels of eating disorder symptoms were less likely to "act with awareness" and "accept without judgment" and more likely to "observe" their surroundings (Prowse et al., 2013, p. 82). Since mindfulness has been found to be effective for stress reduction and weight loss (Chiesa & Serretti, 2009; O'Reilly, Cook, Spruijt-Metz, & Black, 2014; Olson & Emery, 2015), its application as a tool for stress-related BE appears promising.

Results from a literature review on mindfulness and ME suggest strong evidence for the efficacy of mindfulness interventions in reducing the frequency and intensity of BE symptoms (Warren, Smith, & Ashwell, 2017). Kristeller and colleagues (2014) conducted a randomized trial to explore the efficacy of Mindfulness-Based Eating Awareness Training (MB-EAT), a manualized 12-session group treatment, compared to a cognitive-behavioral (PECB) intervention and a waitlist control. Compared to control, MB-EAT and PECB showed similar improvement after one and four months post-intervention on frequency of binge days per month, the Binge Eating Scale, and depression. At four months post-intervention, 95% of individuals with BED in MB-EAT no longer met BED criteria vs. 76% receiving PECB; additionally, binges that did occur were significantly smaller (Kristeller, Wolever, & Sheets, 2014). Including hunger and disinhibition subscales, there were larger effect sizes for the MB-EAT group than for the PECB group on multiple measures of emotional reactivity toward food intake. These results suggest that MB-EAT decreased BE and related symptoms at a clinically meaningful level, with improvement related to the degree of mindfulness practice (Kristeller, et al., 2014).

The MB-EAT program is founded on models of self-regulation (Kristeller and Hallet, 1999; Kristeller et al., 2006; Kristeller and Wolever, 2011) and incorporates theory and research on mindfulness meditation (Kabat-Zinn, 1990; Segal et al., 2002), in combination with literature on regulating food intake (Raynor and Epstein, 2001; Rolls, 2007) and emotional dysregulation in BED and other EDs (Goldfield et al., 2008). The program incorporates mindfulness meditation techniques and guided practices (Kabat-Zinn, 1990) to address eating processes, including emotional versus physical hunger cues, sensory-specific satiety (SSS), food choice, and emotional regulation (Kristeller et al., 2014). Participants were assigned weekly homework, which included meditation practice and mindful eating exercises.

In particular, the MB-EAT program helps individuals re-identify natural bodily processes through generating awareness of internal physical cues (Schwartz, 1975), appetite regulation, distinctions such as "liking" vs. "wanting" (Finlayson et al., 2007), and executive functioning reasoning processes over emotionally driven or reactive processes (Appelhans, 2009; Kristeller et al., 2014, p. 283). MB-EAT emphasizes eating for "quality over quantity" or the importance of gaining pleasure from the moment-to-moment experience of eating, rather than from the quantity of food ingested (Kristeller et al., 2014, p. 283). Through attentively eating small amounts of progressively challenging foods, "eating meditations" promote awareness of the experiences of hunger, fullness, taste, satisfaction, and food choice (Kristeller et al., 2014, p. 283). A core element of ME that is used in the MB-EAT program is the focus on sensory-specific satiety (SSS), or the phenomena by which sensitivity to taste decreases after consuming small amounts of any food (Heatherington & Rolls, 1996; Rolls, 2006). Attending to the present moment experience of taste and noticing when pleasure or satisfaction begins to diminish, helps individuals to increase pleasure from eating smaller portions (Kristeller et al., 2014). Thus,

individuals learn to notice their taste buds becoming satiated, to reconsider their "liking" vs. "wanting" patterns, and to disrupt the BE cycle (Kristeller et al., 2014).

Majority of Kristeller et al.'s (2014) sample included individuals who met DSM-IV criteria for BED at baseline (N= 100), another group of individuals (N= 11) reported fewer binges per month (five to seven), but met all other BED criteria, and the rest (N= 39) met the behavioral criteria (two binges per week) for BED, but reported subclinical levels of distress (Kristeller et al., 2014). These authors excluded participants with previous meditation practice, simultaneous participation in a weight loss program or therapy for weight or eating issues, or purging or laxative abuse within six months (Kristeller et al., 2014).

The effects of a mindful eating intervention have also been documented in a study where participants in an experimental group ate a cookie while listening to an audio recording that asked them to focus on the sensory properties of the cookie (Tapper, Seguias, & Pathmanathan, 2018). The experimental group ate significantly fewer cookies and chips than the control group and demonstrated a stronger association between levels of desire for and consumption of cookies (r= .39 compared to r=-.14 in the control group). The authors suggest that the mindfulness strategy encouraged participants to monitor and respond to their desire for the food (Tapper et al., 2018) more carefully.

Given that both traditional and current psychotherapy requires more intensive and long-term commitment, ME practices may be an appropriate and easy-to-implement strategy for college students who struggle with subclinical levels of BE. Acting with awareness and acceptance without judgement are two skills associated with greater resilience against ED pathology (Prowse et al., 2013); however, these skills are difficult to benefit from if not practiced daily. Thus, research exploring more effective methods (i.e., mobile apps) beyond traditional

psychotherapeutic treatment for teaching and practicing these specific mindfulness skills is warranted.

Limitations of and Barriers to Traditional Treatment Approaches

Among undergraduate male and female students with positive SCOFF screens, (a brief eating disorder measurement tool) fewer than 5% had ever received an ED diagnosis, and only 21.7% had received any mental health treatment despite 52.8% of females and 31.7% of males thinking they needed help for emotional difficulties within the past year (Eisenberg, Nicklett, Roeder, Kirz, 2011). The most commonly endorsed answers among students who were asked why they did not receive mental health services were “I have not had any need”, “stress is normal in college”, “the problem will get better by itself,” and “I don’t have time” (Eisenberg et al., 2011, p. 706). These findings demonstrate that a significant number of college students with substantial ED-related symptoms are not assessed or treated, despite the persistence and recurrence of these symptoms. It also appears that college students may not have the resources necessary to understand how to recognize and manage their mental health needs.

Additionally, the variability associated with body dissatisfaction, dieting, and BE may be amenable to an intervention method that can prompt users throughout the day, for example precipitating binge episodes or when body image dissatisfaction is high. Thus, mobile technology may be one scalable method of providing college students with convenient access to mental health education and treatment. The findings regarding risk and maintenance factors for BE among college students suggests that improvements in psychosocial functioning, greater awareness of external and internal cues, and tolerating intense emotions might improve the outcome of eating symptoms and treatment interventions. Additionally, mobile interventions that

create an “in the moment” awareness of physiological and emotional cues can lead to greater tolerance of distressing thoughts and emotions and lead to therapeutic benefits over time.

Although there are existing clinical practice guidelines for effective treatments (Wilson & Fairburn, 1998), knowledge and practice of evidence-based treatments have advanced slowly, with only a small quantity of individuals seeking and receiving treatment (Darcy & Lock, 2017; Hoek, 2006; Hart, Granillo, Jorm, et al., 2011; Tregarthen, et al., 2015). Barriers include shame associated with the illness (Fairburn, Hay, & Welch, 1993), a lack of adequately trained clinicians (Hart et al., 2011), and substantial costs associated with treatment (Burns, Durkin, & Nicholas, 2009). These factors highlight the importance of using methods that college students find accessible, affordable, discrete, and convenient.

Kristellar and Hallet (1999) state that “one possible limitation in these [traditional] treatments is the lack of attention to increasing awareness and acceptance of bodily cues that maintain bingeing behavior, in particular the sensations of hunger and satiety” (p. 359). For mindfulness to be an effective therapeutic intervention, individuals must practice moment-to-moment awareness of emotional and physiological cues. Most cognitive based interventions inadequately address individuals’ thoughts and emotions as they occur in their everyday lives (Heron, 2011). ME practices require one to first become aware of thoughts/behaviors related to food, whereas CBT focuses on changing thoughts and behaviors regarding food to reduce BE, without a focus on increasing more adaptive eating behaviors. A major limitation of virtually all empirical examinations of mindfulness interventions is the absence of baseline assessments of intuitive or mindful eating.

Understandably, research mainly examines the outcomes of various treatment approaches on clinical samples; thus, it is difficult to distinguish cases in which participants, ideally college

students, with subclinical eating concerns are examined. Perhaps this is a limitation of current recruitment methods, a reflection of non-treatment seeking behavior in individuals with subclinical symptomology, or the inability of college students to access the care they need due to busy schedules and/or high cost of treatment. Developing and evaluating novel methods (i.e., mobile apps) to improve skill acquisition and utilization in ME is a research priority for individuals with subclinical levels of BE. These preventative methods may help to reduce the likelihood that BE will turn into full blown BED. Research on mental health apps for BE are largely CBT-based, and although mindfulness has been shown to be a promising approach for BE, there are no studies that have evaluated the preliminary efficacy of a mindfulness-based app for BE.

Like most psychotherapeutic approaches, mindfulness-based interventions (MBIs) strongly rely on face-to-face delivery with dissemination limitations as a result (van Emmerik et al., 2018). Not enough therapists are available to provide face-to-face interventions, and not all patients are willing or able to attend face-to-face interventions (p. 188). Additionally, MBIs are not covered by most health insurance plans because they are not yet considered a gold-standard treatment option. Smartphone-based (mHealth) interventions may help to overcome these problems by providing, at little to no cost, treatment at the individuals' chosen time and place. MBIs may be mostly suitable for technology-based treatment modalities because many exercises are easy to learn and involve repetitive practicing, which in theory, can be as easily achieved in other contexts as under the direction of a therapist (van Emmerik, et al., 2018).

The Use of Smartphone Applications for Mental Health Intervention

Generally, mobile interventions extend the psychotherapeutic intervention by providing structure and support in everyday life, with or without the assistance of a therapist. The National

Institute for Mental Health classifies mental health apps into six categories based on functionality: self-management, cognition improvement, skills-training, social support, symptom tracking, and passive data collection (Chandrashekar, 2018; NIMH, 2017). Compared to other technology platforms, mobile apps are a preferred choice due to ease of habit, low effort expectancy, and high hedonic motivation (i.e., users' willingness to use platform in order to avoid pain and experience pleasure; Chandrashekar, 2018; East & Havard, 2015; Yuan, Ma, Kathawala et al., 2015).

These sophisticated apps can leverage the smartphone's sensors to gather information on behavioral patterns. For example, if the app detects a change in behavior, it may indicate that help is needed before a crisis happens (NIMH, 2017). Others apps can help the user connect to a peer counselor or to a healthcare professional (NIMH, 2017). The functions of these apps span all stages of clinical care provision, from educational (e.g., prevention, definition and symptoms of a specific illness), to assessment (e.g., diagnosis, tracking symptoms), to treatment (e.g., cognitive behavioral treatment, meditation, immediate crisis intervention) and post-treatment management (Juarascio, et al., 2015; Price, Yuen, Goetter, et al., 2014; Chandrashekar, 2018).

As a result of the flourishing relevance of mobile apps, there have been preliminary efforts on behalf of researchers and clinicians to formally develop and evaluate treatment apps for depression (Burns, Begale, Duffecy et al., 2011; Kauer, Reid, Crooke et al., 2012; Watts, Mackenzie, Thomas et al., 2013), bipolar disorder (Bardram, Frost, Szanto et al., 2013; Bardram, Frost, Szanto, & Marcu, 2012; Depp, Mausbach, Granholm et al., 2010; Puiatti, Mudda, Giordano, Mayora, 2011), anxiety disorders (Fletcher, Tam, Omojola, Redemske, & Kwan, 2011; Repetto, Gaggioli, Pallavicini et al., 2013), substance use disorders (Fletcher, Tam, Omojola et al., 2011; Gustafson, Shaw, Isham et al 2011; Marsch, 2011; Rizvi, Dimeff, Skutch et

al, 2011; Valdivieso-Lopez, Flores-Mateo, Molina-Gomez et al 2013), schizophrenia (Depp, Mausbach, Granholm et al 2010; Granholm, Ben-Zeev, Link et al, 2011), and borderline personality disorder (Rizvi et al, 2011). Chandrashekar (2018) also provides a review of depression, anxiety, and schizophrenia to show that the efficacy of evidence-based mobile apps is comparable to traditional psychiatric treatment (not psychological).

These apps largely have not been assessed for efficacy and many are not based on empirically-supported principles (Juarascio et al., 2015). One possible reason that a majority of mental health apps do not have peer-reviewed research may be that scientific testing tends to be a slow process, whereas technology evolves quickly, and apps may be outdated by the time it has been rigorously tested (National Institute for Mental Health, 2018). Most research into mobile health has focused on confirming single entrepreneurial apps, rather than pursuing rigorous RCTs to validate principles of feasibility and acceptability that can guide the development of current and future treatment apps (Bakker et al., 2016; Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013). Because of the infancy of the field, it is necessary for inquiry to first understand these early stage facets to guide and inform future RCTs.

Feasibility and Acceptability of Smartphone Applications for Mental Health

Donovan et al. (2016) tested the feasibility of a mobile-based application called BodiMojo, with material based on Neff's (2003a; 2003b) model of self-compassion, which includes three constructs: mindfulness, self-kindness (showing warmth and understanding towards oneself, especially in times of suffering), and common humanity (recognition that suffering and feelings of inadequacy are part of the shared human experience). The app features a customizable (color, facial features) animated "buddy" and consists of two daily activities: tracking feelings and reviewing/practicing a wellness tip. Tracking feelings involved selecting

words that populate a “mood cloud”, providing a visual representation of the participant’s mood (Donovan, Rodgers, Cousineau, McGowan, Yates, & Franko, 2016). The daily wellness tip prompted adolescents to engage in mindful acceptance, self-kindness, and self-regulation and was sometimes linked to an audio relaxation. During the four week intervention period, 16 participants were instructed to open the app daily to record feelings and review wellness tips. Findings indicated that adolescents used the app on a majority of the month, enjoyed using it, found it easy to use, and believed that they benefited from the suggested activities. Adolescents suggested the app could be improved by increasing customization, increasing content, and sharing via social media (Donovan et al., 2016).

Ahtinen et al (2013) examined the feasibility and acceptability of a mental wellness training app for stress management called Oiva. Although this app is ACT-based, it incorporates mindfulness methods for increasing psychological flexibility. The authors designed a one-month field study where they collected data from 14 patients including: (a) online questionnaires completed at baseline, after one week’s use, and after one month’s use, (b) interviews conducted after one month’s use and (c), the usage log of Oiva app. Some of the themes that were included in these interviews were situations where Oiva was used, whether using Oiva affected the participant’s well-being, the user experiences of different features, the app’s ability to encourage and reinforce usage, and desired new features of Oiva (Ahtinen, et al., 2013). They found statistically significant improvements in stress and life satisfaction, suggesting that the participants attributed these positive effects to Oiva. However, the study was limited in that the authors did not select participants from the direct target group of the app (i.e., working-age people who suffer from stress), arguing that for ethical motives, they did not want to present an un-tested app to people with severe distress, thus chose a healthy group of participants for the

feasibility study. Additionally, usage patterns were not entirely reflective of typical usage because the participants were not able to use Oiva in their own smartphones (Ahtinen et al., 2013).

Preliminary Efficacy of Mindfulness-based Smartphone Applications for Mental Health

The results of a recent systematic review of mindfulness-based interventions, including web-based, mobile-app based, and audio, demonstrated their effectiveness for stress reduction (Lyzwinski et al., 2018). However, web-based interventions far outnumbered mobile app interventions, as Lyzwinski and colleagues (2018) only identified four app trials for stress reduction. Thus, there is a need for more mindfulness based app trials. Several recent studies have established the potential of apps for delivering MBIs (van Emmerik et al., 2018). Ly et al. (2014) compared an eight week mindfulness-based app intervention (MBI) to an eight week behavioral activation (BA) app program in 81 participants with major depressive disorder. The MBI app offered an 8-week smartphone-based intervention with minimal therapist contact (maximum time of 20 min per participant per week), consisted of a short web-based psychoeducation, and a step-by-step mindfulness practice program administered via app. After both interventions, they found large reductions in depressive symptoms that lasted for six months but noted that the study lacked a control condition. For participants with higher severity of depression, the BA treatment was more effective than the mindfulness treatment. For participants with lower initial severity, the treatment based on mindfulness superior to the treatment based on BA (Ly et al., 2014).

As described by van Emmerik and colleagues (2018), Howells et al. (2016) compared Headspace's smartphone-based Take 10 program consisting of 10 minutes of mindfulness practice over 10 consecutive days, to a neutral but active control task (the Catch Notes app) in a

nonclinical population (van Emmerik, Berings, & Lancee, 2018). Howells et al. (2016) found significant improvements in positive affect and depression, but not on satisfaction with life, social-psychological well-being, and negative affect. There was no follow up test to determine if these changes were maintained. Importantly, although both Ly et al. (2014) and Howells et al. (2016) found improvements on multiple clinical outcomes, they did not measure mindfulness as the therapeutic mechanism underlying these improvements (van Emmerik et al., 2018).

van Emmerik et al. (2018) expanded on these earlier studies by conducting an efficacy trial to test the hypothesis that an app, the VGZ Mindfulness Coach, could affect instant and long-term improvements in mindfulness, quality of life, general psychiatric symptoms, and self-actualization, without any additional therapeutic help aside from the self-help app. A total of 191 participants received the VGZ app, which provides 40 mindfulness exercises and psychoeducation. Compared to 186 control participants, they reported large (d= 0.77) and statistically significant increases of mindfulness after eight weeks and small-to-medium increases of the observing, describing, acting with awareness, nonjudging, and nonreactivity mindfulness subscales as measured with the Five Facet Mindfulness Questionnaire (d= 0.66, 0.26, 0.49, 0.34, and 0.43, respectively). There were also significant reductions in general psychiatric symptoms (d= -0.68) and moderate increases of psychological, social, and environmental quality of life (d= 0.38, 0.38, and 0.36, respectively). These gains were maintained for at least three months (van Emmerik, Berings, and Lancee, 2018). van Emmerik et al. (2018) concluded that it appears possible to achieve long-lasting positive effects on mindfulness, general psychiatric symptoms, and numerous aspects of quality of life at low costs with smartphone apps for mindfulness. Although internal validity is maintained through conducting RCT's, the ecological validity remains unknown for smartphone app interventions. In order to better understand phenomena in

the context that it naturally happens, studies should first attempt to examine the behaviors as they are likely to occur in a real-world context.

The Use of Smartphone Apps for Binge Eating

Juarascio et al. (2015) identified six "treatment-focused" eating disorder apps and evaluated them from two perspectives: its use of strategies taken from evidence-based treatments and how well it utilized smartphone technology. These authors found that a variety of treatment approaches were delivered by the six apps; some interventions were from evidence-based interventions (particularly CBT) and were brief in nature, containing a few sentences of text (Fairburn & Rothwell, 2015; Juarascio, Manasse, Goldstein, Forman, & Butryn, 2015). This same review purported that intervention apps are not completely using the advanced capabilities of smartphone apps (Juarascio et al., 2015). In a separate review of apps for EDs, the most common functions were the provision of advice and information, the quality of which ranged from sound to potentially harmful, and surprisingly few apps were judged by users to provide sound information (Fairburn & Rothwell, 2015). More studies are needed that include the perspectives of clinical experts in the field of disordered eating who can evaluate the quality of psychoeducation and intervention of smartphone apps.

Feasibility and Acceptability of Smartphone Applications for Binge Eating

Mason et al (2018) measured the feasibility of a mindful eating text message intervention targeting "craving-related" eating. Out of 1,651 individuals who completed the online screener, 719 qualified to participate, 104 completed all consent procedures, 78 completed the 28-day intervention, and 72 completed the in-person follow-up visit (one-month post intervention). The authors determined this application was feasible given that participant retention was similar to rates observed in other smartphone-delivered interventions focused on weight loss (89%; Turner-

McGrievy & Tate, 2011) and a mobile intervention that included text messages, apps, coaching calls, and emails (88%; Allman-Farinelli et al., 2016; Mason, Jhaveri, Cohn, & Brewer, 2018).

