

THE COMMON PATHWAYS OF EATING DISORDERS AND ADDICTION:
EXPLORING THE LINK BETWEEN REWARD/MOTIVATION, AFFECT
REGULATION AND COGNITIVE CONTROL

A Dissertation
Submitted to
the Temple University Graduate Board

In Partial Fulfillment of the
Requirements for the Degree
DOCTOR OF PHILOSOPHY

by
Dawn M. Eichen
August 2013

Examining Committee Members:

Michael McCloskey, Ph.D., Department of Psychology, Temple University

Tania Giovannetti, Ph.D., Department of Psychology, Temple University

Robert Fauber, Ph.D., Department of Psychology, Temple University

Eunice Chen, Ph.D., Department of Psychology, Temple University

Mark Schmitz, Ph.D., School of Social Work, Temple University

Richard Heimberg, Ph.D., Department of Psychology, Temple University

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ABSTRACT

Eating disorders involve the inability to appropriately regulate a behavioral response to food due to impaired reward sensitivity, affect regulation and cognitive control, resulting in deleterious effects on the individual's physical and mental well-being. In this way eating disorders may be analogous to addictive disorders (e.g. alcoholism). Furthermore, eating and addictive disorders co-occur at very high rates and appear to have similar contributing mechanisms (impaired reward sensitivity, impaired affect regulation and impaired cognitive control). Overvaluation of weight and shape concerns appears to be one unique characteristic of eating disorders, not shared with addiction. The current study examined the relationship between impaired reward sensitivity, impaired affect regulation and impaired cognitive control with addiction vulnerability. Furthermore, weight and shape concerns were examined as a potential moderator of the relationship between addiction vulnerability and binge eating. A total of 1000 undergraduate students completed self-report measures examining the three posited mechanisms for addiction vulnerability and disordered eating. A subset of 101 students (50 binge-eaters and 51 non-binge eaters) also completed behavioral measures of the three posited mechanisms. The results of this study support the proposed model that weight and shape concerns moderate the relationship between addiction vulnerability and binge eating. Results also demonstrated on a behavioral task that individuals who endorsed binge eating were more likely to act impulsively and quit the PASAT-C task faster than control subjects. Furthermore, they demonstrated a greater increase in irritability while completing the task which may have resulted in their desire to quit the task earlier. No differences were found on behavioral measures of reward sensitivity

(delay discount task) or cognitive control (stop signal task). Future studies should continue to examine the construct of addiction vulnerability to provide additional validity for the construct as well as examine it in the context of all forms of disordered eating.

ACKNOWLEDGEMENTS AND DEDICATION

I would like to thank all of my family, friends and colleagues who supported me throughout this project. Specifically, I wish to acknowledge my parents Debbie and Marty Eichen, my sister Jaime Eichen for their constant support. I would also like to thank Michael McCloskey, Tania Giovannetti, Robert Fauber, Eunice Chen, Mark Schmitz and Richard Heimberg for their feedback and guidance on the project.

This study is dedicated to my mother.

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CHAPTER 1 INTRODUCTION

Eating disorders (EDs) and addictive behaviors, namely substance abuse, are both significant public health concerns. Independently, these disorders are associated with some of the highest natural and unnatural (i.e. suicide) mortality rates of all psychological disorders (Harris & Barraclough, 1998). Of note, there is significant overlap between these two conditions with as many as 36.8% of individuals with EDs meeting criteria for a substance use disorder (Hudson, Hiripi, Pope, & Kessler, 2007) and as many as 26% of individuals with alcohol use disorders meeting criteria for an ED (Peveler & Fairburn, 1990). This has sparked an ongoing debate regarding the relationship between EDs and addiction. While some have suggested that EDs should be considered a type of addiction, others maintain that the two represent distinct conditions (Gold, Frost-Pineda, & Jacobs, 2003; Wilson, 2010). Regardless, there are strong parallels between EDs and addiction that warrant the translation of the work conducted in the addictions literature to EDs to gain a better understanding of both of these disorders.

Eating Disorders

EDs (Anorexia Nervosa [AN], Bulimia Nervosa [BN], and Eating Disorder Not Otherwise Specified [EDNOS] which includes Binge Eating Disorder [BED]) are characterized by extreme, repetitive food-related behaviors such as severe restriction of caloric intake (AN) and uncontrolled episodes of eating and/or purging behaviors (BN, BED). Another commonality across all eating disorders is that they are associated with high levels of weight and shape concern. EDs are among the more common psychological diagnoses with a prevalence rating as high as 4.5% (Hudson et al., 2007)

and are often comorbid with mood, anxiety, and personality disorders. EDs result not only in a lower quality of life accompanied by social difficulties, but also significant health problems like osteoporosis, cardiovascular disease, and high mortality rates (Agras, 2001).

Although EDs are associated with significant complications, the etiology of EDs is largely unknown. The predominantly accepted cognitive theory of EDs emphasizes that over-evaluation of weight and shape is a central mechanism that contributes to the development and maintenance of all EDs (Fairburn, Cooper, & Shafran, 2003). The two major classification systems, ICD-10 and DSM-IV, both stress that shape and weight concerns are part of the criteria necessary to receive a diagnosis of either AN or BN. Individuals with BED often demonstrate comparable levels of weight and shape concerns as those with AN and BN and increased concerns when compared to obese and normal weight non-ED controls (Ahrberg, Trojca, Nasrawi, & Vocks, 2011; Eldredge & Agras, 1996; Goldschmidt et al., 2010; Grilo, Masheb, & White, 2010; Striegel-Moore et al., 2001; Striegel-Moore et al., 2000). As such, it has been suggested that the DSM-V include weight and shape concern as part of the diagnostic criteria for BED or at least use it as a diagnostic qualifier to indicate severity of the disorder (Grilo et al., 2010; Wilfley, Bishop, Wilson, & Agras, 2007). Taken together, concern about and over-evaluation of weight and shape represent hallmark characteristics of individuals with EDs.

Addictive Disorders

Addictive disorders (e.g. alcoholism, drug dependence) are characterized by preoccupation with behaviors initially seen as appetitive, which the individual has lost

control of and continues despite the negative consequences that accompany the excessive behavior (Goodman, 2008). Addictive disorders are both highly prevalent and significantly deleterious. For example, alcoholism, a prototypical addiction, occurs in 3.8 % of the population and is linked to cirrhosis, domestic violence, neurocognitive impairment, fetal alcohol syndrome and other developmental problems in offspring, and significant economic costs (Hasin, Stinson, Ogburn, & Grant, 2007). Addictive disorders traditionally show high relapse rates (Moos & Moos, 2006) and are comorbid with mood, anxiety, eating, personality and/or other addictive disorders (Hasin et al., 2007). Overall, addictive disorders appear to be characterized by the confluence of three deficits: impaired reward/motivation systems, impaired affect regulation, and impaired cognitive control, all of which have been linked to dopaminergic dysregulation. Though traditionally associated with alcohol and other drugs, more recent research has suggested that other disorders may evidence both the signs of addictions and their underlying deficits. These “behavioral addictions” include compulsive gambling, internet use, sex, exercise and spending (Sussman, Lisha, & Griffiths, 2011).

Overlap of Eating Disorders and Addictive Disorders

In addition to the high rates of comorbidity between the EDs and addiction (Harrop & Marlatt, 2010), both disorders show a similar developmental trajectory, with onset occurring in adolescence, following a chronic course, with periods of remission and recurrence. The repetitive and often impulsive and/or compulsive nature of the disordered eating behaviors also likens the disordered eating behaviors to addictive behaviors. Furthermore, biological evidence suggests that similar neurotransmitter systems are impaired in both EDs and addictions, namely the dopaminergic and serotonergic systems

(Goodman, 2008; Kaye, 2008). Due to these biological and behavioral similarities, a debate in the field exists as to whether EDs could be considered “behavioral” addictions or if eating and addictive disorders are simply two distinct syndromes with overlapping characteristics.

