Cover Page

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1. Project background

Obesity is associated with numerous health problems and all-cause mortality [1,2]. Gold-standard weight loss interventions (behavioral treatment; BT) generally produce clinically significant weight losses of 5–8% [3]. Certain mindfulness and acceptance-based treatments (MABTs) have demonstrated superior weight loss efficacy to BT [4,5]. However, outcomes are heterogeneous, likely because MABTs vary considerably in components included and emphasized (see Table 1) [4–9].

Because MABTs are delivered as packages, determining which intervention components drive weight loss is difficult. Mediation analyses provide preliminary support of willingness- and values-linked mechanisms of action [4–6], but are limited in interpretability due to measurement error (e.g., limited insight, recall or demand biases), assessment timing (i.e., measuring mediators too early or late) [10], and because they do not clarify which components affect which mediators [11]. Thus, current understanding of efficacious MABT components is limited, hindering the streamlining, cost-effectiveness and further improvement of MABTs.

An ideal method for optimizing MABTs is the Multiphase Optimization Strategy (MOST) framework, a comprehensive method for optimizing and engineering multicomponent interventions [12] which involves identifying core components within multicomponent interventions and using a factorial design to test each component's individual and interactive efficacy. A randomized controlled trial (RCT) can then evaluate the optimized intervention (containing the most efficient combination of components) [13]. The MOST framework identifies active treatment components, thus enabling the creation of enhanced intervention packages more quickly than successive RCTs. Yet, despite the promise of this approach, only one study has used it to optimize weight loss treatment [14].

Consistent with Phase I of MOST, we reviewed theoretical and empirical literature and identified three key MABT components [4–8]: 1) mindful awareness (paying attention to and labeling internal experiences); 2) willingness (accepting or being willing to experience all internal experiences, so as to engage in beneficial behaviors regardless of desires to avoid or reduce discomfort); and 3) values (clarifying what one finds most meaningful in life to guide decision-making).

Consistent with Phase II of MOST, we will evaluate the independent and interactive efficacy of each identified component. Following a 2 × 2 × 2 factorial design, we will randomly assign individuals with overweight/obesity to one of eight conditions, each representing a permutation of the MABT components delivered alongside foundational BT content. We will examine outcomes at mid-treatment (6-months) post-treatment (12-months, the primary study endpoint), and 6-, 12-, and 24-month follow-up. The primary aim is evaluating the independent efficacy of the MABT components on weight loss above BT. The secondary aims are: 1) evaluating the independent efficacy of components on calorie intake, physical activity, and quality of life; 2) evaluating target engagement and 3) testing the hypothesis that susceptibility to internal and external food cues moderates component efficacy (i.e., those with greater susceptibility benefit most). The exploratory aims are quantifying any component interaction effects, which may be synergistic, fully additive, or partially additive. An ultimate aim of this work is to construct an optimized treatment that includes efficacious components (e.g., producing ≥2% additional weight loss—alone or in concert with another component—at the furthest assessment for which such clinically meaningful differences are observed).

2. Methods

Study design

The current clinical trial will use a MOST approach, including a 2 × 2 × 2 factorial design. Consistent with the factorial design, we will randomize 288 participants with overweight/obesity to one of eight conditions, stratifying by BMI category (<30, 30–40, and > 40), sex, and race (White and Other). Randomization will occur at the baseline assessment and will be conducted by the study coordinator using a table containing predetermined group assignments designed to equally balance the distribution of participant across treatment components based on sex and race. Assessors (e.g., research staff and graduate students) but not interventionists, will be blinded to allocation, and allocations will also be evident (although not explicitly stated) to participants. The eight conditions represent all combinations of the following treatment components turned On or Off (see Table 2): Mindful Awareness ("Awareness"), Willingness ("Willingness") and Values Clarity ("Values"). The base of each condition will be a 20-session, small group-based, gold-standard behavioral weight loss program. Thus, the eight treatment conditions will be: Behavioral treatment (BT) only (treatment as usual), and BT in conjunction with a combination of the three core MABT components: BT + Values, BT + Awareness, BT + Willingness, BT + Awareness + Values, BT + Awareness + Willingness, BT + Willingness + Values, and BT + Awareness + Willingness + Values. MABT components will be adapted from prior treatments, such as Acceptance and Commitment Therapy (ACT) [15,16], Dialectical Behavior Therapy (DBT) [17], Relapse Prevention for addictive behaviors [18], Mindfulness-Based Eating Awareness Training (MB-EAT) program [6,19], as well as prior MABTs for weight loss [4,5,20,21].