Tregarthen, Lock, and Darcy (2015) developed a smartphone application called Recovery Road through which people with EDs can self-monitor meals, emotions, behaviors and thoughts. The app also included positive reinforcement, coping skill suggestions, social support, and feedback components. To explore feasibility and utilization as a self-monitoring tool, the authors collected data on usage statistics, consumer ratings on app-stores to use as indicators of satisfaction, and EDE questionnaire scores from 15,327 individuals over a two-year period. The most regularly occurring ED symptoms were objective (62%) and subjective binge episodes (61%). Regular occurrence was defined as equal to or greater than four occurrences over a span of 28 days. Over a two year-period, 2,503 anonymous ratings were received; 84% were five out of five and 13.3% rated the app four out of five. Acceptability was defined by utilization data. Over two years, 108,996 people utilized the application, and of these individuals 89% monitored at least three meals, and 67% continued to utilize the application 30 days later (Tregarthen et al., 2015). Continued utilization was defined as "logging at least one meal per day in the previous week". A mean of 90.3 (SD= 52.21) meals were self-monitored by individuals who were still utilizing the application at 30 days, with users spending a mean of 1.4 minutes per session using the application. The level of uptake and utilization of Recovery Road suggests that tools such as these are likely to be feasible for self-monitoring and have the potential to act as a support tool to supplement clinical treatment (Tregarthen et al., 2015).

Using focus groups, Juarascio et al. (2015a) found that the features of a proposed app for BE (i.e., self-help CBT, self-monitoring, and ecological momentary intervention [EMI]) appeared to be highly feasible to users. Participants conveyed enthusiasm and interest in using

the proposed app if it were to be developed as presented, though concerns about the degree of personalization and customizability were noted (Juarascio, Goldstein, Manasse, Forman, & Butryn, 2015a). The prototype app had several functions: manual data entry, automated data entry, machine learning algorithm, CBT-based self-help learning modules, coping strategies, data visualization (feedback), and a clinician portal. Manual data entry would allow self-monitoring through one-touch recording of food intake, emotions, and binges. Automated data entry would include time-stamps, location services, detecting physical activity through accelerometer connection and weight through wireless scale connection. These two types of entries would provide important data to the app's algorithm that analyzed the relationships between binge triggers and binge episodes, and then use this information to predict future binge episodes (Juarascio et al., 2015a). For example, the system could "learn" that when the user enters a risky location (e.g., a supermarket) after a documented emotional experience (e.g., shame), a binge is likely to occur. The next time that app detects these specific conditions, the app would notify the user that he or she is at risk for BE, and then deliver a brief intervention customized to the triggers that the user had previously identified (Juarascio et al., 2015a).

In Juarascio et al.'s (2015a) study, individual interviews were also completed with clinicians who regularly treat BE/BED (*N*= 10). All but one clinician reported familiarity with existing treatment-based apps for EDs, and only four clinicians reported using these apps in their practice (Juarascio et al., 2015a). These experts reported eagerness to use the app in their practices and believed that components of the app would enhance treatment delivery and effectiveness, specifically with self-monitoring, CBT based help, and using coping strategies. Majority inquired about the potential cost and availability and indicated that if the app was developed, they would recommend it to patients in their practice. Users and clinicians both

strongly believed in the potential for the app to help with reducing BE because it incorporated elements of EMI (Juarascio et al., 2015a).

Preliminary Efficacy of Smartphone Applications for Binge Eating

There have been several mobile applications designed for reducing disordered eating behaviors (e.g., Recovery Road, Rise Up); however, research supporting the use of these applications specifically for subclinical BE is clearly lacking. Anastasiadou et al. (2018) presented a study protocol of a randomized controlled trial to assess the clinical efficacy of a combined intervention for EDs that includes an online intervention through a mobile application (called TCApp), plus standard face-to-face CBT in comparison to standard face-to-face CBT alone. The authors also aimed to examine the cost-effectiveness of the app and identify potential predicting, moderating, and mediating variables that promote or hinder the implementation of the app in inpatient ED units (Anastasiadou, Lupianez-Villanueva, Fauli et al., 2018). Although data on the trial is not yet available, the authors described a mixed methods approach using two parallel groups (intervention group with TAU and TCApp and a TAU control condition). Participants, their caregivers, healthcare providers, as well as technical staff involved in the development and maintenance of the app were assessed at baseline, post-intervention and six months follow up. Primary outcome measures for patients include ED symptomology, general psychopathology, and quality of life. Secondary measures will include engagement related variables for all participants involved, such as perceived usability, user's satisfaction and technology acceptance (Anastasiadou et al., 2018).

To date, only one randomized controlled trial exists comparing smartphone adapted (i.e., Noom) versus traditional CBT guided self-help for adults with BE (Hildebrandt, Michaelides, Mackinnon et al., 2017). Hildebrandt et al (2017) utilized a customized smartphone app called

Noom Monitor, which recorded activities and allowed for direct entry notes for each event. Patients receiving CBT-GSH and Noom demonstrated a larger reduction in objective BE than in standard CBT-GSH. Compared to an active control, Noom produced a decrease of approximately 21% more in BE (81% vs. 60% in CBT-GSH; Hildebrandt, et al., 2017). Notably, it appeared that consuming regular meals was a significant mediator of the CBT-GSH + Noom treatment effect, suggesting a possible advantage to using smartphones that influences outcomes (Hildebrant et al., 2017).

Mindfulness. Mason and colleagues (2018) administered a 28-day mindful eating mobile app intervention that focused on the scientific underpinnings of how food cravings develop and are reinforced and research showing how mindfulness directly targets changing the craving behavior. Course materials taught users to attend to three aspects of eating: *why* they eat (including environmental and emotional triggers unrelated to physiological hunger); *what* types of food are most likely to lead to and reinforce urges; and *how* to eat with awareness and attention to physiological cues (Mason, Jhaveri, Cohn, Brewer, 2018). The authors found that among women in larger bodies who experience food cravings, the intervention was associated with reductions in craving-related eating (Mason, et al., 2018). To date, this is the first study to demonstrate that an app-based ME intervention can improve craving-related eating. However, the authors did not measure associated changes in mindful and/or intuitive eating.

In Lyzwinski et al's (2018) systematic review of mindfulness based electronic interventions, the authors only identified two studies that integrated a mindfulness-based component to a weight loss study, which involved mindful/intuitive eating (Boucher, 2015; Gow, Trace, & Mazzeo, 2010). Gow et al. (2010) utilized a mindfulness approach (MBSR) that led to increased dietary intake and reduced fast food intake and Boucher (2015) targeted eating

behaviors through an intuitive eating approach which led to increased IE. Based on this very limited number of studies, the authors concluded that they were unable to assess their overall effectiveness. As there were only two interventions that used ME approaches, it is unknown whether other types of mindfulness-based approaches are effective and feasible when delivered technologically. Given that a growing body of literature suggests that mindfulness may assist with eating behaviors, particularly emotional eating and BE, additional studies are needed to explore if these interventions may be delivered successfully through a smartphone application medium (Lyzwinski et al., 2018). Of most interest from these studies findings were the combination of methods by which they assessed feasibility and acceptability, and preliminary efficacy. Additionally, the findings suggest that a mobile app may be a feasible way to disseminate mindfulness-based techniques widely among young adults (Donovan et al., 2016).

Clinician Perspectives on Apps for Binge Eating

Fairburn and Rothwell (2015) assessed four separate self-monitoring apps for eating disorders from user and clinician perspectives. The user experience was not positive; recording using an app was in most instances no faster than using a paper food journal form and users found it frustrating. Preset options sometimes prevented users from logging an accurate depiction of their thoughts, feelings, and behaviors. Users found it difficult to review earlier entries due to the number of "clicks" required and visualizing the output was difficult due to screen size. For individuals who use written self-monitoring records, neither of these difficulties occur, and thus the convenience of using a smartphone is lost. The findings also suggested that the ability to exchange information between a patient's app and that of their clinician might either interest them or be a possible drawback. The authors suspected that few clinicians want to hear from

their patients 24 hours a day and this degree of accessibility might potentially encouraging dependence within the patient (Fairburn and Rothwell, 2015).

Lindgreen et al. (2018) examined clinicians' perspectives on the use of an app for patient self-monitoring of meals in eating disorder treatment and encountered similar concerns. Although clinicians found advantages in using the app, they were mostly preoccupied with challenges associated with the added workload in monitoring patient logs, finding it necessary to have adequate amounts of time between and immediately before sessions to go through patient logs. In addition, clinicians found themselves managing treatment expectations with patients, of whom were disappointed when providers did not mention topics they had logged during their sessions. The discrepancy in expectations are likely to impair the patient-clinician relationship, for example by decreasing patients' confidence in their clinicians and encouraging patients' passivity in treatment sessions (Lindgreen et al., 2018). Considering these findings, Fairburn and Rothwell (2015) further contended that self-monitoring among those with EDs may be harmful given that keeping detailed records of food intake (in addition to other phenomena) is characteristic of people with EDs; apps provide a new and convenient method for doing so. With empirically-informed platform development, mobile app-based interventions may be well suited for and accepted by an undergraduate population with subclinical BE concerns. Prior to recommendation, the goals of the app must be considered. It appears that for both users and clinicians, self-monitoring is less favored despite strong evidence for this technique in CBT approaches. Prompt and reminder features of apps appear to be the most useful for users in addressing binge-related phenomena. For clinicians, apps that serve as stand-alone interventions emerged as more favorable than apps providing additional patient data. The unique contribution of the current study is the assessment of preliminary outcomes via measuring changes in ME and

interviews with college students and clinical experts to help further gauge feasibility and acceptability of using a self-help app from the standpoint of practice implementation.

To address the identified treatment and research gaps, the present study sought to evaluate the feasibility, acceptability, and preliminary efficacy of the mindful-eating virtual coach among undergraduate women who binge eat.

Research Questions

1. Among female college students who express interest to change their binge eating behavior, what are their attitudes towards and motivations for using a mindful eating smartphone application?
2. Among clinicians who are experts in the field of treating disordered eating and/or who provide nutritional consultation (e.g., to college students), what are their opinions of the strengths and limitations of the mindful eating app and attitudes towards implementing a mindful eating application into their practice?
3. What is the preliminary efficacy of the "Am I Hungry?" Mindful Eating application among college women who binge eat for reducing binge eating frequency and severity and for improving mindful eating?

Aims

1. Introduce and orient 25 college women with binge eating concerns to mindful eating application during a baseline orientation session. Eating behavior will be assessed using self-report measures.
2. Conduct individual interviews to inquire about acceptability and feasibility of using a mindful eating application for binge eating after four weeks. Feasibility will be assessed

by determining whether recruitment goals were met, attrition/retention, and frequency of app use. Eating behaviors will be measured again at follow-up.

3. Introduce and orient five clinical experts (i.e., psychotherapists and nutritionists) to the mindful eating application. Conduct interviews with experts regarding their evaluation of the app and considerations for practice implementation.

Researcher Statement

There is the potential for my assumptions as the primary researcher to influence the nature of this study's findings. I have worked as a primary therapist in training at a private eating disorder clinic. This makes me especially aware of eating behaviors and the psychological, biological, and social processes that influence eating behavior. I am a daily smartphone app user and I favor the integration of technology into healthcare practices. My research has focused on analyzing images containing #proana and #prorecovery hashtags on Instagram, a social media smartphone application, through the lenses of objectified body consciousness and positive body image frameworks. I've also conducted a qualitative review that identified themes that encompassed patient and provider perspectives on eating disorder recovery.

Chapter 4: Methods

Research Design

Applying Mixed Methods in Action Research

Derived from a social justice perspective, action research upholds the notion of knowledge as socially constructed and recognizes that research is embedded within a system of values and promotes human interaction (Brydon-Miller, Greenwood, & Maguire, 2003); thus an action research paradigm seeks to advance practical and comprehensive knowledge that is grounded in a participatory worldview. An appropriate framework for action research is a mixed methods design (Ivankova, 2015) because the nature of the problem is exploratory and the scope of the research questions is expansive, and so neither purely qualitative nor quantitative methods of data collection would be adequate. Mixed methods research integrates quantitative and qualitative approaches to best understand a research problem by taking advantage of their opposing strengths (Creswell & Plano Clark, 2011; Greene, 2007; Hesse-Biber & Johnson, 2015; Plano Clark & Ivankova, 2016; Tashakkori & Teddlie, 2003, 2010). The triangulation of multiple sources of data is a central component of action research and works to integrate contrasting sources of qualitative data with descriptive quantitative data (Richardson & Reid, 2006). This involves a combination of elements including different perspectives, research questions, data sources, analytic techniques and interpretations. The integration of multiple data sources enriches credibility and validity of the findings and ensures better transferability of results to other contexts and settings.

Mixed methods and action research take a collaborative approach to research because they seek to understand "what works" in practice (Ivankova, 2015). Action research when combined with mixed methods can assist practitioner-researchers in developing data-driven

decision-making processes to inform the improvement of current practices (Ivankova, 2015; Lyons & DeFranco, 2010). This methodological strategy is optimal for the purposes and intentions of this project because qualitative methods can help to uncover and describe experiences and attitudes related to app use (i.e., what and why) that are still relatively unknown, whereas quantitative methods can determine the effectiveness of this intervention (what and how much), albeit preliminary. The collaborative nature of an action research paradigm was captured through engaging students and clinical experts in the research process and framing quantitative outcomes with themes derived from discussions with them. However, quantitative methods alone cannot describe individuals' diverse experiences with the intervention, whereas qualitative methods alone cannot determine more precise change in behaviors. Conducting individual interviews with undergraduate women with BE and clinical experts is one way that this study seeks to contextualize knowledge through a collaborative process. This approach also addressed the limitations of the TPB by uncovering factors that may account for changes over time that are not related to attitudes and post-intentional factors leading to behavior changes.

"Am I Hungry?" Smartphone Application

Intervention Overview and Aims

The present study evaluated the use of a smartphone mobile app called "Am I Hungry?" that was designed to help users end restrictive dieting and resolve "mindless and emotional" eating. This app was developed as a companion to Michelle May's, M.D. *Am I Hungry? Programs* and *Eat What You Love, Love What You Eat* book series. The app is meant to guide users through the "Mindful Eating Cycle" whenever one feels like eating. This cycle provides the necessary structure for learning how to apply the concepts of mindfulness to all aspects of eating, including asking individuals why, when, what, how, and how much they eat, and where they

invest their energy. The premise of the Mindful Eating Cycle (see Figure 1) is to generate awareness around users' eating behavior to guide their decision-making process without resorting to rules, restriction, or overeating. It consists of six stages that answer six main questions.

Core App Elements

After being guided through a series of mindful exercises presented as questions, the user is presented with information regarding advantages and disadvantages to their decision (e.g., to eat despite not feeling hungry), as well as considerations for becoming more aware of their eating behavior (e.g., why do I feel like eating despite not being hungry?), and possible physical, environmental, and emotional triggers contributing to these decisions. The app's design is such that users must select from series of questions and multiple-choice answer options. This format helps guide users through a mindful practice.

Body-Mind-Heart Scan. Users have the option to set a notification prompt to engage in a body-mind-heart scan (see Figure 2), which also functions as a reminder to check-in with the app during selected time intervals.

Hunger and Fullness Rating Scale. Participants are asked to rate their hunger and fullness levels using a scale (see Figure 3) before, during, and after eating.

Mindful Eating Pathway Questions. The user is guided through a series of questions within the app and are described below.

Why do I eat? Why do I think I eat? Am I really aware of all the situations and/or emotions that trigger me to want to eat when I'm not hungry? Do I find myself eating even though I said I wouldn't? Why? Have I tried a lot of diets? How did they work for me in the long term? (May & Anderson, 2014).

When do I eat? How often do I feel like eating? Why? How do I know if I'm hungry? Can I tell the difference between physical hunger and head hunger? How could I redirect my attention away from food until I'm hungry? What could I do to cope better with my emotional triggers for eating when I'm not hungry? (May & Anderson, 2014).

What do I eat? What do I eat in a typical day? Would an awareness journal help me recognize patterns? What types of foods do I feel like eating when I'm eating for emotional reasons? Why? Do I restrict myself from eating certain foods, then later given in and overeat those food? Do I feel guilty when I eat? Am I afraid of losing control when I eat certain foods? (May & Anderson, 2014).

How do I eat? Do I eat while I'm distracted? Do I truly eat as though I love food? Do I eat fast, barely tasting my food? Do I eat differently in private than I do in public? (May & Anderson, 2014).

How much do I eat? How do I feel when I'm done eating? Do I like the way I feel? Do I feel compelled to clean my plate? If I'm not hungry when I start eating, how do I know when to stop? What situations or emotions trigger me to overeat? What do I do after those times I eat too much anyway? (May & Anderson, 2014).

Where do I invest my energy? Am I physically active? Do I watch too much TV or spend too much free time in front of the computer? How do I feel about exercise? Is there anything else I'd like to do that I'm not doing now? What are my goals for my relationships, my career, and my life? (May & Anderson, 2014).

Procedure

Recruitment

The institutional review board of the University of North Carolina at Charlotte approved the study procedures. This study consisted of two separate samples: (a) students recruited from the University of North Carolina at Charlotte and (b) clinical experts in the fields of treating disordered eating and/or nutrition recruited via email. An email advertisement was sent out to students attending an undergraduate institution in the southeastern United States, aimed at female students who were interested in trying a non-dieting, mindful eating approach to binge eating. A research assistant responded to students interested in the study and their eligibility was determined via an online screener. Eligibility criteria included: (a) being a woman between the ages 18-30 years old, (b) not currently dieting, (c) own and use a smartphone, (d) reporting two or more binges within the past 28 days, (e) willing to commit to using an app for four weeks.

Incentives

Clinical experts received a $40 Amazon gift card and a $10 iTunes or Google Play gift card to purchase the app. At baseline, each of the 25 students received a $10 iTunes or Google Play gift card to purchase the app. Each student received a $25 Amazon gift card after completing the follow up interview.

Student Orientation Meeting (Baseline)

Informed consent from each participant was obtained. A graduate research assistant helped students download the app using a gift card onto their mobile phone. Students were asked to download the app and were oriented to its features. After the participants were oriented to the app, they were instructed to use the app at least three times per day and before snacks or meals and anytime they have the urge to eat. They were required to set a desired hour interval for a reminder check-in. Baseline measures were collected via online survey.

Student Interviews

After four weeks, a team of graduate researchers conducted individual interviews to assess the users' experiences with the application and to collect timeline follow back data. Post-intervention measures were collected via online surveys. See Appendix for the student interview guide.

Clinician Interviews

The graduate researcher conducted four clinician interviews individually in person and one by phone. Prior to the interview, the clinicians were instructed to download and review the app. The interviews were audio recorded and transcribed into separate word documents. See Appendix for the clinician interview guide.

Measures

Demographics

Standard demographic questions assessing age, gender, weight, height, race/ethnicity, and education level were collected in a survey format during the initial orientation meetings.

Eating Behavior

Eating Disorder Examination Questionnaire with Instruction (EDE-QI; Fairburn & Beglin, 1994). The EDE-QI is a self-report version of the Eating Disorder Examination, a well-established investigator-based interview (Fairburn & Cooper, 1993). The 28-item questionnaire contains four subscales: Restraint, Eating Concern, Shape Concern, and Weight Concern. The three binge eating subscale items (questions 13-15) do not fall within any of the subscales. These questions were: "Over the past 28 days, how many times have you eaten what other people would regard as an unusually large amount of food (given the circumstances)?", "On how many of these times did you have a sense of having lost control over your eating (at the time that you were eating)?", "Over the past 28 days, on how many days have such episodes of overeating

occurred (i.e., you have eaten an unusually large amount of food and have had a sense of loss of control at the time)?" The BE questions were used as a screener for recruiting participants as well as a post-4 week follow up measure. Each item was summed together to create an index score. Internal consistency alphas for EDE-QI at time 1 and time 2 were .94 (M= 32.3, SD= 27.0) and .95 (M=14.6, SD= 15.2), respectively[1].

