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Relations of Hedonic Hunger and Behavioral Change to Weight Loss Among Adults in a Behavioral Weight Loss Program Utilizing Meal-Replacement Products

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Abstract

Greater self-regulatory behavior usage is associated with greater weight loss within behavioral weight loss treatments. Hedonic hunger (i.e., susceptibility to environmental food cues) may impede successful behavior change and weight loss. Adult men and women (N = 111, body mass index $M \pm SD$ = 35.89 ± 6.97 kg/m^2) were assessed before and after a 15-week lifestyle change weight loss program with a partial meal-replacement diet. From pre- to post-treatment, reported weight control behavior usage improved and hedonic hunger decreased, and these changes were inversely related. Individuals with higher hedonic hunger scores at baseline showed the greatest weight loss. Similarly, participants with lower baseline use of weight control behaviors lost more weight, and increased weight control behavior usage was associated with greater weight loss—particularly among individuals

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with low baseline hedonic hunger. Further study is warranted regarding the significance of hedonic hunger in weight loss treatments.

Keywords
obesity, weight loss treatment, eating behavior

Introduction

Lifestyle modification weight loss programs typically lead to clinically significant weight loss, although achieving sustained weight control is challenging, and there is variability in treatment response (Jeffery et al., 2000). Prior research indicates that increased engagement in key self-regulatory behaviors (e.g., self-monitoring of food intake and weight) and following dietary recommendations (e.g., limiting portion sizes) are associated with better weight loss during treatment (Acharya et al., 2009; Burke, Wang, & Sevick, 2011; Williamson et al., 2010). Within behavior modification weight loss interventions, an improvement in reported weight control behavior usage during treatment is associated with greater weight loss (O'Neil & Rieder, 2005).

However, impediments to following behavioral and dietary recommendations are commonly reported, such as the overabundance of palatable, high energy-dense foods in the environment, presenting a constant temptation to individuals attempting to restrict their energy intake. Individuals commonly eat for reasons other than physiological hunger, perhaps reflecting the common struggle that many face in maintaining energy homeostasis and thus a healthy body weight (Lowe & Levine, 2005).

Individual differences in susceptibility to the obesogenic environment have been described in terms of *hedonic hunger*—a construct that may be relevant to successful weight management (Lowe & Butryn, 2007). Emerging research has demonstrated that obese adults tend to report a higher level of hedonic hunger as compared to normal weight adults (Cappelleri et al., 2009; Schultes, Ernst, Wilms, Thurnheer, & Hallschmid, 2010). Furthermore, higher levels of hedonic hunger appear related to greater reported cravings (Forman et al., 2007) and greater food intake within laboratory paradigms assessing eating in the absence of hunger (Appelhans et al., 2011; Levitsky & Shen, 2008). Weight status and hedonic hunger may interact with the obesogenic environment to promote overeating, as supported by one ecological momentary assessment study in which heavier individuals reported increased likelihood of overeating in proportion to the increasing presence of palatable foods (Thomas, Doshi, Crosby, & Lowe, 2011). Another study conducted with obese older adults found an interaction between hedonic hunger and

physiologic hunger (i.e., whether or not participants had just consumed a preload); individuals who were fasted reported stronger food cravings and reduced confidence that they could control their eating behavior, but this pattern was particularly pronounced among individuals with high hedonic hunger (Rejeski et al., 2012).

Recent data suggest that weight loss may be associated with decreases in hedonic hunger among overweight adults. Schultes and colleagues (2010) administered the Power of Food Scale to individuals who had received gastric bypass surgery. Adults post-gastric bypass (most of whom were still overweight or obese) reported levels of hedonic hunger similar to nonobese controls, which were lower than obese individuals who had not undergone gastric bypass (Schultes et al., 2010). A recent study by our group found that hedonic hunger decreased from baseline to post-treatment within a 12-week commercial weight loss program format, and that greater reduction in hedonic hunger was associated with greater weight loss (O'Neil, Theim, Boeka, Johnson, & Miller-Kovach, 2012). Furthermore, the association between improved weight control behaviors and weight loss was somewhat moderated by hedonic hunger, being stronger among individuals with high baseline hedonic hunger than among those with low hedonic hunger.

