Internal Disinhibition Predicts Weight Regain Following Weight Loss and Weight Loss Maintenance

Heather M. Niemeier, Suzanne Phelan, Joseph L. Fava, and Rena R. Wing

Abstract

Objective: The disinhibition scale of the Eating Inventory predicts weight loss outcome; however, it may include multiple factors. The purpose of this study was to examine the factor structure of the disinhibition scale and determine how its factors independently relate to long-term weight loss outcomes.

Research Methods and Procedures: Exploratory factor analysis of the disinhibition scale was conducted on 286 participants in a behavioral weight loss trial (TRIM), and confirmatory factor analysis was conducted on 3345 members of the National Weight Control Registry (NWCR), a registry of successful weight loss maintainers. Multivariate regressions were used to examine the relationships between the disinhibition scale factors and weight over time in both samples.

Results: Using baseline data from TRIM, two factors were extracted from the disinhibition scale: 1) an "internal" factor that described eating in response to internal cues, such as feelings and thoughts; and 2) an "external" factor that described eating in response to external cues, such as social events. This factor structure was confirmed using confirmatory factor analysis in the NWCR. In TRIM, internal disinhibition significantly predicted weight loss at 6 months ($p = 0.03$) and marginally significantly predicted weight loss at 18 months ($p = 0.06$), with higher levels of internal disinhibition at baseline predicting less weight loss; external disinhibition did not predict weight loss at any time-point. In NWCR, internal disinhibition significantly predicted one-year weight change ($p = 0.001$), while external disinhibition did not.

Discussion: These results suggest that it is the disinhibition of eating in response to internal cues that is associated with poorer long-term weight loss outcomes.

Key words: weight regain, weight maintenance, weight loss, Eating Inventory

Introduction

One of the greatest challenges facing the field of obesity treatment is the problem of weight regain after weight loss (1). Participants in behavioral weight loss programs lose 10% of their body weight, on average, and these losses are associated with significant health benefits (2). Unfortunately, the majority of participants return to their baseline weight within 3 to 5 years (3,4). However, there is considerable variability among participants in behavioral weight loss trials, with some participants losing very little weight, some losing large amounts of weight and maintaining, and others losing and regaining (5). An understanding of the characteristics associated with long-term weight loss success would be helpful in efforts to refine treatments to better address the problem of weight regain.

The Eating Inventory (EI),[1] originally known as the Three Factor Eating Questionnaire (6), is a widely used measure in obesity research that has often been used to predict weight loss outcome (7–9). The disinhibition subscale of the EI assesses eating in response to emotional, cognitive, or social cues and is of particular interest because of its association in several studies (8–11) with long-term

The Warren Alpert Medical School of Brown University/Miriam Hospital, Providence, Rhode Island.

[1] Nonstandard abbreviations: EI, Eating Inventory; NWCR, National Weight Control Registry; CFA, confirmatory factor analysis; BDI-II, Beck Depression Inventory-II; CES-D, Center for Epidemiological Studies Depression Scale; PSS, Perceived Stress Scale; EDE-Q, Eating Disorder Examination-Questionnaire; PCA, principal components analysis; NS, not significant.

outcome after weight loss. Karlsson et al. found that higher baseline disinhibition predicted weight regain at 2-year follow-up after completion of a behavioral weight loss treatment (8). Similarly, Cuntz et al. found that disinhibited eating on completion of an inpatient weight loss treatment program predicted weight regain (10). In the National Weight Control Registry (NWCR), a registry of successful weight loss maintainers, disinhibition has also been shown to predict weight regain. McGuire et al. reported that those with higher levels of disinhibition at entry into the NWCR were at increased risk for weight regain one year later and that those who regained were more likely to report increased disinhibition over the year (11). However, other studies have failed to find a relationship between disinhibition and outcome after weight loss (7,9,12).

One reason for the contradictory findings may be the psychometric properties of the disinhibition scale itself. Several authors have re-examined the factor structure of the EI as a whole (13–15) and of the disinhibition scale specifically (16) and have questioned the original factor structure of the disinhibition scale as described by Stunkard and Messick (6). Results from different samples (normal-weight college students to obese men and women) have consistently suggested the existence of an "emotional eating" factor (e.g., eating in response to negative affect) made up of select items from the original disinhibition scale. However, the actual items comprising this factor have varied (13,15).

Therefore, the purpose of the current study was 2-fold. First, we wanted to re-examine the factor structure of the disinhibition scale of the EI. Despite its widespread use, only one study has used the more rigorous confirmatory tests to examine the factor structure of the EI, and they failed to confirm the original factor structure when examining the questionnaire as a whole (17). In addition, no study has used confirmatory methods on the disinhibition subscale specifically. In the current study, we conducted exploratory factor analysis on the disinhibition scale and confirmed the factor structure on a second independent sample using confirmatory factor analysis (CFA).