Binge Eating Scale (Gormally et al., 1982). The Binge Eating Scale (BES; Gormally et al, 1982) was used to assess the affective, behavioral, and cognitive aspects of BE. The BES contains 16 items presented as groups of three or four statements from which respondents are asked to indicate the statement that best describes them. Scores range from zero to 46, with higher scores indicating greater severity of binge eating symptomatology. A cutoff score of >27 indicates severe BE, 17-27 as moderate, and <17 mild to no BE. The BES has good psychometric properties and is the most widely used measure to assess for BED (Marcus, Wing, & Lamparski, 1985). The BES demonstrated adequate internal consistency in the original validation study, with alpha coefficients for the overall sample and the African American and Caucasian women ranging from .88 to .90. In the present study, alphas for time 1 and time 2 were .84 (M= 41.2, SD= 7.2) and .87 (M=32.8, SD= 7.2), respectively.

Dietary Restriction Screener (DRS; Haynos & Fruzetti, 2015). The Dietary Restriction Screener (DRS; Haynos & Fruzzetti, 2015) was used to assess the presence of restrictive eating. The DRS is a single-item measure designed to categorize individuals by whether or not they have recently engaged in restrictive eating. The DRS clearly defines problematic restrictive eating (i.e., consuming objectively or contextually too little in order to impact body image), provides examples of restrictive eating (e.g., fasting, eating a small salad when very hungry,

[1] All reported internal consistency values are preliminary. This sample was not powered to detect changes in subscales. Summary scores were the main focus for this study.

eating a diet frozen meal at Thanksgiving dinner), and asks participants to indicate whether they have engaged in restrictive eating in the past month. The DRS produces a dichotomous variable (Yes/No) that classifies individuals according to whether they endorse versus deny engaging in any restrictive eating in the past month. Endorsement of restrictive eating on the DRS has been found to predict eating disorder symptoms and reduced objective caloric intake better than the EDE Restraint scale (Haynos & Fruzzetti, 2015). In the present study, 79.2% of participants endorsed restrictive eating at time 1 and 45.8% at time 2.

The Mindful Eating Questionnaire (MEQ; Clementi, Casu, & Gremigni, 2017). The MEQ (Framson, Kristal, Schenk, Littman, Zeliadt, & Benitez, 2009) was developed to assess individuals' ME skills; the original scale consists of 28 items; however, an abbreviated 20 item version (Clementi et al., 2017) was used for this study. Exploratory and confirmatory factor analyses supported two domains: Awareness and Recognition of Hunger and Satiety Cues, with adequate internal consistency (α= .75 and .83, respectively) and test-retest reliability (0.73 and 0.85, respectively). Factors demonstrated small to moderate effect sizes in associations with general mindfulness, meditation experience, yoga practice, not being on a diet, and BMI (Clementi et al., 2017). In the present study, alphas for the Awareness and Recognition subscales were .85 (M= 29.1, SD= 6.4) and .76 (M= 18.7, SD= 4.9) for time 1, and .87 (M= 33.9, SD= 5.9) and .83 (M= 23.1, SD= 5.5) for time 2, respectively. Internal consistency for the total scale for time 1 and time 2 were .84 (M= 47.8, SD= 9.2) and .89 (M=57.2, SD= 9.9), respectively.

The Intuitive Eating Scale (IES-2; Tylka & Kroon Van Diest, 2013). The 23-item IES-2 measures individuals' ability to track physical hunger and satiety cues when deciding what, when, and how much to eat. The IES-2 was developed by adding an additional component of IE, Body-Food Choice Congruence (B-FCC), along with the following subscales: Eating for

Physical Rather Than Emotional Reasons (EPR), Unconditional Permission to Eat (UPE), Reliance on Hunger and Satiety Cues (RHSC). For women, Cronbach's coefficient alphas were .87 for the total scale, .93 for EPR, .82 for UPE, .88 for RHSC, and .87 for B-FCC, demonstrating good internal consistency. Test-rest reliability over a three week period was .88 among women for the IES-2 total score. Total scores and subscale scores were positively associated with body appreciation, self-esteem, and satisfaction with life, and negatively associated with eating disorder symptoms and poor interoceptive awareness. In the current study, total scale alphas were .74 (M= 75.5, SD= 15.7) and .89 (M=97.2, SD= 20.7) for time 1 and time 2 respectively, and the following time 1 and time 2 alphas for subscales: .83 (M= 24.0, SD= 9.9) and .94 (M= 28.5, SD= 12.1) for EPR, .62 (M= 22.6, SD= 6.9) and .69 (M= 26.3, SD= 5.6) for UPE, .84 (M= 18.6, SD= 6.7) and .90 (M=27.2, SD= 8.0) for RHSC, and .80 (M= 11.2, SD= 4.3) and .93 (M= 14.0, SD= 5.4) for B-FCC. It is possible that lower subscale scores for UPE were the result of pre-existing diet mentality and restrictive eating behaviors in this sample as compared to the original validation sample.

Mindfulness

Cognitive and Affective Mindfulness Scale-Revised (CAMS-R; Feldman, Hayes, Kumar, et al., 2007). The CAMS-R is a 12-item measure designed to capture a broad conceptualization of mindfulness with language that is not specific to any particular type of meditation training. The overall CAMS-R demonstrated acceptable levels of internal consistency (α= .76), discriminant, and convergent validity among an ethnically diverse sample of 548 university students (Feldman et al., 2007). Mindfulness scores on the CAMS-R were significantly correlated with scores on measures of mindfulness, distress, well-being, and emotion-regulation (Feldman et al., 2007). The CAMS-R demonstrated reliable internal

consistency at time 1 (.81, M=24.3, SD= 5.1) and time 2 (.82, M= 26.3, SD= 5.4), which is also consistent with previous findings.

Readiness to Change

Theory of Planned Behavior Questionnaire (TPB; Ajzen, 2013). There are no standardized questionnaires for general measurement of TPB constructs for every behavior; instead each item is developed based on the specific target behavior (Oluka, Nei, & Sun, 2014). Therefore, the TPB Questionnaire Construction (Ajzen, 2013) was tailored to measure participants' beliefs and intentions around using an app to change their eating behaviors at least three times a day for the next four weeks. The questionnaire contained seven items that assessed subjective norms, perceived behavioral control, intention, and past behavior. Responses were indicated on a 7-point Likert scale (1= *strongly disagree*…7= *strongly agree*). Cronbach's alpha for this scale was .70 in this sample.

Change Questionnaire (CQ; Miller & Johnson, 2008). The Change Questionnaire is a brief self-report screening tool to measure motivation for change using common language. The item stems were tailored to target specific change related to eating. An abbreviated version of the original 12-item scale was used given that the following 3-items accounted for 81% of variance in the full scale: (a) It is important for me to [change my eating behavior], (b) I could [change my eating behavior], and (c) I am trying to [change my eating behavior]. Participants indicated either "yes" or "no" in response to each item. Cronbach alphas for time 1 and time 2 for this scale were .45 and .60, respectively.

Frequency of App Usage

To determine how often users engaged with the app, the researcher conducted a timeline followback method of assessment with the participant. This required the researcher to record

participants' app use on a 28-day calendar sheet estimating the number of times per day and number of minutes each time they used the app. The participants were encouraged to recall something for each day, even if it was a "0" and to provide context for use and their best estimates of use. When applicable, they were also encouraged to use their smartphone calendars to help recall app use and identify any weekend/weekday patterns that assisted them with recall.

Qualitative Analysis

The 6 phase thematic analysis (TA) process was conducted separately for student and clinician data over the course of several virtual meeting sessions. Audio recordings were transcribed and analyzed by the author and two trained postbaccalaureate research assistants. The first phase of TA involved becoming familiar with the data through transcribing verbal data, reading and re-reading the data, and noting down any initial ideas. The second phase entailed generating a list of ideas about what was in the data and what was interesting about those ideas, also known as initial coding. All the data was initially coded and organized into a codebook which was reviewed; new codes were added, and repeat codes were removed. To refine the codebook, ten percent of the dataset was split between two coders, who then independently coded that subset of the data. Phase 3 involved sorting the codes into potential themes, essentially starting the process of analyzing the codes, and considering how different codes combined to form an overarching theme (Braun & Clarke, 2006). Initial themes were generated by each team member independently from the codebook, the team met to discuss and refine these initial themes, and candidate themes and subthemes were established. The team independently identified exemplars of candidate themes and subthemes from the raw data, forming a theme codebook. Phase 4 involved review and refinement of the initial themes established in Phase 3. Some candidate themes were not really themes (e.g., not enough data to support them, or the data

are too diverse), some themes that initially seemed separate collapsed into one theme, and other themes were broken down into separate themes. Phase 5 involved defining and naming the themes, specifically, the 'essence' of what each of theme was about and what aspect of the data each theme captured was clearly identified. Phase 6 involved reporting the final analysis of themes (Braun & Clarke, 2006; Goodell, Stage & Cooke, 2016; Nowell, Norris, White, & Moules, 2017).

'Sensitizing concepts' (Blumer, 1954; Glaser, 1978; Bowen, 2006) were drawn from the Theory of Planned Behavior and the Technology Acceptance Model. These concepts were used as interpretive devices to give coders a general reference point and guidance during coding and analysis, but the qualities and attributes of codes and themes were developed inductively. The following TPB and TAM concepts were used: attitude toward behavior, subjective norms, perceived behavioral control, perceived usefulness, perceived ease of use, motivation, and intention. Salience and frequency were the main determining factors for generating themes. Judgments were also guided by continuously reflecting on the original research questions. To ensure rigor and trustworthiness, (a) memos were used to maintain an audit trail of the analytic decision process and as a reflexive writing method (Lincoln & Guba, 1985), (b) team members followed the 5-phase process of thematic analysis (Braun & Clarke, 2006), (c) provided quotes as evidence of our findings (Lincoln & Guba, 1985), (d) referred back to raw data to provide additional context and to achieve "fit" between participants' views and the research teams' representation of them (Tobin & Begley, 2004), and (e) identified "exception cases" to demonstrate how leading patterns did not match the experience of every participant (McPherson & Thorne, 2006).

Statistical Analysis

Frequencies, means, and standard deviations were performed for descriptive data, readiness to change, and timeline follow back data. Paired samples t-tests were conducted to determine changes in ME, IE, BE, dietary restriction, general mindfulness, and BMI over time.

Data Management

The data were collected via online surveys posted on www.qualtrics.com. Participants who responded to the recruitment email were sent a link to the eligibility survey. Among those who were invited to participate, a research assistant provided them with access to a secure laptop to complete the time 1 and time 2 surveys in-person. The data were transferred to IBM's SPSS Statistical Software, version 23 (IBM, 2015) in order to conduct statistical analyses. Quality of the data were assessed by searching for missing data. There were no outliers. Audio recordings were saved on flash drives that were kept in a locked cabinet that only members of the research team had access to; copies of these recordings and de-identified transcriptions were saved in a password protected Google drive folder. Word documents were used to manage all raw and coded data.

Figure 1

A screenshot of the Mindful Eating Cycle.

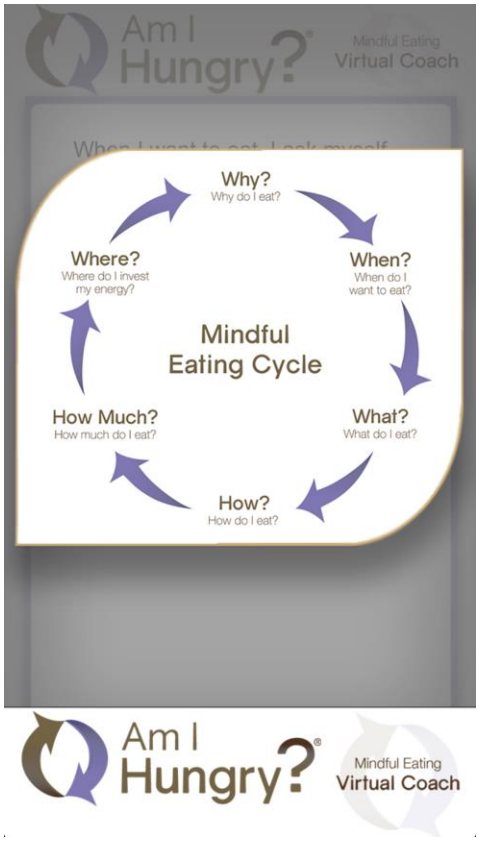


Figure 2

A screenshot of the Body-Mind-Heart Scan.

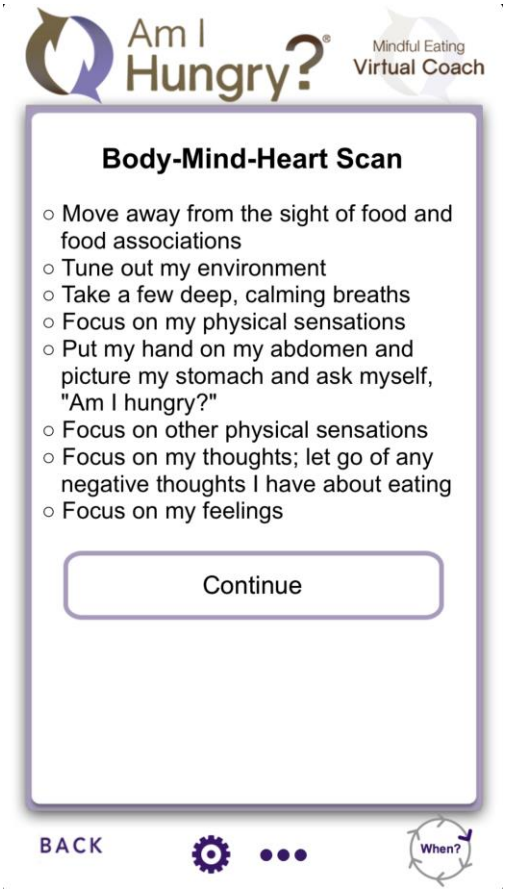


Figure 3

Screenshots of the Hunger and Fullness Scale.

Chapter 5: Results

The following section describes in detail participant characteristics, app usage, feasibility and adherence data, preliminary eating behavior outcomes, and thematic analyses of student and clinician interviews.

Participant Characteristics

UNCC Student Sample

See Table 1 for baseline student participant characteristics. Eligibility survey data indicated that all participants fell within the ages of 18-30 years old[2]. Ninety-six percent of participants were working on a bachelor's degree. All participants reported they self-identified as a woman. At time 1 and time 2, participants mean weights were 177.6 (SD= 55.0) and 177.0 (SD= 55.3), respectively. There was no statistically significant difference between weights.

Clinician Sample

A total of five clinicians participated in interviews. The professional backgrounds of these clinicians included: a licensed clinical social worker, a licensed clinical psychologist in a college counseling center, two registered dieticians, and a registered college campus dietician. All clinicians, except for the campus dietician, reported extensive knowledge and experience in working with clients who have disordered eating.

[2] Mean age is not available. This question was unintentionally omitted in the demographic questionnaire.

Table 1

Baseline participant characteristics

	n (%) or *Mean* (*SD*)
Race/ethnicity	
White	12 (48.0)
African American/Black	3 (12.0)
Asian/Asian-American	4 (16.0)
Hawaiian/Pacific Islander	3 (12.0)
Mixed race/other	2 (8.0)
Hispanic/Latino	1 (4.0)
Native American/Alaskan	0 (0.0)
Class standing	
First Year	4 (16.0)
Second Year	3 (12.0)
Third Year	5 (20.0)
Fourth Year	10 (40.0)
Fifth Year and beyond	3 (12.0)
Daily App Use	20 (83.0)
Previous ED Diagnosis	5 (20.8)
Prior ED Treatment	2 (8.3)
Weight	177.6 (55.0)

Note. *N*= 24

Characteristics of Student App Usage

Eighty-three percent of student participants indicated that they currently used apps daily, whereas 16.7% did not (*N*= 24). Participants were asked how often they used smartphone apps in their everyday life for their health. About thirty-eight percent indicated "never", 33.3% indicated "a few times a week", 8.3% indicated "most of the time", and 20.8% indicated "always" (*N*=24). When asked to indicate the top three apps used most over the past month, 45.8% of participants reported using at least two social media apps and 25% using one or more health/fitness apps.

Readiness to Change

See Table 2. The Theory of Planned Behavior Questionnaire asked participants to rate readiness to change on a Likert scale specifically regarding using an app for eating behavior. Participants held favorable attitudes towards using the app in the recommended way, with stronger beliefs about the app's helpfulness as compared to ease of use. Participants were less likely to agree that using mental health apps for was a daily norm for others who were important and/or similar to them. They reported confidence and higher levels of personal control in using the app as recommended. Participants indicated a strong likelihood to use the app as recommended. Lastly, participants reported that they had not used an app for their eating behavior within the last month. Results from the Change Questionnaire show that participants endorsed being in multiple stages of change simultaneously, which was due to measurement error. Participants were asked to respond to each item of the CQ with a "yes" or "no" response rather than a typical Likert scale. These items were not related to specific changes to eating behavior or app use, but rather general readiness for behavior change.

Feasibility and Retention

See Figure 4. Recruitment began in February 2019 and ended in May 2019. A total of 79 individuals took the online eligibility screener, 37 of those surveys were incomplete and 3 individuals were ineligible. A total of 39 were eligible to participate in the study; the target sample size was 25, and ultimately 26 students were scheduled, completed all consent procedures and participated. Of all 26 participants who completed a baseline survey and were provided with the smartphone application, 1 withdrew because she was not using the app regularly and did not like the way the app was making her consider what she eats, and 1 participant was lost to follow up. It is possible that the participant who withdrew did not fully understand the objective of the app or was not ready to change binge eating; however, it remains unknown because the authors did not follow up with this participant for further clarification. Twenty-four participants completed the 28-day intervention between February 2019 and May 2019 and returned for the in-person follow up interview and post-intervention survey. Overall, recruitment goals were met, and a 92% retention rate was achieved, both of which support the feasibility of this intervention.

Table 2

Readiness to change and planned behavior change

Variable	% Y/N	
CQ		
Precontemplation	96.0	
Contemplation	92.0	
Action	96.0	
TPBQ	M	SD
Attitude toward using app		
Helpfulness	5.8	1.4
Ease	4.0	1.7
Perceived social norm		
Important others	1.6	1.7
Similar others	2.3	1.8
Perceived behavioral control		
Confidence	5.7	1.1
Personal control	6.3	1.1
Intention	6.8	0.53
Past behavior	1.2	2.0

Note. *N*= 24. Change Questionnaire (CQ); Theory of Planned Behavior Questionnaire (TPBQ) used a 7-point Likert scale, with 1 indicating the lowest level of agreement.

Engagement and Adherence

Table 3 shows user engagement and adherence with the app over the 28-day intervention. Over time, participants used the app less frequently and spent less time using it throughout the day. A total of 62.5% participants used the app 3 times a day in week 1, 25% in week 2, 25% in week 3, and 20.8% in week 4. This was calculated based on the average number of times a participant used the app per day each week, with rounding up from 2.5 times per day.

Table 3

Engagement and Adherence

ME App Usage	Week 1		Week 2		Week 3		Week 4	
	M	SD	M	SD	M	SD	M	SD
Number of times per day	2.5	0.9	1.8	0.8	1.7	0.8	1.6	1.5
Minutes each time	4.2	3.4	3.2	2.4	2.5	1.6	2.0	2.2

Note. $N = 24$; Average total number of days app used 23.8 ± 5.7; Average total number of days app not used 5.7 ± 5.6.

Preliminary Analyses

Eating

Table 4 shows changes in eating behavior. There were significant differences in both subjective and objective aspects of BE demonstrated by a significant reduction in BES and EDE-QI scores at baseline and follow-up. The total mean score on the BES decreased in severity from moderate to mild. Participants' mean scores on the EDE-QI demonstrated a clinically significant change from severe (between 8-13 binge episodes/week) to moderate (4-7 episodes/week) (DSM-5, 2013). Participants also reported engaging in significantly fewer instances of dietary restriction between time 1 and time 2. Mindful eating scores increased pre to post intervention and this was marginally significant with a small effect size. Intuitive eating scores showed significant increases pre and post intervention, with a large effect size.