The present study sought to replicate those findings using data from a fee-for-service clinical weight loss program which differed from the prior study in several ways: In the current study, the diet for the first half of the program was based largely on meal-replacement products; the present program was administered on an individual, rather than group basis; and the present study had a greater focus on individual behavior changes such as self-monitoring, adherence to personalized exercise prescriptions, and goal-setting. Indeed, the use of meal-replacement products during treatment essentially alters individuals' food environments and habits, which in turn may impact their reported eating behaviors and hedonic hunger. Thus, the present study's primary aim was to examine whether, among patients completing this clinic-based intensive behavioral weight loss program, participation was associated with changes in reported weight control behavioral skills usage and hedonic hunger, and whether those changes are associated with weight loss. It was hypothesized that, from baseline to post-treatment: (a) reported weight control behavior usage would improve and hedonic hunger would decrease, (b) an improvement in weight control behavior usage and a decrease in hedonic hunger would be associated with greater weight loss, and (c) changes in weight control behavior usage and hedonic hunger would be inversely associated. In addition, secondary analyses examined whether, as in our earlier study (O'Neil et al., 2012), baseline hedonic hunger is associated with weight

loss during treatment, and whether baseline hedonic hunger moderates the relation between weight control behavior improvement and weight loss.

Method

Archival data were examined from 162 patients enrolled in the Focus program at the Medical University of South Carolina Weight Management Center. The Focus program is an ongoing fee-for-service weight loss program, described below. All applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research.

Beginning in March, 2011, the Power of Food Scale (PFS) was added to the clinical assessment questionnaires administered pre-and post-treatment. Data reported here are from all patients who received the PFS on program entry through June, 2012 and who completed post-treatment questionnaires. During the study period, 162 participants enrolled in the 15-week Focus program. The average number of sessions attended by these participants was 11.98 (SD = 4.35). Of the 162 participants who started treatment during the study period, 119 completed the program (defined as having attended at least 8 out of 15 possible visits, and remaining in the program at least through visit 11 of 15); of those completers, 111 completed post-treatment questionnaires. See Figure 1 for the CONSORT diagram. Treatment completion was required for inclusion in analyses because post-treatment questionnaire data were only available from completers. Specifically, participants needed to have complete pre- and post-treatment data on measures of weight, weight control behavior usage (Eating Behavior Inventory [EBI]), and hedonic hunger (PFS), as described below. The final sample of 111 patients represented 68.5% of all patients who began the Focus program during the specified time period.

Participants

Participants were 111 weight loss treatment-seeking adult men and women (80.2% female), aged 20 to 72 years ($M \pm SD$ = 45.95 ± 13.61 years). There was no weight requirement for entry into the program; participants' $M \pm SD$ body mass index (BMI; kg/m^2) was 35.89 ± 6.97 (range = 24.61-60.10). Most (68.5%) participants self-identified as Caucasian, with 25.2% African American, 5.4% Hispanic, and 1% Other races/ethnicities. Very few exclusion criteria were employed, other than the requirement that participants be deemed ineligible for the treatment program if they were pregnant or lactating.