The second goal of this study was to determine whether the factors identified on the disinhibition scale relate to long-term weight loss outcomes. To assess this, we examined two very different samples: 1) overweight men and women participating in a behavioral weight loss treatment trial, and 2) members of the NWCR.

Research Methods and Procedures

Samples

TRIM. Participants were 286 overweight men and women (mean age, 40.7 ± 6.6 years; mean baseline BMI, 31.3 ± 3.0 kg/m^2) who completed baseline assessment for enrollment in a behavioral weight loss treatment trial comparing two different physical activity prescriptions (energy expenditure goal of 1000 kcal/wk vs. 2500 kcal/wk). Both groups were provided with a standard behavioral weight loss intervention (differing in the physical activity recommendation) and met weekly for 6 months, biweekly for 6 months, and monthly for 6 months. Participants in the high physical activity condition were invited to recruit friends and family members to participate in treatment with them. Of the 286, 202 were randomized participants, with the remainder serving as their invited partners. In-person assessments were conducted at baseline and 6, 12, and 18 months. Of randomized participants, 168 (83%) completed the 18-month follow-up. Independent t tests comparing participants who withdrew vs. those who completed the 18-month assessment revealed no significant differences at baseline in initial BMI, age, gender, ethnicity, or 6- or 12-month weight losses. Detailed descriptions of the treatments and their outcome are available elsewhere (18).

NWCR. The NWCR is an ongoing longitudinal study of adults who have lost at least 30 lbs. and have maintained that loss for at least one year. Registry members are recruited via national and local media outlets and advertisements. All study data are collected via mail. Participants in this study were 3345 registry members (mean age, 47.2 ± 12.5 years; mean baseline BMI, 25.2 ± 4.9 kg/m^2) who had been enrolled in the registry for at least one year and completed the EI on entry into the registry. Of the 3345 registry members who enrolled, 2765 (83%) completed the 1-year follow-up. Independent t tests comparing participants who withdrew vs. those who completed the 1-year assessment revealed significant differences in baseline age, BMI, and magnitude below maximum lifetime weight. At baseline, individuals who subsequently dropped out were younger (44.2 ± 12.5 vs. 47.8 ± 12.5 years; $p < 0.0001$), had a higher BMI (25.9 ± 5.1 vs. 25.1 ± 4.8 kg/m^2; $p < 0.0001$), and had lost more weight at entry into the Registry (34.7 ± 17.9 vs. 32.0 ± 17.6 kg; $p < 0.001$). χ^2 Analyses revealed that individuals who subsequently dropped out were also more likely to be non-white (27.0% vs. 16.7%; $p < 0.001$). No significant differences in dropout as a function of gender were observed. Detailed information about the registry is available elsewhere (19).

Table 1 shows demographic and anthropometric characteristics of the samples.

Measures

Demographics. Demographic data on age, sex, and race/ethnicity were collected at baseline in both studies.

Anthropometrics: TRIM. Body weight was measured at all assessments using a calibrated scale, with the participant in a hospital gown and no shoes. Height was measured at baseline using a wall-mounted ruler. BMI was computed.

Anthropometrics: NWCR. Participants in the NWCR self-report their current weight and height as well as lifetime

Table 1. Demographic and anthropometric characteristics of participants in TRIM and NWCR

Characteristic	TRIM (N = 286)			NWCR (N = 3345)		
	%	Mean	SD	%	Mean	SD
Gender (% female)	63.6			76.1		
Age		40.7	6.6		47.2	12.5
Ethnicity (% white)	80.3			95.2		
Baseline BMI		31.3	3.0		25.2	4.9
TRIM weight change (kg)						
6 months		−8.8	7.1			
12 months		−7.7	8.2			
18 months		−5.8	8.4			
NWCR weight characteristics						
Weight (kg) lost from maximum weight					32.5	17.7
Duration at >13.6-kg loss (months)					69.1	90.2
Weight change baseline to 1 year (kg)					2.2	5.5
Baseline internal disinhibition		4.2	2.4		2.7	2.2
Baseline external disinhibition		3.8	1.6		2.4	1.7
BDI		7.4	5.9			
CES-D					9.3	8.8
Binge eating frequency					0.7	2.1
PSS					4.9	3.0

NWCR, National Weight Control Registry; SD, standard deviation; BDI, Beck Depression Inventory; CES-D, Center for Epidemiological Studies Depression Scale; PSS, Perceived Stress Scale.

maximum weight, which is used to calculate their total weight loss. The reliability and validity of self-reported weights of registry members have been documented (11). Participants also report the duration of weight loss maintenance in months.

Psychological Measures

Eating Inventory: Disinhibition Scale. The disinhibition scale of the EI (6) includes 16 items. Responses to these items are scored 0 or 1 and are summed. Higher scores indicate higher levels of disinhibition. The scale is widely used in obesity research and has documented reliability and validity (15,20,21).