Mindfulness

Table 4 shows changes in mindfulness. Participants endorsed moderate levels of mindfulness as evidenced by pre and post intervention scores on the CAMS-R, with no significant statistical difference in mean scores.

Table 4

Changes in binge eating, eating behavior, BMI from pre- to post-intervention

	Time 1		Time 2					
	M	*SD*	*M*	*SD*	*df*	*t*	*p*	*d*
EDE-QI 13	11.8	10.1	6.1	6.5	23	2.48	.021	0.51
EDE-QI 14	11.4	10.8	4.1	4.4	23	3.03	.006	0.62
EDE-QI 15	9.5	8.0	4.4	4.7	23	2.63	.015	0.54
EDE-QI Total	31.4	27.2	14.7	15.2	23	2.90	.008	0.28
BES	25.3	6.9	17.0	7.2	23	6.02	.000	1.23
MEQ	2.4	0.45	2.7	.47	20	2.03	.056	0.41
IES-2	3.3	0.64	4.3	0.90	21	4.55	.000	0.97
DRS	.79	0.41	0.46	0.51	23	2.89	.008	0.59
CAMS-R	19.8	2.9	20.8	3.8	23	-1.01	.321	0.21
Weight	177.6	55.0	177.0	55.3	23	.033	.974	

Note. *N*= 24; Eating Disorder Questionnaire with Instruction (EDE-QI); EDE-QI Total is a composite score of all three EDE-QI items. Binge Eating Scale (BES); Mindful Eating Questionnaire (MEQ); Intuitive Eating Scale (IES-2); Dietary Restriction Screener (DRS); Cognitive and Affective Mindfulness Scale Revised (CAMS-R). EDE-Q1 scores were not combined because they address different aspects of BE.

Student Interviews

In the following sections, students' attitudes, and motivations towards using a ME app for reducing BE and increasing IE skills are described. A total of 23 interviews were completed, with an average length of 25 minutes and a total of 191 pages transcribed. Four main themes were generated from student interviews: something new, personal growth, practicality, and suggested features. Definitions and examples of themes and subthemes (italicized) are explained within each section below. All names reported are pseudonyms.

Something New

Participants' actively wanted to try to change problems with eating, had tried other approaches without success (i.e., talking with a nutritionist, going to therapy, diet and exercise, calorie tracking apps), and were open to learning a novel approach for helping with BE. Many participants described struggling with BE for years, either having been diagnosed with BED and/or noticing themselves eating more than they believed they should and wanting to "break the habit" with a solution that wasn't dieting and exercising. Participants reported unfamiliarity with mindful eating, despite engaging in prior counseling. Some viewed the app as a "stepping stone" or a tool that was a helpful alternative to binge eating that they can incorporate into daily life. Summer mentioned that mindful eating was a new approach for nutrition and was finding her nutritionist's recommendations hard to follow: "I go to a nutritionist sometimes and they tell me what to do, but they don't tell me how to do it." Regarding other apps, Marzipan stated:

> I've used a lot of different apps to try to like monitor my eating before and I never really found them helpful but I've always been kind of curious in what a helpful app might look like and then also curious about mindful eating because I know I've tried

> a lot of different things to try to manage my eating and I've never really tried the mindful approach in a very like committed way before.

Expectations. Participants' described their expectations about the app prior to using it and how their thoughts of it changed over time. Participants expressed feeling either optimistic or skeptical about the app's potential to help with BE by using mindfulness as an approach, and general concerns about implementing the app into their routine. Some reported initial skepticism due to their unfamiliarity with mindful eating and because the app does not offer meal plan recommendations. Others were optimistic about the lack of recommended calorie-based meal plans, as Remy stated, "this sounds so great because it literally said on there like you don't need to be on a diet for the rest of life, you just need to know how to eat and be mindful and things like that." After using the app, some participants were surprised with the quantity and variety of self-help suggestions offered and were pleased with the incremental steps it provided for practicing ME skills.

Personal Growth

Participants described how the app helped them with more overall wellbeing by promoting self-care activities beyond eating (i.e., doing yoga, spending time with family, watching a funny video, drinking water, etc.). In addition, personal growth encompasses subthemes related to actual changes to eating behaviors and increased knowledge of mindful eating. Marzipan explained:

> I guess it brought to mind kind of self-care a lot more…It kind of helped me realize that I need to. Just because of the way the app is and I know all the suggestions that it gave are all very like you know take care of yourself. Like if you're struggling with eating it's probably because you need to take better care of yourself and then you know to the point

> where you have to binge eat to deal with everything. And so I think I think it actually did have a positive effect in that way and like me being more mindful about like how I'm taking care of myself in ways other than eating.

The app also seemed to function as a mediating tool for providing a structure to thought processes and for feeling emotionally grounded so participants could enact changes to their behavior. As Daniella stated:

> It's just such common sense. It's like sometimes you're like, your thoughts get all convoluted and then all of a sudden you pull it out and it's like really simple and straightforward. And it's like oh yeah, it's like the voice of reason I'd say.

Some participants described the app as a "coach" that gave them a sense of accountability during times when they felt stressed, while another participant felt it gave them a sense of purpose to their day, especially during times when binging was likelier to occur. Participants described the overall positive impact of "holding off on an immediate desire" and learning to reflect on one's feelings and actions. Nicole remarked:

> I've learned that it's it helps you to reflect on yourself and, you know, how you actually feel about things in that in that moment. How can I explain it…I guess it helps you become more aware of how you actually feel as opposed to doing stuff at a surface level. When you're actually thinking about what you're doing. It kind of can change your mindset on how you think of that situation.

Changes to eating. Participants' experienced growth with respect to identifying and understanding physiological hunger cues. They have started to make different choices as a result of increasing emotional awareness and thinking more flexibly about food and eating. Food became less of a reward and instead was consumed based on physical needs. Many participants

described taking a pause to reflect before or during eating, which led to less snacking, less eating out of boredom, eating smaller quantities of food, and less night eating. Although it wasn't a goal of the study, Nicole even mentioned losing a little bit of weight as a result of changes to eating:

> Definitely just not feeling the need to eat as much because when I'm actually realizing that I'm not hungry, I'm just eating because I'm bored or eating because, you know, I just feel like I need to because I'm in a social situation. It definitely eliminated that. So it made it easier for me to lose weight because I'm not eating as much.

Jenny explained that as a result of her busy schedule, she no longer had time to cook or meal plan, yet because of the app she was more willing to eat intuitively instead of pre-plan all of her meals. Similarly, Delia described thinking more flexibly and feeling less guilty about making certain types of food choices:

> I realized it was helpful in a different kind of way which I really liked, it's not like restricting your diet and it's not going to make you feel bad about eating like ice cream or you know sweets like every once in awhile and stuff.

Specific mindful eating skills were acquired that created a sense of being more in control of eating. Summer recalled:

> One of the first things I actually tried was one of the things the app says is that focus on eating and bite slowly and recognize what flavors like in my mind and list what flavors am I tasting. And I think that's a very, very good approach to it. Because when you're thinking about it sometimes you know, you feel more full.

Some participants mentioned that the app does not eliminate binging in all circumstances, as Marzipan clarified, "overeating and that's what this helped me with. But like as far as like binge eating at night it doesn't do anything." Ash also noticed improvements with overeating and

mentioned, “I also knew realistically this one thing probably isn’t gonna stop it [binging] for good. It’s definitely gonna take a combination with therapy and everything.” Overall, most participants described feeling more in control of their eating and observed the positive future impact of “holding off on an immediate desire” as a result of using the app.

Learning curve. The app’s step-wise process for presenting ME concepts and repetitive interface helped participants memorize and learn ME concepts until they became innate, which in turn led to using the app less over time. Participants reported that after exploring and using the app for about a week, they began to recall ME concepts automatically and this was particularly helpful in situations when using the app was not feasible. Some participants also stated that moving forward, they plan to use the app occasionally to refresh their memory.

Practicality

Participants described certain contexts in which the app was either convenient or inconvenient to use. Overall, it appeared that for most participants the app was practical and helpful to use before, during, and/or after eating to help identify hunger/fullness. Norms around phone usage in this college-aged sample influenced opinions regarding the app’s convenience, as Kendall stated, “But I mean it's pretty handy. I mean we live on our phones anyway so if you’re going to be on it while you're eating you may as well, you know check in before you eat.” Using the notification feature was helpful for reminding users to check-in with the app periodically, which for Megarocker98, turning on notifications was dependent on her motivation to change:

> Like I had my notification turned on all the time just because, well because of the study and like I wanted to use it to the full ability. But also because it was just like I was in the mindset where I was like I need to make a change. So definitely if I turn off notification

> and I completely forget about the app then it's like, I will yeah. If there's no notification I will forget.

There were certain contexts in which the app's prompts did not apply, for example, Ash had an unpredictable eating schedule while traveling, or in situations where it was not possible to make specific food choices or being too busy. Remy described:

> I feel like a lot of times it the app was expecting me to be completely in control of the entire situation and a lot of times I'm not like, I'm going to a restaurant with my boyfriend or I'm going over to my friend's house and they've ordered pizza and things like that.

Some participants noted that the execution of the app needs improvement. For one participant, the app kept crashing and notifications were not working. Many participants remarked that having notifications to serve as reminders were helpful for participants' to periodically check-in. At times, the app's prompts were confusing to use. For example, it was unclear to one user that she needed to check in and rate her hunger multiple times during and after eating. For another user, multiple check-ins felt unnecessary. The app also did not account for times when a participant needed to eat despite not feeling hungry, as Remy also noted:

> So I have to eat breakfast right beforehand because I don't get any breaks and if I'm not hungry I know I should eat breakfast anyway. And so there's not really an option for that so I just kind of have to say like Yeah I do want to eat. I'm not really hungry. I don't know what to put in but I need to eat right now.

Negative emotions. Participants reported that a negative emotional state (i.e., stress, apathy, feeling hungry) or being in a "binge mood" overrides their motivation to use the app and/or employ ME skills. These were instances in which a binge episode occurred. Participants

described a cycle in which feelings of shame and guilt led to BE, and failure to use the app and binge instead heightened these negative emotions. Marzipan explained:

> Well I think the problem for me was that because my binge eating is very much related to like feelings of guilt and feeling of like you know like fuck it all its like when I'm feeling like I'm going to binge is like the last time I'm going to use this app…I think it helped me when I wasn't like in a bingeing mood to eat more mindfully and feel better about eating and to feel more in control when eating. But when I was really going to have like a bad binge I don't think it really changed that. In fact it might have kind of made it worse because I felt like oh I'm not pulling out the app I being really bad now so I'm just gonna do whatever I want.

For Marzipan, there appears to be an emotional tipping point that obfuscated her motivation to apply ME concepts in situations when bingeing occurs. Not using the app during these episodes actually exacerbated the cycle of negative emotions that lead to a binge. Rather than using it before a binge episode, it may be more suitable for individuals to use the app when feeling good. For Daniella, eating for comfort still occurred even though she used the app:

> That I'd still eat even after using the app. I still feel like I need to eat to kind of like feel better even after the app is like you shouldn't and there are other ways. That'd probably be it. Or just like not finishing cause it's like I want this.

It appears that the app does not offer "eating just for comfort" as an option for its users. The app was also less helpful when Ashley described feeling very hungry and felt frustrated with having to take the time to go through the prompts:

> …there would be times like I said my dinner time fluctuates so there'll be time where I be eating well before I would eat I'd be really hungry and would be irritated at the fact that I have to go through these questions before I'm ready to eat.

Overall, these opinions speak to the app's lack of tools for managing negative emotions, as well as managing users' expectations regarding its' utility before, during, or after a binge episode.

Usage in social settings. Many participants felt comfortable using the app while in the company of others and denied feeling shame or embarrassment. Phone use while eating with friends was viewed as a norm, and using the app briefly took attention away from conversation. Some participants were comfortable with letting other people know they are using the app and felt supported by close relationships to continue using it. Participants who reported discomfort with using the app attributed this to the social unacceptability of using their phone while eating, either with family, friends or in a professional setting. For these individuals, phone use was viewed as impolite and disrupted the flow of conversation. Additionally, participants mentioned that they were sometimes distracted with conversation and forgot to use the app.

Changes over time. Over the 4 week period, participants tailored how they used the app to their specific needs and/or eating concerns. Ash used the app at night or between meals:

> …it's still at night definitely and still between meals was a big one because I tend to have more problems between meals when I'm not actually hungry needing food just boredom and emotions and stuff. So I started using it more between meals than at night than I did before meals like in the beginning.

Jungle Jane used the app when feeling a loss of control:

> But I think now like within the last week or so I really am just like using it to check-in. Like I'll just open it and I'll be in and out of it in like a minute because typically now I'm

> only opening it right before meal just like I plan to. Whereas before I felt like I was you know opening it and not really for a meal but for the thought that I wanted to binge through an entire box of something. So now I feel like I'm just opening it to kind of be like am I hungry yeah I am actually pretty hungry and then I can get through it.

Some used the app if they needed to refresh their memory of the ME cycle. Majority of participants decreased their app use from three times a day to check-ins as needed. As Arielle stated,

> I definitely will be keeping this app just to check in. Even if it's not everyday maybe like every other day.

Overall, users began to self-tailor how and when they used the app depending on their needs over a one month period. Using the app less over time may be reflective of the app's lack of engaging features and undynamic interface, which is explained in more detail below.

Time consuming. Some participants had difficulty finding time to use the app because they had busy schedules and often needed to eat and study at the same time. Others felt the app would be easier to read through with less text and/or options, especially if the user had difficulties with reading in general. Ash did note however that using the app took less time than binging:

> My main concern was kind of like okay but like every time I eat I'm gonna have to get on this app I'll go through the cycle, its gonna take so long. But I realized like it's taking less time for me to go on this app and look at the cycle or at least the parts of the cycle that I need and eat a normal meal than it was to have a full binge. I found myself having more free time and then instead of using the free time as the binge time I was using the free time to do homework to see friends that I haven't even hung out with in a while…

> So it was actually more practical to be using the app than it was to be doing my normal behaviors.

Suggested Features

Participants wanted more interactive features to sustain their engagement with the app (i.e., a log to track food and mood, calorie counting, words of encouragement). Not having features to enhance users' engagement may have led to dwindling motivation to use the app over time. As Remy stated,

> It wasn't dynamic. It just told me the same thing every single time. And so I just kind of like whenever I thought about using it I would just think like well I know exactly what it's going to tell me. So why would I need to pick it up again.

Although calorie counting conflicts with Health At Every Size and ME approaches, one student mentioned that they would pay more for the app if it included a feature that counted calories. This differed from another student's suggestion to include a food logging feature, as described by Jess below, which would assist a user in identifying changes in binge eating patterns:

> Nice if there was an area or section of it where you could log your food. Like what you're eating so you could look back on it and see what you're eating and how your habits are changing. I feel like that would make me think even more about what I'm eating if I was able to put it down and log it.

Additionally, a tutorial to aid in defining ME concepts, as well as a home button to facilitate navigation throughout the app was desired. Two participants mentioned wanting more social interaction to feel less alone and more supported, either through a community thread to share common experiences with others or a live person to speak with and guide the user through ME steps. Jungle Jane stated,

> Yeah having someone speak to you, I think there's a lot of like loneliness and in the binge eating world even between fellow bingers you know no one really talks about it, it's super secret. To have someone to maybe talk to you, like are you hungry, like feel less alone. Like you're actually interacting with someone versus just quietly clicking through something and reading it and trying to get its information so that would be helpful.

Cost. Participants reported that most college students do not pay for apps and often overlook apps that cost money in the app store. Some mentioned that the ME app "as is" is not worth its price ($2.99). One participant stated that the cost of treatment for BE is more than the cost of the app, and therefore the app is worth paying for. A free trial, in-app purchases, and/or marketing by psychologists may lead some to buy the app. Marketing was believed to be influenced by whether the app had more engaging features.

Clinician Interviews

The following section describes clinician's opinions of the strengths and limitations of the ME app and their attitudes towards implementing this into their practice. Five main themes were generated from these interviews: clinician expertise, education, language, complementary, and cost. Definitions and examples of themes and subthemes (italicized) are explained within each section below.

Expertise

Clinicians described their theoretical orientation and specific treatment approaches to working with clients who struggle with BE. All clinicians endorsed using third wave approaches, intuitive eating, and mindful eating in their work with clients. Approaches consisted of Health at Every Size (HAES), Acceptance and Commitment Therapy (ACT), Cognitive Behavioral

Therapy (CBT), Mindfulness Based Eating Awareness Training (MB-EAT), Dialectical Behavioral Therapy (DBT), Multigenerational Family Systems Theory, and Relational Cultural Theory (RCT). One dietician stated that her approach is trauma informed. Clinicians utilize both individual and group therapy formats and described starting clients with learning basic psychoeducation, then moving towards building awareness of behavioral patterns, recognition of hunger and satiety cues, practicing meditations and conducting food exposures.

Prior app experience. Some clinicians reported using apps, including Recovery Road, Get Healthy, My Diet Checklist, PTSD coach, Breathe to Relax, Calm, Insight Timer, and In the Moment. Most clinicians were cautious about recommending apps for various reasons, one of which was confidentiality concerns with client data. One clinician uses My Diet Checklist with her clients because it is not additive like other apps that track food/calories, stating that calorie tracking makes people more anxious, whereas My Diet Checklist broadly tracks servings of food. The campus dietician reported that her company has a contract with My Fitness Pal, but that she disagrees with it being used in dining hall settings because its calorie tracking feature has the potential to be harmful to people with disordered eating or in recovery from disordered eating. Other clinicians reported similar concerns with using My Fitness Pal. In general, clinicians looked for apps that can help clients with food journaling, noticing hunger/fullness, reducing anxiety through mindfulness practices, and tend to stay away from calorie tracking apps.

Education

Clinicians asserted that the ME app would be useful in their practice as a foundational tool for assisting clients with learning basic awareness and interoceptive skills. Clinicians were eager about the app's potential to help clients practice skills outside of session. They liked the

app's prompt/notification feature because it allows clients to set specific time intervals, take a pause, slow down, and serves as a reminder to check-in with themselves. Most clinicians believe the app can help users differentiate hunger cues (i.e., physical vs. emotional). Some thought the app's broad integration of multiple aspects of coping through self-care (i.e., intellectual, physical, spiritual, emotional) encompasses a wide range of client needs and can help clients recognize contextual factors related to eating. Although, one clinician remarked the app "does too much" (i.e., too much information, to many steps/tips) and could detract from helping clients make sense of the basics around ME skills. For college students, the app can be useful to help them choose from a variety of different food options in the dining hall.

Readiness. Clinicians discussed the importance of clients' readiness when deciding to recommend the app and were cautious about who they would deem appropriate given the clients' ability to emotionally regulate, especially for clients who are dealing with a lot of shame and judgment. They asserted that clients will have difficulty grasping ME concepts without adequate coping and may even become more frustrated. One clinician remarked that because the app is complex and comprehensive, additional "mental work is going to exhaust them further when they're dysregulated and could get in the way of their abilities", potentially resulting in more shame and feelings of failure. Another stated that binging serves a function and if clients are not aware of other coping tools and/or are not ready to give up BE as a form of coping, then "they are not going to even want to do anything that might disrupt their ability to use that behavior". A clinician clarified these points about user readiness pertaining to emotion regulation:

> If I thought that it would be too much for someone to handle or if they weren't in a position where they had mastery at some point over managing their emotions, if

> this just felt too daunting and they would just feel like a failure. I wouldn't encourage a skill where that didn't think they could have some benefit from it.

For clients who are considered ready to move into an intuitive and mindful eating approach, clinicians would introduce the app to clients and then gauge their interest in using it after they've explored the app on their own. Overall, a client's readiness was characterized by an ability to regulate emotions to some degree, yet still lacking knowledge of triggers to BE and/or ME skills.

> If I didn't think it'd be helpful for them in other ways, like if they already had a really good sense of what triggers a binge, how they soothe, if I didn't think they could use the education, if they already had good insight, then I wouldn't be as apt to use it.

