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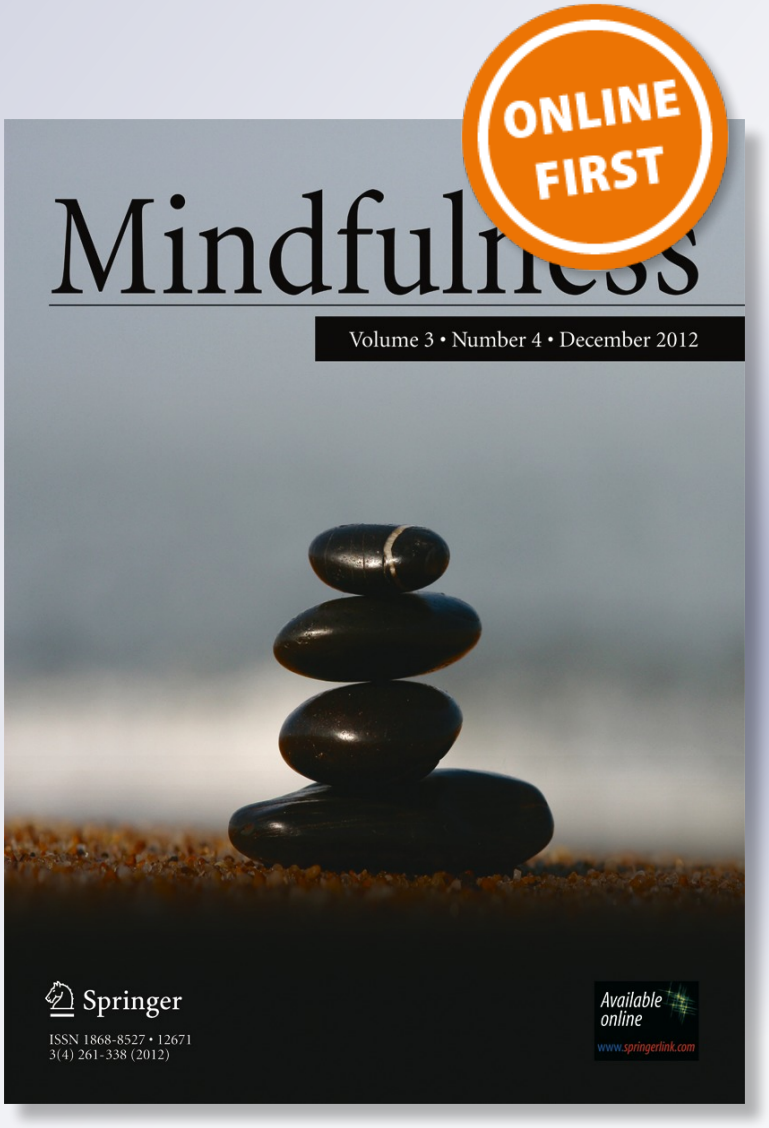

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ORIGINAL PAPER

Mindfulness-Based Eating Awareness Training (MB-EAT) for Binge Eating: A Randomized Clinical Trial

Jean Kristeller · Ruth Q. Wolever · Virgil Sheets

Abstract Binge eating is characterized by significant imbalance in food intake regulation and is often comorbid with obesity and depression. Mindfulness-based approaches may reduce compulsive overeating, address associated behavioral and emotional dysregulation, and promote internalization of change. This randomized trial explored the efficacy of Mindfulness-Based Eating Awareness Training (MB-EAT), a 12-session group treatment, in comparison to a psychoeducational/cognitive–behavioral intervention (PECB) and a wait list control. MB-EAT incorporates sitting and guided mindfulness practices to cultivate greater awareness of hunger and fullness cues, sensory-specific satiety, and emotional and other triggers for eating. The two-site study randomized 150 overweight or obese (body mass index=40.3) individuals (12 % men; 14 % African-American/Hispanic; average age=46.6 years), 66 % of whom met the full DSM-IV-R criteria for binge eating disorder (BED). Compared to the wait list control, MB-EAT and PECB showed generally comparable improvement after 1 and 4 months post-intervention on binge days per month, the Binge Eating Scale, and depression. At 4 months post-intervention, 95 % of those individuals with BED in MB-EAT no longer met the BED criteria vs. 76 % receiving PECB; furthermore, binges that occurred were likely to be significantly smaller. Amount of mindfulness practice predicted improvement on a range of variables, including weight loss ($r=-0.38$, $p<0.05$). Results suggest that MB-EAT decreased binge eating and related symptoms at a clinically meaningful level, with improvement related to the degree of mindfulness practice.

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Introduction

Mindfulness-based treatment approaches are increasingly recognized as having value in addressing a wide range of dysregulation disorders, including anxiety and depression, and addictions (Bowen et al. 2009; Davis and Hayes 2011; Grossman et al. 2004; Hofmann et al. 2010; Kabat-Zinn et al. 1992; Keng et al. 2011; Marlatt and Kristeller 1999; Walsh and Shapiro 2006). In addition, while mindfulness-based interventions have been applied clinically to eating-related issues (Bays 2009; Kabatznick 1998), limited empirical work has been reported (Dalen et al. 2010; Kristeller and Hallett 1999; Miller et al. 2012; Tapper et al. 2009). Multiple mechanisms are believed to underlie the effects of mindfulness meditation on mood and other dysregulation disorders, including the following: cultivating awareness of internal experience, interrupting highly conditioned patterns, integrating higher-level processes, decreasing stress reactivity, and empowering a sense of control and self-acceptance (Bishop et al. 2004; Kristeller 2007; Lynch et al. 2006; Siegel 2010; Teasdale et al. 1995; Walsh and Shapiro 2006; Williams 2010). Such mechanisms are clearly applicable to addressing the dysregulation of affect, cognition, physiology, and behavior observed in binge eating and obesity (Fairburn and Wilson 1993; Kristeller et al. 2006; Kristeller and Wolever 2011; Stunkard et al. 2003; Wolever and Best 2009). Binge eating disorder (BED) is marked by poor self-esteem (Nauta et al. 2000), eating to handle emotional distress, extreme dysregulation of interoceptive awareness, appetite, and satiety mechanisms (Craighead and Allen 1995; McIntosh et al. 2007), and over-reactivity to food cues (Sobik et al. 2005) in amplified versions of more common patterns of mindless or imbalanced eating (Capaldi 1996; Wansink 2007).

Current treatments for binge eating, including cognitive–behavioral approaches and interpersonal therapy, have shown considerable promise (Agras et al. 1995; Wilfley et al. 1993, 2002), but may not be equally effective for all individuals, nor do they necessarily engage all of the underlying mechanisms involved (Sysko et al. 2010; Wilfley et al. 2010; Wilson et al. 2010). Diet-based treatments often positively impact eating patterns as well as weight (Linde et al. 2004; Marcus et al. 1988; Sherwood et al. 1999; Wilfley et al. 1993, 2003), but may further separate individuals from their capacity to register and respond to internal signals (Eldredge et al. 1997; Wood and Neal 2007).

Mindfulness principles have informed other approaches to eating regulation. Linehan's (1993) Dialectical Behavior Therapy has been modified to use with BED (Telch et al. 2001), with participants maintaining substantial improvement at the 6-month follow-up, while Appetite Awareness Training (AAT) (Allen and Craighead 1999; Craighead and Allen 1995) focuses on improving hunger and fullness awareness, without using mindfulness training per se. Tapper et al. (2009) have drawn on Acceptance and Commitment Therapy (Hayes et al. 1999) to incorporate mindfulness into the treatment of binge eating. Timmerman and Brown (2012) has successfully adapted elements of Mindfulness-Based Eating Awareness Training (MB-EAT) for use with restaurant meals, showing weight loss and improved dietary patterns in perimenopausal women. Finally, cultivating mindfulness may also counteract the adverse effects of thought suppression associated with BED (Barnes et al. 2011). Multiple clinical programs that incorporate mindfulness principles have thus shown positive outcomes relative to eating regulation, yet none of them have systematically been designed to address a broad range of regulatory processes in food intake dysregulation. Furthermore, to date, no empirical trials have been reported on programs that predominantly focus on the application of mindfulness to food intake regulation in individuals with more extreme types of significant disordered eating, nor with an active control comparison condition.