Trial registration—The study was pre-registered on ClinicalTrials.gov (identifier: NCT04337619) and conducted through Drexel University. The Drexel Institutional Review Board approved all procedures (protocol number: 1903007097).

Interventions

Groups will last 85–130 min, depending on the number of components included (see Table 2). The goal of session timing and structure is to allocate an equal amount of time for foundational BT content across conditions, and for time allotted to each MABT component to be consistent across conditions for which that component is included (i.e., turned On). Consistent with standard procedures [22], groups initially will meet weekly, then decrease in frequency to facilitate increasing autonomy. Group sessions will be conducted via the Zoom videoconference platform. Participants will submit and receive feedback on assignments (worksheets and food records) via Google Classroom, an online learning platform. (The study was initially designed to be held in-person, but COVID-19 necessitated a switch to remote format.)

Session structure—Groups will begin with "individual consultations" in which participants will meet one-on-one with one of the two study interventionists in Zoom breakout rooms to discuss individualized weight trajectory and key issues. Individual consultations will each last approximately 3 min for each participant. During the time that participants are waiting for their individual consultation or for the group session to start (approximately 15 min), they will be in a virtual "waiting room" with the other participants to facilitate unstructured conversation and group cohesion. Afterward, group check-ins will be conducted, in which participants will report to the group on compliance with their calorie prescription, exercise prescription, daily dietary self-monitoring, and homework

completion. The remainder of the session will be devoted to presenting skills and discussing strategies. Following each session, participants will be assigned worksheets to facilitate skills utilization ("skill builders") and will be asked to submit food records. Participants will submit and receive feedback on these assignments in Google Classroom. Group leaders will leave comments on materials to facilitate skills utilization and increase accountability between sessions.

Foundational behavioral treatment (BT)—This component, which will form the foundation of each additional component, consists of core gold-standard behavioral weight loss strategies adapted from the Diabetes Prevention Program (DPP) [22] and Look Ahead [23]. Participants will be provided with a calorie intake prescription designed to induce approximately 1–2 lbs. (0.45–0.91 kgs) of weight loss per week based on baseline body weight: <250 lbs. (113 kg), 1200–1500 cal per day; >250 lbs. (113 kg), 1500–1800 cal per day [24]. Participants will also be provided with physical activity guidelines based on weekly minutes of moderate-to-vigorous physical activity, gradually increasing to 250 min per week [25,26]. Other topics will include nutrition and physical activity education, prescriptions to self-monitor intake using a mobile app (MyFitnessPal), stimulus control techniques, setting individualized behavioral goals, problem-solving barriers to change, improving social support and preventing relapse. Participants will be provided with frequent praise and reinforcement for achieving behavioral and weight goals and will receive individualized feedback on weekly self-monitoring records.

Awareness—This component, adapted from the MB-EAT program [19], teaches mindfulness techniques to promote the deliberate regulation of attention and awareness of the current moment, including internal experiences (e.g., one's thoughts, emotions, sensations, hunger and fullness) [27,28]. Participants will be taught to monitor their internal experiences before, during, and after eating and exercise bouts to explore cognitive and affective factors contributing to these behaviors. Experiential exercises will cultivate innate appetitive regulatory processes in part by teaching participants to tune into their internal fullness, hunger, and taste satiety signals [6,19,29]. For instance, participants will be guided through increasingly complex mindful eating exercises (e.g., mindfully eating a raisin, decadent snacks, and then a multi-component meal to simulate the experience of eating at a buffet). An emphasis will be placed on eating for quality rather than quantity. Additionally, participants will be encouraged to develop a regular 15-min daily meditation practice outside of sessions [30] and to engage in brief "pre-meal meditations" (i.e., pausing and tuning into the present moment and one's internal experiences prior to meals) [19]. Participants will be taught to make eating decisions with both "inner wisdom" (i.e., knowledge of one's fullness, hunger, and taste satiety) and "outer wisdom" (i.e., calorie tracking and portion control strategies). In this way, we couple Mindful Awareness strategies with core BT strategies. The overarching goal in this component will be to help participants increase physical activity levels and adhere to calorie targets through moving from mindless/automatic patterns of eating and sedentary behavior to mindful/deliberate eating- and exercise-related decisions.