Previous research suggests that disinhibition may be related to mood (15) and binge eating (22), and each has also been found to be associated with weight (23,24). Stress may also play a role in triggering overeating (25,26) and has been found in some longitudinal studies to be a significant predictor of weight gain (23). Therefore, available psychological covariates were included in regression models to isolate the specific relationship between the disinhibition factors and weight regain. Intercorrelations among the disinhibition factors and the psychological covariates from each sample are shown in Table 2.

TRIM. Beck Depression Inventory-II (BDI-II). The BDI-II is a 21-item self-report questionnaire designed to measure depressive symptoms and attitudes (27). Higher scores reflect greater negative affect and depressive symptomatology.

NWCR. Center for Epidemiological Studies Depression Scale (CES-D). The CES-D is a 20-item scale assessing depressive symptomatology (28). Higher scores indicate more depression.

Perceived Stress Scale (PSS). The PSS is a 4-item scale designed to assess the degree to which the respondent appraises situations in his/her life as stressful (29). Higher scores reflect greater perceived stress.

Eating Disorder Examination-Questionnaire (EDE-Q). Items from the EDE-Q were used to assess the frequency of objective binge eating episodes over the previous 28 days (30). The EDE-Q defines binge eating as an episode in which an unusually large amount of food is consumed with an accompanying subjective feeling of loss of control.

Statistical Analysis

Exploratory dimensional analysis of the 16-item disinhibition scale was conducted in the TRIM sample; all 286

Table 2. Intercorrelations among disinhibition subscales and psychological covariates in TRIM and NWCR

	Internal disinhibition	External disinhibition		
TRIM				
Internal disinhibition	—			
External disinhibition	0.40*	—		
BDI	0.29*	0.12		
	Internal disinhibition	**External disinhibition**	**CES-D**	**PSS**
NWCR				
Internal disinhibition	—			
External disinhibition	0.56*	—		
CES-D	0.30*	0.19*	—	
PSS	0.33*	0.19*	0.67*	—
Binge eating frequency	0.36*	0.28*	0.16*	0.16*

NWCR, National Weight Control Registry; BDI, Beck Depression Inventory; CES-D, Center for Epidemiological Studies Depression Scale; PSS, Perceived Stress Scale.
* $p < 0.001$.

participants who completed baseline assessment (including randomized participants and their invited partners) were included in the exploratory factor analysis. Both the Scree Test (31) and an implementation of the parallel analysis procedure (32) were first used in a preliminary step to determine the underlying dimensional structure. Next, a principal components analysis (PCA) using a varimax rotation (33) was conducted to examine the solution. Items with loadings of <0.4 were removed (34–37), and a final PCA was conducted on remaining items; Cronbach's coefficient α was calculated for the subscales (38).

Next, a CFA was conducted on the baseline disinhibition scale items from the NWCR sample using the factor structure identified by the exploratory dimensional analyses. The CFA was implemented using Mplus version 3.11 structural equation modeling program (39). The CFA was performed using the weighted least squares estimator on the derived tetrachoric correlation matrix of the observed items. Use of a tetrachoric correlation matrix has been generally found to provide unbiased estimates of the correlations between normal and moderately non-normal latent response variables (40) and may allow more accurate modeling when using binary measures to represent underlying variables that are assumed to be multivariate normal (41).

Multivariate regression was used to examine the relationship between the disinhibition scale factors and weight regain in both samples. In TRIM, only randomized participants ($n = 202$) were included in regression models. Models predicting weight change at 6, 12, and 18 months from the baseline disinhibition factor scores after controlling for covariates were tested. Covariates were treatment group, age, sex, ethnicity, baseline weight, and BDI score. Regressions included only those participants available at each assessment time-point (6 months, $n = 186$; 12 months, $n = 163$; 18 months, $n = 168$). In NWCR, a model predicting weight change one year after entry into the registry from the baseline disinhibition factor scores after controlling for covariates was tested. Regressions included only those participants who completed the 1-year follow-up assessment. Covariates were age, sex, ethnicity, entry weight, duration of weight loss maintenance (in months), total weight lost, CES-D score, binge eating frequency, and PSS score. Because the binge eating frequency items and the PSS were added to the NWCR assessment battery after the enrollment of nearly 1000 members, regressions were run with and without these covariates. The pattern of results did not change (i.e., all significant predictors remained significant and all non-significant predictors remained non-significant); therefore, the more conservative models controlling for binge eating frequency and PSS are presented here.