MB-EAT (Kristeller and Hallett 1999; Kristeller et al. 2006; Kristeller and Wolever 2011) draws on the theory and research on the clinical value of mindfulness meditation (Kabat-Zinn 1990; Segal et al. 2002), along with the research literature on food intake regulation (Raynor and Epstein 2001; Rolls 2007) and emotional dysfunction in BED and other eating disorders (Goldfield et al. 2008). The MB-EAT program incorporates traditional mindfulness meditation techniques (Kabat-Zinn 1990) as well as guided meditation practices, to address eating-related self-regulatory processes including emotional vs. physical hunger triggers, gastric and sensory-specific satiety (SSS), food choice, and emotional regulation pertinent to self-concept and stress management. In particular, the MB-EAT program is based on models of self-regulation that emphasize the value of helping individuals reengage natural processes through cultivating awareness of internal physical signals (Schwartz 1975), innate appetite regulatory processes, psychological distinctions, such as "liking" vs. "wanting" (Finlayson et al. 2007), and higher-level cortical processes over emotionally driven or reactive motivational systems (Appelhans 2009).

A core component of mindful eating as used in the MB-EAT program is the focus on the processes involved in SSS or the well-documented phenomena by which taste buds decrease their sensitivity to taste after relatively small amounts of any particular food (Heatherington and Rolls 1996; Rolls 2006). Tuning into the immediate experience of taste—and then noticing when the pleasure or satisfaction from a particular food begins to decrease—assists individuals to maximize pleasure from eating much smaller portions, even of favorite foods. By doing so, individuals learn to notice their taste buds becoming satiated, to reevaluate their actual "liking" vs. "wanting" patterns, and to interrupt the typical restraint–craving–bingeing cycle. Consistent with a self-regulation model of mindfulness that focuses on reengaging psychobiological feedback systems, this process of heightened, nonreactive awareness of hunger and satiety cues may be reregulating sensitivity in reward areas of the brain associated with obesity (Stice et al. 2009, 2010a, b) and those identified in addiction models of obesity and BED (Appelhans 2009; Cassin and von Ranson 2007).

The original proof-of-concept study, using a nonrandomized extended baseline design (Kristeller and Hallett 1999), suggested that a mindfulness-based eating intervention can have marked, immediate, and continued impact on episodes of binge eating and associated characteristics. Moreover, that study showed that the degree to which women engaged in mindful eating meditation practice strongly predicted overall improvement. Therefore, the primary purpose of the current study was to extend this pilot work in a larger sample with similar eating and weight issues in a randomized trial comparing MB-EAT against a wait list control and an active psychoeducational treatment group that incorporated cognitive–behavioral principles (PECB). The paper further addresses possible underlying mechanisms that may be involved in the application of mindfulness approaches in reregulating appetite and food intake.

Method

Participants

Participants included 150 individuals (13 % minority, including 20 African-Americans, 1 Hispanic; 12 % men; mean age=46.55 years, range of 20–74 years; body mass index [BMI]=40.26, range of 26–78; weight=242.70 lbs) recruited in Durham, NC and Terre Haute, IN. See Fig. 1

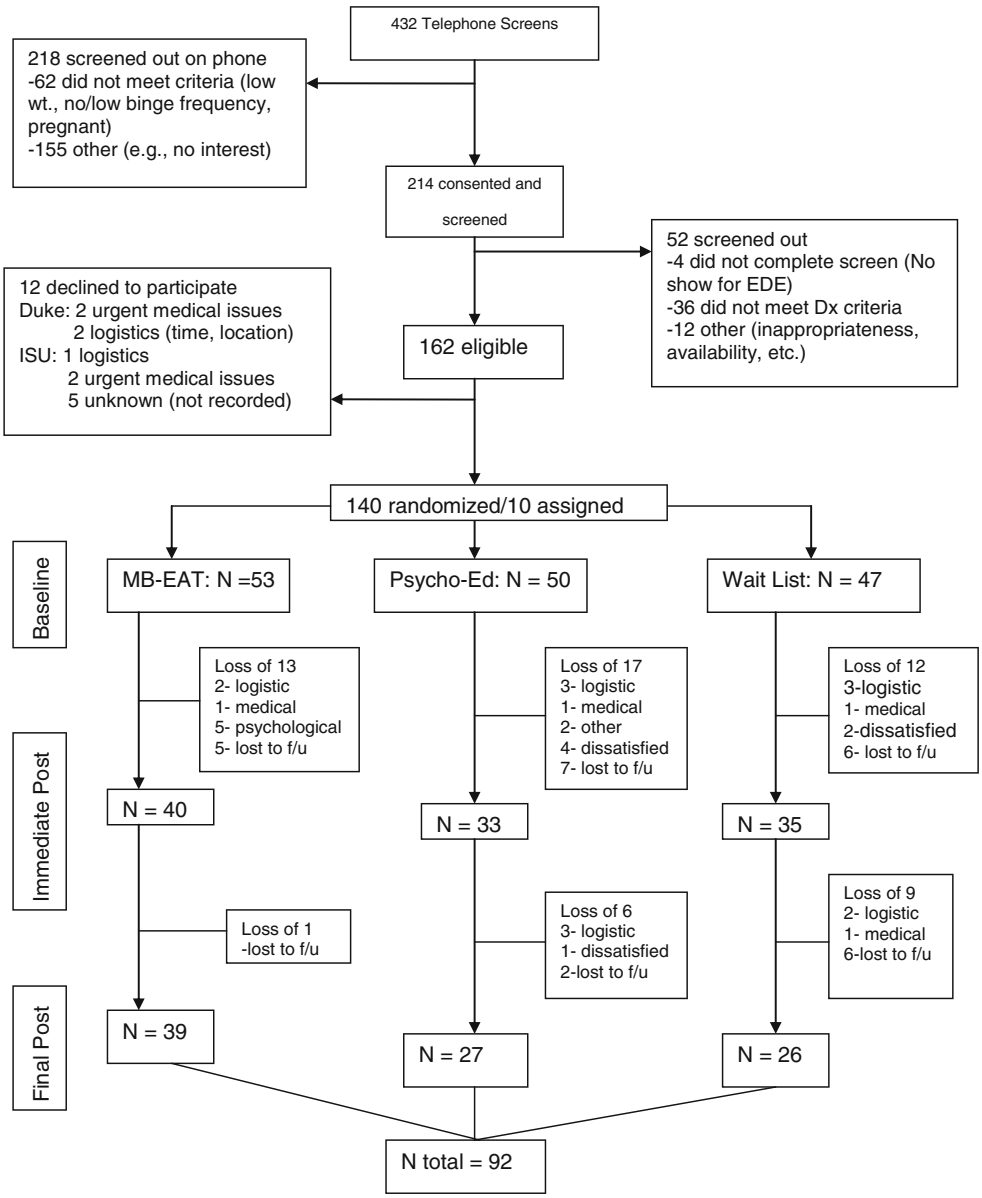

Fig. 1 Consort flow sheet

for the consort flow sheet. Participants were solicited through local advertisements that requested participation from individuals who binge eat and were concerned about their weight, but did not mention mindfulness or weight loss. After an initial phone interview, screening in person included the Eating Disorder Examination, 14th edition (EDE; Fairburn and Wilson 1993) and a semistructured interview assessing weight loss efforts, medical and psychiatric status, and previous or current use of meditation-based practices. Additional psychiatric information was evaluated using the Symptom Checklist-90 (SCL-90; Derogatis and Cleary 1977; Derogatis and DellaPietra 1994) and the Beck Depression Inventory II (BDI) (Steer et al. 1999; Beck et al. 1996), followed by a semistructured interview. Individuals who reported any suicidal symptomology of concern or other psychiatric symptoms potentially likely to interfere with group participation or follow-up (e.g., psychotic symptoms; drug/alcohol abuse; or unstable medication use) were screened out. Exclusion on the basis of comorbid psychiatric diagnoses was purposefully not done in order to include a broader sample that was more generalizable to typical BED populations. Two thirds (n=100) met the full DSM-IV criteria for BED at baseline; another group of individuals (n=11) reported somewhat fewer binges per month (five to seven) but met all other BED criteria, that supports this level as compatible with a BED diagnosis (Wilson and Sysko 2009). Of the rest (n=39), most met the behavioral criteria (two binges per week) for BED, but reported subclinical levels of distress generally due to a sense of having "given up" struggling or to viewing their bingeing behavior as socially acceptable, even if not controllable. Exclusion criteria included previous regular meditation practice; relevant unstable