Although some suggest EDs should be considered under the umbrella of addictive disorders (Gold et al., 2003), many maintain they should be considered distinct syndromes (von Ranson & Cassin, 2007; Wilson, 2010). The proposed study does not seek to determine whether EDs should be considered an addiction, but hopes to highlight several common mechanisms to demonstrate the similarities between the two disorders, which may be related to an underlying “addiction vulnerability”. Specifically, this study will examine three key deficits posited in a model of addiction: 1) impaired motivation/reward, 2) impaired affect regulation and 3) impaired cognitive control (Eichen, Chen, & McCloskey, in prep). Significant support of these three impairments in addiction has been noted in the literature (see Goodman, 2008 for review). To date, few, predominantly self-report based studies have suggested that EDs are associated with each of these deficits individually. However, no study has yet to examine reward processing, affect regulation and cognitive control concurrently, using both self-report and behavioral measures. As such, results of this study seek to fill a gap in the literature and highlight the parallels between EDs and addiction to inform future research on the etiology and treatment of both of these disorders.

Impaired Motivation-Reward

Individuals with an impaired motivation-reward system have significant difficulty tolerating delayed reward and are generally hyposensitive to reward. Evidence from the addiction literature suggests that impaired motivation-reward, measured by poorer performance on delay discounting tasks, is present in addicted individuals (Bickel, Odum, & Madden, 1999; Madden, Petry, Badger, & Bickel, 1997; Vuchinich & Simpson, 1998). Biological research suggests that this impairment is related to dysfunction in the dopamine system which renders individuals hyposensitive to reward making them vulnerable to develop addiction (Everitt, Dickinson, & Robbins, 2001). Thus, once the hyposensitive individuals engage in a behavior that activates the reward system to an extent that they feel rewarded such as drug use, the behavior is highly reinforced (since the individual generally does not experience reward as much) and these effects are learned and addiction is subsequently developed.

A similarly impaired reward system has been demonstrated in individuals with EDs. Impaired decision making, resulting from inability to tolerate delayed reward, is apparent in all people with EDs such that they engage in disordered eating behavior (i.e. fasting, binge eating/purging) to achieve immediate reward (i.e. removal of a negative mood state) without consideration of long term consequences (i.e. medical complications). Results from a meta-analysis of self-report measures of sensitivity to reward and punishment confirm the data observed in behavioral studies and demonstrate impaired reward processing among individuals with EDs (Harrison, O'Brien, Lopez, & Treasure, 2010). Furthermore, individuals with both AN and BN exhibited significant impairment on the Iowa Gambling Task, such that they demonstrated a propensity to

make decisions that resulted in immediate gains but resulted in more negative long term consequences (Boeka & Lokken, 2006; Brogan, Hevey, & Pignatti, 2010). Taken together, these results appear to suggest that individuals with EDs might exhibit similar dysfunctional reward systems as addicted individuals, identifying one area in need of further study to understand the parallels between addiction and EDs.

Impaired Affect Regulation

Another impairment seen among individuals with addiction and EDs is poor affect (emotion) regulation. This construct involves difficulty identifying, evaluating and controlling emotions and their expression in an appropriate manner so as to not result in impaired functioning (Gross, 1998). Research suggests that individuals with EDs and substance dependence have impaired affect regulation (Harrison, Sullivan, Tchanturia, & Treasure, 2009; Thorberg & Lyvers, 2006). Individuals with high levels of affect dysregulation often engage in immediately rewarding behaviors (e.g. substance abuse, bingeing), which ultimately result in long-term negative consequences, to improve their immediate mood (Cooper, Frone, Russell, & Mudar, 1995). Accordingly, it is posited that affect dysregulation functions as a risk factor for addictive and eating disorders through the mechanism of negative reinforcement, in which the addictive behavior or disordered eating behavior is initially used to escape negative affect and over repeated use develops into addiction.

Specifically, in accordance with the Self-Medicating Hypothesis, it has been proposed that individuals engage in continued drug use because use of the substance helps the individual avoid or escape negative affect (Carmody, 1989; Khantzian, 1985,

1997). Further evidence that impaired affect regulation contributes to addiction comes from studies that demonstrate improved affect regulation is associated with less substance use. For example, among individuals with Borderline Personality Disorder (BPD), a disorder characterized by impaired affect regulation and often comorbid with substance abuse, post-treatment assessment suggested that improved emotion regulation explained the variance of decreased substance use (Axelrod, Perepletchikova, Holtzman, & Sinha, 2011). Likewise, cocaine abstinent individuals reported greater clarity of their emotions and better ability to regulate emotions at discharge than during first week of treatment to the point where they exhibited no differences when compared with healthy controls (Fox, Axelrod, Paliwal, Sleeper, & Sinha, 2007). As such, impaired affect regulation appears to significantly contribute to the development and maintenance of addiction, as the individual engages in the addictive behavior to try and eliminate a negative mood state and/or induce a positive mood state.

Similarly, individuals with EDs are believed to engage in disordered eating behaviors to escape from negative emotions that they cannot tolerate in order to suppress the negative feelings (Cooper, Wells, & Todd, 2004). In support, research has suggested that negative affect typically precedes bingeing behaviors (Grilo, Shiffman, & Carter-Campbell, 1994). This may temporarily create feelings of relief, but feelings of distress are ultimately exacerbated largely resulting from feelings of shame and guilt from losing control over eating (Corstorphine, 2006). Thus paralleling the mechanism of addiction in which drug use initially occurs to reduce negative affect initially but ultimately results in increased negative affect (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). One study that concurrently examined individuals with EDs and substance dependence found that

both clinical populations reported lower levels of emotional control than non-clinical participants (Pierrehumbert et al., 2002). As with substance abuse, improved affect regulation is associated with less disordered eating. For example, no differences in emotion regulation were found between recovered ANs and healthy controls (Harrison, Tchanturia, & Treasure, 2010). All in all, impaired affect regulation appears to contribute to both EDs and addiction. However, improvement in emotion regulation is related to the absence of ED symptoms and decreased substance use suggesting that improvements in emotion regulation might be a goal for treatment of both of these disorders.

Impaired Cognitive Control

A final area that both addicted and ED individuals demonstrate significant impairments in is cognitive control. Cognitive control refers to high order executive functioning modulated largely by the prefrontal cortex that encompasses the ability to inhibit behavioral responses, including those responses that are immediately rewarding but ultimately self-destructive (Steinberg, 2007). Accordingly, poor cognitive control manifests as behavioral impulsivity. It is posited that individuals with addiction have underdeveloped cognitive control and fail to stop these behaviors, often acting impulsively. One of the key facets of addiction is the continuation of the addicted behavior despite knowing its negative consequences and the inability to control the behavior. Several studies suggest that substance dependent individuals and pathological gamblers report higher levels of trait impulsivity (Rogers, Moeller, Swann, & Clark, 2010; Verdejo-García, Bechara, Recknor, & Pérez-García, 2007) and respond more impulsively on behavioral measures compared to controls (Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2005; Monterosso, Aron, Cordova, Xu, & London, 2005; Petry,

2001; Verdejo-García, Bechara, Recknor, & Perez-Garcia, 2006). Significant biological research has suggested that a dysregulated inhibitory system (encompassed in cognitive control), found in individuals with addiction is related to the compulsive tendencies found in addiction demonstrated by inability to make behavioral changes despite knowledge of the harmful consequences of continuing the addictive behavior (Lubman, Yucel, & Pantelis, 2004; Yucel & Lubman, 2007).