Willingness—The component will provide participants with strategies to psychologically accept discomfort (e.g., urges to eat, hunger, cravings, fatigue) or a loss of pleasure, thereby enabling choices (e.g., eating an apple instead of a cookie) that are based on health goals rather than one's internal state in a given moment [16,20]. Thus, the core goal of willingness will be to help participants "uncouple" internal experiences from chosen behaviors. To facilitate uncoupling, participants will be taught cognitive defusion skills to first develop the ability to "look at thoughts rather than from thoughts" and in this way gain distance from internal experiences [31]. For example, participants will be taught

to label thoughts as thoughts ("I'm having the thought that") and feelings as feelings ("I'm having the feeling of…") [32]. The overall framework of the willingness component will be "control what you can" and "accept what you can't." In this way, participants will learn to engage core behavioral strategies (e.g., portion control, stimulus control), and to accept (i.e., be willing to experience) all internal experiences that arise when engaging these strategies, including unwanted emotions (e.g., frustration), thoughts (e.g., "this will never work"), and cravings. An emphasis will then be placed on the behavioral corollary of acceptance: that is being willing to engage in weight control behaviors even when uncomfortable or challenging thoughts, feelings or sensations arise. To teach willingness skills, we will incorporate various exercises adapted from prior treatments [15,20]. For example, in one exercise, participants will be asked to consider their thoughts and emotions about two food choices (a more hedonic food, such as a piece of chocolate, and a less hedonic food, such as a carrot), and to imagine the enjoyment that they would derive from the more hedonic food. Then, they will be asked to imagine the enjoyment that they would derive from the more hedonic food while choosing to eat the less hedonic food and discarding the more hedonic food. Of note, we will emphasize that all foods can fit within a weight loss diet when accounted for and will discuss willingness as a strategy that can be used to meet weight loss, physical activity, and calorie goals.

Values—This component will be designed to facilitate clarification of values and connection of those values to weight control behaviors so as to generate a meaningful and intrinsic source of motivation with which to sustain weight control behaviors long-term. Consistent with prior interventions [33], this component will begin with a structured process for the identification of life values. For example, participants will be guided through exercises in which they explore and identify values in ten core life domains (e.g., family, community, spirituality). Consistent with principles of ACT [15,16] and intrinsic motivation theory [34–36], participants will be taught that they will be more motivated for goals that connect to freely-chosen, personal life values (e.g., living a long and healthy life; being a present, loving, and energetic grandmother). Participants will be taught that commitment to difficult behavioral goals is only likely to be maintained when one connects psychologically with life values meaningful enough to make such effort worthwhile. An emphasis will be placed on making connections between these values and weight control behaviors, specifically (e.g., healthy eating as a way to live out the value of being a present and energetic grandparent). Participants will also learn skills to keep values salient (e.g., through written or visual cues), and to use life values, rather than momentary desires to lessen discomfort, to guide decision-making. For example, participants will be taught to use a "values telescope" to envision how various in-the-moment decisions point towards, or away from, long-term values. Participants will also be taught strategies to address competing values (e.g., values integration and prioritization). To avoid contamination with the willingness condition, in this component we will emphasize using values to guide behaviors, but will not discuss acceptance of internal states while engaging in values-informed behaviors.

Component integration—Each treatment condition including an MABT component will include a central framework (i.e., underlying model) intended to integrate components. Where relevant, we will reference existing protocols to inform component integration [4,5]. Examples of central frameworks include "the 4 M's" ("Measure, Modify, Mindfulness and Motivate") in the BT, Awareness and Values condition, and "Control What You Can, Engage Willingness and Use Values as a Guide" in the BT, Willingness and Values condition. Under "the 4 M's" framework, participants will be encouraged to develop greater awareness ("inner wisdom") surrounding hunger, satiety, urges/cravings and external

triggers to overeat or remain sedentary, and then use inner wisdom, coupled with “external wisdom” (i.e., knowledge of portion control and self-monitoring strategies) to guide eating and physical activity decision-making. Participants will be further taught to recognize distinctions between “automatic” decisions (those lacking awareness) and intentional, mindful decisions that move them towards freely chosen weight-related values. Under the “Control What You Can, Engage Willingness and Use Values as a Guide” framework, consistent with ACT approaches [15], participants will be encouraged to practice willingness in the service of their values. In this case, participants will be taught to practice acceptance towards reductions in eating-related pleasure and discomfort associated with increasing physical activity and are encouraged to instead make behavior choices guided by weight-related values (e.g., living a long life for one’s children). Study interventionists will also be encouraged to integrate MABT content throughout each session to facilitate adherence to core strategies for weight control (e.g., self-monitoring).