medical conditions (e.g., diabetes likely to require medication changes); concurrent participation in a weight loss program or psychotherapy focused on weight or eating issues; pregnant or breast-feeding (due to weight fluctuation); or purging or laxative abuse within 6 months that would meet the criteria for purging bulimia. All study procedures were approved by each site's institutional review board, and all participants provided informed consent.

Study Personnel and Treatment Integrity

Study personnel who administered the EDE were clinically supervised by the site's principal investigators (PIs; both licensed clinical psychologists) and/or staff who had been trained by Denise Wilfley, Ph.D. At Indiana State University, interviewers were doctoral psychology students under supervision; at Duke, they were master's level licensed mental health practitioners. Groups were co-led by two facilitators, at least one of whom was a licensed mental health provider (doctoral or master's level); the other facilitator was either a supervised clinical or counseling psychology doctoral student or another master's level professional with relevant experience. Manuals for both interventions were highly structured, detailing activities within 10- to 20-min segments. All group sessions were taped and a subset was reviewed by site PIs to confirm that manuals were followed and that mindfulness-based practices were not discussed in the PECB condition.

Design

One hundred forty participants were randomized to three conditions: (1) the MB-EAT intervention (n=50); (2) a psychoeducational and cognitive–behavioral (PECB) comparison condition (n=48); or (3) a wait list control (n=42). Ten other participants (n=3, 2, and 5 per condition) were assigned to conditions based on logistic constraints (i.e., the only night they could attend meetings); all such assignments occurred prior to the individual knowing which group met on a given night and after all baseline assessments were completed. Sample size was determined to achieve 80 % power utilizing estimated effect sizes for binge frequency from Kristeller and Hallett (1999) and Wilfley et al. (1993). Initial posttreatment assessment point was at 1 month after weekly sessions due to requirements for the EDE. The first cohort was reassessed at 3 and 6 months posttreatment; due to funding constraints, subsequent cohorts were assessed at 1 and 4 months. For the current paper, the 6-month follow-up data from cohort 1 was treated as equivalent to the 4-month data, the terminal point for other cohorts.

Procedure

After baseline assessment, eligible participants were assigned to treatment by random number drawing approximately 2 weeks prior to the initial treatment session. Participants were provided a brief individual orientation to their assigned treatments. In our pilot research in the Terre Haute community (Kristeller and Hallett 1999), we found that this contact, which included providing an information sheet and an opportunity to ask questions, was particularly important to address concerns someone might have about enrolling in a meditation-based intervention. Once treatment began, efforts were made to reach all individuals who missed a session to assess reasons for this and to offer a brief individual appointment to cover core elements of the missed session. This was deemed important due to the new components/skills introduced at each session.

Interventions

Participants in both interventions received a manualized 12-session intervention (9 weekly sessions with 3 monthly booster sessions). In both conditions, sessions were 1 1/2 h, except for 2 h for session 1 and for Session 6 as it included a potluck meal. Rather than focusing on weight loss per se, both interventions focused on becoming more aware of patterns of inappropriate eating and on providing appropriate tools and group support for making sustainable change in these patterns.

Mindfulness-Based Eating Awareness Training

The MB-EAT program is designed to increase mindful awareness of experiences related to eating and to decrease mindless or habitual reactivity. In particular, mindful awareness exercises focus on physical hunger and satiety cues, overall food intake, and physical, cognitive, social–environmental, and emotional triggers of bingeing. See Table 1 for an outline of sessions. Three forms of meditation are used: general (breath/open awareness) mindfulness meditation, guided eating meditations, and "mini-meditations" to be used at mealtime and throughout the day. Modeled on the Mindfulness-Based Stress Reduction (MBSR) program (Kabat-Zinn 1990), general mindfulness meditation develops a greater capacity to focus attention as intended and to engage nonreactive awareness of the object of that attention. Initial practice used the breath as the focus of awareness, which has the value of training attention to a relatively neutral repeating stimulus. This was followed by open awareness meditation, in which instructions were to simply be aware of whatever thoughts, emotions, or bodily sensations arise, returning attention to the breath whenever attention becomes engaged with another focus. This practice teaches individuals to observe the contents of the mind and

Table 1 Outline of sessions and home practice for the MB-EAT group

Outline of Sessions	Home Mindfulness Practice
Session 1: Introduction to self-regulation model; raisin exercise; introduction to mindfulness meditation with practice in group	Sessions 1–3: Meditate 20 min with audio recording, with full instructions. Meditation practice (other sessions) Sessions 4–5: Mindfulness track, minimal instructions. Session 6: Guided mindful eating meditation track. Session 7: Choice of either general mindfulness or mindful eatingmeditation tracks. Sessions 8–9: Either general or mindful eating meditation; if general mindfulness, then choice of with or without audio.
Session 2: Brief meditation (continues all sessions); mindful eating exercise (cheese and crackers); concept of mindful eating; body scan	Home practice: Eat one snack or meal per day mindfully (repeated for all sessions, with increasing number of meal/snacks to be eaten mindfully per day)
Session 3: Theme: Binge triggers. Binge trigger meditation; mindful eating exercise (sweet, high fat food, such as brownies)	Home practice: Mini-meditation before meals
Session 4: Theme: Hunger cues—physiological vs. emotional. Hunger meditation; eating exercise: mindful food choices (cookies vs. chips); healing self-touch	Home practice: Eat when physically hungry
Session 5: Theme: Taste satiety cues—type and level of cues. Taste satiety meditation; seated yoga	Home practice: Attend to taste and satisfaction/enjoyment
Session 6: Theme: Fullness cues—type and level of cues. Fullness meditation; potluck meal	Home practice: Stop eating when moderately full; eat at a buffet
Session 7: Theme: Forgiveness. Forgiveness meditation	Home practice: Eat all meals and snacks mindfully
Session 8: Theme: Inner wisdom. Wisdom meditation; walking meditation	Home practice: Eat all meals and snacks mindfully
Session 9: Theme: Have others noticed? Where do you go from here? Maintaining change/relapse prevention; celebratory potluck meal	
Booster sessions: Meditation practice; review of progress; other weight management approaches	

sensations of the body without judgment, increasing self-awareness and decreasing reactivity. For mini-meditations, instructions are to take a few moments to stop and become aware of feelings, thoughts, and sensations, at times of stress, prior to meals, when binge urges occur, etc. "Mini-meditations," although developed for this program, are conceptually grounded in the principle within traditional mindfulness practice of bringing moment-to-moment awareness into all activity. At the start of treatment, each participant received a home-practice audio recording containing a 20-min general mindfulness meditation (with two levels of instruction) and a 20-min scripted general eating meditation that incorporated several elements of the guided eating practices used during the treatment sessions.