Results

Exploratory Dimensional Analysis: TRIM

Both the Scree Test and the parallel analysis procedure suggested that a two-dimensional solution would best fit the observed correlational data structure. In the two-factor PCA using varimax rotation, 2 of the 16 items had item loadings

Table 3. Item loadings for the two-dimensional principal components analysis with varimax rotation

Item	F1	F2
1. (1) When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal.	0.49	
2. (2) I usually eat too much at social occasions, like parties and picnics.	0.68	
3. (7) Sometimes things just taste so good that I keep on eating even when I am no longer hungry.	0.50	
4. (13) When I am with someone who is overeating, I usually overeat too.	0.48	
5. (15) Sometimes when I start eating, I just can't seem to stop.	0.59	
6. (16) It is not difficult for me to leave something on my plate.	0.59	
7. (9) When I feel anxious, I find myself eating.		0.73
8. (11) Since my weight goes up and down, I have gone on reducing diets more than once.		0.47
9. (20) When I feel blue, I often overeat.		0.78
10. (27) When I feel lonely, I console myself by eating.		0.78
11. (36) While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods.		0.51
12. (45) Do you eat sensibly in front of others and splurge alone?		0.49
13. (49) Do you go on eating binges even though you are not hungry?		0.60
14. (50) To what extent does this statement describe your eating behavior? "I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow."		0.48

<0.4 on both components and were removed from further analyses. The other 14 items were clearly represented in a two-dimensional solution, with 6 items loading >0.4 on an external disinhibition subscale and 8 items loading >0.4 on an internal disinhibition subscale. Item content and loadings for the two-dimensional solution from the final PCA on the 14-item correlation matrix are presented in Table 3. Reliability, as measured by Cronbach's coefficient α statistic (38), was 0.63 for the 6-item external disinhibition subscale and 0.78 on the 8-item internal disinhibition subscale.

Confirmatory Factor Analysis: NWCR

The results of this analysis support the factor structure previously found in the exploratory analyses in TRIM. Specifically, the values of several fit indices and combinations of fit indices (42) lend support for a 2-correlated factors model, with the Comparative Fit Index (43) equal to 0.95, the Tucker Lewis Index (44) equal to 0.96, the Root Mean Square Error of Approximation (45) equal to 0.07, and the Standardized Root Mean Square Residual (46) equal to 0.07. The standardized item loadings and factor correlation (0.77) are depicted in Figure 1. Reliability, as calculated by Cronbach's coefficient α statistic (38), was 0.67 for external disinhibition and 0.78 for internal disinhibition.

Prediction of Weight Change: TRIM

To examine the independent relationship between each of the factors of the disinhibition scale and weight change over time, the two subscale scores, baseline internal disinhibition and external disinhibition, were entered into multivariate regression analyses predicting weight change from baseline to 6, 12, and 18 months, controlling for treatment group, age, gender, ethnicity, baseline weight, and BDI score. At 6 months, internal disinhibition was a significant predictor of weight loss [$F(1,177) = 5.00$, $p = 0.03$], such that higher levels of internal disinhibition at baseline predicted less weight loss at 6 months. External disinhibition did not significantly predict weight loss at 6 months [$F(1,177) = 1.16$, not significant (NS)]. Neither baseline internal disinhibition nor baseline external disinhibition predicted weight change at 12 months [$F(1,154) = 2.65$, NS; $F(1,154) = 0.05$, NS, respectively]. Internal disinhibition was marginally significant in the prediction of weight change at 18 months [$F(1,159) = 3.52$, $p = 0.06$], again with higher levels of internal disinhibition at baseline predicting less weight loss at 18 months. External disinhibition remained non-significant at 18 months [$F(1,159) = 1.16$, NS]. Each additional point on the internal disinhibition scale predicted an increase of 0.59 kg and 0.62 kg at 6 and 18 months, respectively. The 6- and 18-month mod-