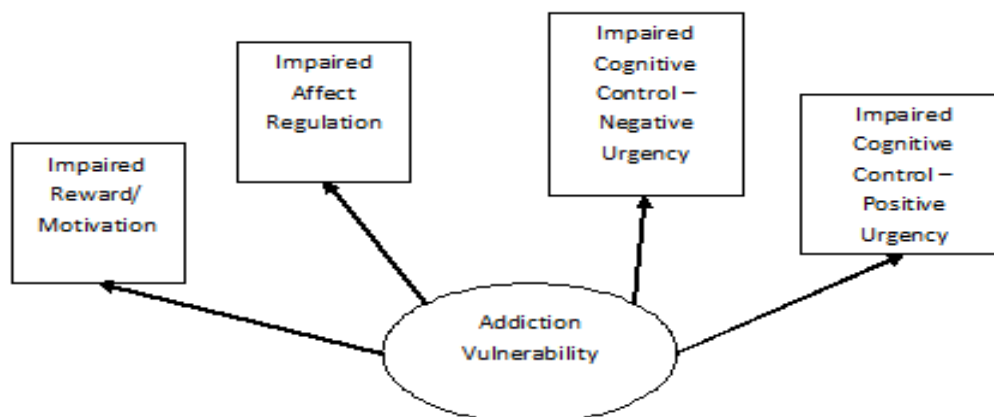
Similarly, individuals with EDs, particularly BN, appear to have impairments in cognitive control as they endorse high levels of impulsivity on self-report measures (Kemps & Wilsdon, 2010; Robinson, Pearce, Engel, & Wonderlich, 2009). Both of these studies demonstrated that self-reported impulsivity moderated performance on behavioral inhibition tasks, further suggesting impairments in cognitive control and inability to modulate behavior. Furthermore, results of a meta-analysis examining the relationship between subtypes of impulsivity and bulimic symptomatology showed that Urgency (largely related to affect regulation) had the greatest effect size (Fischer, Smith, & Cyders, 2008). However, all other areas of impulsivity demonstrated small to medium effect sizes suggesting impulsivity is a multifaceted trait related to ED symptomatology in various ways. Although impulsivity is most clearly related to BN, individuals with AN also demonstrate some behavioral impulsivity, suggesting they also exhibit impaired cognitive control. A study utilizing behavioral and self-report measures found that although individuals with AN did not self-report high levels of impulsivity, behavioral measures suggested they in fact have more difficulty inhibiting behavior than controls (Butler & Montgomery, 2005). Taken together, impaired cognitive control, largely represented by high levels of impulsivity and inability to inhibit behaviors, is found

among individuals with addiction and EDs, demonstrating a third parallel between the two disorders.

Proposed Relationship of Addiction and Eating Disorders

Significant commonalities between addiction and EDs are found in the three impaired mechanisms of a) reward and motivation processing, b) affect regulation, and c) cognitive control. It is posited that these deficits are associated with an “addiction vulnerability” or likelihood to develop an addiction. The research presented highlights that impairments in the three aforementioned areas are all present in addiction. Thus, addiction vulnerability can be conceptualized as a latent construct representing the likelihood an individual will develop an addiction based on how impaired said individual’s reward and motivation processing, affect regulation and cognitive control are. A proposed model of addiction emphasizes that these three common mechanisms contribute to the development of vulnerability to addiction (see figure 1). This model was further extended to try and discriminate when impairments in these three areas would lead to the development of EDs as opposed to addictive disorders like substance dependence. Weight and shape concerns are a central characteristic of EDs, whereas there is no known data to suggest these concerns are associated with addictive disorders. Accordingly, it is posited that the presence of weight and shape concerns is the key feature that discriminates individuals with and without EDs who are otherwise predisposed to addictive behaviors via deficits in the aforementioned areas of reward sensitivity, affect regulation and cognitive control. It is proposed that weight and shape concerns moderate the relationship between addiction vulnerability and disordered eating such that individuals who have high addiction vulnerability and high weight and shape

Figure 1

Measurement Model of Addiction Vulnerability

Note. Ovals represent latent constructs and rectangles represent measured constructs

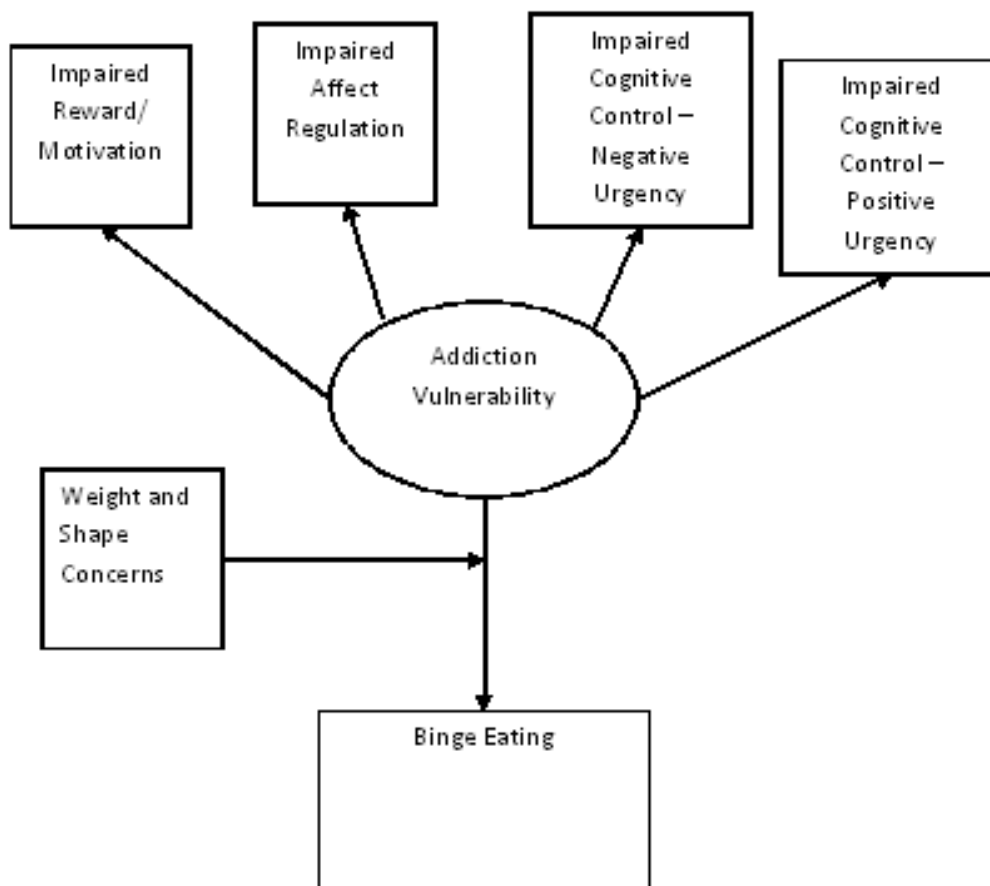
concerns will develop disordered eating, whereas the absence of weight and shape concerns will not result in disordered eating (see figure 2).

The Current Study

Significant evidence suggests that reward, affect regulation and cognitive control deficits are linked to addictive disorders. There is some (mostly self-report), evidence that these deficits are also associated with EDs. However, to date, no study has concurrently examined reward processing, affect regulation and cognitive control deficits as they relate to EDs. The current study utilized self-report (experiment 1A) and behavioral measures (experiment 1B) of a) reward and motivation processing, b) affect regulation, and c) cognitive control as well as a self-report

Figure 2

Proposed Model Reflecting Weight and Shape Concerns Moderate the Relationship between EDs and Addiction



Note. Ovals represent latent constructs and rectangles represent measured constructs

measure of weight and shape concerns to examine their relationship to disordered eating behaviors. This was done within the context of two experiments:

In the first part of the experiment (1A), 1000 undergraduate students completed a battery of questionnaires administered online including primary measures of disordered

eating behaviors and attitudes, including weight and shape concerns (the Eating Disorder Examination-Questionnaire; EDE-Q), affect regulation (the Difficulties in Emotion Regulation Scale; DERS), reward sensitivity (Sensitivity to Punishment and Sensitivity to Reward Questionnaire; SPSRQ) and cognitive control/impulsivity (Urgency, Perseverance, Premeditation, Sensation Seeking and Positive Urgency Impulsive Behavior Scale; UPPS-P). The second part of the experiment (1B) involved selecting two subsets of 50 participants from the initial sample, based on cutoff points established by the EDE-Q and confirmed by diagnostic interview to distinguish 50 binge eaters and 50 controls. These participants completed behavioral measures of each of the three addictive mechanisms including a) reward sensitivity (delay discounting), b) affect regulation (PASAT-C) and c) impulsivity / cognitive control (Stop Signal Task). Specific goals and hypotheses of the current study are outlined below.