Priming. Clinicians discussed the importance of giving clients adequate education about ME before recommending the app to their clients. Without proper counseling on mindfulness beforehand, concepts may be confusing, "[clients] are going to bring their diet culture baggage into the app", and it won't be as useful. This theme is distinct from readiness in that in addition to having adequate coping skills, clients must have some foundational awareness of how diet culture influences their binge eating cycle and how they may perceive ME concepts within the app.

Complementarity

Clinicians discussed the pros and cons of using the app as either a complement to their treatment approach and a potential standalone treatment. They detailed how implementation and utilization of the app might differ depending on the client's phase of treatment and how the app's functions could be tailored to a client's specific needs (i.e. what works, what doesn't work). At the start of treatment, the app could provide basic psychoeducation around ME and interoceptive awareness. During treatment, the app could be used for a client needing assistance with

identifying triggers and/or to explore additional self-care tools. Upon discharge from treatment, the app could be used as a tool or "safety net" to reference during stressful times.

Of all clinicians, the campus dietician reported least familiarity with ME approaches and discussed how the app helped her gain knowledge of ME and strengthened her ability to convey the ME cycle to others at campus events (which was well received) and through social media posts. Another clinician remarked that the app gave her additional terminology to use when discussing ME skills with clients (including those with prior treatment experience) and helped tie together things discussed in therapy. One clinician imagined using the app while doing food exposures with clients, while another would use the app to support them outside of sessions. The app was viewed as a "coach"; oftentimes, people use their smartphone for soothing, so this app could be incorporated into an existing habit. The app may be particularly useful to freshmen eating in the dining halls who are faced with a variety of new options, and convenient to those who'd rather not carry a paper food journal with them. One clinician described how she would specifically introduce the app:

> Maybe put aside two meals over the weekend where you feel like you could engage with the app in a way where you're gonna be eating you know like you know you expect you're going to be eating anyway and you can run through and see how it asks you those questions so you can build a positive connection between deciding when to eat enjoying your food and feeling good about what you're eating. And then saying something like and give me some feedback like let me know what you feel like you were able to learn that you think could be helpful.

It was important to reinforce that "no app is perfect, this is not about giving [clients] a bunch of rules around food and eating". If the app is deemed trustworthy, clinicians are willing to use it to

help supplement the work they do. If marketed to college students, students should be encouraged to seek additional help from therapists and dieticians in conjunction with using the app.

Suggested Features. Clinicians described specific features they believed would improve the app's delivery of ME concepts and increase their confidence with implementing it into practice. They suggested adding a tutorial to explain the ME cycle, related concepts, goals, and to provide further clarification that the app is not intended for weight loss or dieting. All clinicians desired journaling, logging mood, the ability to track eating patterns over time, and data sharing capabilities. Tailoring and customization are things that people expect from apps. Customizing the hunger and fullness scale to include the clients' thoughts, feelings, and physical sensations was discussed. Expanding the hunger/fullness scale can allow clients to identify discomfort on one dimension of fullness, and comfort in another, which can give more nuance to the various reasons for eating. As one clinician explained:

> It seems like very dichotomous. Like I'm either hungry. I'm neutral or I'm full. But like, I think our experience of our hunger and our fullness is much more complex. Yeah. Yeah. And I think also when I talk to people, I separate out fullness and satisfaction, I think those two things are very different. And so I might be very full but I might not be all satisfied if I'm choosing only the healthiest option.

Additionally, the app should integrate more skills for helping clients with chronic health conditions, like hypertension or diabetes. Because people these conditions are told to limit certain foods, clients may need more assistance with giving themselves full permission to eat while also supporting health maintenance.

Regarding the initial prompt “I want to eat”, this was thought to preclude people who binge eat even when they don’t want to eat or are unsure. Expanding this prompt to include “I don’t want to eat” or provide a way to navigate to identifying needs rather than responding to this prompt would help capture more user experiences. Prior to navigating through the ME cycle, the app could at the forefront assist users with crisis management and emotion dysregulation through simple deep breathing, self-compassion, and acceptance based messages (i.e., “It’s going to be OK, take 5 deep breaths.”). One clinician argued that app’s content addressed more emotional aspects of eating through mindfulness yet did not do enough to combat negative thoughts related to eating (i.e., self-talk, thought police).

Concerns about wordiness leading to increased frustration and shame among clients already struggling with emotion regulation. As noted:

> There is a lot to learn about the subject and you can see that in text form and it's black on white so it's readable it's just small font and it just looks and feels like a lot of work to get through different steps.

One clinician even tried using the app when she was in a great mood and still felt that it was too much. They suggested adding in one-minute video or audio clips and provide prompts that users can respond to in their free time for additional educational elements. Additionally, prompts can also get the client to think about “joyful movement” or to establish a physical activity plan for regulating emotions.

Personalized features incorporating clients’ values could also increase motivation to use the app. As one clinician described, the app might ask the client “what are some of my values where you know it sort of like reminds them of their why, like why they're doing what they're doing.” This could include adding in pictures of loved ones. For two clinicians, relational

elements were important to address in the app, finding that a significant trigger for BE with their clients is relationship distress.

Lastly, a clinician considered how the app's aesthetic might dissuade non-female clients from using the app. While showing a male client the ME cycle, the clinician felt the app appeared "flowery"; the language and color scheme were less gender neutral than what might be appropriate given the stigma surrounding men with eating disorders. She stated:

> It has kind of a feminine feel to it and I think it might not work for more masculine people, and I don't have a lot of concrete sense of that, but I just get the sense that it definitely seems like it was made by a woman for women.

Language

Two clinicians provided insights regarding the potential implications of problematic language used within the app, particularly with references to diet culture and "healthism". These harmful subtleties with language would inhibit them from implementing the app in their practice. Language that alludes to a healthy vs. unhealthy dichotomy can bring up shame and thoughts that reinforce the BE cycle. Clinicians stressed that people who have struggled with their eating and/or are recovering from BE do not have the ability to connect to their hunger and fullness in a clear way, and it is important to recognize how messages around hunger/fullness can contribute to black and white thinking about eating. For example, identifying a '5' (satisfied) or '6' on the hunger/fullness scale comes with descriptions such as, 'I feel light and energetic' and 'I don't feel the food in my body'. A clinician stated,

> This idea of 'lightness'. Like it all sort of feels tidy…It's all these assumptions about how you feel…And I don't 'I don't feel the food in my body' like I mean, that is straight out of what people with, you know, anorexia tell me who are like I can't I can't bear the

> feeling of having food in my stomach. It's like somehow that's a bad thing. We should feel food in our stomach after we're done eating.

Another clinician pointed out problematic messages among the listed advantages and disadvantages for eating when not hungry,

> One of them [disadvantage] lists ‘store fuel’, which I feel like is a euphemism for get fat a little bit…I would think that actually storing fuel if we're looking at this neutrally would probably be an advantage. Like what's the disadvantage of storing fuel? So, if we're looking at it as a disadvantage like in the form of fat…that seems to be the subtle message to me…Again, implied well, maybe it'll store it as fat and like what a terrible thing. That's not helpful.

Additionally, a clinician remarked that healthism language existed around the ME question “What do I need?” This section contained the question, “What is the healthiest choice I could make?” In this same section, another question prompts clients to consider selecting foods appropriate for specific health issues, which although clinicians agree is important to incorporate, clients may feel regret or guilt if they do not make the healthiest choice. She stated,

> I didn’t really see anything weight specific that jumped out at me um but it was more you know…I think certainly some of my clients have diabetes or have other things that they need to be aware of I just worry about like when they say things like the healthiest choice that it’s sort of implies that there’s a better choice that they could be making.

This may be particularly salient for clients who are not yet capable of stopping themselves from eating despite not being physically hungry. The clinician suggests rephrasing this question as “What is a choice I could make that would be satisfying?” or “What choice would meet my

needs?" One clinician mentioned that the content and terms used to describe ME, mindfulness, and coping were consistent with what she knows to be appropriate, healthy, and helpful.

Cost

There were mixed opinions about paying for this app. Some clinicians stated they would not purchase nor recommend the app to clients in its current form. Other clinicians believed that $2.99 was a reasonable price for this app, and because their clients are willing to purchase books recommended for treatment, they believe their clients would be willing to pay for the app. One clinician was willing to pay $5.00 if the app was revised according to suggested improvements. However, some clinicians remarked that most people, especially college students, are less willing to pay for apps because they expect apps to be fully free or have free components with options for in app-purchases. For those who were willing to pay, suggestions included monthly subscriptions (~$50.00/month) with a charting program connected to the app.

Ethics. The psychologist working in the Counseling and Psychological Services setting discussed that university policy prohibits psychologists and counselors from recommending apps to clients, especially apps that are not free. She explained that in order to uphold equity of service, counselors should support mental health applications that don't create a barrier to the clients. This clinician was open to sharing knowledge about the app to her clients, but would not advocate for them to purchase the app.

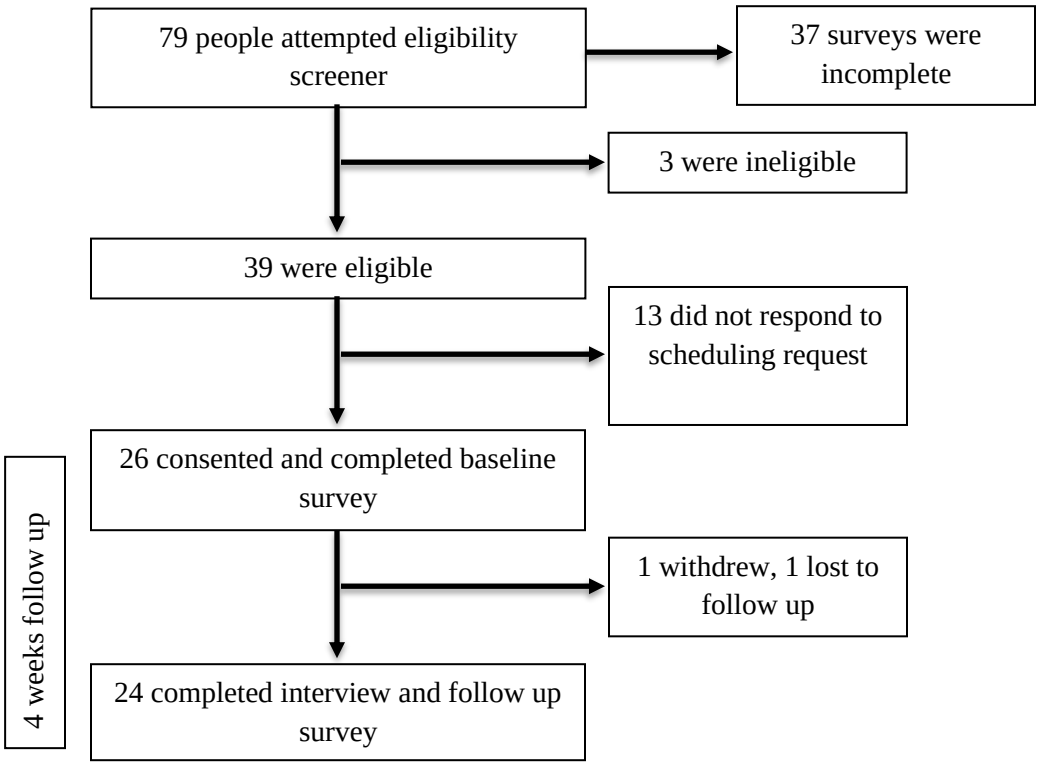
> We as a rule do not recommend any payment services for apps for our clients. We have considered what's kind of our ethical standpoint, and so we have pretty strict rules about what we might recommend, like I said confidentiality is the first one, and what sort of data is collected. And not to recommend anything that's for payment, so in this setting here I would not.

Another clinician considered the potential for an app to cause more harm for clients who have extensive trauma histories or emotional issues that necessitate higher levels of care; services that are often out of network for insurance. Lastly, one clinician stated she would recommend an app if it were evidence based. As for the ME app, this clinician felt she could trust the information because it was researched and created by a medical doctor.

In sum, students discussed their opinions regarding their motivations and attitudes towards using an app for learning ME skills, and clinicians discussed their opinions regarding issues with implementation of this app into practice with clients.

Figure 4

Recruitment and Retention Flowchart



Note. Recruitment began in February 2019 and ended in May 2019. Ineligible participants did not meet study criteria for BE (< 2 instances of BE and/or < 2 instances of loss of control past 28 days).

Chapter 6: Discussion

The purpose of this study was to evaluate the feasibility, acceptability, and preliminary efficacy of a mindful eating smartphone app among college women with binge eating using both quantitative and qualitative methods. The main research questions were: (a) What are undergraduate women's attitudes towards and motivations for using a mindful eating smartphone application for changing binge eating? (b) What are clinicians' opinions of the strengths and limitations of the mindful eating app and attitudes towards implementing this app into their practice? and (c) What is the preliminary efficacy of the "Am I Hungry?" Mindful Eating application among undergraduate women who binge eat for reducing BE frequency and severity and for improving ME? The results addressing the study aims, implications, strengths, limitations, and future directions are discussed in detail below.

Feasibility and Acceptability

One aim of this study was to determine the feasibility and acceptability of a mindful eating intervention for college women that consisted of using an app at least three times per day and/or before meals or snacks for 4 weeks. Twenty-four participants completed the 28-day intervention. Retention rate among this sample of students was similar to rates observed in other feasibility studies (Allman-Farinelli et al., 2016; Mason et al., 2018; Turner-McGrievy & Tate, 2011). Overall, data demonstrate that this intervention can successfully recruit and retain participants' engagement and adds to preliminary research showing that mHealth apps have good feasibility and acceptability (Wang, Varma, & Prosperi, 2018). Given that one participant withdrew due to discomfort with the app's focus on eating behavior, assessing participants' stage of change and/or readiness should be considered prior to engagement. This was assessed in this study using the Change Questionnaire; however, this was not part of the study's overall aims.

Participants used the app for an average of 23.8 days over a 28-day period, with the amount of time spent on the app decreasing from 4.2 minutes in the first week to 2.0 minutes on average in the fourth week. Similar utilization was observed in a study examining Recovery Road, with 67% of users continuing to use the app at least once per day after 30 days and spending a mean of 1.4 minutes per time (Tregarthen et al., 2015). It appeared that using the app in this way for the allotted time period was a practical recommendation. Qualitative data revealed that over time, many participants internalized the mindful eating cycle and thus, were still implementing ME concepts even if they were not using the app itself and using the app to "check-in" during times when binging was likelier to occur. The one month time period appeared to be sufficient for users to learn ME skills, whereas one study found that app users believed one month was too short to integrate lifestyle changes (Ahtinen et al., 2013). This is notable given that majority of participants in this study reported no prior knowledge of ME. Overall, reminders/notifications was a key feature that seemed to largely facilitate users' engagement with the app.

Changes in Eating Behavior

Another aim of this study was to gather preliminary evidence for changes in eating behavior pre- and post- intervention. Statistically significant improvements in binge eating, restrictive eating, mindful eating and intuitive eating were observed. Clinically significant reductions in BE were determined by mean scores on the EDE-Q-I; this measure has been shown to provide stronger accuracy in assessing BE frequency and BED diagnosis when compared to the BES (Celio, Wilfley, Crow, Mitchell, & Walsh, 2004; Goldfein et al., 2000). Positive changes to eating behavior and increased learning of ME concepts were elicited from participants through interviews, most often reporting reduced intensity and frequency of BE

symptoms, outcomes which have been shown in a review on mindfulness and ME (Warren et al., 2017). This is the first study to demonstrate changes in BE, ME, and IE through the use of an app.

Interestingly, there were larger increases in intuitive eating scores than mindful eating at follow up. Intuitive eating is a broad framework that encompasses aspects of mindful eating. Whereas ME mainly entails present, non-judgmental awareness while eating (Framson et al., 2009), IE involves the ability to identify and understand physiological hunger and satiety cues to determine when, what, and how much to eat; while rejecting dietary rules that lead to emotional eating (Tribole & Resch, 1996). In line with the smaller effect sizes for ME (as well as a small sample size), changes in general mindfulness were not significant, which makes sense given the app was not designed to expose participants to more formal mindfulness meditation practices. In interviews, many participants reported learning foundational mindful eating skills, discussed aspects of increasing awareness as it relates to hunger cues, and more flexibility around what types of foods they ate, which supports the observed significant changes in IE over time. Participants also frequently mentioned feeling distracted while eating with others (it is hard to be mindful about eating when conversing with others), being too pressed for time to go through all the prompts, and studying while eating, which may explain the smaller effect size for ME.

In addition, the Mindful Eating Questionnaire (MEQ) may not entirely overlap with how the app introduces and assists users in learning and practicing ME skills. For example, pertaining to the hunger fullness scale, items describing a “5” or “6”, which suggest the user is full and satisfied, is accompanied by the following descriptors of awareness: “I noticed the flavor of the food began to fade” and “It became harder to give every bite my full attention”. Whereas awareness items on the MEQ that most closely match these are: “I notice subtle flavors in the

foods I eat" and "I taste every bite of food I eat." A criticism of the MEQ is that it does not include an acceptance or nonjudgmental dimension, which is an aspect of the general mindfulness construct. Thus, the MEQ focuses only on how attention is directed toward internal cues as opposed to emotional or external cues to guide eating behavior (Clementi, et al., 2017; Hulbert-Williams, Nicholls, Joy, & Hulbert-Williams, 2014). Moreover, language from diet culture may also play a role in how ME is presented in the ME cycle. Diets tend to focus on rules of eating-what to eat, how much to eat, when to eat, etc.- these questions that form the basis of the app's ME cycle may confuse app users into thinking less about the present moment awareness process and focus more on judgment-based perceptions and specific outcomes of eating.

Promising Avenues for App Use and Implementation

Something New

Participants in this study were not currently engaged in treatment, although two had been previously. Many individuals with BE experience shame associated with seeking treatment. One student in this study had mentioned not wanting to discuss these behaviors with her medical provider out of fear of being judged. Norms regarding phone use in social settings among this sample speaks to the app's utility as a discrete method for providing basic psychoeducation to alleviate BE symptoms and/or the stigma associated with seeking treatment. It also has the potential to widely spread ME concepts more broadly and in conjunction with treatment. It is possible that the use of stand-alone technologies may encourage individuals with subclinical concerns to engage in the treatment process (via mobile application), whereas without this technology they may not otherwise seek treatment. The content of this app was enticing to students because it presented novel approaches to treating a longstanding condition. Although

preliminary outcomes for this sample shows promise in using the app as a stand-alone technology among subclinical populations, the content of self-help apps should help users in managing expectations around what can and cannot be expected from a self-help tool; without this information, users may experience delays in seeking adequate treatment (Mehrotra et al., 2017).

Complementary

Technology-enhancements combined with clinician involvement may be more effective than stand-alone self-help technologies, particularly for populations with clinically significant symptomatology (Jones, 2014; Mohr et al., 2013; Tate & Zabinski, 2004). Technology-enhancements also demonstrate relatively low dropout rates compared to stand-alone technologies, with some work suggesting that they may actually increase engagement and decrease dropout (Jones, 2014; Mohr et al., 2013; Tate & Zabinski, 2004). Users who have never sought professional help may not recognize how direct interventions can provide a more contextualized approach as compared to standalone self-help interventions, which tend to be generic in nature (Mehrotra et al., 2017). In the current study, clinicians discussed how they might use the app as a tool to tailor treatment and/or draw on components that are most appropriate with respect to the client's history and specific vulnerabilities.

Education

Overall, clinicians viewed the app as a helpful tool for psychoeducation as long as a client was deemed ready to engage in learning ME skills. The need for a variety of sources of information has been previously recommended by app users (McClelland & Fitzgerald, 2018). Both clinicians and students were impressed with the wide range of available self-care options and information related to BE triggers, viewing this as a strength of the ME app. Some clinicians

thought the app addressed more emotional aspects of eating and did not adequately challenge cognitive aspects of BE; therefore, incorporating elements of CBT alongside mindfulness can foster an awareness of negative self-talk that contributes to BE cycle. There is also significant research suggesting an association between eating disorders and difficulties in romantic relationships as likely maintaining factors (Arcelus, Yates, & Whiteley, 2012). Providing education within the app to help clients to recognize how relational distress impacts their ability to be mindful may further assist clients in understanding what contributes to patterns of BE.