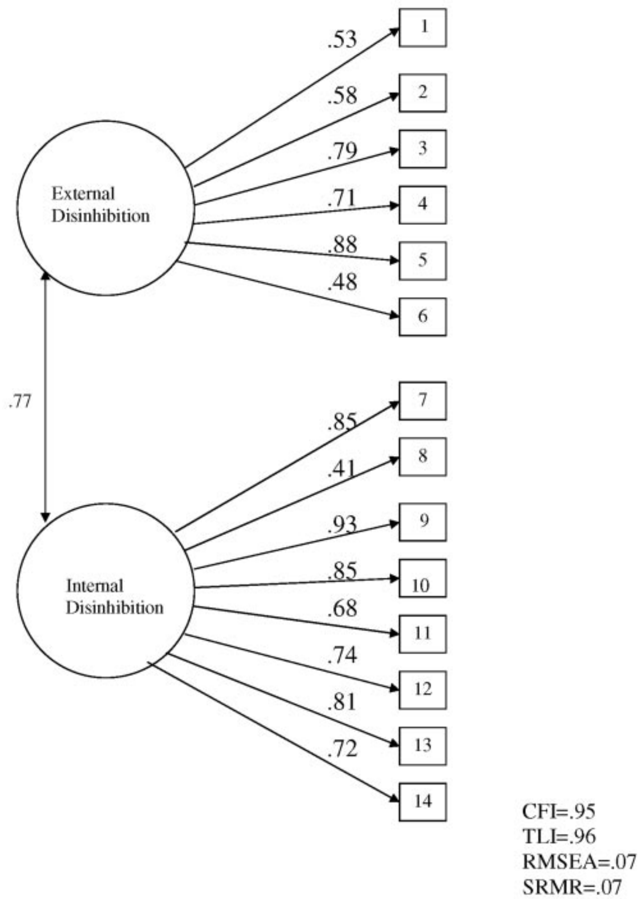

Figure 1: Standardized item loadings, factor correlation, and fit indices for the two-correlated factors model in the NWCR participants. CFI, Comparative Fit Index; TLI, Tucker Lewis Index; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual.

els are presented in Table 4. Similar analyses were conducted without the BDI as a covariate, and regression coefficients for internal disinhibition were 0.51 (standard error = 0.26) and 0.61 (standard error = 0.32) at 6 and 18 months, respectively.

Prediction of Weight Change: NWCR

In the NWCR, multivariate regression analyses were again used to determine whether each of the disinhibition subscales independently predicted weight change over the first year of Registry membership, controlling for age, gender, ethnicity, baseline weight, magnitude of initial weight loss, duration of weight loss maintenance, CES-D score, binge eating frequency, and PSS score. Internal disinhibition was an independent significant predictor of weight change over the year [$F(1,1791) = 10.58$, $p = 0.001$], while external disinhibition was not [$F(1,1791) = 0.01$, NS]. Higher levels of internal disinhibition on entry into the registry predicted more weight regain in the first year of membership. Each additional point on the internal disinhibition scale predicted an increase of 0.26 kg over the year. The model is presented in Table 5. Similar analyses were conducted without the psychological covariates (e.g., CES-D score, binge eating frequency, and PSS score), and the regression coefficient increased to 0.32 (standard error = 0.06).

Discussion

The first goal of this study was to conduct a re-examination of the factor structure of the disinhibition scale of the EI. We found that the disinhibition scale actually represents two distinct factors, and this factor structure was confirmed in an independent sample. An examination of the items on the first factor revealed items that describe the experience of disinhibition in situations that are *external* to the individual, and this disinhibition was, therefore, labeled external disinhibition. Examples of external disinhibition include "When I am with someone who is overeating, I usually overeat too" and "I usually eat too much at social occasions, like parties and picnics." Interestingly, the 6-item external disinhibition factor was nearly identical to the 5-item factor labeled "Situational susceptibility to disinhibition" by Bond et al. (16). We note that internal consistency of the external disinhibition subscale in our studies (0.63 and 0.67) and the study by Bond et al. (0.60) was low. This may reflect the low number of items or the binary nature (0 or 1) of the items on the disinhibition subscale. The use of binary data may restrict the range of responses, providing less opportunity for accurate endorsement and a possible decrease in the inter-item correlation.

On the second factor, items describe the experience of disinhibition of eating in response to thoughts and feelings that are *internal* to the individual. Internal disinhibition includes emotional eating items such as, "When I feel lonely, I console myself by eating," as well as items that describe dichotomous thinking such as, "While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods." This factor includes three "emotional eating" items that have been found in prior research (14–16) to make up an independent factor, as well as five additional items that were labeled "Habitual susceptibility to disinhibition" by Bond et al. (16). This factor is consistent with the 6-item factor termed "Emotional Eating" by Ganley (13). The finding that two original disinhibition items (items 25 and 31) did not load on either factor in this study is also consistent with prior findings (14–16).

A second goal of this study was to examine the relationship between the separate disinhibition factors and weight loss over time to determine which of the constructs measured by the scale drive its relationship with weight. In TRIM, internal disinhibition on entry into the treatment predicted weight loss at 6 months and 18 months, such that

Table 4. Models predicting 6- and 18-month weight change in TRIM

Predictor	B (SE)	β	p*
6-month weight change			
Treatment group (standard behavior treatment = 0; high physical activity = 1)	−0.31 (1.03)	−0.02	NS
Age	−0.14 (0.08)	−0.12	0.08
Gender (female = 0; male = 1)	−1.33 (1.45)	−0.09	NS
Ethnicity (white = 0; other = 1)	3.35 (1.4)	0.17	0.02
Baseline weight	−0.10 (0.07)	−0.14	NS
BDI	−0.14 (0.09)	−0.11	NS
Internal disinhibition	0.59 (0.27)	0.20	0.03
External disinhibition	−0.40 (0.37)	−0.09	NS
18-month weight change			
Treatment group (standard behavior treatment = 0; high physical activity = 1)	−2.12 (1.28)	−0.13	0.10
Age	−0.13 (0.10)	−0.10	NS
Gender (female = 0; male = 1)	1.56 (1.78)	0.09	NS
Ethnicity (white = 0; other = 1)	4.89 (1.69)	0.23	0.004
Baseline weight	−0.10 (0.08)	−0.11	NS
BDI	−0.01 (0.11)	−0.01	NS
Internal disinhibition	0.62 (0.33)	0.19	0.06
External disinhibition	−0.49 (0.45)	−0.10	NS