AIM 1: Examination of the Relationship between Addiction Vulnerability and Disordered Eating Utilizing Self-Report Measures

The major aim of experiment 1A is to confirm the proposed model (figure 2) which posits that a) the three putative addiction mechanisms (reward sensitivity, affect regulation and cognitive control (positive and negative urgency) adequately tap the construct of addiction vulnerability and subsequently that b) weight and shape concerns moderate the relationship between addiction vulnerability and disordered eating (figure 2).

Hypothesis 1a: Confirmatory Factor Analysis. The confirmatory factor analysis (CFA) will demonstrate good model fit and each of the mechanisms will significantly load onto addiction vulnerability for individuals with high weight and shape concerns as

well as individuals with low weight and shape concerns, demonstrating no difference in the factor structure of the two groups, providing support for the proposed measurement model.

Hypothesis 1b: Moderation of weight and shape. The tested model will demonstrate that the relationship between addiction vulnerability and disordered eating will be significant for individuals with high weight and shape concerns and insignificant for those with low weight and shape concerns, supporting the model that weight and shape concerns is a moderator for the relationship of addiction vulnerability and disordered eating.

AIM 2: Behavioral differences between control subjects and binge eaters.

The second aim of the present study is to examine whether performance on the behavioral measures of the putative addiction mechanisms can differentiate between individuals who engage in clinical levels of binge eating from controls.

Hypothesis 2a: Delay Discounting. Primary: Binge eating participants will show greater delay discounting than healthy controls by having a steeper delay discount function. Secondary: Analysis of indifference points will show that binge eating participants are more likely to take less money than wait for a greater reward at each time period.

Hypothesis 2b: Affect Regulation. Primary: Binge eating participants will quit the PASAT-C earlier than healthy controls. Secondary: Binge eating participants will demonstrate a greater increase in negative emotional responses upon exiting than control participants.

Hypothesis 2c: Cognitive Control. Primary: Binge eating participants will show more commission errors on the Stop Signal task than healthy controls. Secondary: On responding trials, binge eating participants will respond more quickly than control participants.

CHAPTER 2
EXPERIMENT 1A – METHOD AND RESULTS

Design Issues

A total of 1000 Temple University undergraduate students, ages 18-25 years old completed the online self-report questionnaires. All participants were enrolled in a Temple University undergraduate course (primarily psychology) that offered course credit for participating in research. Of these 1000 individuals, only 730 individuals had valid data. In total, 107 individuals were missing data such that the appropriate subscales/totals needed for the subsequent analyses could not be calculated. The other 163 individuals whose data were not used had significant inconsistencies on the responses used to determine the number of binges over the past month. The three questions on the EDE-Q that examine bingeing are Item 13) Over the past 28 days, how many times have you eaten what other people would regard as an unusually large amount of food (given the circumstances)? Item 14) On how many of these times did you have a sense of having lost control over your eating (at the time you were eating)? Item 15) Over the past 28 days, on how many DAYS have such episodes of overeating occurred (i.e., you have eaten an usually large amount of food and have had a sense of loss of control at the time)? Based on the wording of the questions, individuals who endorsed more episodes of losing control while eating a large amount than they endorsed number of times they ate a large amount and those who endorsed a greater number of days with a binge on item 15 than number of episodes they lost control would be inconsistent responses. As this was the primary measure of disordered eating these data were deemed invalid and could not be included.

To determine the level of weight and shape concerns, individuals who endorsed scores on the weight and shape scales in the top 3rd of valid data were placed in the high concerns group and those in the bottom 3rd were placed in the low concerns group. When this was initially conducted with all of the valid participants, the gender disparity was too great (89.9% female in the high group versus 40.97% female in the low group). As such it was determined necessary to examine each gender separately. However, due to an insufficient number of males endorsing high weight and shape concerns (only 15 males endorsed both weight and shape subscales over 3), a valid model could not be constructed such that high and low concern groups with enough power could be created. As such, only data on the valid females are presented.

Participants

Overall, 272 undergraduate females were included in the current study. Females (n=137) who endorsed no more than 1.75 and no more than 1.20 on the shape and weight subscales of the EDE-Q respectively were placed in the low weight/shape concerns group. Similarly, 135 females were placed in the high weight/shape concerns group having endorsed at least 3.625 and 3.20 on the shape and weight subscales of the EDE-Q. The average age of all participants was 20.16 years (SD=1.67). Regarding ethnicity, the sample composition was 61.5% Caucasian, 16.5% African American, 8.1% Asian and 5.1% Latino.

Self-Report Measures

Demographic Information. A brief set of items was administered to assess age, gender, and ethnicity of each participant. This information was used to assess the generalizability of the sample.

Eating Disorder Symptomatology. The Eating Disorder Examination

Questionnaire (EDE-Q; Fairburn & Beglin, 1994), is a 28-item self-report questionnaire version of the *Eating Disorder Examination* (Fairburn & Cooper, 1993). This widely used assessment tool to assess ED diagnoses, was administered to assess the presence of ED symptomatology (including binges and compensatory / purging behavior) and attitudes (i.e. weight and shape concerns). Questions assess the frequency of behaviors and attitudes (including weight and shape concerns) associated with EDs over the previous four weeks. The EDE-Q has demonstrated good concurrent and adequate criterion validity (Mond, Hay, Rodgers, Owen, & Beumont, 2004b), as well as high internal consistency (Mond, Hay, Rodgers, Owen, & Beumont, 2004a). In the current experiment, the weight and shape concerns subscales were used to determine whether individuals had high weight/shape concerns or low weight/shape concerns. Also the number of binges endorsed in the past 28 days was utilized as the measure of disordered eating.

Reward Processing. The Sensitivity to Punishment and Sensitivity to Reward

Questionnaire (SPSRQ; Torrubia, Ávila, Moltó, & Caseras, 2001) was used to assess reward sensitivity. The SPSRQ is a 48 item self-report questionnaire that is comprised of two 24-item subscales that assess an individual's avoidance of punishment and approach of reward. This scale was developed to assess Gray's model of personality (Gray, 1987) that consisted of two motivational systems: the behavioral inhibition system (BIS) and the behavioral activation system (BAS). The SPSRQ has demonstrated good internal consistency, temporal stability and concurrent validity (Caseras, Àvila, & Torrubia,

2003). The Sensitivity to Reward (SR) subscale was used as the primary self-report measure of reward sensitivity.

Affect Regulation. The *Difficulties in Emotion Regulation Scale* (DERS; Gratz & Roemer, 2004) is a 36-item self-report questionnaire that was used to assess emotion (dys) regulation. The DERS assesses dysregulated emotion across six domains: non-acceptance of emotional responses, difficulties engaging in goal-direct behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies and lack of emotional clarity. Each item is rated on a 5-point likert scale ranging from almost never to almost always, with higher scores representing more emotion dysregulation. The DERS has demonstrated strong internal consistency and test-retest reliability as well as adequate construct and predictive validity (Gratz & Roemer, 2004). The overall score on the DERS will be used as the primary self-report measure of affect regulation.

Cognitive Control. The *UPPS-P Impulsivity Scale* (Lynam, Smith, Whiteside, & Cyders, 2006) is a 59-item self-report inventory that measures five distinct pathways to impulsivity and limited cognitive control: (negative) Urgency, (lack of) Perseverance, (lack of) Premeditation, Sensation Seeking, and Positive Urgency. Each item is rated on a 4-point likert scale ranging from strongly agree to strongly disagree. The first four pathways originated from the original UPPS and have demonstrated divergent relationships with various psychopathology (Whiteside, Lynam, Miller, & Reynolds, 2005). All five scales have demonstrated good convergent validity across assessment measures and good discriminant validity between the subscales (Cyders & Smith, 2007; Smith et al., 2007). For this current study, the (negative) and positive Urgency subscales

were used as the primary measures of cognitive control, as (negative) Urgency was the factor that most closely resembles the behavioral inhibition associated with poor cognitive control (Whiteside et al., 2005) and (negative) and positive urgency have more recently been understood to be representative of 2 distinct facets that represent a disposition into mood-based rash action (Cyders & Smith, 2007). To avoid confusion (negative) urgency will hereon be referred to as NEGU and positive urgency as POSU.