Barriers to Student Use and Clinician Implementation

Practicality

Overall, participants appeared to have favorable views towards using a ME app, which supports past research demonstrating that clients hold a positive attitude toward using apps in treatment (Ben-Zeev, 2016). However, past studies have shown that ease of use is still a relative drawback (Alqahtani & Orji, 2020). Many students reported that an intense negative emotional state was a main barrier to using the app. Participants' discussion of how negative emotions impacted motivation to use the app coincides with clinicians' critique that the app does not provide features to assist users with emotion regulation "in the moment". This is highlighted further by the overlap between students' descriptions of how overwhelming emotions impacted the app's effectiveness with clinicians' dialogue of client readiness. Mehrotra et al (2017) discussed issues with managing motivation in the context of unguided self-help apps, particularly among users who have never sought professional help. Because these apps rely only on users' motivation to review content and practice skills, "depletion of motivational resources due to mental health problems can interfere with sustaining self-care efforts" (p. 709).

Therefore, this type of self-help intervention is most likely to be initiated and completed by a subset of individuals who can garner external and internal resources to assist with motivation. For individuals with additional cognitive and emotional barriers, involvement of a therapist would be more helpful and/or incorporating features that enhance motivation (i.e., direct coaching, notification reminders, etc.) may address these challenges (Mehrotra, Kumar, Sudhir, Rao, Thirthalli, & Gandotra, 2017). The authors also note that users should be aware of the limitations to unguided self-care approaches, specifically among youth who may overemphasize peer support in dealing with mental health concerns. To address this, Mehrotra et al (2017) recommend efforts to incorporate education regarding the limits of self-care, knowing when to seek professional support, initial screening to provide appropriate suggestions to users, and crisis support strategies within apps.

Although some participants were frustrated with how much time it took to run through the prompts (no more than 5 min on average), many noted that after learning the concepts in the first week, the app was convenient to use as a brief "check-in". Since social norms for app use vary based on context and personal preference, what remains unclear is whether concerns about time were limited to social settings in which the user was distracted by others, or whether negative emotions and lack of motivation moderate the relationship between time spent on the app and its perceived usefulness.

Suggested Features

Participants discussed how frequency of app use decreased over time because they internalized ME concepts as a result of its repetitive interface. Given the nonsignificant preliminary changes in ME, it is unclear how strongly these concepts were internalized and actually put into practice. Other methods of learning can be incorporated in the app, to both

maintain users' engagement and foster additional increases in ME and IE skills. Broussard and Teng (2019) discussed methods for increasing engagement for users and to foster more collaboration with clinicians by implementing aspects of experiential learning in app development. By creating "here-and-now" experiences using a range of visual, auditory, and tactile cues, users can learn to respond or not respond to cues, specifically to those that users associate with negative emotional states, to make abstract concepts more concrete (Broussard & Teng, 2019). For example, individuals experiencing increased worry about binge eating at night can be presented with videos or audio clips that provide them with mindfulness or self-compassion exercises, or two- or three-dimensional visualizations of the hunger/fullness scale that can be manipulated by the user. Incorporating elements of self-compassion can help to down-regulate neural pathways in the amygdala, the brain region responsible for producing negative emotions (Schulyer, Kral, Jacquart, et al., 2014). Additionally, these exercises can encompass options for combating negative beliefs, challenging diet mentality, and planning alternative behaviors.

To develop sufficient mastery over ME as a skill, apps can include a stepwise process that guides users through each level of a skill with the option to receive feedback on their performance of that skill. Performance can be reviewed with tracking and recording capabilities, as seeing these patterns are engaging for users (McClelland & Fitzgerald, 2018). For example, using color to track mood, graphs with smiley faces, a cloud to convey changes in mood or hunger/fullness. Integrating users' emotions can provide a framework for maintaining increased layers of complexity as related to attitudes, emotions, and values within interventions that are more overtly focused on thoughts and behaviors (Broussard & Teng, 2019). All of these elements can provide additional scaffolding for treatment, help to close gaps in traditional CBT

treatments, and garners more meaningful practice and repetition outside of session (Broussard & Teng, 2019).

In the present study, most clinicians believed the app provided a solid building block for education and developing ME skills, although some reported hesitance to implement and recommend the ME app in their practice as a result of the app's inability to log clients' mood and behaviors (i.e., self-monitoring). Juarascio et al (2015a) found that clinicians believed self-monitoring via EMI, coping strategies, and CBT-based concepts have the potential to help with reducing BE, and thus were eager to use apps in practice. Whereas Fairburn and Rothwell (2015) purport that clinicians might find self-monitoring apps burdensome if patient information was shared with them, and worried about the potential for encouraging dependence within the patient if the app offered constant access to the clinician. Similar issues arose for clinicians in Lindgren et al.'s (2018) study, with concerns about added workload for reviewing patient logs and managing patient expectations for clinicians to review these logs prior to treatment sessions. Additionally, self-monitoring may be more harmful than beneficial given that keeping detailed records of food intake is characteristic of people with eating disorders (Fairburn & Rothwell, 2015). Though the ME app did not offer logging capabilities, the development of self-monitoring was encouraged through the use of mindfulness skills, and so the definition of self-monitoring may require further refinement in the context of mindfulness based behavior change apps for disordered eating (i.e., logging mood/behavior vs. tracking food/caloric intake).

Additionally, clinicians were concerned that text-heaviness would be too mentally taxing for their clients, and students echoed this sentiment. McClelland and Fitzgerald (2018) found that users felt information conveyed via an app should be limited and manageable, for example through the use of quizzing to aid acquisition of mental health concepts. However, the authors

note that quizzing users may pose challenges if wrong responses elicit negative emotions in users (McClelland & Fitzgerald, 2018). For sections of apps that include large portions of informational text, note taking, highlighting, and cross-referencing features are simple ways to increase interactivity (Broussard & Tend, 2019).

Priming and readiness were salient themes that can be addressed through content-related alterations within the app. Both clinicians and students agreed that a "roadmap" for the ME app would enhance both user and provider understanding. Mehrotra et al (2017) offered recommendations to address challenges associated with unguided self-help apps. Additional features, like a tutorial, can inform users of the evidence basis for content and the app itself and provide explicit information on the scope and limitations of the app. This can increase literacy of users and determine its' potential usefulness. Folding this feature into the app's content can also alleviate some of the burden on mental health clinicians to give anticipatory guidance to clients who are interested in using an app.

Language

Subtle diet culture messages within the ME app were a main drawback for clinicians. These messages led them to feel cautious and insist on providing adequate client education beforehand so that these messages do not further contribute to harmful diet mentality. Interestingly, the app does provide users with some psychoeducation on diet mentality as an emotional trigger to eating when not hungry. Users are given a list of 16 options for emotional triggers to choose from, one of which is "I have diet thinking". Other messages within the app that challenge diet mentality are: "focus on improving health rather than on losing weight" and "be careful not to turn Am I Hungry into a diet by trying to follow it perfectly or feeling guilty when I don't, no one does and it isn't necessary in order to be healthy". It is unclear whether

these sections counteract or contribute to the subtle diet messages within the app, or if they are too embedded for users to recognize and internalize. It may be helpful to streamline these elements and/or give users a tutorial so that they can easily find and access these elements within the app itself.

Studies exploring the nature of language and messages within mental health apps are quite limited. Parker et al (2018) conducted a content analysis of mental health messages to understand how popular mHealth apps frame mental health and illness. Two dominant themes were identified from apps' advertising materials: (a) mental health issues existed for everyone, and (b) individuals can easily self-manage mental health problems with apps. Additionally, screenshots and descriptions tended to represent everyone as employed, white, and in a family- a depiction that may alienate people with serious mental health needs (Parker et al., 2018). These authors conclude that efforts to normalize mental health problems may help to reduce stigma, but might lead to overdiagnosis and overtreatment of mild or temporary symptoms; this medicalization of "normal life" may limit resources from those who are in greater need (Parker, Bero, Gillies, Raven, Mintzes, Jureidini, & Grundy, 2018). Although Parker et al (2018) did not explore diet culture messaging within apps specifically, this study highlights how mHealth apps may harmfully promote the idea that individuals should be personally responsible for their own health. Without recognition of the limitations of apps and the impact of social determinants of health (e.g., diet culture), users may experience increased shame and feelings of personal failure if their mental health conditions do not improve or worsen (Parker et al., 2018).

Cost

Most participants' concerns about cost were not strongly tied to their inability to purchase the app, rather, there are norms about paying for apps in this age group with preference given to

free apps. Additionally, opinions about the app's lack of sophistication and ability to sustain their engagement led some to assert that the ME app was not worth the price. Comparable apps for disordered eating in the app store are free to download but have in-app purchases for additional content. A review of weight loss apps demonstrated that paid apps did not contain additional evidence-based skills than free counterparts (Boudreaux, et al., 2014; Breton, Fuemmeler, & Abroms, 2011). Other factors of acceptability, mentioned in both student and clinician interviews, are worth further investigating as it relates to norms and ethics about students paying for apps, as well as the influence of marketing (i.e., endorsement from clinicians, user testimonials/ratings) on app purchases.

Implications for Research and Practice

Despite the increasing number of mHealth apps, studies on efficacy and effectiveness remain insufficient. mHealth apps that do have a larger empirical base tend to focus more on increasing physical health (i.e., quitting smoking, losing weight, stress management), and less on decreasing symptoms of more severe forms of mental illness (e.g., Ben-Zeev et al., 2014; Gustafson et al., 2011; Karcher & Presser, 2016). Majority of these findings come from studies examining feasibility and acceptability (rather than symptom reduction), whereas existing studies on preliminary effectiveness have shown that mHealth apps are valuable for cultivating client engagement with treatment (Karcher & Presser, 2016).

After reviewing 21 studies on 18 apps, Lui et al. (2017) asserted that no app was considered empirically supported given that no study on one app had been replicated among the same population and clinical problem. Wang et al. (2018) reviewed mHealth app studies from 2013 to 2017 and found that only 11 out of 120 studies supported evidence of efficacy. A small number of more recent reviews of RCTs have shown varied positive effects across mental health

conditions, for both depression and anxiety (Linardon et al., 2019) and only for depression, not anxiety (Weisel et al., 2019). Although there is some growing evidence for the positive effects of apps, the opinions of mental health professionals in app development can help to mitigate potentially harmful or unhelpful effects of apps. Fairburn and Rothwell (2015) found that 12 out of 24 eating disorder apps had poor or harmful advice, and Juarascio et al. (2015) found that all 20 apps reviewed recommended coping strategies that were not evidence based. In the present findings, clinical experts provided additional caution regarding the potential harm that apps may present, specifically around how diet culture messaging within the app may contribute to and/or maintain the cycle of disordered eating and for clients with more severe symptomatology. This highlights an important issue regarding for whom this type of self-help intervention might be best suited for (i.e., subclinical populations).

Ethics. Now with the collective need to reduce in-person contact to slow the spread of the coronavirus pandemic, Wang et al (2020) recommends clinicians should first and foremost examine evidence base, app content, cost, privacy policies, and monitor outcomes. Parker et al (2018) found that app developers offered very limited scientific evidence for benefits claimed by mental health apps. Bearing in mind the lack of empirical evidence for mHealth apps, clinicians should exercise caution when choosing and/or recommending apps to their clients. Issues with data security, client privacy, clinician-patient boundaries, avoiding harm, fees, and scope of practice are just a few of the ethical, legal, and clinical problems (Karcher & Presser, 2016). According to the American Psychological Association's Ethical Principles of Psychologists and Code of Conduct (i.e., Ethics Code), psychologists' practices should be founded in reputable knowledge, and they should suggest therapeutic interventions for which there is established evidence (APA, 2017). Given the novelty of mHealth apps and the growing body of research, it

is tricky for psychologists to know which apps are strongly supported by evidence (Karcher & Presser, 2016).

With respect to privacy, psychologists are responsible for protecting clients' information (Standard 4.01, Maintaining Confidentiality). There is a potential for confidential information to be breached by third parties because mHealth apps are not entirely secure. This was not of particular concern for the ME app because it does not collect patient data; although given both student and clinician feedback, collecting data would improve the clinical utility of the app. Psychologists interested in using technology to enhance their practice should consult professional practice guidelines regarding telehealth (Karcher & Presser, 2016).

Psychologists should provide services based on their education, training, experience, and only treat mental health concerns that fall within the scope of practice (Standard 2.01, Boundaries of Competence). mHealth requires additional areas of skill acquisition that ensures adequate competency and up-to-date education prior to recommending appropriate interventions. This may include "an understanding of diversity factors that may impede or facilitate the use of particular mHealth services" (Standard 2.01b; Karcher & Presser, 2016). For example, one clinician highlighted the potential for the ME app's feminine aesthetic to prevent more masculine identified clients to use the app. Other factors that can create a divide in accessibility to digital interventions include age and socioeconomic issues.

Lastly, it remains unclear whether psychologists should be reimbursed for mHealth app services and/or require clients to pay for mHealth apps (Standard 6.04, Fees and Financial Arrangements). This may be dependent on treatment context/setting and population, since certain state laws exist where telehealth services are billable. As one clinician mentioned, college counseling centers in particular may not support mHealth apps because they create a barrier to

clients in the form of payment, and in order to uphold equity of service, they do not recommend students purchase an app. Psychologists should check existing regulations regarding suitable pricing and/or fee schedules for mHealth interventions (Karcher & Presser, 2016).

Mindful eating. The concept of mindful eating has been circulating throughout the mindfulness literature for at least 3 decades. Surprisingly, ME was an unfamiliar concept among largely all participants, even those who had received previous treatment. Participants expected the app to contain rules around how ME is applied and practiced, similar to what is typically required for restrictive dieting. The lack of uptake even by those who've heard of mindfulness practices in a treatment setting speaks to the importance of how these concepts are delivered, and these findings demonstrate the app's early promise in teaching these concepts.

Alternatively, there may be limitations to the app's ability to effectively teach and foster ME skills. Specifically, although the app's comprehensiveness was considered a strength by some, others may find the amount of information overwhelming and actually inhibit learning. Some participants also reported wanting features that allowed food logging and calorie counting, which speaks to the app not being sufficient by itself to challenge diet culture mentality. Ultimately the app is helpful for ME education, but as for challenging rule-based thinking, it is not an adequate replacement for professional treatment. Researchers and clinicians should consider additional methods to more effectively address educational components and continue fostering the "undoing" of rule-based diet mentality.

College students are high utilizers of smartphones, and even though these devices are a convenient vehicle for dissemination, they may also serve as a distraction and inhibit mindfulness practice. For example, after checking in with the app before or during eating, users may continue to use other apps (i.e., social media). There is some evidence that social media may

be harmful to mental health, leading to more social comparison and lower self-esteem (Vogel, Rose, Roberts, Eckles, 2014) and negative body image (Fardouly & Vartanian, 2016), factors known to increase risk for disordered eating. Understanding contextual factors related to the impact of clients' overall app usage can offer additional avenues for research and practice.

Strengths and Limitations

Findings from this study provide foundational insights regarding use of the "Am I Hungry?" Mindful Eating Coach app for BE among undergraduate women. This research adds to the body of literature examining the use of smartphone technology for delivering evidence based practices in populations with disordered eating (Juarascio et al., 2015; Juarascio et al. 2018; Hildebrandt et al., 2017; Levinson et al., 2018). Suggested improvements of the app from a user and provider perspective both challenge and confirm important findings regarding elements of practicality and acceptability of mHealth to the emerging literature on mHealth and app development. Identified strengths and limitations related to the use of this app in clinical practice will guide clinicians in providing accessible and effective interventions for their clients.

A main strength of this study was the novelty of a mixed methods design and the focus on app usage for reducing binge eating in college women, a population at high risk for engaging in disordered eating. It is also the first study to measure and demonstrate changes in various eating domains, including mindful eating, intuitive eating, binge eating, and restrictive eating. The sample was fairly diverse in terms of racial/ethnic demographics and this was representative of the larger student body.

A main limitation to the study was a lack of control group. Since the overall focus of the study was to understand factors related to feasibility and acceptability, a control group was not used; however, given the observed significant outcomes among this small sample, these results

should be considered indicative and warrant a future randomized controlled trial. Another limitation was reliance on self-report due to the inability of the app to objectively record usage, which may introduce bias. Additionally, these findings do not reflect the opinions and experiences of men and women in different age groups.

Future Directions

The current study paved the way for a future effectiveness and/or efficacy trial utilizing a control group. Future feasibility and acceptability research may consider incorporating apps like this into college counseling centers. Since academic stress predicts difficulties with managing eating (Bardone-Cone et al., 2012), it is important to consider education on coping skills specific to college students. According to clinicians, providing adequate prior education on mindfulness and ME was deemed vital the app's capacity to be useful. Therefore, it may be worth investigating the effectiveness of using Dr. Michelle May's self-help book tailored to college students as an accompaniment to app use. Given the role that motivation plays in the adoption of any treatment intervention, these studies may consider incorporating a measure of behavior change potential specific to smartphone apps, such as the App Behavior Change Scale (ABACUS; McKay, Slykerman, & Dunn, 2019).

Further exploration may also seek to examine whether the ME app has comparable results for other forms and varying levels of severity of disordered eating (i.e., Anorexia Nervosa, Bulimia Nervosa). Additionally, individuals who have experienced longstanding issues with BE are more prone to chronic health conditions such as diabetes. Since previous research has demonstrated that ME leads to greater regulation of food choice in those with diabetes (Miller, 2017), it may be valuable to examine how the ME app can assist with self-management of these conditions. In further seeking to understand which populations the ME is best suited for,

it may also be worth exploring whether body image plays a role in the acquisition of adaptive eating skills, given that higher body acceptance is associated with intuitive eating (Koller, Thompson, Miller, Walsh, & Bardone-Cone, 2020). For future ED-related apps, developers should give more attention to features that focus on emotion regulation; these features should incorporate elements from empirically-based mindfulness-based treatments (MB-EAT; Kristellar, et al., 2014) shown to improve emotion dysregulation among individuals with BE.

Conclusions

The present study assessed the feasibility, acceptability, preliminary efficacy, and clinical practice implementation of a mindful eating smartphone application using a mixed methods approach among undergraduate women with BE and clinical experts. Results revealed that on average, participants experienced increases in IE and ME, with decreases in BE and restrictive eating. Interestingly, ME was only marginally significant, with larger effect sizes for IE. This may be explained by limitations of the tool used to assess ME in combination with how the app presented ME concepts. Both students and clinicians provided feedback to improve engagement, learning, and clinical utility of the app, of which included adding a tutorial, logging/tracking features, customization of the hunger/fullness scale, and audio/video clips. Criticisms were related to the app's inability to foster emotion regulation skills and inclusion of problematic messages referencing diet culture. Clinicians reported that the app has the potential to provide foundational insights for clients deemed ready to learn ME. Issues related to ethics were also discussed. Together, these findings highlight the importance of accounting for both user and clinician perspectives when developing an app and considering relevant client factors when deciding to recommend an app in clinical practice. Certain types of people seem more amenable to using apps prior to engaging in treatment for BE, especially those who are avid smartphone app users. The app may give these individuals some foundational tools if treatment is not easily

accessible or for those who are not yet ready to engage in treatment. It appears that for individuals with less severe forms of BE, benefits gleaned from the app were much more apparent. However, the author would not recommend the app as a standalone treatment in the case of more severe forms of binge eating, as the app does not serve as a sufficient replacement for traditional treatment approaches, but rather can buttress treatment goals outside of regular sessions.

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APPENDIX: MEASURES

Time 1 Questionnaire

Demographics

Please provide your birthdate [mm/dd/yyyy]

Please indicate your race/ethnicity.