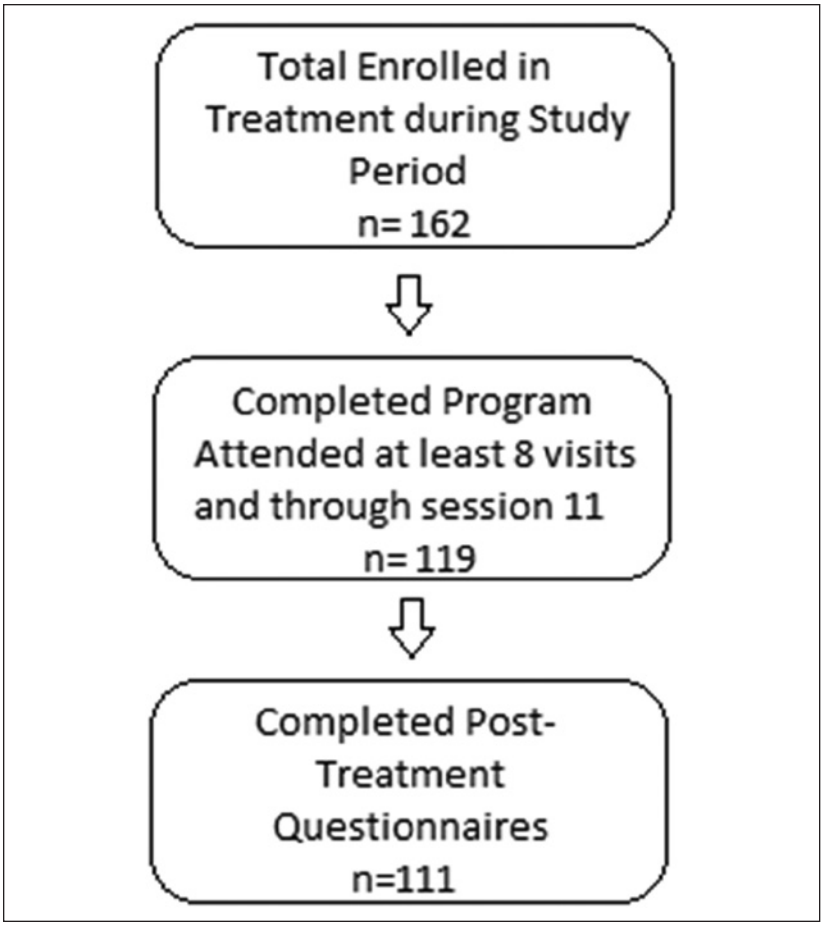

Figure 1. CONSORT diagram.

Measures

Demographic and anthropometric measures. Participants self-reported their age, gender, and race/ethnicity. Height was measured by trained personnel using a wall-mounted stadiometer. Weight was measured at baseline and post-treatment using a calibrated Mettler Toledo Panther model digital scale. Participants' BMI was calculated from height and weight.

EBI. The EBI (O'Neil et al., 1979) is a 26-item measure of behaviors conducive to weight control, including both positive or adaptive weight

management behaviors (e.g., "I carefully watch the quantity of food that I eat") and negative or maladaptive weight management behaviors (e.g., "I eat quickly compared to most other people"). Items are rated on a 5-point scale ranging from *never or hardly ever* to *always or almost always*, with negative or maladaptive items reverse-scored. Higher EBI total scores indicate a greater usage of weight control behaviors. EBI scores consistently improve following intensive behavioral weight loss interventions, and greater increases are associated with greater weight loss (O'Neil & Rieder, 2005).

Power of Food Scale (PFS). The PFS (Lowe et al., 2009) is a 15-item self-report measure of hedonic hunger (i.e., food-related thoughts and desires unrelated to physiological need). Three subscales are designed to assess responsiveness to food when it is not present (e.g., "I find myself thinking about food even when I'm not physically hungry"), present (e.g., "If I see or smell a food I like, I get a powerful urge to have some"), or tasted (e.g., "Just before I taste a favorite food, I feel intense anticipation"). Higher scores on the PFS indicate greater hedonic hunger, with scores on each subscale and the total score ranging from 1 to 5. The PFS has demonstrated adequate test-retest reliability, incremental validity, and internal consistency (Cappelleri et al., 2009; Lowe et al., 2009).

Treatment Program

The Focus program is a fee-for-service, lifestyle change weight loss program. Participants have weekly individual sessions with a registered dietitian, exercise physiologist, or behavioral therapist, according to the schedule in the treatment protocol. The standard length of treatment is 15 weeks, during which a primarily supplement-based diet (typically three shakes and two bars, plus a small, controlled food-based meal daily) is prescribed for the first 8 weeks. Patients then transition onto an all food-based diet, although treatment is somewhat individualized, such that patients are permitted to continue some meal-replacement use beyond 8 weeks if desired. In addition, patients have the option of adding four extra treatment sessions (which included an extension of the primarily meal-replacement product diet mid-way through treatment); this option was elected by 21 (18.9%) of the patients in the present sample.

Analyses

Data were analyzed using IBM SPSS version 19.0 (Chicago, Illinois). Percent weight loss was computed using: [(Baseline weight − Week 15 weight) / baseline weight] × 100; thus, weight losses were treated as

Table 1. Baseline Subject Characteristics.