Procedure

All participants in Experiment 1A were recruited from the Temple Research Participation System (<http://temple.sona-systems.com/default.asp>), referred to as “Sona System”, a HIPAA compliant online data management server. All undergraduates enrolled in Psychology (or other) classes (age 18-25) are invited to register with the Sona system so they could participate in online studies or sign-up to participate in laboratory-based studies, in order to fulfill their course research requirements. The current study was listed under the title “Assessment of Personality and Eating Behavior”. All students who elected to participate in this study voluntarily agreed to the terms outlined in the consent form presented online and then were directed to complete all of the self-report measures (Demographic Information, EDE-Q, SPSRQ, DERS, and UPPS-P) through the SONA system at their own convenience. Students were provided one hour of research credit for their participation to be used towards their fulfillment of their course research requirement.

Data Analytic Plan

Descriptive Statistics - Demographic differences (age and ethnicity) between the high and low weight/shape concerns groups were examined using t-tests or chi-square

tests as appropriate. Any significant differences found in the demographic variables were further examined to determine if it was necessary to incorporate age or ethnicity into the model.

Confirmatory Factor Analysis – Hypothesis 1a. A multiple-sample confirmatory factor analysis (CFA) was conducted to test the proposed factor structure and assess whether impaired reward sensitivity, impaired affect regulation and impaired cognitive control (utilizing both positive and negative urgency) accurately tap into the latent construct, addiction vulnerability for individuals with high weight/shape concerns and individuals with low weight/shape concerns. A multiple-sample CFA is used to statistically test whether the a priori hypothesized factor structure fits the structure in the data and determines if this structure differs across groups. The demo version of M-plus version 6.12, (Muthén & Muthén, 1998-2010) was used to conduct the CFA.

Data were analyzed using the maximum-likelihood estimation procedure (ML). In order to determine whether the hypothesized structure was present in the data, goodness of fit statistics were analyzed. The primary method of estimating goodness of fit is the χ^2 statistic. The χ^2 analysis tests the hypothesis that the designated model fits the observed covariances. An insignificant χ^2 value is desired as it demonstrates that the measured variable correlations from the specified model are not different from those correlations in the data. However, the χ^2 statistic is very sensitive to sample size and will often detect small divergences as significant when they are not (Bentler & Bonnet, 1980). In order to address this issue, the Comparative Fit Index (CFI; Bentler, 1990) and Root Mean Square Error of Approximation (RMSEA; Steiger 1990) were calculated. The CFI indicates the improvement of fit of the tested model compared to an independent model of the

measured variables while the RMSEA compares the residuals between the observed and predicted covariance structure (Hu & Bentler, 1999). The CFI ranges from 0 to 1, with values greater than .9 indicative of acceptable fit, and values greater than .95 indicative of superior fit. The RMSEA ranges from 0 to 1 and values ranging from .08-.10 indicate mediocre fit, values of .05-.08 represent reasonable fit and values under .05 indicate a good fitting model (Hu & Bentler, 1999). The 90% confidence interval for the RMSEA is also helpful in interpreting fit (Byrne, 2010; Kline, 2011). Ideally, the lower bound value is less than .05 (close-fit hypothesis) and the upper bound variable is less than .1 (poor-fit hypothesis). When the lower bound is less than .05 and the upper bound is greater than .1, it can be concluded that the RMSEA is subject to sampling error (Kline, 2011) as such the size of the confidence interval can indicate preciseness (Byrne, 2010).

Once the goodness of fit for both CFA models was examined, multiple group comparisons were performed in order to assess critical differences between the high weight/shape concerns and the low weight/shape concerns groups, by constraining various parameters of the model to be equal between the two groups (Bentler, 2004). First, an initial baseline model was specified in which no constraints were imposed to be used as a basis for comparison. Next, a model was tested in which the factor structure for each group was constrained to be equal. Then, the goodness of fit statistics mentioned above were examined for the constrained models. Last, a χ^2 test of differences was conducted to determine if the models differed significantly. A non-significant chi square difference result provided support for the hypothesis that the factor structure for both groups was equal and testing of the full model could proceed.

Relationship of Addiction Vulnerability to Binge Eating - Hypothesis 1b. Once the factor structure was confirmed to be equal for both groups, predictive path models were estimated for each group. The models for each group were compared to determine if the relationship between addiction vulnerability and disordered eating was different for individuals with high weight/shape concerns from individuals with low weight/shape concerns. Thus, this process examined whether weight and shape concerns could be considered a moderator of the relationship between addiction vulnerability and disordered eating. Moderation is when a third variable influences the relationship between a predictor variable and an outcome variable such that the relationship changes according to levels of the third variable (Baron & Kenny, 1986). The M-Plus program demo version 6.12, (Muthén & Muthén, 1998-2010) was used to conduct the necessary path analysis following a similar analysis plan to that utilized by Conner, Stein and Longshore (2005).

The proposed model suggests that each of the three putative addictive mechanisms (reward sensitivity, affect regulation and cognitive control) are predicted by the latent construct of addiction vulnerability, such that high impairments of reward sensitivity, affect regulation and cognitive control will be associated with greater addiction vulnerability. It is hypothesized that the relationship between addiction vulnerability and disordered eating will be moderated by weight and shape concerns. Addiction vulnerability will significantly predict disordered eating among individuals with high weight and shape concerns, but will not be related to disordered eating among individuals with low weight and shape concerns. In order to test for moderation, the proposed model (figure 2), which depicts that the relationship between addiction vulnerability and disordered eating is affected by the level of weight and shape concerns,

was examined by comparing the models for individuals with high weight and shape concerns and individuals with low weight and shape concerns. Following the logic mentioned in the previous analyses, first, the unconstrained model for each group was specified and used as a baseline measure of comparison. Goodness of fit statistics, including the maximum likelihood χ^2 , the CFI, and the RMSEA were calculated for each model. Then, the models were constrained such that the two groups are forced to be equal by forcing the parameter estimates from the high weight/shape concerns group on the low weight/shape concerns group. The same goodness of fit statistics were examined. Then the χ^2 difference test was performed and the $\Delta \chi^2$ was then examined. If it is significant, it suggests that there is a decrement in fit which means that the models for both groups are not the same, thus supporting the hypothesis that the relationship between addiction vulnerability and disordered eating is moderated by weight and shape concerns.

Results

All data were analyzed for normality using the Kolmogorov-Smirnov test of normality. Only NEGU scores in the low weight/shape concerns group ($D = .095, p = .004$) and POSU scores for both groups (Low W/S: $D = .161, p < .001$; High W/S $D = .104, p = .001$) produced significant test results. However, in large samples, it is not unusual for small deviations to register as significant deviations from normality.

According to Field (2005), in large samples Z-scores of Skewness and Kurtosis below the critical value threshold of 3.29 are not very concerning. All critical values fell below this threshold suggesting the deviations from normality will not affect the results. Lastly, an examination of Q-Q plots further suggests no sharp deviations from normality. Taken

together, analyses of the relevant variables indicate that there is no need to transform the data. Data for the POSU and NEGU variables were transformed and entered into the analyses. Pattern of the results did not differ so the results from the original data are presented below.

Preliminary Analyses

The demographic information for the total sample used in experiment 1, along with age and ethnicity breakdown for the high and low weight/shape groups is included in Table 1. Overall, there was no difference in age between the two groups ($p > .05$); however, a significant difference in the composition of ethnicity between the low weight/shape concern group and high weight/shape concern group exists ($p = .044$). Post-hoc single DF χ^2 contrasts determined that these groups differed on the proportion of African Americans and Caucasians, $\chi^2(1) = 8.76, p = .004$, such that the high weight/shape concerns group had a greater proportion of Caucasians in relation to African Americans compared to the low weight/shape concerns group. All other post-hoc contrasts were not significant (all $p > .05$). To examine if ethnicity interacted with the variables of interest (SPSRQ-SR, DERS Total, NEGU, POSU), separate linear regression models were conducted to examine the main effects of shape/weight concern, ethnicity and the interaction of the two with each of the four main variables entered as dependent variables. Neither ethnicity nor the interaction term produced significant effects in any of the regression models (all $p > .05$) so it was concluded that testing of the model could continue without special consideration of ethnicity.

Means and standard deviations of the main variables of interest are presented in Table 2 for the overall sample as well as the high and low weight/shape concerns groups.