SE, standard error; BDI, Beck Depression Inventory; NS, not significant.
* p values <0.10 shown.

higher levels of internal disinhibition were associated with losing less weight over time. The same was true in the NWCR in that internal disinhibition predicted weight regain over the first year of Registry membership. In both studies, external disinhibition was not a significant predictor of weight over time. Thus, these results suggest that it is the

Table 5. Model predicting 1-year weight change in NWCR

Predictor	B (SE)	β	p*
Age	−0.01 (0.01)	−0.01	NS
Gender (female = 0; male = 1)	1.07 (0.37)	0.08	0.004
Ethnicity (white = 0; other = 1)	−0.12 (0.66)	−0.004	NS
Baseline weight	−0.02 (0.01)	−0.05	0.08
Weight maintenance duration	−0.01 (0.001)	−0.14	<0.0001
Total weight loss	0.02 (0.01)	0.07	0.005
CES-D	−0.01 (0.02)	−0.02	NS
Binge eating frequency	0.20 (0.07)	0.08	0.002
PSS	0.11 (0.06)	0.05	0.09
Internal disinhibition	0.26 (0.08)	0.10	0.001
External disinhibition	0.01 (0.10)	0.002	NS

NWCR, National Weight Control Registry; SE, standard error; CES-D, Center for Epidemiological Studies Depression Scale; PSS, Perceived Stress Scale; NS, not significant.
* p values less than 0.10 shown.

experience of eating in response to emotions or thoughts that is associated with poorer outcome after weight loss. Importantly, baseline internal disinhibition predicted weight change over time above and beyond other psychological constructs including baseline depression in TRIM and depression, binge eating, and perceived stress in the NWCR. It may be that the relationship between depression and stress and poorer weight loss outcome is present most strongly in those individuals who also display a tendency to eat in response to such cues. A cycle might be created in which negative mood or experiences trigger eating, which leads to further negative mood due to failure to adhere to eating or activity goals.

Despite considerable clinical interest, research on the role of eating in response to negative affect or dysfunctional cognitions on weight regain has been limited. However, its importance has been supported by research on relapse episodes after behavioral weight control treatment. In two studies that interviewed participants regarding their most recent eating lapse after behavioral weight loss treatment, one half of lapse episodes were reported to have occurred in the presence of negative affect (e.g., anger, anxiety, etc.) (47,48). More recently, Carels et al., using ecological momentary assessment, found that increased negative affect was associated with both temptations and lapses (49,50). In addition, Byrne et al., in a qualitative analysis, found that "regainers" more often reported eating in response to adverse life events and use of eating to regulate or distract from negative mood than those who maintained their weight loss (51). "Regainers" were also more likely to display a dichotomous ("black and white") thinking style. In a follow-up study, Byrne et al. found that persistence of a dichotomous thinking style after successful weight loss prospectively predicted weight regain one year later (52). Our findings converge with this literature and highlight the significant role of emotions and dichotomous thinking (i.e., internal disinhibition) in weight loss.

Previous research has shown little or no association between weight changes during treatment and baseline disinhibition (12). High heterogeneity in the EI subscale may explain, in part, the failure of this and other eating measures to predict weight loss outcomes in prior research (12). Future research is needed to replicate findings from the current study that suggest that internal disinhibition is related to subsequent outcome. If replicated, our findings suggest that modification of the pattern of eating in response to affective and cognitive triggers may help improve weight loss outcomes. Current behavioral weight loss treatments include minimal sessions addressing the effect of emotional eating and dysfunctional cognitions on eating and activity behaviors (2). It may be that strengthening these components of treatment to help patients learn alternative strategies for dealing with these triggers may improve their ability to maintain weight loss behaviors over time, even in the face of affective and cognitive difficulties.

Strengths of this study include the use of confirmatory methods in the factor analysis, the use of two independent and distinct samples, and the prospective nature of analyses. However, the generalization of these findings is limited by the homogeneous nature of the samples (i.e., primarily white females).

In summary, our findings highlight the distinct nature of *internal* triggers in disinhibited eating and suggest that it is these triggers that are associated with weight loss outcomes. Replication of these findings separating the disinhibition scale into internal and external factors and examining their relationship with weight regain over time is needed. Future research could then focus on strengthening current behavioral approaches to better address these issues.

Acknowledgment

This work was supported by a grant from National Institute of Diabetes and Digestive and Kidney Diseases (K23 DK073536) (to H.M.N.).