- White
- African American or Black
- Hispanic or Latino
- Asian or Asian American
- Native American or Alaska Native
- Native Hawaiian or Other Pacific Islander
- Other (please specify)

Please indicate your current level of education.

- High school or G.E.D.
- Working on an associate's degree
- Working on a bachelor's degree
- Bachelor's degree
- Master's degree
- Doctoral degree

Please indicate your undergraduate class status. [Choose an option: freshman, sophomore, junior, senior]

- First-year
- Second-year
- Third-year
- Fourth-year
- Fifth-year or beyond

Indicate weight (in pounds) and height (in inches) [open response].

Do you identify as a "woman"?

- Yes
- No

Eating Behavior History

Have you ever been diagnosed with any eating disorder or disordered eating?

- Yes
- No

Have you ever received treatment for an eating disorder?

- Yes
- No

If you answer yes to the last question, please briefly describe that experience. [Open response]

DRS

We are interested in assessing restrictive eating. Restrictive eating occurs any time you intentionally eat less than seems appropriate for the situation out of concern for your body shape and/or weight. I am going to give you a few examples of what I mean by restrictive eating.

• Restrictive eating can mean eating an amount of food that most others would think is too little. For example, eating an apple for dinner or fasting all day could be considered restrictive eating.

• Restrictive eating can mean eating far less than others in a similar situation. For example, eating a diet frozen meal at Thanksgiving dinner with family could be considered restrictive eating.

• Restrictive eating can mean eating less than is appropriate for your body size or hunger level. For example, if you are very hungry and you eat only a small salad for dinner, this could be considered restrictive eating.

Have there been any times within the past month when you have eaten in this manner because you were concerned about your body shape and/or weight? [Indicate Y/N]

CAMS-R

Please respond to each item by marking one box per row		Rarely/Not at All	Sometimes	Often	Almost Always
CAMS-R1	It is easy for me to concentrate on what I am doing.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R3	I can tolerate emotional pain.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R4	I can accept things I cannot change.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R5	I can usually describe how I feel at the moment in considerable detail.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R6	I am easily distracted. (R)	☐ 4	☐ 3	☐ 2	☐ 1
CAMS-R8	It's easy for me to keep track of my thoughts and feelings.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R9	I try to notice my thoughts without judging them.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R10	I am able to accept the thoughts and feelings I have.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R11	I am able to focus on the present moment.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R12	I am able to pay close attention to one thing for a long period of time.	☐ 1	☐ 2	☐ 3	☐ 4

EDE-QI

Some questions ask about (1) eating what most people would regard as an unusually large amount of food and (2) feeling a sense of having lost control while eating.

1. An unusually large amount of food is something that most people would feel is more than a large meal.

2. A sense of having lost control while eating might be experienced as feeling driven or compelled to eat; not being able to stop eating once you have started; not being able to keep yourself from eating large amounts of certain kinds of food in the first place; or giving up on even trying to control your eating because you know that, no matter what, you are going to overeat.

Here are some examples:

After work one evening, Dina ate two pieces of chicken, a 16-ounce package of frozen vegetables, three cups of rice, three fourths of a coffee cake, and a piece of fruit. This is an unusually large amount of food. While she ate Dina felt completely out of control, ate more quickly than usual, and ate until she felt uncomfortably full. Afterwards, Dina was very upset about how much she had eaten, and said she felt depressed, guilty, and hated herself for giving in to the urge to binge.

Several times a week JoAnne ate lunch at McDonald's with two coworkers. Her usual order was a Big Mac, a fish fillet sandwich, two large orders of fries, and a large chocolate shake. This is an unusually large amount of food. Although she ate somewhat more than her friends did and knew she was eating a lot of high-fat food, she did not feel out of control while eating or feel upset afterwards about how much she had eaten.

For lunch one day, Joseph had a ham and cheese sandwich with mayonnaise on a roll, a small bag of potato chips, a candy bar, and a diet coke. Although this was a large meal, it was not unusually large. However, Joseph felt out of control because he had planned to have turkey on whole wheat with lettuce and tomato plus a piece of fruit for dessert but changed his mind at the last minute while ordering his sandwich.

Carol ate two donuts someone brought to the office one morning. She had started a diet that day and planned to skip breakfast. Carol initially refused the donuts, but after everyone else had gone to a meeting she snuck into the break room and very quickly ate the donuts, so no one would see her eating. She felt very guilty and ashamed afterwards and hated feeling so out of control of her eating, resolving to start dieting again the next day. Although Carol felt bad about eating the donuts, this was not an unusually large amount of food.

Dina and JoAnne ate an unusually large amount of food, but Joseph and Carol did not. Dina, Joseph, and Carol felt a loss of control while eating, but JoAnne did not. Of the four, Dina is the

only one who actually had a binge episode, which includes both (1) eating an unusually large amount of food and (2) feeling a sense of having lost control while eating.

“Over the past 28 days, how many times have you eaten what other people would regard as an unusually large amount of food (given the circumstances)?” [Indicate number of times binges occurred in the past 28 days]

“On how many of these times did you have a sense of having lost control over your eating (at the time that you were eating)?” [Indicate number of times loss of control occurred for each episode of bingeing]

“Over the past 28 days, on how many days have such episodes of overeating occurred (i.e., you have eaten an unusually large amount of food and have had a sense of loss of control at the time)?” [Indicate number of days overeating occurred]

BES

Below are groups of statements about behavior, thoughts, and emotional states. Please indicate which statement in each group best describes how you feel:

1. ○ I do not think about my weight or size when I’m around other people.
   ○ I worry about my appearance, but it does not make me unhappy.
   ○ I think about my appearance or weight and I feel disappointed in myself.
   ○ I frequently think about my weight and feel great shame and disgust.
2. ○ I have no difficulty eating slowly.
   ○ I may eat quickly, but I never feel too full.
   ○ Sometimes after I eat fast I feel too full.
   ○ Usually I swallow my food almost without chewing, then feel as if I ate too much.
3. ○ I can control my impulses towards food.
   ○ I think I have less control over food than the average person.
   ○ I feel totally unable to control my impulses toward food.
   ○ I feel totally unable to control my relationship with food and I try desperately to fight my impulses toward food.
4. ○ I do not have a habit of eating when I am bored.
   ○ Sometimes I eat when I am bored, but I can often distract myself and not think about food.
   ○ I often eat when I am bored, but I can sometimes distract myself and not think about

food.

- I have a habit of eating when I am bored and nothing can stop me.

5. Usually when I eat it is because I am hungry.
   - Sometimes I eat on impulse without really being hungry.
   - I often eat to satisfy hunger even when I know I've already eaten enough. On these occasions I can't even enjoy what I eat.
   - Although I am not physically hungry, I feel the need to put something in my mouth and I feel satisfied only when I can fill my mouth (for example with a piece of bread).
6. After eating too much:
   - I do not feel guilty or regretful at all.
   - I sometimes feel guilty or regretful.
   - I almost always feel a strong sense of guilt or regret.
7. When I'm on a diet, I never completely lose control of food, even in times when I eat too much.
   - When I eat a forbidden food on a diet, I think I've failed and eat even more.
   - When I'm on a diet and I eat to much, I think I've failed and eat even more.
   - I am always either binge eating or fasting.
8. It is rare that I eat so much that I felt uncomfortably full.
   - About once a month I eat so much that I felt uncomfortably full.
   - There are regular periods during the month when I eat large amounts of food at meals or between meals.
   - I eat so much that usually, after eating, I feel pretty bad and I have nausea.
9. The amount of calories that I consume is fairly constant over time.
   - Sometimes after I eat too much, I try to consume few calories to make up for the previous meal.
   - I have a habit of eating too much at night. Usually I'm not hungry in the morning and at night I eat too much.
   - I have periods of about a week in which I imposed starvation diets, following periods of when I ate too much. My life is made of binges and fasts.

10. I can usually stop eating when I decide I've had enough.
    - Sometimes I feel an urge to eat that I cannot control.
    - I often feel impulses to eat so strong that I cannot win, but sometimes I can control myself.
    - I feel totally unable to control my impulses to eat.
11. I have no problems stopping eating when I am full.
    - I can usually stop eating when I feel full, but sometimes I eat so much it feels unpleasant.
    - It is hard for me to stop eating once I start, I usually end up feeling too full.
    - It is a real problem for me to stop eating and sometimes I vomit because I feel so full.
12. I eat the same around friends and family as I do when I am alone.
    - Sometimes I do not eat what I want around others because I am aware of my problems with food.
    - I often eat little around other people because I feel embarrassed.
    - I'm so ashamed of overeating, I only eat at times when no one sees me. I eat in secret.
13. I eat three meals a day and occasionally a snack.
    - I eat three meals a day and I usually snack as well.
    - I eat many meals, or skip meals regularly.
    - There are times when I seem to eat continuously without regular meals.
14. I don't think about impulses to eat very much.
    - Sometimes my mind is occupied with thoughts of how to control the urge to eat.
    - I often spend much time thinking about what I ate or how not to eat.
    - My mind is busy most of the time with thoughts about eating. I seem to be constantly fighting not to eat.
15. I don't think about food any more than most people.
    - I have strong desires for food, but only for short periods.
    - There are some days when I think of nothing but food.
    - Most of my days are filled with thoughts of food. I feel like I live to eat.

16. ○ I usually know if I am hungry or not. I know what portion sizes are appropriate.

○ Sometimes I do not know if I am physically hungry or not. In these moments, I can hardly understand how much food is appropriate.

○ Even if I knew how many calories I should eat, I would not have a clear idea of what is, for me, a normal amount of food.

IES-2

For each item, please circle the answer that best characterizes your attitudes or behaviors.

1. **I try to avoid certain foods high in fat, carbohydrates, or calories.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. **I have forbidden foods that I don't allow myself to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. **I get mad at myself for eating something unhealthy.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. **If I am craving a certain food, I allow myself to have it.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. **I allow myself to eat what food I desire at the moment.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. **I do NOT follow eating rules or dieting plans that dictate what, when, and/or how much to eat**.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. **I find myself eating when I'm feeling emotional (e.g., anxious, depressed, sad), even when I'm not physically hungry.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

8. **I find myself eating when I am lonely, even when I'm not physically hungry.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. **I use food to help me soothe my negative emotions.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. **I find myself eating when I am stressed out, even when I'm not physically hungry.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

11. **I am able to cope with my negative emotions (e.g., anxiety, sadness) without turning to food for comfort.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

12. **When I am bored, I do NOT eat just for something to do.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

13. **When I am lonely, I do NOT turn to food for comfort.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

14. **I find other ways to cope with stress and anxiety than by eating.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

15. **I trust my body to tell me when to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

16. **I trust my body to tell me what to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

17. **I trust my body to tell me how much to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

18. **I rely on my hunger signals to tell me when to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

19. **I rely on my fullness (satiety) signals to tell me when to stop eating.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

20. **I trust my body to tell me when to stop eating**.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

21. **Most of the time, I desire to eat nutritious foods.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

22. **I mostly eat foods that make my body perform efficiently (well).**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

23. **I mostly eat foods that give my body energy and stamina.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

MEQ

For each item, please circle the answer that best characterizes your attitudes or behaviors.

1. **Before I eat I take a moment to appreciate colors and smells of food**.

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

2. **I notice when the food I eat affects my emotional state.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

3. **I taste every bite of food I eat.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

4. **When eating a pleasant meal, I notice if it makes me feel relaxed.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

5. **I appreciate the way my food looks on my plate.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

6. **I notice subtle flavors in the foods I eat.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

7. **I recognize when I am eating and not hungry.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

8. **I notice when foods and drinks are too sweet.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

9. **I recognize when food advertisements make me want to eat.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

10. **When I eat a big meal, I notice if it makes me feel heavy or sluggish.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

11. **I notice when I am eating from a dish of candy just because it is there.**

1	2	3	4

Never/Rarely Sometimes Often Usually/Always

12. **If there is good food at a party, I will continue eating even after I am full.**

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

13. **If there are leftovers that I like, I take a second helping even though I am full.**

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

14. **When I eat at all you can eat buffets, I tend to overeat.**

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

15. **I stop eating when I am full even when eating something I love.**

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

16. **When a restaurant portion is too large, I stop eating when I am full.**

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

17. **When I am eating one of my favorite foods, I do not recognize when I have had enough.**

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

18. **At a party with a lot of good food, I notice when it makes me want to eat more than I should**.

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

19. **If it does not cost much more, I get the larger size food or drink regardless of how hungry I feel.**

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

20. **I snack without noticing that I am eating.**

1 2 3 4
Never/Rarely Sometimes Often Usually/Always

CQ [Indicate Y/N]

1. I am trying to change my eating behavior.
2. It is important for me to change my eating behavior.
3. I could change my eating behavior.

The following questions will be provided after orientation to the app.

App Use

"What are your initial thoughts about the mindful eating app?" [Open responses]

"Do you currently use any apps daily?" [Y/N]

"How often do you use smartphone apps in your everyday life for your health?" [Open responses]

"What apps have you used within the past month?" [Open response. Give some examples of categories, i.e., diet or fitness apps, if student does not already mention those]

"What are the functions of these apps?" [Open response]

"Why were you interested in participating in this study?" [Open response]

"Would you tell other people that you are using this app? Why or why not?" [Open response]

"How comfortable would you feeling using this app in social contexts? For example, when you're out the eat or around friends or at home with a roommate or partner? [Open response]

TPBQ

Please indicate your response to the following items.

1. Using the mindful eating app at least 3 times per day for the next 4 weeks would be helpful.

   Unhelpful: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Helpful

   Easy: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Difficult

2. Most people who are important to me use mental health apps daily or frequently.

   Disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Agree

3. Most people like me use mental health apps.

   Unlikely: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Likely

4. I am confident that I can use the mindful eating app at least 3 times per day for the next 4 weeks.

   False: 1 : 2 : 3 : 4 : 5 : 6 : 7 : True

5. Using the mindful eating app at least 3 times per day for the next 4 weeks is up to me.

   Disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Agree

6. I intend to use the mindful eating app at least 3 times per day for the next 4 weeks.

   Unlikely: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Likely

Within the past month, I have used an app for my eating behavior daily.

False: 1 : 2 : 3 : 4 : 5 : 6 : 7 : True

Time 2 Questionnaire

Indicate your current estimated weight (in pounds) and height (in inches) [Open response].

DRS

We are interested in assessing restrictive eating. Restrictive eating occurs any time you intentionally eat less than seems appropriate for the situation out of concern for your body shape and/or weight. I am going to give you a few examples of what I mean by restrictive eating.

- Restrictive eating can mean eating an amount of food that most others would think is too little. For example, eating an apple for dinner or fasting all day could be considered restrictive eating.
- Restrictive eating can mean eating far less than others in a similar situation. For example, eating a diet frozen meal at Thanksgiving dinner with family could be considered restrictive eating.
- Restrictive eating can mean eating less than is appropriate for your body size or hunger level. For example, if you are very hungry and you eat only a small salad for dinner, this could be considered restrictive eating.

Have there been any times within the past month when you have eaten in this manner because you were concerned about your body shape and/or weight? [Indicate Y/N]

CAMS-R

Please respond to each item by marking one box per row		Rarely/Not at All	Sometimes	Often	Almost Always
CAMS-R1	It is easy for me to concentrate on what I am doing.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R3	I can tolerate emotional pain.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R4	I can accept things I cannot change.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R5	I can usually describe how I feel at the moment in considerable detail.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R6	I am easily distracted. (R)	☐ 4	☐ 3	☐ 2	☐ 1
CAMS-R8	It's easy for me to keep track of my thoughts and feelings.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R9	I try to notice my thoughts without judging them.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R10	I am able to accept the thoughts and feelings I have.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R11	I am able to focus on the present moment.	☐ 1	☐ 2	☐ 3	☐ 4
CAMS-R12	I am able to pay close attention to one thing for a long period of time.	☐ 1	☐ 2	☐ 3	☐ 4

EDE-QI

Some questions ask about (1) eating what most people would regard as an unusually large amount of food and (2) feeling a sense of having lost control while eating.

1. An unusually large amount of food is something that most people would feel is more than a large meal.

2. A sense of having lost control while eating might be experienced as feeling driven or compelled to eat; not being able to stop eating once you have started; not being able to keep yourself from eating large amounts of certain kinds of food in the first place; or giving up on even trying to control your eating because you know that, no matter what, you are going to overeat.

Here are some examples:

After work one evening, Dina ate two pieces of chicken, a 16-ounce package of frozen vegetables, three cups of rice, three fourths of a coffee cake, and a piece of fruit. This is an unusually large amount of food. While she ate Dina felt completely out of control, ate more quickly than usual, and ate until she felt uncomfortably full. Afterwards, Dina was very upset about how much she had eaten, and said she felt depressed, guilty, and hated herself for giving in to the urge to binge.

Several times a week JoAnne ate lunch at McDonald's with two coworkers. Her usual order was a Big Mac, a fish fillet sandwich, two large orders of fries, and a large chocolate shake. This is an unusually large amount of food. Although she ate somewhat more than her friends did and knew she was eating a lot of high-fat food, she did not feel out of control while eating or feel upset afterwards about how much she had eaten.

For lunch one day, Joseph had a ham and cheese sandwich with mayonnaise on a roll, a small bag of potato chips, a candy bar, and a diet coke. Although this was a large meal, it was not unusually large. However, Joseph felt out of control because he had planned to have turkey on whole wheat with lettuce and tomato plus a piece of fruit for dessert but changed his mind at the last minute while ordering his sandwich.

Carol ate two donuts someone brought to the office one morning. She had started a diet that day and planned to skip breakfast. Carol initially refused the donuts, but after everyone else had gone to a meeting she snuck into the break room and very quickly ate the donuts, so no one would see her eating. She felt very guilty and ashamed afterwards and hated feeling so out of control of her eating, resolving to start dieting again the next day. Although Carol felt bad about eating the donuts, this was not an unusually large amount of food.

Dina and JoAnne ate an unusually large amount of food, but Joseph and Carol did not. Dina, Joseph, and Carol felt a loss of control while eating, but JoAnne did not. Of the four, Dina is the

only one who actually had a binge episode, which includes both (1) eating an unusually large amount of food and (2) feeling a sense of having lost control while eating.

“Over the past 28 days, how many times have you eaten what other people would regard as an unusually large amount of food (given the circumstances)?” [Indicate number of times binges occurred in the past 28 days]

“On how many of these times did you have a sense of having lost control over your eating (at the time that you were eating)?” [Indicate number of times loss of control occurred for each episode of bingeing]

“Over the past 28 days, on how many days have such episodes of overeating occurred (i.e., you have eaten an unusually large amount of food and have had a sense of loss of control at the time)?” [Indicate number of days overeating occurred]

BES

Below are groups of statements about behavior, thoughts, and emotional states. Please indicate which statement in each group best describes how you feel:

1. ○ I do not think about my weight or size when I’m around other people.
   ○ I worry about my appearance, but it does not make me unhappy.
   ○ I think about my appearance or weight and I feel disappointed in myself.
   ○ I frequently think about my weight and feel great shame and disgust.
2. ○ I have no difficulty eating slowly.
   ○ I may eat quickly, but I never feel too full.
   ○ Sometimes after I eat fast I feel too full.
   ○ Usually I swallow my food almost without chewing, then feel as if I ate too much.
3. ○ I can control my impulses towards food.
   ○ I think I have less control over food than the average person.
   ○ I feel totally unable to control my impulses toward food.
   ○ I feel totally unable to control my relationship with food and I try desperately to fight my impulses toward food.
4. ○ I do not have a habit of eating when I am bored.
   ○ Sometimes I eat when I am bored, but I can often distract myself and not think about food.
   ○ I often eat when I am bored, but I can sometimes distract myself and not think about

food.

- I have a habit of eating when I am bored and nothing can stop me.