Differences between the high and low weight/shape concerns groups were found on all variables of interest (all $p < .001$) with the exception of the POSU subscale of the UPPS-P ($p = .073$). Correlations of the primary self-report subscales (SPSRQ, DERS, NEGU, POSU), the EDE-Q shape and weight subscales and the reported number of binges are presented in Table 3. Among individuals with high weight/shape concerns, all of the variables were significantly correlated with the exception of (a) the number of binges which was not significantly correlated with the SPSRQ or the DERS and (b) the POSU subscale which was not correlated with the EDE shape and EDE weight concerns subscales. A similar pattern was found among individuals with low weight/shape concerns but additionally POSU was not correlated with number of binges and the DERS was not correlated with the EDE shape or EDE weight concern subscales.

Table 1. Age and Ethnicity Demographic Data for Experiment 1A

Variable	Overall Sample (n=272)	Low W/S Concerns (n=137)	High W/S Concerns (n=135)	Test Statistic
Age (years)	20.16(1.67)	20.08(1.61)	20.23(1.73)	$t(265) = -.738$
Ethnicity				$\chi^2(4) = 9.79^*$
Caucasian	168 (61.8%)	74 (54%)	94 (69.6%)	
African American	45 (16.5%)	31 (22.6%)	14 (10.4%)	
Asian	22 (8.1%)	13 (9.5%)	9 (6.7%)	
Latino	13 (4.8%)	6 (4.4%)	7 (5.2%)	
Other	20 (7.4%)	11 (8.0%)	9 (6.7%)	

Note. W/S Concerns = Weight/Shape Concerns. * $p < .05$

Table 2. Mean Responses on Primary Self-Report Measures

Variable	Overall Sample (n=272) <i>M (SD)</i>	Low W/S Concerns (n=137) <i>M (SD)</i>	High W/S Concerns (n=135) <i>M (SD)</i>	<i>t</i> -test high vs. low W/S Concerns (n = 272)
EDE-Q				
Shape Subscale	2.73 (2.09)	.75 (.51)	4.74 (.70)	-53.753*
Weight Subscale	2.47 (2.08)	1.20 (.50)	4.47 (.79)	-52.428*
# of Binges	2.00 (3.74)	.42 (1.59)	3.61 (4.54)	-7.737*
SPSRQ – SR	71.33 (13.97)	66.45 (14.48)	76.30 (11.51)	-6.205*
DERS Total	86.67 (25.01)	76.07 (20.68)	97.44 (24.48)	-7.781*
UPPS-P				
NEGU	2.34 (.61)	2.18 (.59)	2.51 (.58)	-4.696*
POSU	1.88 (.65)	1.81 (.64)	1.95 (.65)	-1.800

Note. W/S Concerns = Weight/Shape Concerns. EDE-Q = Eating Disorder Examination Questionnaire. SPSRQ – SR = Sensitivity to Punishment and Reward Questionnaire – Sensitivity to Reward Subscale. DERS Total = Overall Score on the Difficulties in Emotion Regulation Scale. UPPS-P = UPPS-P Impulsivity Scale. NEGU = (negative) Urgency subscale of the UPPS-P. POSU = Positive Urgency subscale of the UPPS-P. * $p < .001$

Table 3. Correlations among all Variables in Experiment 1A for High (n = 137) and Low (n = 135) Weight/shape Concerns

	I	II	III	IV	V	VI	VII
I SPSRQ-SR		.31**	.32**	.24**	.27**	.06	.14
II DERS Total	.29**		.62**	.49**	.17	.17	.14
III NEGU	.50**	.49**		.68**	.23*	.19*	.17*
IV POSU	.53**	.40**	.71**		-.04	.01	.03
V EDE-Q -S	.22*	.30**	.21*	.06		.62**	.20*
VI EDE-Q - W	.24**	.22*	.22**	.09	.72**		.22*
VII EDE-Q - B	.14	.11	.31**	.20*	.23**	.19*	

Note. Low weight/shape concern females above diagonal; high weight/shape concern females below diagonal.

SPSRQ – SR = Sensitivity to Punishment and Reward Questionnaire – Sensitivity to Reward Subscale. DERS Total = Overall Score on the Difficulties in Emotion Regulation Scale. NEGU = (negative) Urgency subscale of the UPPS-P. POSU = Positive Urgency subscale of the UPPS-P. EDE-Q-S = Eating Disorder Examination Questionnaire Shape Subscale. EDE-Q-W = Eating Disorder Examination Questionnaire Weight Subscale. EDE-Q-B = Eating Disorder Examination Questionnaire # of Binges reported. * $p < .05$; ** $p < .01$ (2-tailed).

Confirmatory Factor Analysis – Hypothesis 1a

Table 4 presents the factor loadings for the hypothesized latent factor of addiction vulnerability. All measured variables loaded significantly on the hypothesized latent factor in both the low and high shape/weight concerns group. Without any model modifications, fit indices were acceptable for both groups: low weight/shape concerns, $\chi^2(2) = 1.549$, $p = .4610$, RMSEA = 0.000, 90% CI = 0-.157, CFI = 1.000; high weight/shape concerns, $\chi^2(2) = 2.865$, $p = .2387$, RMSEA = .057, 90% CI = 0-.19, CFI = .995.

Table 4. Factor Loadings of CFA for Low and High Weight/Shape Concerns

Indicator	Low Weight/Shape Concerns (N=137)			High Weight/Shape Concerns (N=135)		
	Unstandardized	SE	Standardized	Unstandardized	SE	Standardized
NEGU	1.000 ^a	--	.919*	1.000 ^a	--	.866*
DERS – Total	26.095*	3.389	.679*	25.718*	4.192	.528*
SPSRQ-SR	9.650*	2.443	.358*	13.679*	2.096	.598*
POSU	.876*	.104	.735*	1.061*	.123	.817*

Note. SPSRQ – SR = Sensitivity to Punishment and Reward Questionnaire – Sensitivity to Reward Subscale. DERS Total = Overall Score on the Difficulties in Emotion Regulation Scale. NEGU = (negative) Urgency subscale of the UPPS-P. POSU = Positive Urgency subscale of the UPPS-P. * $p < .001$ (2-tailed).

^a Not tested for statistical significance.

To compare the factor structure between the two groups, a CFA multiple-group model without equality constraints was conducted. Initially, all indicators still loaded significantly on the latent factor but the fit statistics were not acceptable. After applying minimal model modifications (described below), fit indices demonstrated good fit: $\chi^2(7) = 6.954$, $p = .434$, RMSEA = .000, 90% CI = 0-.105, CFI = 1.000. After conducting measurement model tests (see Table 5), it was apparent that allowing the intercepts to vary freely for the SPSRQ-SR, DERS-Total and POSU indicators produced significant improvements to the chi-square fit and when combined produced a model with acceptable fit. Next, a model in which the factor structure was constrained to be equal among the groups resulted in a non-significant decrement in fit: $\chi^2(8) = 6.964$, $p = .5405$, RMSEA = .000, 90% CI = 0-.092, CFI = 1.000; χ^2 difference(1) = .010, $p > .05$. As such it was concluded that the factor structure for the low and high weight/shape concerns has the same meaning for both groups. This equivalent factor structure provides the support needed to proceed to test the relationship between this factor and binge-eating behavior

as it demonstrates results from additional analyses are not complicated by differences in how the groups respond to the questionnaires in the factor structure.

Moderation of Weight and Shape – Hypothesis 1b

The final model included the addition of a predictive path from the latent factor, addiction vulnerability to binge eating. This model demonstrated excellent fit: $\chi^2(13) = 13.07, p = .442$; RMSEA = .006, 90% CI = 0 -.085; CFI = 1.000. Next, the model was constrained such that the path between addiction vulnerability and binge eating episodes of the low group was constrained to be equal to that of the high group. This resulted in a significant decrement of fit: $\chi^2(14) = 19.86, p = .135$, RMSEA = .055, 90% CI = 0-.107, CFI = .983; χ^2 difference (1) = 6.79, $p < .05$. The path coefficients for the additional path (see Table 6) demonstrate that the relationship between addiction vulnerability and binge eating is significant in the high weight/shape group but is only marginally significant in the low/weight shape group, providing support for moderation.