References

1. **Jeffery RW, Drewnowski A, Epstein LH, et al.** Long-term maintenance of weight loss: current status. *Health Psychol.* 2000;19:5–16.
2. **Wing RR.** Behavioral approaches to the treatment of obesity. In: Bray GA, Bouchard C, eds. *Handbook of Obesity.* New York, NY: Marcel Dekker; 2004, pp. 147–67.
3. **Wadden TA, Frey DL.** A multicenter evaluation of a proprietary weight loss program for the treatment of marked obesity: a five-year follow-up. *Int J Eat Disord.* 1997;22:203–12.
4. **Wadden TA, Sternberg JA, Letizia KA, Stunkard AJ, Foster GD.** Treatment of obesity by very low calorie diet, behavior therapy, and their combination: a five-year perspective. *Int J Obes.* 1989;13(Suppl 2):39–46.
5. **Wing RR, Phelan S.** Behavioral treatment of obesity: strategies to improve outcome and predictors of success. In: Eckel RH, ed. *Obesity: Mechanisms and Clinical Management.* Philadelphia, PA: Lippincott Williams & Wilkins; 2003, pp. 415–35.
6. **Stunkard AJ, Messick S.** The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res.* 1985;29:71–83.
7. **Foster GD, Wadden TA, Swain RM, Stunkard AJ, Platte P, Vogt RA.** The Eating Inventory in obese women: clinical correlates and relationship to weight loss. *Int J Obes Relat Metab Disord.* 1998;22:778–85.
8. **Karlsson J, Hallgren P, Kral J, Lindroos AK, Sjöström L, Sullivan M.** Predictors and effects of long-term dieting on mental well-being and weight loss in obese women. *Appetite.* 1994;23:15–26.
9. **Pekkarinen T, Takala I, Mustajoki P.** Two year maintenance of weight loss after a VLCD and behavioural therapy