	Completers (n = 111)	Non-completers (n = 51)	Test statistic	p value
Gender, female, n (%)	89 (80.1%)	45 (88.2%)	χ^2 = 1.58	.21
Race/ethnicity, n (%)				
Caucasian	76 (68.4%)	43 (84.3%)	χ^2 = 0.95	.76
African American	28 (25.2%)	16 (11.7%)	χ^2 = 0.61	.43
Other	1 (1.0%)	1 (2.0%)	χ^2 = 1.02	.31
Age, years, mean (*SD*)	45.95 (13.62)	44.29 (13.09)	t = −0.98	.34
Weight, kg, mean (*SD*)	97.74 (19.76)	99.81 (25.17)	t = 0.23	.82
Body mass index, kg/m^2, mean (*SD*)	35.89 (6.97)	36.22 (10.61)	t = −0.26	.80

positive numbers and gains as negative numbers. Changes in EBI and PFS scores were computed using Week 15 score − Baseline score, such that increases in each measure were positive numbers. Paired samples t tests were used to test Hypothesis 1 (changes in reported weight control behavior usage and hedonic hunger) using baseline and post-treatment EBI and PFS scores. To examine Hypotheses 2 and 3, Pearson correlations tested associations among reported weight control behavior usage, hedonic hunger, and percent weight loss. Where appropriate, effect sizes (i.e., Cohen's d, η^2) were calculated to determine the magnitude of effects.

Results

No significant differences were observed in key demographic variables or baseline EBI or PFS scores across completers and non-completers (see Table 1). Significant differences were found in weight loss based on last weight carried forward, with participants who completed treatment showing significantly greater weight loss—completers' weight loss: 9.50 ± 4.72 kg versus non-completers' weight loss: 4.86 ± 4.19 kg, $t(160) = 6.01$, $p < .01$. All results presented below report on the 111 participants who completed both pre-treatment and post-treatment data collection.

Overall Treatment Outcome

From baseline to post-treatment, participants lost an average of 9.50 ± 4.72 kg, which represented 9.81% ± 4.69% of their baseline body weight (range = −4.77% to 23.98%). A reduction in body weight of at least 5% was seen among 87% of participants, and a reduction in body weight of at least 10% was seen among 47% of participants.

Hypothesis 1: Weight control behavior usage and hedonic hunger will improve from baseline to post-treatment.

Mean EBI total score significantly increased from baseline (70.18 ± 10.59) to post-treatment (97.35 ± 11.80), $t(109) = 22.55$, $p < .01$, $d = 2.45$. At the item level, most individual EBI items (24 of 26) improved from baseline to post-treatment (see Table 2). Similarly, improvements were observed on PFS total score, $t(110) = -7.92$, $p < .01$, $d = .79$, and on all three subscale scores, ps ≤ .001 (see Table 3).

Hypothesis 2: Changes in weight control behavior usage and hedonic hunger will be associated with greater weight loss.

As hypothesized, greater percent weight loss was associated with both improvement in EBI total score, and decrease in PFS total score, $r(110) = .31$, $p < .001$ and $r(110) = -.24$, $p < .01$, respectively. Changes in seven individual items on the EBI were associated with weight change (see Table 1). Two individual PFS subscales (the "Food Present" and "Food Tasted" subscales) also were significantly associated with percent weight loss (see Table 3).

Hypothesis 3: Changes in weight control behavior usage and hedonic hunger will be associated.

As hypothesized, pre- to post-treatment change in EBI total score was negatively correlated with change in PFS total score, $r(110) = -.41$, $p < .001$, along with changes in all three PFS subscales: "Food Not Present," $r(110) = -.46$, $p < .001$; "Food Present," $r(110) = -.36$, $p < .001$; and "Food Tasted," $r(110) = -.26$, $p = .005$. That is, an improvement in reported weight control behavior usage was associated with a decrease in hedonic hunger from baseline to post-treatment.

Exploratory analyses also examined relations of *baseline* PFS total score and EBI scores (total score and individual items) with percent weight loss. Baseline PFS total scores was significantly predictive of percent weight loss, with individuals with *higher* baseline PFS scores showing *greater* weight loss, $r = .21$, $p = .02$. Baseline EBI score was also a significant predictor of percent weight loss, but it was individuals with the *lower* EBI scores at baseline who showed *greater* weight loss, $r = -.19$, $p = .04$. At baseline, PFS total score was inversely related to EBI total score, $r(110) = -.43$, $p < .001$; higher levels of hedonic hunger were associated with less usage of weight control behaviors.

Table 2. Correlations Between Changes in Weight Control Behavior Usage and Percent Weight Loss.