Table 5. Measurement Model Tests of Chi-Square Differences for Multi-Group CFA

Model/Modifications	χ^2_M	df _M	χ^2_M Sig.	χ^2_D	df _D	χ^2_D Sig.
Multi Group Factor Structure	59.76	10	<.001	--	--	--
Constraining Parameters to Equality						
DERS Total	56.64	9	<.001	3.12	1	.078
NEGU	56.78	9	<.001	2.98	1	.085
POSU	58.95	9	<.001	.81	1	.369
SPSRQ-SR	56.58	9	<.001	3.16	1	.074
Allowing Intercepts to be free						
DERS Total	32.95	9	<.001	26.82	1	<.001
NEGU	50.11	9	<.001	9.65	1	.002
POSU	40.32	9	<.001	19.44	1	<.001
SPSRQ-SR	45.55	9	<.001	14.22	1	<.001
DERS Total and POSU	20.89	8	.008	38.87	2	<.001
DERS Total POSU and SPSRQ-SR	6.95	7	.4337	52.81	3	<.001
Correlating Residuals						
DERS Total with NEGU	59.23	9	<.001	.55	1	.457
DERS Total with POSU	56.82	9	<.001	2.94	1	.086
DERS Total with SPSRQ-SR	56.86	9	<.001	2.90	1	.088
NEGU with POSU	48.50	9	<.001	11.26	1	<.001
NEGU with SPSRQ-SR	57.94	9	<.001	1.82	1	.117
POSU with SPSRQ-SR	57.55	9	<.001	2.21	1	.137

Note. χ^2_D test calculated to compare each measurement model to original multi-group CFA. CFA = Confirmatory Factor Analysis. SPSRQ – SR = Sensitivity to Punishment and Reward Questionnaire – Sensitivity to Reward Subscale. DERS Total = Overall Score on the Difficulties in Emotion Regulation Scale. NEGU = (negative) Urgency subscale of the UPPS-P. POSU = Positive Urgency subscale of the UPPS-P.

Table 6. Path Coefficients for both Weight/Shape Concerns Groups in Full Path Model

Group	# of Binges			
	Unstandardized	SE	Significance	Standardized
Low Weight/Shape Concerns	.509	.273	.062	.169
High Weight/Shape Concerns	2.616	.753	.001	.307

CHAPTER 3 EXPERIMENT 1B – METHOD AND RESULTS

Design Issues

The sample for experiment 1B consisted of a subset of the 1000 participants originally recruited for experiment 1A. The two groups of individuals recruited for the second part of the experiment were selected based solely on binge eating behavior. The decision was made not to include level of weight and shape concerns as a criterion for group membership as weight and shape concerns is not being considered in the analyses for this part of the project and further constraints might have impeded subject recruitment. Initially, the plan was to match the control group to the binge eating group on gender so the ratio did not differ between groups. However, given that the research pool consisted of more females and as recruitment progressed, the individuals who endorsed binge eating were almost exclusively female, a decision was made to only continue to recruit females for experiment 1B.

Females were recruited with the aim to have 50 individuals in the healthy control group and 50 in the binge eating group who met study criteria. As some individuals were excluded, an attempt to meet this goal required the recruitment of some additional people. Based on responses from the EDE-Q, 101 individuals were invited to the study and completed the prescreening procedures and came into a laboratory session. After completing the diagnostic portion of the laboratory visit, individuals who came in for binge eating that did not endorse a sufficient number of binges (n=2) or endorsed exclusionary criteria (namely past substance dependence issues; n=3) were excluded from all analyses. Four individuals who came in for the control group, but endorsed lifetime

substance dependence were also excluded. No control participants demonstrated a history of ED or sub-threshold ED symptomatology (e.g. any presence of bingeing, purging, abuse of diet pills/laxatives and severe food restriction occurring 2 or more times in any given year). Thus, the control group had an absence of disordered eating behavior and the binge eating group demonstrated pathology similar to the criteria proposed for DSM-V for significant number of binges per week (American Psychiatric Association, 2011).

Participants

Following results of the diagnostic interview, based on the criteria explained above and in the procedure section, 47 females were included in the control group and 45 females in the binge eating group. The average age of participants was 20.05 years ($SD=1.78$). Overall the sample was 65.2% Caucasian, 14.1% African American, 12% Asian and 2% Latino

Behavioral Measures

Reward Processing. The *Delay Discounting Task* (Steinberg et al., 2009), administered on a computer for a duration of approximately 10 minutes, measures an individual's propensity to accept immediate rewards in comparison to a fixed delayed receipt of \$1,000. In this adaptation, the time to delay varies over six blocks (1 day, 1 week, 1 month, 3 months, 6 months, and 1 year) and is presented in random order. For each block, the starting value of immediate reward is randomly determined to be \$200, \$500, or \$800. If the participant prefers the immediate reward, the subsequent question asks about a lower immediate reward. If the delayed reward is selected, the next question

asks about a higher immediate reward. Participants work through a total of nine ascending and descending choices until reaching the “indifference point” (Ohmura, Takahashi, Kitamura, & Wehr, 2006) such that the “discounted” value of the delayed reward is determined (i.e., when preference for immediate and delayed reward are equal; Green, Myerson, & Macaux, 2005). Individuals who have a lower indifference point and/or a relatively steeper discounting rate demonstrate a preference for immediate reward and are unable to tolerate delay of reward. The discount rate will be used as the primary behavioral measure of reward sensitivity.

Affect Regulation. The computer administered *Paced Auditory Serial Addition Task* (PASAT-C; Lejuez, Kahler, & Brown, 2003) requires the participant to add numbers presented on the screen at various speeds. The initial task was developed to measure information processing (Gronwell, 1977). However, the modified computer version has been repeatedly used as a measure of distress tolerance which can serve as a proxy for affect regulation (Feldner, Leen-Feldner, Zvolensky, & Lejuez, 2006; Leyro, Zvolensky, & Bernstein, 2010; Tull, Gratz, Latzman, Kimbrel, & Lejuez, 2010). The utility of the measure has been confirmed by self-report measures built into the task completed at baseline and following completion of the task that demonstrate induced negative affect and frustration, following completion of the task (Lejuez et al., 2003). The initial phase of the task presents the numbers initially at 3 seconds phasing into 1.5 seconds without warning, and the individual is supposed to provide an answer for the sum of the previous 2 numbers presented by clicking a number from 1-20 presented on the screen. An individual’s score is shown such that they can tell if they are providing the correct response or not. During the experimental phase, numbers are presented at 1

second intervals, making it impossible to regularly provide correct answers regardless of mathematical ability. Individuals are told they are allowed to elect to “quit” the task at any point by pressing a yellow Quit button that sits below the response choices. The primary measure used to examine affect regulation is the amount of time the individual spends on the last phase of the task before quitting.

Cognitive Control. The *Stop-Signal Task (SST)* is a behavioral measure of motor impulsivity that can serve as a measure of cognitive control. During the task, the individuals are required to click on a target within 1 second to earn rewards. However, on certain trials, an auditory signal, the stop-signal, occurs and the participant should inhibit the response to gain points. The interval between initiating the trial and the stop signal is varied throughout the task. Performance on the SST has been correlated with self-reported impulsivity (Avila & Parcet, 2001). Reliability and validity for the task has been demonstrated (Kindlon, Mezzacappa, & Earls, 1995; Tannock, Schachar, Carr, Chajczyk, & Logan, 1989). Failure to inhibit responses on the stop signal trials (commission errors) across stop intervals reflects a general inability to control responses, demonstrating increased impulsivity and decreased cognitive control, and thus errors of commission will be the primary behavioral measure of cognitive control.