Contamination—Special efforts will be made to avoid contamination across components. For example, in conditions with Awareness On, but Willingness Off, an emphasis will be placed on being aware of and tuning into internal experiences, rather than cultivating an accepting attitude towards them. In conditions where Values is Off, conversations about goals will center on concrete endpoints rather than higher-order values that inspire those goals. Thus, when Willingness is On but Values is Off, we will emphasize willingness to engage in weight control behaviors in service of goals as opposed to underlying values. When Willingness is On but Awareness if Off, we will not emphasize present moment awareness, or tuning into and making distinctions between different types of internal experiences (e.g., biological vs. hedonic hunger, fullness and satiety). Instead, participants will be taught to label experiences into broad categories (i.e., thoughts or feelings) as a means to separate internal experiences from behavioral choices (i.e., defusion).

Participants

Adults aged 18–70 with overweight/obesity (N = 288; BMI = 25–50 kg/m2) will be recruited from the Philadelphia area. Participants will be recruited through a variety of streams including social media, radio, and flyer. All recruitment streams were approved ahead of time by the Institutional Review Board. Participants will first be screened briefly by phone to assess preliminary eligibility. Potentially eligible participants will then be invited to attend one of several virtual group orientation sessions (run by study investigators) where they will learn about the study. Interested participants will then be provided with an informed consent and scheduled to attend a clinical interview where full eligibility will be confirmed.

Eligibility

Individuals will be excluded if they are not able to engage in physical activity (defined as walking a city block without stopping); have a medical or psychiatric condition that may pose a risk to the participant during intervention, cause a change in weight, or limit ability to comply with the program; recently began or changed the dose of a medication that can cause significant change in weight; history of bariatric surgery; weight loss of >5% in the previous 6 months; currently pregnant or breastfeeding; planning to become pregnant, or participate in another weight loss treatment in the next 3 years. BMI < 27 kg/m2 will be deemed ineligible at phone screen. BMI will be calculated using height measured in a medical office, if available from a visit in the past year; otherwise, through self-measured height (using a measuring tape) on the day of the eligibility screen. Similarly, phone screen BMI will be calculated using self-reported weight that day, or, if a participant does not have a scale, they will report their last measured weight. If recent (i.e., within 1-month) height or weight are not available, eligibility is deferred until the clinical interview. Study eligibility (in this case

BMI < 25 kg/m2) will be reassessed at the clinical interview using weight from a wireless scale that we will mail to participants. Weights will automatically sync to a secure portal in a de-identified format accessible only to research staff. In the clinical interview, participants will be instructed on how to set up and calibrate their scales, and asked to follow standard weighing protocols (i.e., instructed to remove bulky clothes and to remove items from their pockets, to ensure the scale is on a hard flat surface, and step onto their scale and stand still). Although access to a smartphone and an internet connection will be required for all participants, participants who lack access will not be excluded, and will instead be loaned a smartphone with a mobile data connection for the duration of the study. Based on national rates of smartphone ownership and internet access, it is anticipated that approximately 15% of participants will lack access to a smartphone and/or internet connection [37].

Training and fidelity

All groups will be led by a trained clinician with, at minimum, a master's degree in psychology, nutrition, or a related field. The study will be comprised of a team of six clinicians. Clinicians vary in the extent to which they have training and experience in mindfulness- and acceptance-based treatments and behavioral treatments. Clinicians' prior training will be supplemented through eight hours of training and ongoing clinical supervisions. All groups will also be assigned a junior co-leader (most commonly a graduate student in clinical psychology). Both leaders and co-leaders will receive specific training on the components utilized in the treatment corresponding to their group's condition and have access to a manual outlining operational definitions of each component and examples of contamination across conditions. Study interventionists will be provided weekly clinical supervision for the duration of the treatment. This study will utilize the fidelity coding system used in a past trial that was found to have excellent inter-rater reliability [5]. To track fidelity, group sessions will be video-recorded and 20% of sessions will be randomly reviewed independently by a single co-investigator to monitor: (1) the proportion of time spent on each component; (2) competence and fidelity to treatment manuals; and (3) any contamination of treatment content across conditions. Study interventionists will receive feedback on their fidelity to the intervention.