EBI item	Baseline	Week 15	*r*, EBI change with % weight loss
EBI total score	70.18 (10.59)	97.35 (11.08)**	.31**
1. I carefully watch the quantity of food which I eat.	2.43 (1.04)	4.41 (0.77)**	.40**
2. I eat foods that I believe will aid me in losing weight.	2.44 (0.85)	4.24 (0.78)**	.36**
3. I keep one or two raw vegetables available for snacks.	1.60 (0.91)	3.41 (1.32)**	.18
4. I record the type and quantity of food which I eat.	1.25 (0.70)	3.49 (1.32)**	.14
5. I weigh myself daily.	2.07 (1.41)	4.80 (0.62)**	.16
6. I refuse food offered to me by others.	2.17 (0.97)	3.86 (0.98)**	.24*
7. I eat quickly compared to most other people.[a]	3.05 (1.57)	2.70 (1.31)**	−.03
8. I consciously try to slow down my eating rate.	2.09 (1.07)	3.15 (1.19)**	.30**
9. I eat at only one place in my home.	2.76 (1.51)	3.54 (1.15)**	.03
10. I use the same placemat and other utensils for each meal.	2.19 (1.46)	2.61 (1.47)**	.09
11. I eat and just can't seem to stop.[a]	1.92 (1.08)	1.43 (0.62)**	.02
12. I eat in the middle of the night.[a]	1.35 (0.78)	1.24 (0.69)	.02
13. I snack after supper.[a]	2.83 (1.29)	2.37 (1.25)**	.04
14. My emotions cause me to eat.[a]	2.83 (1.32)	2.26 (1.05)**	−.12
15. I buy ready to eat snack foods for myself.[a]	2.64 (1.28)	2.39 (1.34)**	−.02
16. I shop when I'm hungry.[a]	2.15 (0.85)	1.79 (0.75)**	−.11
17. I shop from a list.	2.95 (1.40)	3.63 (1.36)**	.07
18. I leave food on my plate.	1.65 (0.82)	2.38 (1.17)**	.30*
19. I serve food family style.[a]	2.53 (1.43)	1.92 (1.21)**	.03
20. I watch TV, read, or do other things while I eat.[a]	3.62 (1.25)	2.86 (1.30)**	.03
21. If I'm served too much, I leave food on my plate.	2.69 (1.39)	3.75 (1.10)**	.09
22. Generally, while I'm at home, I leave the table as soon as I finish eating.	3.35 (1.35)	3.63 (1.22)	−.01
23. I keep a graph of my weight.	1.20 (0.70)	4.10 (1.29)**	.23*
24. I eat when I'm not really hungry.[a]	2.68 (1.05)	1.81 (0.86)**	−.12
25. I store food in containers where it is not readily visible or in a closed cabinet.	2.83 (1.43)	3.35 (1.48)**	−.04
26. I decide ahead of time what I will eat for meals and snacks.	2.25 (1.15)	3.99 (0.93)**	.23*

Note. *Ns* = 109 to 111. Week 15 items marked as statistically significant reflect a significant change from baseline values. Percent weight loss is coded positively for weight loss and negatively for weight gain. EBI = Eating Behavior Inventory.

[a]Negative items, for which lower values indicate greater behaviors conducive to weight control; negative items were reverse-scored in the final calculation of EBI total score.

*$p < .05$. **$p < .01$.

Table 3. Correlations Between Changes in Hedonic Hunger and Percent Weight Loss.

PFS scores	Baseline	Week 15	*r*, PFS change with % weight loss
PFS total score	2.69 (0.95)	2.12 (0.71)**	−.247**
Food not present	2.42 (1.06)	1.92 (0.84)**	−.136
Food present	3.19 (1.10)	2.23 (0.93)**	−.196*
Food tasted	2.47 (0.89)	2.27 (0.78)**	−.219*

Note. *N*s = 109 to 111. Change scores marked as statistically significant reflect a significant change from baseline to Week 15. Percent weight loss is coded positively for weight loss and negatively for weight gain. PFS = Power of Food Scale.
*$p < .05$. **$p \leq .001$.

At the EBI individual item level, baseline PFS total score was correlated with four of the nine negative/maladaptive EBI items, indicating that higher hedonic hunger was associated with more frequently reported negative or maladaptive eating behaviors ("I eat and just can't seem to stop," "My emotions cause me to eat," "I eat when I'm not really hungry," and "I shop when I'm hungry"), *r*s = −.28 to −.54, *p*s < .05. In contrast, only 4 of the 17 EBI items reflecting positive weight control behaviors were significantly correlated with baseline PFS scores ("I eat foods that I believe will aid me in losing weight," "I buy ready to eat snack food for myself," "I leave food on my plate," and "If I'm served too much, I leave food on my plate," *r*s = −.20 to −.36, *p*s < .05), with higher hedonic hunger associated with lower usage of positive behaviors.