for obesity: correlation to the scores of questionnaires measuring eating behaviour. *Int J Obes Relat Metab Disord.* 1996;20:332–7.
10. **Cuntz U, Leibbrand R, Ehrig C, Shaw R, Fichter MM.** Predictors of post-treatment weight reduction after in-patient behavioral therapy. *Int J Obes Relat Metab Disord.* 2001; 25(Suppl 1):99–101.
11. **McGuire MT, Wing RR, Klem ML, Lang W, Hill JO.** What predicts weight regain in a group of successful weight losers? *J Consult Clin Psychol.* 1999;67:177–85.
12. **Teixeira PJ, Going SB, Houtkooper LB, et al.** Pretreatment predictors of attrition and successful weight management in women. *Int J Obes Relat Metab Disord.* 2004;28: 1124–33.
13. **Ganley RM.** Emotional eating and how it relates to dietary restraint, disinhibition, and perceived hunger. *Int J Eat Disord.* 1988;7:635–47.
14. **Hyland ME, Irvine SH, Thacker C, Dann PL, Dennis I.** Psychometric analysis of the Stunkard-Messick Eating Questionnaire (SMEQ) and comparison with the Dutch Eating Behavior Questionnaire (DEBQ). *Curr Psychol Res Rev.* 1989;8:228–33.
15. **Karlsson J, Persson LO, Sjöström L, Sullivan M.** Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. *Int J Obes Relat Metab Disord.* 2000;24:1715–25.
16. **Bond MJ, McDowell AJ, Wilkinson JY.** The measurement of dietary restraint, disinhibition and hunger: an examination of the factor structure of the Three Factor Eating Questionnaire (TFEQ). *Int J Obes Relat Metab Disord.* 2001;25: 900–6.
17. **Mazzeo SE, Aggen SH, Anderson C, Tozzi F, Bulik CM.** Investigating the structure of the eating inventory (three-factor eating questionnaire): a confirmatory approach. *Int J Eat Disord.* 2003;34:255–64.
18. **Jeffery RW, Wing RR, Sherwood NE, Tate DF.** Physical activity and weight loss: does prescribing higher physical activity goals improve outcome? *Am J Clin Nutr.* 2003;78: 684–9.
19. **Klem ML, Wing RR, McGuire MT, Seagle HM, Hill JO.** A descriptive study of individuals successful at long-term maintenance of substantial weight loss. *Am J Clin Nutr.* 1997;66: 239–46.
20. **Stunkard AJ, Messick S.** *Eating Inventory Manual.* San Antonio, TX: Psychological Corporation; 1988.
21. **Klem ML, Wing RR, McGuire MT, Seagle HM, Hill JO.** Psychological symptoms in individuals successful at long-term maintenance of weight loss. *Health Psychol.* 1998;17: 336–45.
22. **de Zwaan M, Mitchell JE, Seim HC, et al.** Eating related and general psychopathology in obese females with binge eating disorder. *Int J Eat Disord.* 1994;15:43–52.
23. **Korkeila M, Kaprio J, Rissanen A, Koshenvuo M, Sorensen TI.** Predictors of major weight gain in adult Finns: stress, life satisfaction and personality traits. *Int J Obes Relat Metab Disord.* 1998;22:949–57.
24. **Spitzer RL, Yanovski S, Wadden T, et al.** Binge eating disorder: its further validation in a multisite study. *Int J Eat Disord.* 1993;13:137–53.
25. **Newman E, O'Connor DB, Conner Newman E, O'Connor DB, Conner M.** Daily hassles and eating behaviour: the role of cortisol reactivity status. *Psychoneuroendocrinology.* 2007; 32:125–32.
26. **Crowther JH, Sanftner J, Bonifazi DZ, Shepherd KL.** The role of daily hassles in binge eating. *Int J Eat Disord.* 2001; 29:449–54.
27. **Beck AT, Steer RA, Brown GK.** *Beck Depression Inventory-II Manual.* San Antonio, TX: Psychological Corporation; 1996.
28. **Radloff LS.** The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas.* 1977;1:385–401.
29. **Cohen S, Kamarck T, Mermelstein R.** A global measure of perceived stress. *J Health Soc Behav.* 1983;24:385–96.
30. **Fairburn CG, Beglin SJ.** Assessment of eating disorders: interview or self-report questionnaire? *Int J Eat Disord.* 1994; 16:363–70.
31. **Cattell RB.** The scree test for the number of factors. *Multivariate Behav Res.* 1966;1:245–76.
32. **Horn JL.** A rationale and test for the number of factors in factor analysis. *Psychometrika.* 1965;30:179–85.
33. **Kaiser HF.** The varimax criterion for analytic rotation in factor analysis. *Psychometrika.* 1958;23:187–200.
34. **Fava JL, Velicer WF.** The effects of overextraction on factor and component analysis. *Multivariate Behav Res.* 1992;27: 387–415.
35. **Velicer WF, Fava JL.** Effects of variable and subject sampling on factor pattern recovery. *Psychol Methods.* 1998;3: 231–51.
36. **Guadagnoli E, Velicer WF.** Relation of sample size to the stability of component patterns. *Psychol Bull.* 1988;103:265–75.
37. **Comrey AL, Lee HB.** *A First Course in Factor Analysis.* Hillsdale NJ: Erlbaum; 1992.
38. **Cronbach LJ.** Coefficient alpha and the internal structure of tests. *Psychometrika.* 1951;16:297–334.
39. **Muthen LK, Muthen BO.** *Mplus User's Guide.* Los Angeles, CA: Muthen & Muthen; 2004.
40. **Flora DB, Curran PJ.** An empirical evaluation of alternative methods of estimation for confirmatory factor analysis with ordinal data. *Psychol Methods.* 2004;9:466–91.
41. **Muthen BO.** Goodness of fit with categorical and other non-normal variables. In: Bollen KA, Long JS, eds. *Testing Structural Equation Models.* Newbury Park, CA: Sage; 1993, pp. 205–34.
42. **Hu L, Bentler PM.** Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling.* 1999; 6:1–55.
43. **Bentler PM.** Comparative fit indexes in structural models. *Psychol Bull.* 1990;107:238–46.
44. **Tucker LR, Lewis C.** A reliability coefficient for maximum likelihood factor analysis. *Psychometrika.* 1973;38:1–10.

45. **Steiger JH, Lind JD.** Statistically based tests for the number of common factors. *Psychometric Society*. Iowa City, IA, 1980.
46. **Bentler PM.** *EQS: A Structural Equations Program.* Los Angeles, CA: BMDP Statistical Software; 1989.
47. **Drapkin RG, Wing RR, Shiffman S.** Responses to hypothetical high risk situations: do they predict weight loss in a behavioral treatment program or the context of dietary lapses? *Health Psychol.* 1995;14:427–34.
48. **Grilo CM, Shiffman S, Wing RR.** Relapse crises and coping among dieters. *J Consult Clin Psychol.* 1989;57: 488–95.
49. **Carels RA, Hoffman J, Collins A, Raber AC, Cacciapaglia H, O'Brien WH.** Ecological momentary assessment of temptation and lapse in dieting. *Eat Behav.* 2001;2:307–21.
50. **Carels RA, Douglass OM, Cacciapaglia HM, O'Brien WH.** An ecological momentary assessment of relapse crises in dieting. *J Consult Clin Psychol.* 2004;72:341–8.
51. **Byrne S, Cooper Z, Fairburn C.** Weight maintenance and relapse in obesity: a qualitative study. *Int J Obes Relat Metab Disord.* 2003;27:955–62.
52. **Byrne SM, Cooper Z, Fairburn CG.** Psychological predictors of weight regain in obesity. *Behav Res Ther.* 2004;42: 1341–56.