Assessments

Assessments will be conducted by study staff and graduate students in the lab. These assessments will be completed at baseline, mid-treatment (6 months), post-treatment (12 months) and at 6-, 12- and 24-month follow-up. (i.e., at 18, 24 and 36 months from baseline; Fig. 1). For one week at baseline, mid-treatment and post-treatment, participants will also complete ecological momentary assessment (EMA) surveys delivered at random, six times a day, via a smartphone application. Assessments will be conducted remotely via Zoom. To maximize retention and attendance of assessments, compensation will increase over consecutive assessments. The compensation structure is US$50 for baseline, US$100 for mid-treatment, US$125 for post-treatment, US$150 for 6 month follow-up, US$175 for 12 month follow-up, and US$200 for 24 month follow-up, with deductions for noncompliance (e.g., US$3 for each EMA survey missed).

3. Measures

Primary outcomes

Percent of initial body weight lost is the primary outcome variable. Weight will be measured weekly, using a wireless scale. In addition, the morning of assessments, participants will be asked to weigh themselves three times in immediate succession. If there is a variation greater than 0.2 lbs. (0.09 kg), they will be instructed to weigh a fourth time. Participants will be

provided with detailed instructions on how to self-weigh accurately (e.g., ensuring scale is on a hard, flat surface, weighing upon waking but after using the bathroom, before eating or drinking anything, and without wearing heavy clothing or shoes).

Secondary outcomes

The secondary outcome measures are dietary intake, physical activity and quality of life. Measures will be taken for one week, at baseline, mid-treatment and post-treatment. Although dietary intake will be measured at all timepoints, data collected at mid- and post-treatment will be of primary of interest, as the validity of dietary self-monitoring records at baseline may be poor (i.e., because participants have not yet been trained in accurate and comprehensive tracking). Dietary intake will be recorded on the popular mobile application MyFitnessPal at each assessment point for 1 week (for 2 of 5 waves, we will record dietary intake for 3 weeks to better investigate relations between physical activity and diet). Total energy intake estimated using MyFitnessPal has shown a high level of concordance with other food composition databases [38] and also shows strong associations with energy intake estimated via more traditional, paper-based records, although total energy intake may be somewhat underestimated [39,40]. Quality of dietary intake data will be assessed at all timepoints through a qualitative review of individual self-monitoring records and by examining relationships between calorie intake and weight change within participants. Physical activity will be measured as minutes per week of moderate-to-vigorous physical activity [41] using the FitBit Charge 4, a consumer-grade wrist-worn activity tracker. A 7-day Physical Activity Recall [42] will gather information about bouts of swimming and biking, and estimates of PA will be calculated with and without the self-report data. Quality of life will be measured using the Quality of Life Inventory [43].

Exploratory outcomes

Target engagement—Target engagement will be assessed at each assessment point via behavioral and self-report measures, and with EMA items. For all study waves, mindful awareness will be assessed via self-report, with the Awareness subscale of The Philadelphia Mindfulness Scale [44]. Self-reported willingness will be assessed using the Food Craving Acceptance and Action Questionnaire [45] Values will be assessed using a structured interview [33], as well as a self-report measure, the Treatment Self-Regulation Questionnaire [46,47]. In the EMA protocol, participants will report on MABT strategies utilized over the past few hours (Mindful Awareness: “I have been fully aware of my present moment experience, such as my thoughts, feelings, and urges;” Willingness: “I felt I could make healthy eating and activity decisions regardless of my thoughts, feelings, urges;” Values: “I have thought about my values when making eating or activity decisions”). A short-term retrospective reporting period was used for EMA because we judged it relatively unlikely that a participant would be using an MABT strategy in the exact moment of receiving an EMA prompt, and because this method aligns with prior EMA studies on overweight/obesity and eating behavior [48–50]. EMA, rather than retrospective self-report, will be used to assess MABT strategies due to concerns that the latter would suffer from greater recall bias. Strategy use will be summed across surveys to create a composite index of each individual’s use of MABT strategies at each assessment point.

Moderators—To evaluate the potential moderating effects of susceptibility to internal and external food cues, we will administer measures of food responsivity, disinhibited eating, emotional eating, and impulsivity. To assess food responsivity, we will administer a self-report measure (the Power of Food Scale [51]), as well as a computerized test of the association between food stimuli and “good vs. bad” categories (the Implicit Association Test [52]). To assess disinhibited eating, we will administer a self-report

measure (the Eating Inventory.) Emotional eating will be measured using two self-report (the Emotional Eating Scale [8] and the Emotional Eating subscale of the Dutch Eating Behavior Questionnaire [53]). Impulsivity will be assessed using two behavioral tasks: the Delayed Discounting Task [54] and the Stop Signal Task [55].