Moderating Effects of Hedonic Hunger

Secondary analyses examined whether baseline PFS total scores moderated the association between change in EBI total score and percent weight loss, as had been seen in our prior study (O'Neil et al., 2012).

A hierarchical regression model was run including baseline PFS total score (continuously measured) and EBI total score change in the first step, followed by their interaction. This two-way interaction was not significantly associated with percent weight loss, $p = .168$. However, baseline PFS total score, $\beta = .44$, $p = .04$, and EBI total score change, $\beta = .67$, $p = .02$, were significant in the model. That is, higher baseline hedonic hunger and greater improvement in weight control behavior usage were associated with greater weight loss from baseline to post-treatment. More specifically, for every 1-point elevation on baseline PFS score, percent weight loss would be estimated to increase by 1.03 percentage points (*SE* = .05). Furthermore, for every 10-point increase in

EBI score from pre-to post-treatment, percent weight loss would be estimated to increase by 1.2 percentage points (SE = .03).

To further permit direct comparison with our prior analyses conducted on these measures within a different type of treatment program (O'Neil et al., 2012), we also divided the sample into *high* (n = 56) and *low* (n = 55) PFS groups, based on a median split of baseline PFS total scores (median = 2.73). Patients with high PFS scores lost an average of 10.06 ± 4.75 kg (range = 23.98-0.18) and patients with low PFS scores lost an average of 8.94 ± 4.66 kg (range = 19.00 to −0.59), p = .22. Change in EBI total score and percent weight loss was significantly correlated among individuals with *low* PFS scores, $r(55) = -.39$, $p < .01$, although this association was not significant among those with high PFS scores, $r(56) = -.21$, $p = .13$. However, based on a Fisher's z transformation, the strengths of these correlations did not significantly differ, $z(110) = 1.45$, $p = .14$.

Discussion

Within this behavioral weight loss program featuring a partial meal-replacement diet, reported weight control behavior usage improved and hedonic hunger decreased, and these changes were associated with greater weight loss. Improvements in weight control behavior usage and hedonic hunger were also significantly associated with one another. These findings are quite consistent with those reported recently within a sample of adults participating in a group-based commercial weight loss program format over a similar time period (O'Neil et al, 2012). The present study extended those findings to an individually administered lifestyle change program incorporating meal-replacement products, in which greater average weight loss was observed (9.5% vs. 4.3%). However, it is noteworthy that the relations between weight control behavior usage and weight loss were stronger in the previous study (r = .59 vs. r = .31, z = 2.61, $p < .01$). This may reflect, in part, an overshadowing effect of the use of structured, pre-portioned meal replacements in the present study, as such products have been shown to induce greater weight loss when added to a lifestyle modification program (Heymsfield, van Mierlo, van der Knapp, Heo, & Frier, 2003). Other potentially influential differences between the previous study's commercial weight loss program and the present study are this behavioral program's slightly extended duration (15 weeks [with the option to extend] vs. 12 weeks) and delivery format (individual versus group).

The nature of the relations among behavior change, hedonic hunger, and weight loss remains to be explored further. Specifically, it may be that individuals beginning the program initiated behavior changes, which then

decreased the amount and variety of environmental food exposure (i.e., due to the majority of individuals' diet consisting of meal-replacement products), contributing to a reduction in hedonic hunger. This pattern may have been especially evident among individuals with high hedonic hunger and low weight control behavior usage at baseline. Alternatively, hedonic hunger may have been reduced via other aspects of the program (e.g., weight monitoring, regular contact with treatment staff), and thereby facilitated adoption of behavioral changes conducive to weight loss. Indeed, this treatment program directly targeted, in part, behaviors and cognitions relevant to hedonic hunger (e.g., resisting cravings, stimulus control such as limiting tempting foods in the environment) as well as weight control behaviors, including those measured on the EBI (e.g., dietary self-monitoring, self-weighing and graphing weight).

In the current study, individuals with *lower* usage of weight control behaviors at baseline appeared to achieve slightly more weight loss than those with higher usage of weight control behaviors at baseline. Although, this finding was not significant in our prior study (O'Neil et al., 2012), the magnitude of the correlations was similar (current study: $r = -.19$, prior study: $r = -.17$). One possible reason for this finding is that individuals with lower usage of weight control behaviors have greater room for improvements in the types of behaviors targeted by behavioral treatment programs, compared to individuals who are already utilizing many of the suggested strategies for weight control.