Eating meditations cultivate awareness of the experiences of hunger, fullness, taste experience, taste satisfaction, and food choice through mindfully eating small amounts of increasingly challenging foods. With the exception of mindfully eating a raisin, adapted for MB-EAT from Kabat-Zinn's (1990) MBSR program, all eating meditations were developed specifically for MB-EAT. See Kristeller and Wolever (2011) for an in-depth conceptual overview of the program elements. The foods used represent those that individuals with binge eating typically identify as frequently overeaten, including cheese and crackers, brownies, corn chips, and cookies. Midway through the program, participants bring two dishes for a potluck meal (one dish they consider healthier and one less so, but that they would like to continue eating in moderation, such as macaroni and cheese). This experience serves to integrate all elements of mindful eating within a full meal experience and prepares participants for their homework of going to an "all-you-can-eat buffet," a very challenging situation for most individuals in which to maintain mindful awareness and moderate food intake.

The choice of eating-related practices are carefully informed by the research literature on food intake regulation in both normal and abnormal eaters, such as heightening awareness of physiological vs. environmental or emotional "hunger" triggers (Fassino et al. 2004); the key role of SSS (referred to in the program as "taste satiety"/taste satisfaction) in modulating food intake (Rolls 2006); and awareness of stomach fullness to signal the end of a meal (Samuels et al. 2009). Throughout, the program emphasizes eating for "quality over quantity" or the importance of deriving enjoyment from the moment-to-moment experience of eating, rather than from the quantity of food ingested.

Other treatment components include body awareness and self-acceptance practices, including chair-based yoga, a body scan exercise, and healing self-touch, a process that engages self-judgment related to body size and shape and cultivates forgiveness and acceptance. Body-focused practices were modified substantially from those used in the MBSR program for three reasons: (1) floor yoga is extremely physically challenging for very heavy individuals; (2) the central role of the body scan was modified due to the anxiety most of these individuals feel about observing their body; and (3) the need

to focus more of the time in the program on processing thoughts, feelings, and experiences related to eating itself. In the version of the MB-EAT program used in this study, weight management was briefly introduced in session 4, in the context of physical hunger and calorie balance, and reinforced in session 9 (the last weekly session), but was not a primary focus of the intervention. Session 9 also includes an integrative "wisdom" meditation and material on relapse prevention, maintenance, and further growth. It was frequently emphasized that the program was providing a set of tools to be used indefinitely and that long-standing habits of food preferences and eating could continue to be challenging for many months, such that holding an attitude of mindful curiosity and creative change would be most helpful.

Each session began with a brief meditation period, with more extended instruction in the first four sessions. This was followed by 15–20 min for discussing progress and difficulties experienced during the previous week. As identified in Table 1, each session focused on a specific theme related to normalizing eating patterns and overcoming binge eating. Homework included meditation practice and mindful eating exercises, in addition to certain other practices specific to each week's theme. Booster sessions at 1, 2, and 3 months introduced no new material but reinforced practice.

Psychoeducational Cognitive–Behavioral Treatment

The PECB treatment was closely modeled on the program developed at the Duke Diet and Fitness Center for clients with BED. PECB was designed to provide a comparison treatment known to be clinically effective and to control for nonspecific factors including expectancy, group support, instructor attention, and time spent on homework. Content includes education on obesity and binge eating and on basic concepts drawn from cognitive–behavioral models, such as emotional and cognitive triggers for eating (e.g., stress, the abstinence violation effect, Craighead's AAT model (Craighead and Allen 1995)), and cultivating alternative coping strategies. It also contains education and skill-building exercises on nutrition (e.g., using the USDA Food Guide Pyramid), portion control, fitness, principles for making lifestyles changes, stress management (including problem solving, progressive muscle relaxation, and assertiveness training), and psychosocial recommendations for managing binge eating and building a support network. Homework was specific to weekly lessons, such as creating a meal plan using guidelines presented in that session. A potluck meal also occurred, with a focus on nutrients and portion sizes, rather than on mindful choice and mindful eating. While much of the group was structured around educational and skill-building materials, time was allowed for discussion of the personal relevance of the material, as in MB-EAT. Information about calories and nutrition formed a much more substantial part of the PECB program, but was still entirely presented from a self-management perspective, rather than being framed in the context of calorie restriction and dieting. Recommended calorie levels specifically encouraged participants not to target weight loss, but rather to maintain current weight while addressing eating difficulties.

Wait List Control

The wait list control participants received no treatment during the course of the active cohort in which they were enrolled, but were offered access to either mindful eating or PECB training subsequently. They were contacted midway through the active treatment period for assessment and to encourage retention.

Measures

Eating Disorder Examination

The Eating Disorder Examination (EDE) (Fairburn and Wilson 1993) is a semistructured interview used to confirm DSM-IV diagnosis of BED and to rule out bulimia; calendar recall helped determine frequency and duration criterion for BED criteria. High inter-rater reliability, internal consistency, and discriminant validity have been shown for the EDE (Wilson et al. 1993). Binge frequency was estimated using number of days in the previous month when objective binge episodes occurred.

Binge Eating Scale

The Binge Eating Scale (BES) (Gormally et al. 1982), rather than being diagnostic, assesses the extent and severity of compulsive overeating in obese persons and is sensitive to a wide range of problems (Celio et al. 2004; Marcus et al. 1988). For example, an item characteristic of severe BED is "Even though I might know how many calories I should eat, I don't have any idea what is a 'normal' amount of food for me." The BES has excellent test–retest reliability (r=0.87, p<0.001) (Timmerman 1999).

Three-Factor Eating Questionnaire

The Three-Factor Eating Questionnaire (TFEQ) (Stunkard and Messick 1985) was developed to be sensitive to variability in food intake regulation, particularly in the obese population. It measures three dimensions of eating behavior: cognitive restraint or ability to utilize behavioral control; disinhibition or susceptibility to compulsive overeating; and hunger sensitivity. The measure has acceptable reliability and validity.

Power of Food Scale

The Power of Food Scale (PFS) (Lowe et al. 2009) measures perceived influence that proximity of food has on craving, with three factors (food available, food present, and food

tasted). Cronbach's alphas for our sample were 0.81, 0.74, and 0.75, respectively. In an analog study, Forman et al. (2007) compared a brief acceptance-based manipulation to a self-control manipulation and found that the PFS differentially predicted better response for the acceptance-based intervention for those who reported high craving levels when presented with a highly desirable food.

Eating Self-Efficacy Scale

The Eating Self-Efficacy Scale (ESES) (Glynn and Ruderman 1986) measures difficulty with controlling eating in various situations. The total score was used. The measure has acceptable psychometric properties; our sample had a baseline Cronbach's alpha of 0.91.

Beck Depression Inventory II

The BDI (Beck et al. 1988) has adequate reliability and validity, has been used with diverse populations, and is sensitive to both clinical and subclinical changes in mood or affect.

Rosenberg Self-Esteem Inventory

The Rosenberg Self-Esteem (RSE) Inventory (Rosenberg 1979) is a widely used 10-item scale measuring global level of self-esteem. The measure has demonstrated adequate validity and reliability, with a baseline Cronbach's alpha of 0.90 in our sample.

Body Mass Index

Height and weight were measured without shoes, in street clothes, on a calibrated scale. BMI was calculated using the formula: weight (kg)/height $(m)^2$. A BMI≥28 at the initial baseline assessment was the goal criteria for participation. Two cases were below this, at BMI=25.6 and 26.8, but these individuals were retained in the study since they still met the BED criteria and one had experienced recent weight loss. Key analyses were run excluding these individuals and no differences in results were identified. Weight was measured at all assessment points.

Process Measures

Meditation Practice and Homework

Participants in the MB-EAT condition were asked to self-monitor meditation practice daily, recording the number of times they meditated, the type of meditation (sitting meditation, other guided meditation, or mini-meditation), and the length of time spent meditating for sitting and other guided practices. Length of time for mini-meditations was defined as 2 min for purpose of analysis. Ratings were collected prior to each treatment session. Similarly, in the PECB group, participants turned in records of homework completion time prior to each treatment session.