Power analysis

Although we expect that some components will demonstrate larger effects, we conservatively powered for a small-to-moderate (Cohen's d = 0.30) treatment component main effect of ≥2% weight loss over the year-long intervention period (i.e., between conditions with the component turned "on" versus conditions with the component turned "off"). We powered for a 2% difference in our primary outcome (percent weight loss) at post-treatment (12 months) based upon our recent trial (which achieved >3% weight loss between conditions [4]), and because 2% additional weight loss is a clinically significant difference. We conducted the power analysis with the SAS macro %FactorialPowerPlan [56], assuming an alpha level of 0.05 and power of 0.80. We included covariation, based on variance explained in our previous trials [57]. Participants are clustered within groups and power calculations were performed based on participants, rather than clusters, being randomly assigned to each of the 8 conditions. We conservatively assumed a weight loss standard deviation of 10 (based on previous weight loss trials) and an intraclass correlation coefficient (ICC) of 0.10 based on an ICC of 0.06 in our most recent trial [4] (which used similar recruitment methods and clustering to 18 groups), a projected 12 participants per cluster. Participants will be randomly assigned individually as opposed to by intact clusters. Given these assumptions and accounting for 25% attrition (based upon past work [4,7–9]), a total of N = 288 individuals (n = 36 per cell) are needed. Of note, the SAS macro assumes effect rather than dummy coding, which is important for the secondary and exploratory aims because we have essentially the same power to detect interactions as we do main effects.

Statistical analysis

For the primary outcome, all statistical analyses will use an alpha level of 0.05. For the secondary outcomes and evaluation of moderating effects, multiple comparisons will be addressed using the Benjamini-Hochberg procedure to control the false discovery rate [58]. Consistent with an intent-to-treat approach, we will assess for any between-condition differences in patterns of missing dietary, physical activity and weight data [59] and impute missing data using multiple imputation via chained equations if appropriate, after assessing for differential patterns of missing data between groups among each of these variables [60]. Any differences in demographic, outcome, or key baseline variables between conditions will be controlled for. Any continuous outcome variables showing evidence of substantial skewness/kurtosis will undergo normalizing transformation. Accounting for estimated 25% attrition, power analyses indicated that 288 participants would provide adequate statistical power for analyses.

Primary aim and secondary aim 1: evaluating component independent efficacy on outcomes—To evaluate the primary aim, we will construct three-level multilevel regression models including randomization to each component (i.e., experimental condition) as a predictor of percent weight loss, using model specifications described elsewhere [61]. The models will take into account nesting of participants within groups as well as repeated observations within participants (i.e., time), with covariates included at the participant level. The first model will include weight as an outcome and other models will include secondary waist circumstance, calorie intake (estimated as a mean daily calorie average over each assessment period, using each individual participant's self-monitoring records) and physical activity as outcomes. The experimental condition predictor will be

effect-coded to reflect which components are “on” vs. “off” in each condition.

Secondary aim 2: evaluating target engagement—To evaluate the main effects of randomization to each component on the target engagement measures of that component, a three-level multilevel regression model will be constructed nesting time within participants and participants within groups. Outcomes will be the target variables at the first post-treatment assessment, with experimental condition again effect-coded. To analyze EMA data, we will use mean-centered momentary strategy utilization variables as predictors of the probability of a dietary lapse (which could include eating a larger meal or snack than intended, eating when not intended, or eating a type of food that the participant intended to avoid), modeled via generalized linear mixed-effects models using a logit link function (which are robust to unbalanced data, assuming data are missing at random). Participants completing less than 40% of EMA prompts at a given assessment point will have data for that assessment point excluded. Momentary strategy utilization variables will be summed across assessment points (baseline, mid-treatment, post-treatment) for each participant.

Secondary aim 3: the moderating effect of susceptibility to internal and external food cues—To evaluate the moderating role of susceptibility to internal and external food cues on outcomes, interaction terms will be modeled between these variables and each of the components in the model described for the primary aim.

Exploratory aim 1: The moderating effect of susceptibility to internal and external food cues—To test component interaction effects, higher-order interaction terms (e.g., three-way interaction between mindful awareness, willingness, and values) will be added to the multilevel models outlined in the primary aim.

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