Interestingly, individuals with *higher* baseline hedonic hunger appeared to achieve even better weight loss than those with lower baseline hedonic hunger. This finding was unexpected, considering the lack of association between baseline hedonic hunger and weight loss found in the aforementioned study that used a commercial weight loss program format (O'Neil et al., 2012). One possible explanation is that individuals with relatively high hedonic hunger (i.e., who report feeling a strong appetitive reaction to palatable food cues in the environment) may especially benefit from a treatment program which limits exposure to preferred high-calorie foods. The treatment plan examined in the present study used meal-replacement supplements for a large portion of patients' dietary intake during the initial half of the program. Thus, individuals with at least moderate adherence to the prescribed diet were exposed to a sharply decreased variety of highly palatable foods. Anecdotally, patients commonly reported changing their habits to accommodate the prescribed diet (e.g., eating out at restaurants less often, eliminating tempting foods from the home). In addition, results appear consistent with finding that individuals with high hedonic hunger may be particularly susceptible to the effects of physiologic hunger (i.e., having fasted for several hours, as compared with

having just consumed a meal-replacement shake; Rejeski et al., 2012). The weight loss treatment program delivered in the present study asked patients to adhere to a schedule of regular eating (i.e., eating every 2-4 hr) to minimize physiological hunger. This strategy may have been especially helpful for individuals with high hedonic hunger attempting weight loss.

In the current study, hedonic hunger scores at baseline did not appear to significantly moderate the relation between change in weight control behaviors and weight loss. However, there was a non-significant trend toward individuals with *low* baseline hedonic hunger showing a stronger association between weight loss and improvement in weight control behaviors. This pattern was opposite that observed in our prior study, although the baseline levels of hedonic hunger were similar in the two samples (O'Neil et al., 2012). Overall, it appears that the impact of hedonic hunger on the association between weight control behavior usage and weight loss may depend on the type of program and the type of population studied. In particular, the present study employed an intensive behavior modification program that included significant use of meal-replacement supplements, whereas findings from this previous study utilized a commercial weight loss program.

A particular strength of the present study is that broad inclusion criteria were used (i.e., an "all-comers" clinic-based approach). In addition, the present study presents novel pre- to post-treatment use of the Power of Food Scale to measure changes in hedonic hunger within a partial meal-replacement weight loss program. Furthermore, given that this study used the same measures and analytic plan as was used in our earlier study of participants following a commercial weight loss program format (Weight Watchers), the two studies permit some estimate of the extent to which the reported relations are specific to the type of weight loss program.

Limitations of this study include its short-term nature (i.e., 15 weeks) and the fact that no control group was available to monitor naturalistic changes over the same time period in weight, weight control behavior usage, and hedonic hunger. Furthermore, data were restricted to individuals with post-treatment data, which may have biased findings in that treatment non-completers were excluded. Not having post-treatment data on the large number of individuals who did not complete treatment limits the generalizability of these findings. However, as noted above, completers and non-completers did not differ on any baseline variables, including EBI or PFS scores, although it is possible that the groups differed on other unmeasured characteristics. Finally, the questionnaires examined in the present study were only administered at baseline and post-treatment; more frequent assessment administrations, despite increasing subject burden, may have allowed for meditational analyses illustrating the mechanism by which in-treatment changes in weight control behaviors and hedonic hunger are interrelated.

The present study's findings, in conjunction with our prior study of participants in a 12-week commercial weight loss program (O'Neil et al., 2012), indicate that lifestyle modification weight loss programs appear associated with at least short-term reductions in hedonic hunger and increases in usage of weight control behaviors. Furthermore, greater weight losses are associated with greater increases in behavior usage and reductions in hedonic hunger from pre- to post-treatment. Additional studies are warranted to determine whether these changes are maintained over long-term follow-up, and by employing appropriate controls, whether the treatment program actually causes these changes. The current study also suggests that patients presenting with high hedonic hunger and low usage of weight control behavior experience greater weight loss in the type of program studied here. However, the present study does not provide sufficient data to clarify which elements of the treatment program were uniquely effective for individuals with low as compared with high hedonic hunger. If future studies verify that individuals differing in level of pretreatment hedonic hunger and weight control behavior usage respond differently to lifestyle change weight loss programs, results would continue to inform the development and tailoring of effective weight loss interventions based on this and related patient characteristics.

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