Frequency and Size of Binges

MB-EAT and PECB participants also reported number of binges per week on a weekly monitoring sheet. In our pilot research (Kristeller and Hallett 1999), individuals enrolled in MB-EAT reported that, even if they were still bingeing at the end of the treatment, the size of binges had decreased substantially. In order to assess this more systematically in the current study, an exploratory measure was developed, the Binge Size Assessment Tool (B-SAT). Individuals were asked at baseline to describe, in writing, the content and amount of foods making up a "typical" small, medium, and large binge and to estimate the number of binges in each category over the previous month. At 1 month post and at final follow-up, anyone still reporting any bingeing was given back a copy of their baseline descriptions to remind them of their own definitions of small, medium, and large binges, to guard against slippage, and were again asked to report the overall number of binges and the number of binges at each level. Percentage of binges at each level was then calculated.

Data Analysis

Four sets of preliminary analyses were performed. First, initial analyses of our continuous dependent measures utilized group×site×time repeated-measures analyses of variance (ANOVAs). Since no three-way interactions involving study site reached significance, all reported analyses are collapsed across site. Second, similar analyses compared treatment effects for those who did not fully meet the DSM-IV BED criteria; no three-way interactions approached significance and, except as noted, all reported analyses are for the full sample. Third, the three treatment conditions were compared on baseline measures to assure the success of randomization. Finally, other analyses compared baseline measures for those completing the study and those leaving prematurely to assure that any treatment differences were not an artifact of differential attrition.

The primary analyses reported here take advantage of three assessment points: baseline (pretreatment), posttreatment (taken 1 month after weekly sessions to assure the validity of the EDE), and follow-up (taken at least 4 months after weekly sessions). Selected measures were also assessed at other points (e.g., mid-intervention and immediately following treatment), and missing data on active participants were imputed from the most proximal measurement point. All continuous dependent measures were subjected to repeated-measures ANOVAs with

treatment condition as a between-groups fixed factor. Significant treatment differences (as evidenced by group×time interactions) were further explored with two planned contrasts, one comparing the two treatment conditions with the control and another comparing the MB-EAT condition with PECB. The categorical variables of abstinence from bingeing and BED status were analyzed via chi-square tests.

"Intention-to-treat" (ITT) analyses were conducted to assess the robustness of the treatment (i.e., whether treatment effects would be evident when noncompleters were assumed to have been unaffected by the treatment).

Results

Baseline Comparisons

Baseline comparisons between sites showed that participants in Terre Haute had lower income (≥$50,000, 28.2 vs. 49.4 % in Durham, $p=0.05$) and less education (14.01 vs. 15.88 years in Durham, $p<0.01$). In addition, participants in Terre Haute reported significantly higher levels of psychopathology on 9 of 12 subscales of the SCL-90 and had higher depression scores (BDI: $M=23.59$ vs. 17.59, $p<0.01$). They were also significantly heavier (BMI=42.98 vs. 37.82, $p<0.01$), but endorsed fewer binge eating criteria on the EDE ($p<0.05$). The only difference observed for minority status at baseline was on the RSE scale; minority participants had higher scores than did Caucasians (28.42 vs. 25.26, $t(146)=2.10$, $p<0.05$). Analyses comparing the treatment groups at baseline on continuous dependent measures revealed one significant difference: the PECB group scored significantly higher than the MB-EAT group on the second subscale (food present) of Lowe's PFS ($p<0.05$).

Assessing Treatment Effects

Binge Eating Disorder Status

Based on the formal EDE interviews, of those who had met the full BED classification criteria at baseline and were retained in the study ($n=68$), a majority of those in the treatment groups no longer qualified at 1 month follow-up for a BED diagnosis (80 % (16 out of 20) of MB-EAT participants; 82 % (18 out of 22) of PECB participants) as compared to 38 % (10 out of 26) in the wait list group ($p<0.01$). In addition, 25 % (9 out of 36) of MB-EAT and 31 % (10 out of 32) of PECB participants reported no longer bingeing at all, in contrast to none of the wait list ($p<0.01$). Somewhat greater differences were observed at 4 months posttreatment ($n=56$), with 95 % (18 out of 19) of MB-EAT participants and 76 % (12 out of 16) of PECB no longer qualified for a BED diagnosis, as compared to 48 % (10 out of 21) of wait list participants; the difference between the two treatment groups approached significance ($p<0.10$). At this point, 31 % (11 out of 35) of the MB-EAT group and 39 % (10 out of 24) of the PECB group had abstained from bingeing in the previous month, in contrast to 20 % (5 out of 25) of the wait list participants ($p>0.05$).

For those individuals who still reported any bingeing at follow-up (regardless of meeting the BED criteria), a group difference emerged on the B-SAT regarding the self-reported size of binges. Figure 2 displays the average proportion of reported binges described as small, medium, and large at each time point. As seen there, at baseline, the groups reported approximately similar patterns, with 74–87 % of binges being "medium" or "large" in size. There were also no group differences at immediate posttreatment. However, those still bingeing at follow-up showed significantly different patterns in proportions of binges that were small [$F(2,59)=8.76$, $p<0.001$], medium [$F(2,59)=5.04$, $p<0.05$], and large [$F(2,59)=4.27$, $p<0.05$]. Control participants continued to report, on average, that most binges were "medium" or "large" (85 %); PECB participants reported that a majority of their binges (59 %) were "medium"; and MB-EAT participants now reported that a majority of their binges (60 %) were "small."

Continuous Dependent Measures

Table 2 presents the means (standard deviations) at baseline, 1 month posttreatment, and 4 months follow-up for those who completed all phases of the study, as well as the F values for tests of the group×time interaction that reflect differences in changes over time between the conditions. Also shown are within-group effect sizes (Cohen's D, as calculated as the

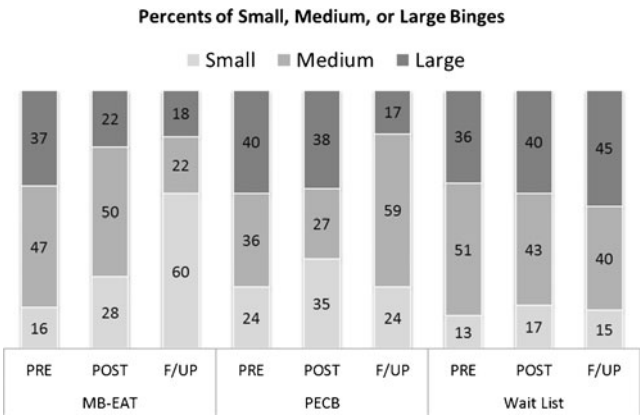

Fig. 2 Proportion of binges reported as small, medium and large. Pre and Post: no group differences; 4-month follow-up: small [$F(2,59)=8.76$, $p<0.001$]; medium [$F(2,59)=5.04$, $p<0.05$]; large [$F(2,59)=4.27$, $p<0.05$]. Statistics apply within time periods only due to the highly variable sample sizes between time points. At F/Up, sample size of those reporting any binges relative to those retained were MB-EAT, 25 out of 39 (64 %); PECB, 17 out of 27 (63 %); control group, 20 out of 26 (77 %)

Table 2 Means and standard deviations at baseline and 1 and 4 months posttreatment