5. Usually when I eat it is because I am hungry.
   - Sometimes I eat on impulse without really being hungry.
   - I often eat to satisfy hunger even when I know I've already eaten enough. On these occasions I can't even enjoy what I eat.
   - Although I am not physically hungry, I feel the need to put something in my mouth and I feel satisfied only when I can fill my mouth (for example with a piece of bread).
6. After eating too much:
   - I do not feel guilty or regretful at all.
   - I sometimes feel guilty or regretful.
   - I almost always feel a strong sense of guilt or regret.
7. When I'm on a diet, I never completely lose control of food, even in times when I eat too much.
   - When I eat a forbidden food on a diet, I think I've failed and eat even more.
   - When I'm on a diet and I eat to much, I think I've failed and eat even more.
   - I am always either binge eating or fasting.
8. It is rare that I eat so much that I felt uncomfortably full.
   - About once a month I eat so much that I felt uncomfortably full.
   - There are regular periods during the month when I eat large amounts of food at meals or between meals.
   - I eat so much that usually, after eating, I feel pretty bad and I have nausea.
9. The amount of calories that I consume is fairly constant over time.
   - Sometimes after I eat too much, I try to consume few calories to make up for the previous meal.
   - I have a habit of eating too much at night. Usually I'm not hungry in the morning and at night I eat too much.
   - I have periods of about a week in which I imposed starvation diets, following periods of when I ate too much. My life is made of binges and fasts.
10. I can usually stop eating when I decide I've had enough.
    - Sometimes I feel an urge to eat that I cannot control.
    - I often feel impulses to eat so strong that I cannot win, but sometimes I can control

myself.

- I feel totally unable to control my impulses to eat.

11. I have no problems stopping eating when I am full.

- I can usually stop eating when I feel full, but sometimes I eat so much it feels unpleasant.
- It is hard for me to stop eating once I start, I usually end up feeling too full.
- It is a real problem for me to stop eating and sometimes I vomit because I feel so full.

12. I eat the same around friends and family as I do when I am alone.

- Sometimes I do not eat what I want around others because I am aware of my problems with food.
- I often eat little around other people because I feel embarrassed.
- I'm so ashamed of overeating, I only eat at times when no one sees me. I eat in secret.

13. I eat three meals a day and occasionally a snack.

- I eat three meals a day and I usually snack as well.
- I eat many meals or skip meals regularly.
- There are times when I seem to eat continuously without regular meals.

14. I don't think about impulses to eat very much.

- Sometimes my mind is occupied with thoughts of how to control the urge to eat.
- I often spend much time thinking about what I ate or how not to eat.
- My mind is busy most of the time with thoughts about eating. I seem to be constantly fighting not to eat.

15. I don't think about food any more than most people.

- I have strong desires for food, but only for short periods.
- There are some days when I think of nothing but food.
- Most of my days are filled with thoughts of food. I feel like I live to eat.

16. I usually know if I am hungry or not. I know what portion sizes are appropriate.

- Sometimes I do not know if I am physically hungry or not. In these moments, I can hardly understand how much food is appropriate.
- Even if I knew how many calories I should eat, I would not have a clear idea of what is, for me, a normal amount of food.

IES-2

For each item, please circle the answer that best characterizes your attitudes or behaviors.

1. **I try to avoid certain foods high in fat, carbohydrates, or calories.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. **I have forbidden foods that I don't allow myself to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. **I get mad at myself for eating something unhealthy.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. **If I am craving a certain food, I allow myself to have it.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. **I allow myself to eat what food I desire at the moment.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. **I do NOT follow eating rules or dieting plans that dictate what, when, and/or how much to eat**.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. **I find myself eating when I'm feeling emotional (e.g., anxious, depressed, sad), even when I'm not physically hungry.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

8. **I find myself eating when I am lonely, even when I'm not physically hungry.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. **I use food to help me soothe my negative emotions.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. **I find myself eating when I am stressed out, even when I'm not physically hungry.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

11. **I am able to cope with my negative emotions (e.g., anxiety, sadness) without turning to food for comfort.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

12. **When I am bored, I do NOT eat just for something to do.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

13. **When I am lonely, I do NOT turn to food for comfort.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

14. **I find other ways to cope with stress and anxiety than by eating.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

15. **I trust my body to tell me when to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

16. **I trust my body to tell me what to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

17. **I trust my body to tell me how much to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

18. **I rely on my hunger signals to tell me when to eat.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

19. **I rely on my fullness (satiety) signals to tell me when to stop eating.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

20. **I trust my body to tell me when to stop eating**.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

21. **Most of the time, I desire to eat nutritious foods.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

22. **I mostly eat foods that make my body perform efficiently (well).**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

23. **I mostly eat foods that give my body energy and stamina.**

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

MEQ

For each item, please circle the answer that best characterizes your attitudes or behaviors.

1. **Before I eat I take a moment to appreciate colors and smells of food**.

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

2. **I notice when the food I eat affects my emotional state.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

3. **I taste every bite of food I eat.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

4. **When eating a pleasant meal, I notice if it makes me feel relaxed.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

5. **I appreciate the way my food looks on my plate.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

6. **I notice subtle flavors in the foods I eat.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

7. **I recognize when I am eating and not hungry.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

8. **I notice when foods and drinks are too sweet.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

9. **I recognize when food advertisements make me want to eat.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

10. **When I eat a big meal, I notice if it makes me feel heavy or sluggish.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

11. **I notice when I am eating from a dish of candy just because it is there.**

1	2	3	4

Never/Rarely	Sometimes	Often	Usually/Always

12. **If there is good food at a party, I will continue eating even after I am full.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

13. **If there are leftovers that I like, I take a second helping even though I am full.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

14. **When I eat at all you can eat buffets, I tend to overeat.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

15. **I stop eating when I am full even when eating something I love.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

16. **When a restaurant portion is too large, I stop eating when I am full.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

17. **When I am eating one of my favorite foods, I do not recognize when I have had enough.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

18. **At a party with a lot of good food, I notice when it makes me want to eat more than I should**.

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

19. **If it does not cost much more, I get the larger size food or drink regardless of how hungry I feel.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

20. **I snack without noticing that I am eating.**

1	2	3	4
Never/Rarely	Sometimes	Often	Usually/Always

CQ [Indicate Y/N]

1. I am trying to change my eating behavior.
2. It is important for me to change my eating behavior.
3. I could change my eating behavior.

TPBQ

Please indicate your response to the following items.

1. Using the mindful eating app at least 3 times per day for the past 4 weeks was helpful.

   Unhelpful: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Helpful

   Easy: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Difficult

2. Most people who are important to me use mental health apps daily or frequently.

   Disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Agree

3. Most people like me use mental health apps.

   Unlikely: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Likely

4. I am confident that I can continue to improve my eating skills by using the mindful eating app.

   False: 1 : 2 : 3 : 4 : 5 : 6 : 7 : True

5. Using a mindful eating app to improve my eating skills is up to me.

   Disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Agree

6. I intend to continue to use the mindful eating app to improve my eating behaviors.

   Unlikely: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Likely

7. Within the past month, I have used an app daily for my eating behavior for at least one month.

   False: 1 : 2 : 3 : 4 : 5 : 6 : 7 : True

MOBILE APP USE TIMELINE CALENDAR INSTRUCTIONS

To help us evaluate your mobile app use for purposes other than work or school, we need to get an idea of what your mobile app use was like in the past _28__ days. To do this, we would like you to fill out the attached calendar.

 Filling out the calendar is not hard!

 Try to be as accurate as possible.

 We recognize you won't have perfect recall. That's OKAY.

WHAT TO FILL IN

 The idea is to put a number in for each day on the calendar.

 On days when you did not use the mindful eating app, you should write a "0".

 On days when you did use the mindful eating app, you should write in the total number of hours you think you were using the app.

 We want you to record your app use on the calendar using minutes.

 It's important that something is written for every day, even if it is a "0".

YOUR BEST ESTIMATE

 We realize it isn't easy to recall things with 100% accuracy.

 If you are not sure whether you were using the app for 5 or 10 minutes or if you weren't sure whether you were using it on a Thursday or a Friday, give it your best guess! What is important is that 1 or 2 minutes is very different from 7 or 8 minutes. The goal is to get a sense of how frequently you accessed the mindful eating app, how long you think you were using it at a given time, and your patterns of mindful eating app use (e.g., whether you spent very little time using it during the week but several minutes on the weekends).

HELPFUL HINTS

 If you have an appointment book or calendar on your smartphone you can use it to help you recall your app use.

 Holidays such as Thanksgiving and Christmas are marked on the calendar to help you better recall. Also, think about how much you used the app on personal holidays & events such as vacations.

 If you have regular app use patterns you can use these to help you recall your use. For example, you may have a daily or weekend/weekday pattern, or use the app more when you're alone versus eating with other people.

COMPLETING THE CALENDAR

 A blank calendar is attached. Write in the number of minutes that you used the app.

APPENDIX: INTERVIEWS

Student Interview Guide

Why did you choose to participate in this study?

Eating Behavior Questions

When did you first learn that you binge eat?

When did your bingeing start?

For what reasons do you think you binge?

How do you feel about your bingeing? Is this something that you want to or have tried to change?

What do you normally do to help with your binge eating?

Prior to this study, what do you know about mindfulness?

As a result of this study, what did you learn about mindfulness?

Prior to this study, what do you know about mindful eating?

As a result of this study, what did you learn about mindful eating?

App Use

What were your goals for using the mindful eating app?

How have you used this app over the past month?

How practical was it to use the app as recommended?

What were the challenges you faced in using the app as recommended?

What changes have you noticed in your eating behavior after using this app? Have you noticed any other changes?

What were your experiences like in using this app in social contexts? For example, eating out with friends or at home with a roommate or partner?

Opinions of the Mindful Eating App

How have your thoughts changed about using this app for reducing binge eating since you were first introduced to it?

What features and/or improvements would you like to see in this app that would assist you in your eating behavior?

What are the ways that this app might [or might not be] useful to you?

For what reasons might you continue using this app?

For what reasons might you discontinue using this app?

Closing Questions

Would you recommend this app?

Would you pay for this app? How much?

Is there anything else that you would like to tell me about the app that we did not already cover?

Clinician Interview Guide

Current Treatment Practices

What disordered eating behaviors do your clients/patients present with?

As an expert in the field of disordered eating, what is your theoretical orientation?

How familiar are you with the concept of mindfulness as an approach to treating binge eating? Please explain.

How familiar are you with concepts of mindful eating as an approach to treating binge eating? Please explain.

How do you apply mindful eating approaches in working with your clients?

App Use for Treatment

Do you currently use or recommend any eating apps and/or any apps in general to your patients/clients/students you consult with? Please specify the app(s), how you use it, and/or why you recommend it.

What are the strengths of the "Am I hungry?" Mindful Eating Virtual Coach app?

What are the weaknesses of the app?

What are the potential advantages of having your clients or students you consult with use this app?

What are the disadvantages or limitations of having your clients or students you consult with use this app?

In what ways would this app be useful for your clients? Please explain.

Clinical Implementation

What do you think of the scientific reliability/credibility/trustworthiness of this app?

How do you think the mindful eating concepts are represented in this app?

How could this app be improved?

What capabilities of the app would you like to see that would complement/benefit your current treatment or consultative approach?

For what reasons would you implement this into your practice?

For what reasons wouldn't you implement this into your practice?

Closing Questions

Would you pay for this app for your clients to use?

How much would you pay for the app yourself?

How much do you think your clients or students you consult with would be willing to pay?

Is there anything that you would like to tell me that we have not covered that you think would be important for people to know?

APPENDIX: PSYCHOEDUCATION

Diets Are Like Antacids: It's Time for a Paradigm Shift
By Michelle May, M.D.
Diets are like antacids. Let me explain…

When I was in medical school just a few decades ago, peptic ulcer disease (PUD) was believed to be caused by stress and excess stomach acid. The treatment was a bland diet and antacids, which didn't work very well. Later powerful acid blockers were developed. These treatments worked better, but the ulcers frequently relapsed and required repeated or chronic treatment.

Despite these ultimately ineffective therapies, the discovery by Barry Marshall and Robin Warren that most cases of PUD were caused by a bacterial infection was initially met with great skepticism, defensiveness and criticism. They continued to challenge the dogma, even going so far as to intentionally infect themselves with H. pylori. It was well over a decade before it was widely accepted that PUD could be cured with a single round of triple therapy.

Aha! No wonder the old PUD treatment didn't work: We were treating the symptoms, not the cause. Marshall and Warren **won a Nobel Prize in 2005** for their persistence, and millions of PUD sufferers have finally been cured.

We're at a similar crossroads with dieting, the antacids of our day. Diets temporarily treat symptoms, not causes; diets temporarily change behaviors, not the source of those behaviors. The "treatment" paradigm is flawed, yet so pervasive that millions of people are trapped in outdated beliefs and behaviors, despite all of the evidence that it's not moving the majority toward healthier, happier, more vibrant lives.

There's endless, tiresome debate about which diet works better, but none have shown a permanent cure. Some even resort to blaming or subtly shaming dieters (or themselves) when they quit the diet or regain weight, even though **that is the known outcome** for the vast majority of people.

I've been speaking and writing about a non-restrictive, "non-diet" approach since 1999 when I founded the **Am I Hungry® mindful eating workshops**. In the book based on this program, **Eat What You Love, Love What You Eat** and my latest book, **Eat What You Love, Love What You Eat with Diabetes**, I guide readers through this paradigm shift one step at a time. I'll be the first to admit that although the concepts are simple, it's not always easy. Paradigms are notoriously difficult to see through, much less break through. Yet countless workshop participants and readers have changed the way they think about eating — even after decades of recurrent or chronic yo-yo dieting.

I've seen many other hopeful signs that the shift is finally taking place. Many of my colleagues are now helping their patients and clients learn mindful eating skills rather than teaching restrictive rule-following and preaching willpower and motivation.

In fact, the mantra, "diets don't work," is growing louder. However, in an effort to catch the rising tide, many diets now claim they are "not a diet." But to the trained eye, they clearly are. Just saying so doesn't make it so, and therefore the results will be the same.

It's understandably difficult to see the need for a radical shift, particularly if your reputation, life's work and, in some cases, financial security depend on keeping people trapped in the eat-repent-repeat cycle. I don't think that most who promote various forms of dieting are malicious or ignorant; it's just that restrictive eating is so deeply embedded in our cultural norms that they can't see the difference.

Below are some of the telltale signs that a plan, program, or "lifestyle change" is actually a diet, even if it says it's not. If you feel skeptical, defensive or critical as you read this list, take note; your paradigm is showing.

- The focus is on weight loss rather than health
- You're supposed to write down everything you eat
- There is weighing, measuring or counting involved: calories, exchanges, points, grams, pounds, etc.
- You have to plan your meals days in advance or follow a predetermined meal plan
- Foods are labeled as good/bad, or allowed/not allowed
- "They" say you can "eat what you love," but then they tell you what, when or how much
- Food is provided for you
- You eat substitutes for real food (shakes, bars, supplements)
- Some are based on an addiction model and require restriction or avoidance
- Alternatively, you're "allowed" to "eat whatever you want," but the diet or expert determines the limits for you
- Certain foods are considered indulgences, treats or splurges, and therefore are made special and even more desirable
- There are "cheat" days or "free" days
- There are arbitrary rules, like "don't eat after seven" or "eat every three hours"
- Minutes of exercise are converted to calorie or food equivalents
- Exercise becomes punishment for eating; it is used to earn food or pay penance for eating something "bad"
- There is a weight loss phase and a maintenance phase (in other words, you'll be on this diet for the rest of your life)
- Rules, willpower, incentives, tricks and motivation help temporarily, but repeated "treatment" is necessary to maintain the results
- While you are "on" it, you find yourself thinking about food frequently
- You feel guilty for certain choices
- You crave or miss certain foods
- You have to avoid certain places, people or events because of the "temptations"
- When you eventually "give in" and eat the foods you miss or crave, you find yourself overeating those foods
- You resort to eating differently in private than you do in public to avoid comments, judgment and criticism
- You overdiet the way you overeat: thinking and talking about food all the time
- There are subtle implications that you can't be trusted with food so you need these externally-imposed limits

In short, diets fail because they exert external control on what was once a natural, internal process. (Think of the way a baby eats.) Diets focus on what people "should" eat without addressing why they eat in the first place. Dieters often don't learn to recognize their non-hunger eating triggers or effectively meet their true physical, emotional and social needs. As a result, the overeating cycle is never really broken.

This outdated and ineffective diet paradigm is a result of **dichotomous thinking** that presumes that if we don't control behavior, it will be out of control.

But there is a third radical option: People can relearn to be in charge instead.

When nutrition, fitness, and self-care are approached with a non-diet, mindful eating paradigm, people are able to relearn to balance eating for enjoyment with eating for health, rediscover joy in physical activity and meet their true needs in more fulfilling, satisfying ways. Mindful eating requires awareness, intention, trust, new skills, practice — and revolutionary thinking.

What's the alternative? Argue for an outdated paradigm that obviously doesn't work? Just continue to treat the symptoms? I've moved on. How about you?

https://amihungry.com/articles/diets-like-antacids-time-paradigm-shift/

How to Turn Mindful Eating Into a Diet

By Michelle May, M.D.

Mindful eating is rapidly increasing in popularity as a common-sense approach to resolving myriad eating-related issues. It is particularly effective for breaking the "eat-repent-repeat" cycle that so often results from restrictive eating. Ironically, many people who are jumping on the mindful eating bandwagon don't understand the subtle yet meaningful differences between mindful eating and typical diets. They filter mindful eating concepts through the well-established **diet paradigm** and simply turn it into a mindful eating diet–with the same predictable results!

To highlight some of the most common mistakes, here's how to turn mindful eating into a diet–and what to do instead.

1. Make new diet-y rules like "Only eat when you're hungry" and "Always stop when you are full."

Why: Feeling guilty if you eat when you're not hungry or judging yourself for eating past a 5 or a 6 is no different from dieting. This form of restrictive eating will lead to the same eat-repent-repeat cycle.

Instead: When you feel like eating, pause to ask yourself, "Am I hungry?"–not to decide if you're *allowed* to eat, but to recognize *why* you want to. With this awareness, you can freely choose whether to **eat or not**.

2. Think about mindful eating in terms of "Tips and Tricks" instead of a practice.

Why: Tips like "Chew each bite 20 times" do not lead to increased mindfulness, just boredom! And while we're all used to headlines like "5 Tricks for Sticking to Your Diet," that short term "magical" approach leads to short term behaviors.

Instead: Unlike dieting which typically becomes harder to sustain over time, eating mindfully becomes more natural with **practice**. As you learn how to attend to your physical sensations, thoughts, and feelings over time, you discover that you have an inner expert who guides you naturally toward balance, variety, and moderation.

3. Use mindful eating to resist the foods you crave.

Why: What you resist, persists!

Instead: Mindfulness teaches you to allow whatever you notice to just be. Perhaps you notice that you are craving a favorite food from your childhood. Rather than resisting it, you **become curious about the craving**. What does the craving feel like? What, specifically, do you desire about that food? What associations do you have with that food? Do those associations give you any **hints about your underlying needs**? How might it feel to eat that food? How might it feel if you don't? And so on.

4. Allow yourself to indulge in your favorite treats by savoring just one or two bites.

Why: This seemingly **permissive advice is still restrictive**! When you have to have "permission" to eat a favorite food as long as you follow specific rules, these subtle messages feed unconscious feelings of judgment and deprivation that may lead to paradoxical overeating.

Instead: Don't set arbitrary boundaries around eating that ultimately lead to "cheating" and guilt. Mindful eating helps you learn to trust your internal expert to **eat what you love and love what you eat**.

5. Focus on weight loss.

Why: One simple definition of mindfulness is nonjudgmental awareness of the present moment. You *cannot* change your weight in the present moment so focusing on weight loss keeps you focused on something off in the future.

Instead: Become more mindful of your **physical cues of hunger and satiety** and how you feel when you eat different types and amounts of food. Tune in to the appearance, aromas, flavors, and textures of the foods you select. Notice how you feel when you move your body. Use your body's cues to practice self-care, such as resting when your body is tired, taking a break when you feel stressed, connecting with others when you feel bored or lonely, and so on. Moment by moment, notice the effects of the choices you make and allow that awareness to affect the choices you make in the future.

http://amihungry.com/michellemaymd/articles/mindful-eating-diet/