	Baseline, *M* (SD)	1 month, *M* (SD)	4 months, *M* (SD)	*F* statistic	Probability	Cohen's *D*, W-G	Cohen's *D*, B-G
Binge days per month							
MB-EAT	14.84 (5.67)	4.78 (5.78)	3.78 (5.15)	4.65	$p<0.01$	1.36	0.96
PECB	15.31 (8.99)	5.23 (7.95)	5.46 (7.67)			0.74	0.74
Wait list	14.04 (6.25)	12.83 (8.42)	11.38 (9.26)			0.30	
Binge Eating Scale							
MB-EAT	28.98 (7.78)	15.24 (8.06)	13.53 (9.12)	12.74	$p<0.001$	1.64	1.10
PECB	31.26 (7.64)	18.04 (9.91)	16.44 (9.02)			1.69	0.88
Wait list	28.12 (7.80)	25.88 (8.99)	25.06 (7.04)			0.46	
PFS: food available							
MB-EAT	24.41 (4.38)	16.46 (5.36)	16.51 (6.85)	12.18	$p<0.001$	1.40	1.06
PECB	25.22 (4.67)	19.82 (5.69)	19.56 (5.95)			1.08	0.60
Wait list	24.23 (4.67)	23.27 (5.36)	23.58 (4.82)			0.17	
PFS: food present							
MB-EAT	17.68 (2.52)	13.54 (4.26)	13.14 (4.02)	5.52	$p<0.001$	1.31	0.95
PECB	18.59 (1.76)	14.59 (3.81)	14.44 (4.15)			1.12	0.64
Wait list	17.94 (2.12)	16.27 (3.60)	17.12 (3.24)			0.29	
PFS: food tasted							
MB-EAT	18.38 (4.28)	13.49 (4.21)	13.84 (4.09)	5.12	$p<0.01$	1.06	0.80
PECB	18.63 (4.70)	15.93 (4.68)	15.52 (4.62)			0.56	0.51
Wait list	18.19 (3.57)	17.42 (4.78)	17.81 (4.02)			0.11	
Eating Self-Efficacy							
MB-EAT	67.08 (20.81)	101.57 (28.05)	104.38 (28.61)	7.15	$p<0.001$	1.14	1.13
PECB	72.89 (23.40)	100.96 (31.56)	98.89 (29.70)			0.83	0.95
Wait list	61.37 (28.61)	64.54 (23.20)	69.12 (23.35)			0.40	
TFEQ: hunger							
MB-EAT	10.69 (2.65)	6.69 (3.77)	6.19 (3.56)	8.26	$p<0.001$	1.24	0.86
PECB	9.63 (3.10)	7.41 (3.67)	7.15 (3.43)			0.84	0.60
Wait list	9.84 (2.98)	9.92 (3.56)	9.36 (3.48)			0.17	
TFEQ: disinhibition							
MB-EAT	13.61 (2.06)	9.58 (3.77)	9.31 (3.98)	9.07	$p<0.001$	1.00	1.13
PECB	12.96 (2.07)	10.44 (3.78)	10.33 (3.40)			0.81	0.84
Wait list	13.32 (1.89)	13.44 (1.92)	13.40 (1.19)			0.04	
TFEQ: cognitive restraint							
MB-EAT	6.58 (3.81)	11.00 (3.70)	9.78 (4.22)	6.61	$p<0.001$	0.73	0.26
PECB	6.74 (4.00)	9.74 (4.68)	9.33 (4.23)			0.57	0.15
Wait list	8.32 (4.28)	7.72 (4.07)	8.68 (4.32)			0.10	
Beck Depression Inventory							
MB-EAT	19.75 (11.31)	8.50 (9.47)	9.31 (11.04)	7.61	$p<0.001$	0.94	0.44
PECB	21.19 (12.33)	9.48 (10.22)	10.00 (10.37)			1.19	0.38
Wait list	17.27 (10.20)	17.21 (11.00)	14.12 (10.79)			0.43	
Rosenberg Self-Esteem							
MB-EAT	26.16 (5.97)	29.58 (5.92)	30.14 (5.19)	2.15	$p<0.10$	0.53	0.44
PECB	26.22 (7.79)	29.67 (6.72)	30.30 (6.62)			0.35	0.47
Wait list	25.64 (7.35)	26.52 (6.83)	27.32 (7.26)			0.01	
Body Mass Index							
MB-EAT	39.63 (7.99)	39.54 (8.53)	40.05 (9.21)	0.65	NS	0.21	0.19
PECB	39.04 (8.61)	38.95 (8.79)	38.93 (8.99)			0.07	0.06
Wait list	38.14 (6.42)	38.07 (6.29)	38.42 (6.52)			0.18	

W-G within-group across time, *B-G* between-group in comparison to Wait list

PFS Power of Food Scale, *TFEQ* Three-Factor Eating Questionnaire

change across time within each group divided by the standard deviation of change scores) across time (baseline to follow-up) and also between-group effect sizes (calculated as the difference between each treatment and the control group at follow-up divided by the pooled standard deviation at follow-up). As seen in Table 2, the wait list condition remained fairly stable on every measure across time, while the two treatment groups improved on most measures during treatment (e.g., showing lower BES scores and lower depression), with maintenance or continued improvement for all variables at follow-up. Consistent with this, significant group×time effects were obtained for all of the dependent measures, with the exception of the RSE scale ($p<0.10$) and BMI/weight (ns). To explore these differences, two sets of a priori contrasts were performed.

Except for BMI/weight, a contrast in the changes occurring in the two treatment groups (combined) vs. the wait list control was significant ($p<0.02$) for all variables. In addition, several comparisons between the treatment groups achieved or approached significance: the TFEQ hunger scale (Cohen's *D*: MB-EAT, 1.24; PECB, 0.84; $p<0.05$); the TFEQ disinhibition scale (Cohen's *D*: MB-EAT, 1.00; PECB, 0.81; $p<0.08$); and the food available scale of the PFS (Cohen's *D*: MB-EAT, 1.40; PECB, 1.08; $p<0.07$). For these variables, the MB-EAT group had stronger effects during the treatment that were then sustained over the posttreatment interval.

Intention-to-Treat Analyses

To assess the sensitivity of our treatment effects, we conducted ITT analyses on changes occurring across the study period. Missing data on noncompleters was replaced using the last observation carried forward (LOCF) method (Hollis and Campbell 1999; Mazumdar et al. 1999).

Binge Eating Disorder Status

Recall that, at baseline, there were no treatment group differences in the percentage of participants who met the full criteria for BED. Using the LOCF method for noncompleters, we found that a majority (68 %) of the meditation group who initially met the full criteria for a BED diagnosis ($n=31$) no longer qualified 4 months posttreatment, in contrast to 46 % of those in the PECB condition ($n=35$) and 36 % of wait list participants ($n=31$). The overall chi-square analysis was significant at 4 months posttreatment ($p<0.05$), while the comparison for the two treatment groups only approached significance ($p<0.10$).

Continuous Dependent Measures

As would be expected, treatment effects in the ITT analyses were somewhat smaller on most continuous measures. However, similar levels of significance were obtained on all outcome variables. Except for BMI/weight, all comparisons of changes in the treatment groups against the wait list group were significant. In addition, differences between treatment groups on TFEQ hunger reached significance ($p<0.05$); differences on PFS food available and PFS food tasted approached significance ($p<0.10$), with the MB-EAT group showing more sustained improvement.

Other Analyses

Meditation Practice

Participants in the MB-EAT group reported meditating an average of 16.49 times per week over 6.15 days, including daily sitting and mini-meditations, with the average frequency increasing over the course of treatment. At the end of treatment, they reported over 2 h of sitting meditation per week (with about two thirds breath/open awareness meditation and one third eating visualization meditations) and about one half hour of mini-meditations per week (across a total of 18.95 meditation times on 6.42 days). We computed an index of meditation as the average of *z*-scores of participants' reports of meditation practice (including days, number of times, and minutes in each type of meditation). This index showed adequate reliability in our sample (Cronbach's alpha=0.62). As seen in Table 3, more meditation practice was related to improvement on the BES, the disinhibition scale of the TFEQ, and BMI/weight. Given that every session included meditation practice, analyses were also run controlling for session attendance as an additional indicator of cumulative mindfulness experience. Results were stronger, with several other relationships reaching significance, including a positive relationship with general self-esteem and the relation between meditation practice and change.

Weight Loss

Although the interventions were not focused on weight loss, 29 % of the PECB group and 28 % of the MB-EAT group lost 5 lbs or more during treatment (35 % of completers in both groups lost 5 lbs or more during the course of the study). Of those in both treatment groups who lost 5 lbs or more by 1 month follow-up, the average weight loss was 10.67 lbs; of those who lost 5 lbs or more by 4 months follow-up, the average weight loss was 10.72 lbs.

Although there were no meaningful group differences in weight loss, more meditation practice was related to greater weight loss within the MB-EAT group ($r=-0.33$, $p<0.05$; see Table 3). Somewhat surprisingly, weight loss during the treatment period (i.e., from baseline to the 1-month follow-up point) was not related to change in binge days per month for either condition, but was highly correlated with improvement on other eating-related variables for both treatment

Table 3 Correlations of meditation practice with change in primary measures

By change in	Amount of meditation practice	Amount of meditation practice, controlling for attendance
Binge days per month	−0.22	−0.32^{+}
Binge Eating Scale	−0.37*	−0.35*
PFS: food available	−0.24	−0.41*
PFS: food present	−0.35*	−0.42*
PFS: food tasted	−0.10	−0.20
Eating Self-Efficacy	0.10	0.13
TFEQ: hunger	−0.28^{+}	−0.28*
TFEQ: disinhibition	−0.39*	−0.43*
TFEQ: cognitive restraint	0.06	0.11
Beck Depression Inventory	−0.16	−0.24
Rosenberg Self-Esteem	0.30^{+}	0.31^{+}
Body Mass Index	−0.33*	−0.32^{+}
Weight	−0.33*	−0.32^{+}

All changes are calculated as post minus baseline; thus, high scores indicate improvement from baseline to posttreatment, except for eating self-efficacy and cognitive restraint. Therefore, negative correlations represent a relationship between more practice and improvement for most variables, except for these latter two. Ns=33–38

PFS Power of Food Scale (Lowe et al. 2009), *TFEQ* Three-Factor Eating Questionnaire (Stunkard and Messick 1985)

$^{+}$ $p<0.10$; *$p<0.05$; **$p<0.01$

groups, including the BES (MB-EAT: $r=0.44$, $p<0.01$; PECB: $r=0.46$, $p<0.01$) and the TFEQ disinhibition (MB-EAT: $r=0.44$, $p<0.01$; PECB: $r=0.55$, $p<0.01$). Exploratory analyses of possible baseline predictors of weight change did not reveal any meaningful patterns for either group.

Underlying Processes

There is evidence for possible differences in underlying processes between the two conditions. For example, improvement in depression was highly correlated with improvement in other variables for the PECB group but not for the MB-EAT group (e.g., TFEQ disinhibition × BDI (PECB: $r=0.42$, $p<0.05$; MB-EAT: $r=0.04$, ns), suggesting that change in mood was an independent effect of mindfulness practice, rather than a function of an improved sense of control around eating.

Attrition Analyses

Approximately three fifths (61 %) of participants completed all phases of the study (see Fig. 1); however, overall attrition rates were significantly higher in Terre Haute (58 %) than in Durham (22 %), which may reflect socioeconomic status (SES) differences in samples recruited in the two cities. (Note that missing more than three out of the nine core treatment sessions defined an individual as a noncompleter; this conservative definition was used, given the substantive treatment components presented at each session.) Reasons for attrition included psychological or medical problems (21 %), changes in availability (12 %; e.g., relocation, job change, etc.), SES-related difficulties (9 %; e.g., transportation problems, unable to afford child-care, etc.), and dissatisfaction with treatment (9 %). The remainder occurred for unknown reasons (i.e., inability to recontact the person).

There were group differences in attrition in Terre Haute, where 68 % of MB-EAT participants completed all phases of the study in contrast to 31 % of the PECB and 25 % of the wait list participants. There were no significant group differences in attrition in Durham. Collapsed across sites, there were no significant differences between the treatment groups in attrition (74 % retained in MB-EAT, 54 % in PECB, and 55 % in the wait list). At both sites, a majority (72 %) of noncompleters withdrew during the treatment phase of the study. Baseline measures of completers and noncompleters were compared separately for each study site. Only one significant difference appeared: in Terre Haute, noncompleters reported more binge days during the prior month ($M=16.27$) than completers ($M=12.27$) ($p<0.05$).

Discussion

MB-EAT appears to have value as an intervention for binge eating and warrants further investigation as an approach to weight loss. This study builds on pilot research (Kristeller and Hallett 1999) and adds evidence to the growing interest in applying mindfulness-based approaches to managing eating issues and obesity (Bays 2009; Kabatznick 1998; Kristeller et al. 2006; Tapper et al. 2009; Wolever and Best 2009). The magnitude of change in the MB-EAT condition is consistent with that observed in our pilot work (Kristeller and Hallett 1999) and other related research utilizing components from MB-EAT. The more extended follow-up in the RCT (4 months vs. 3 weeks in the pilot study) establishes that the effects of MB-EAT are sustainable to that point. Results are also consistent with other pilot work that has combined elements of the MB-EAT with elements of the MBSR program and showed improvement in eating, weight, mood, physiological regulation (Dalen et al. 2010; Daubenmier et al. 2011; Smith et al. 2006; Timmerman and Brown 2012), and purging behavior (Proulx 2008) in individuals with a range of eating issues.

Although the impact of the MB-EAT and PECB treatments on outcome variables generally did not reach statistical significance, consistent with other evidence that binge eating patterns may respond to a range of interventions (Agras and Robinson 2008), there was an overall pattern

of larger effect sizes for the MB-EAT group than for the PECB group on several indicators of reactivity toward food and food intake, including the hunger and disinhibition subscales of the TFEQ and the PFS, a pattern indicating greater self-regulation and self-control. Furthermore, while improvement in depression was highly correlated with change in eating patterns in the PECB group, change in depression in the MB-EAT group was independent of such changes, suggesting a more general heightened level of self-acceptance, also a key goal of mindfulness-based interventions (Lillis et al. 2009), and general improvement in emotional regulation (Kemeny et al. 2012; Roberts-Wolfe et al. 2012). The magnitude of improvement in depression in the MB-EAT group was also consistent with that found in a meta-analytic study of the effects of mindfulness-based interventions on depressive symptoms (Hofmann et al. 2010), consistent with such improvements being a function of the cultivation of mindfulness. Similarly, although about 64 % of both treatment groups acknowledged some continued bingeing at the final follow-up point, 60 % of these were identified as "small" for the MB-EAT group but continued to be larger for the PECB group. This pattern also suggests different underlying mechanisms and a greater ability to self-regulate.

As reviewed above, the mechanisms for change designed into the MB-EAT program involve reregulation of appetitive and emotional processes by cultivating awareness, increasing sensitivity to the hedonic process, and disengaging habitual reactivity. It is noteworthy that the differential improvement between the MB-EAT and PECB group on the disinhibition and hunger scales of the TFEQ are consistent with other research (Ochner et al. 2009). Specifically, higher scores on these same TFEQ subscales, but not on the TFEQ cognitive restraint scale, are related to greater prefrontal asymmetry in obese individuals, consistent with a reregulation model of higher cortical processes in the MB-EAT condition.

Anecdotally, most participants in the MB-EAT group noted substantial improvement in their ability to identify and use internal awareness of hunger and satiety cues. In particular, many participants noted a substantial decrease in their inclination to overeat sweets and high fat foods, both in regard to amount eaten and in regard to changes in taste preferences, reporting that they found themselves satisfied with far smaller portions than they had previously eaten and that these changes were surprisingly powerful. This is consistent with evidence that obese individuals have disturbed SSS mechanisms related to high fat–high sweet foods (Nasser 2001). It is also consistent with evidence garnered in structured laboratory environments that these complex SSS mechanisms, as outlined by Rolls (2006, 2007), may not differ from those of normal weight individuals when appropriate attention and cognitive processing is brought to bear on the eating experience (Brondel et al. 2007; Grabenhorst et al. 2008; Samuels et al. 2009). Even though individuals who binge eat tolerate more extreme levels of fullness (Geliebter and Hashim 2001), mindfulness practice may assist in reregulating binge-related processes by increasing appreciation for and satisfaction from smaller amounts of food and by interrupting craving cycles in people's natural settings, both in the presence of food and in response to other triggers. Craving cycles, central to an addiction model of binge eating (Cassin and von Ranson 2007; Mathes et al. 2009), may possibly be driven by the anxiety associated with abstinence from highly palatable food, as supported by animal models (e.g., Cottone et al. 2009). The processes engaged in the MB-EAT program may be regulating neural systems involved in processing impulsive responses to food cravings (Batterink et al. 2010; Stice et al. 2009).

The overall process of bringing mindfulness to eating may help interrupt the emotional struggle associated with strong food cravings (Hill 2007), allowing small amounts of highly preferred foods to be eaten without triggering either guilt or binge-type episodes. Even for those individuals who continued to binge, the binges became smaller over time both within the MB-EAT group (the proportion of self-defined small binges went from 16 to 60 % of binges that occurred) and relative to the PECB condition (for whom the proportion of small binges was 24 % before treatment and 21 % at follow-up). This is consistent with an emphasis in the program on "urge surfing," interrupting the "abstinence violation effect" spiral, and reengaging a sense of control, even once a binge begins, applying principles applicable to other addictive processes (Marlatt and Kristeller 1999). Furthermore, the value of cultivating mindful awareness is consistent with eating disorder research that identifies lack of interoceptive awareness as the primary mediating variable linking negative affect and overeating (Ouwens et al. 2009; Van Strien et al. 2005). The use of eating-specific meditation practices appears to be a valuable aspect of this intervention approach. Problem-focused meditation approaches have also been used effectively in treating psoriasis (Bernhard et al. 1988) and depression (Segal et al. 2002; Teasdale et al. 2002).

Consistent with other approaches to treating BED (Grilo et al. 2011), overall weight loss was not observed. However, there was a substantial range of weight change within both groups, with some individuals gaining weight and others losing substantial amounts of weight (up to 23 lbs in the MB-EAT group and 24 lbs in the PECB group). For those that gained weight but reduced binge eating, a greater focus on nutritional balance may have been needed. In particular, some individuals appeared to have misinterpreted the flexibility of the MB-EAT program as giving permission to loosen restraint in general, as suggested by the lack of predictive power of changes in the TFEQ cognitive restraint scale. Any weight gain is clearly of concern in this

population, and preliminary evidence from current research (Kristeller and Wolever 2011) suggests that explicit attention to nutrition and caloric balance can be integrated into the MB-EAT program appropriately and effectively for individuals with BED (Kristeller and Wolever 2011). Some of the psychoeducational or cognitive–behavioral components of the PECB program could also be compatible and perhaps increase overall efficacy.

Other mechanisms posited to be involved in the MB-EAT approach are a heightened sense of perceived control (not limited to food), an alternative means for relief from distress, and an increased ability to resist impulsive urges and to suspend negative self-judgments. The degree to which individuals engaged in all three types of meditation practice (general, eating-related, and use of mini-meditations) and were exposed to in-session treatment exercises in the MB-EAT group was related to the level of improvement on a variety of eating-related measures, but also to changes in self-esteem. These broader changes are consistent with reframing mindfulness or meditation-based approaches as broader "lifestyle-based" interventions as posited by Roger Walsh (2011).

A larger sample would also allow more complete investigation of mediating effects; nevertheless, participants' reports of their experience suggested anecdotally that broader changes in experience of self were occurring, as illustrated by the following comments at 4 months follow-up:

> Jane: "I use it [mindfulness] with everything. I mean, when I get upset at work I just go in the bathroom and do a mini-meditation. Sometimes I count to 10 or I just breathe and I don't binge anymore, at all. I mean, I don't really diet but I don't binge at all. And like tonight…my husband spilled tea in my car. Usually I would get mad and lash out at him and start screaming at him, but nothing bothers me anymore."
> Bob: "…I don't make a point to go out and binge as I did before. You know the willful rebellion—it seems that that's started to be released some…It doesn't seem as if the willful rebellion is as bad….I [used to] map it out that I'm going to go and really binge. I don't do that anymore."

In general, the MB-EAT program was highly acceptable to participants from varied backgrounds, both ethnically and psychosocially. Given the increased risk of African-American women for obesity and diabetes (Kumanyika 1987; National Institute of Diabetes and Digestive and Kidney Diseases) and recurrent binge eating (Striegel-Moore et al. 2000), we were particularly interested in the value of the MB-EAT program for this group. Baseline values for minority/African-American participants were consistent with those reported in the meta-analysis carried out by Franko and her colleagues (2012) in that African-American participants had a higher BMI (42.37 vs. 39.93), but higher levels of self-esteem, whereas scores on measures of disturbed eating behavior tended to be less elevated than those of Caucasians. In our sample, those minority participants randomized to the PECB intervention showed a comparable pattern of improvement to Caucasians, while minority participants receiving the MB-EAT intervention showed a marginally better response than did the Caucasian participants. However, the small sample size did not allow meaningful statistical comparisons. This data is, however, encouraging as it supports the generalizability of these interventions across ethnic backgrounds (Thompson-Brenner et al. 2013).

Another concern is the misperception of a meditation-based intervention by participants from conservative religious backgrounds. An individual orientation session appeared important for assuring such participants that the meditation-based intervention would not compromise their own personal spiritual or religious practices. The orientation acknowledged the traditional roots of mindfulness meditation practice, framing it in terms of Buddhist psychology, rather than Buddhist religion. We also emphasized the widespread use of contemplative practices across different religions as a means to cultivate "higher levels of wisdom." This approach appeared effective in addressing these types of concerns for almost all individuals.

Several limitations merit mention. First, the observed attrition rate was higher in this trial than in typical behavioral trials. This may have been in part due to characteristics of the study sample and in part due to staff turnover at one of the sites. Given that the highest retention was for the treatment of interest (MB-EAT), it does not appear that attrition was inherently related to the treatment itself. Fortunately, since ITT analyses replicated the per-protocol findings, it does appear that the observed outcomes are valid. Future studies would benefit from greater attention to and specific planning for increased retention. Second, the length of follow-up was limited to 4 months posttreatment. Despite the evidence of sustained treatment effects for other intervention approaches to BED (Hilbert et al. 2012; Ricca et al. 2010), longer-term follow-up will be required to assess the durability of effects of this intervention. Finally, the lack of comparison against manualized BED treatments, such as interpersonal therapy for BED (Hilbert et al. 2012; Wilfley et al. 1993), does not allow for direct comparison of MB-EAT with current state-of-the-art treatments.

In summary, the MB-EAT intervention shows promise as a way to incorporate a mindfulness-based approach into treatment for BED and potentially obesity (Kristeller et al. 2006) and to explore the impact of mindfulness on appetite regulation. The degree to which participants engaged in regular practice was a particularly strong predictor of improvement, not only for binge eating behavior but also for subsequent weight loss. Other possible mediating processes, such as the role of affect regulation and general self-acceptance (Hayes et

al. 1999; Hofmann and Asmundson 2008), deserve further investigation.

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The manual for the MB-EAT program used here may be obtained from Jean L. Kristeller, Ph.D., at JKristeller@indstate.edu. A published version is in preparation. A detailed outline of the PECB treatment may be obtained from Ruth Q. Wolever, Ph.D., at ruth.wolever@duke.edu.

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