Procedure

After completing the measures administered in Experiment 1A, participants were given the opportunity to provide their contact information and consent to the investigators contacting them with an opportunity to participate in Experiment 1B. Among individuals willing to participate in Experiment 1B, those who endorsed 4 or more binges (disordered

eating) over the past 28 days on the EDE-Q or zero binges, purges and periods of starvation (healthy controls) were invited to participate in the screening process for Experiment 1B. Cutoff scores for the disordered eating group are based on the proposed criteria for the DSM-V regarding frequency of binges required for a diagnosis of BED or BN (American Psychiatric Association, 2011). Individuals who met these criteria and agreed to be contacted were invited to participate in a phone screen to determine if they were eligible to participate in Experiment 1B. All individuals interested participated in a brief (10-15 minute) phone screen to determine eligibility. Individuals were excluded if they endorsed currently (past month) taking any psychotropic medication for the presence of any psychological disorders. The phone screen also assessed for the presence of Psychosis, Bipolar Disorder, Current Depression, Alcohol and/or Substance Dependence. To remain eligible, all of which are exclusionary, healthy controls (0 binges on the EDE-Q) also demonstrated the absence of any current or past ED or ED symptomatology. Individuals in the disordered eating group (≥ 4 binges) were allowed to participate if they met criteria for BN or BED; however, it was not necessary. All individuals who remained eligible following the phone screen were scheduled to come into the laboratory to participate in experiment 1B.

All individuals who qualified for experiment 1B came into the laboratory for no more than 2 hours. Individuals were asked to refrain from eating, consuming caffeine, or using nicotine or other substances for the four hours prior to their appointment. Individuals participated in a more comprehensive diagnostic interview to determine whether individuals have a history of any depression, current or history or anxiety, past substance/alcohol issues and revisited the exclusionary criteria mentioned above. The

absence of an eating disorder for individuals in the healthy control group was also examined again. Similarly, individuals in the disordered eating group were assessed to determine if a current diagnosis of BN or BED was warranted. The interview portion on average took between 30 minutes and one hour. Individuals who no longer met criteria were subsequently excluded. After completion of the interview, all participants completed the three behavioral tasks (Delay-Discounting, PASAT-C, SST) with the total duration of tasks averaging at approximately one hour. The order of the tasks was counterbalanced among participants. All individuals who participated in the laboratory portion were provided 2 research credits as compensation for their participation to be used towards the fulfillment of their course research requirements or \$15.

Data Analytic Plan

Descriptive Statistics - Demographic differences (age and ethnicity) between the control and disordered eating groups were examined using t-tests or chi-square tests as appropriate. Whenever appropriate, transformations were conducted to try to normalize the data. In the event that a transformation was not beneficial a non-parametric Mann-Whitney U test was conducted. In the event that any of the preliminary analyses reveal significant differences between groups for demographic variables, they will be controlled for in subsequent statistical analyses .

Delay Discount Differences – Hypothesis 2a. The primary analysis to examine differences in reward sensitivity will be to compare the delay discount function (k) between groups utilizing a t-test or Mann-Whitney U test as determined by the above criteria. Secondary analyses, will compare the indifference point at each of the different

time points. Lastly, a repeated measures ANOVA, examining the indifference points over time by group will be examined.

Affect Regulation Differences – Hypothesis 2b. To determine whether a difference in affect regulation/frustration tolerance exists, a comparison of the quit time between groups will be conducted as the primary analysis. Secondary analyses will examine whether participants rankings of the 6 different emotions differed between groups at posttest controlling for baseline rankings of the 6 different emotions using ANCOVAs.

Cognitive Control Differences – Hypothesis 2c. To determine whether a difference in cognitive control/impulsivity exists, comparison of the number of commission errors across trials will be examined. Secondary analyses examining reaction time will also be conducted.

Results

Preliminary Analyses for Experiment 1B

Demographic data for participants in experiment 1B are presented in Table 7. No significant differences in age ($p = .112$) or ethnicity ($p = .277$) were present. As such it was not necessary to control for any demographic variables in the subsequent analyses. Exploration of normality utilizing Kolmogorov-Smirnov tests of normality for each of the primary outcome variables for experiment 1B was conducted. Significant deviations from normality existed for the discount rate on the Delay Discount task, the PASAT-C quit time and number of commission errors on the SST for both the binge and control groups. Examination of Q-Q plots, histograms and stem and leaf plots further demonstrated these deviations from normality. As such, transformations (e.g. ln, log,

square root) were applied. However, none of these transformations improved the distributions enough to produce non-significant Kolmogorov-Smirnov tests. As such, the results of non-parametric tests are reported for the delay discount discount rate function, PASAT –C time to quit and SST commission errors.

Correlations of the primary variable of interest for each of the 3 behavioral tasks were examined. Only the correlation of the discount function and number of commission errors was significant, $r = .22, p = .025$. The PASAT-C quit time was not correlated with the discount function ($r = .002, p = .982$) or number of commission errors ($r = .04, p = .681$). Correlations between each of the primary variables of interest and the corresponding self-report constructs are presented in Table 8. The PASAT-C quit time was the only behavioral task significantly correlated with its self-report counterpart, the DERS. The PASAT-C quit time was also the only other behavioral task correlated with another self-report measure – the NEGU subscale.

Table 7. Age and Ethnicity Demographic Data for Experiment 1B

Variable	Overall Sample (n=92)	Control (n=47)	Binge-Eating (n=45)	Test Statistic
Age in years (SD)	20.05(1.78)	19.77(1.59)	20.35(1.92)	$t(90) = -1.61$
Ethnicity				$\chi^2(2) = 2.57$
Caucasian	60 (65.2%)	27 (57.4%)	33 (73.3%)	
African American	13 (14.1%)	8 (17.0%)	5 (11.1%)	
Asian	11 (12%)	8 (17.0%)	3 (6.7%)	
Latino	2 (2%)	1 (2.1%)	1 (2.2%)	
Other	6 (6.5%)	3 (6.4%)	3 (6.7%)	

Note. The χ^2 test calculated was a 3 x 2 comparing Caucasian, African Americans and all other ethnicities between control and binge eating groups such that all cells had a count of at least 5.

Table 8. Correlations of Behavioral Tasks and Self-Report Measures

	SPSRQ	DERS Total	NEGU	POSU
Delay Discount	.03	.02	.09	.13
Function (k)				
PASAT-C Quit time	-.15	-.36**	-.21*	-.12
SST Commission Errors	.14	.17	.16	.15

Note. SPSRQ – SR = Sensitivity to Punishment and Reward Questionnaire – Sensitivity to Reward Subscale. DERS Total = Overall Score on the Difficulties in Emotion Regulation Scale. NEGU = (negative) Urgency subscale of the UPPS-P. POSU = Positive Urgency subscale of the UPPS-P. PASAT-C = Paced Auditory Serial Addition Task. SST = Stop Signal Task. * $p < .05$ ** $p < .01$ (2-tailed).

Delay-Discount Results – Hypothesis 2a

The Mann-Whitney U test comparing the discount function between the binge-eating group and control group was non-significant and thus concluded that binge eaters ($Mdn = .0055$) did not differ in discount rate than the control subjects ($Mdn = .0038$), $U = 977$, $p = ns$, $r = -.06$. Comparisons of the indifference point at delays of 1, 7, 30, 90, 180 and 365 days demonstrated that a significant difference only existed at the first day. Specifically, results suggested that binge eaters ($Mdn = 998$), were more likely to take less money than wait for the 1000 compared to control subjects ($Mdn = 999$), $U = 1,414$, $p = .003$, $r = .31$.

The repeated measures ANOVA comparing the indifference points across the delay time periods between groups was conducted to examine how the indifference points varied over time. Mauchly's test indicated that the assumption of sphericity was violated ($\chi^2(14) = 44.019$, $p < .001$); therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = .803$). As with nearly all studies of delay discounting, results show a significant main effect of the repeated time factor, Greenhouse-Geisser $F(4.017, 361.531) = 91.78$, $p < .001$. No significant main effect of group [$F(1,90) = 1.05$, $p = .308$], nor group by time interaction [Greenhouse-Geisser $F(4.017, 361.531) = .55$, $p = .698$] was found,.

PASAT-C Results – Hypothesis 2b

The Mann-Whitney U test was conducted to examine differences in quit time between binge eaters and control subjects. This test demonstrated that binge eaters (Mdn

= 97 ms) quit the task earlier than control subjects ($Mdn = 464$ ms), $U = 1,409.5$, $p = .005$, $r = .29$.

Next, analyses examining the participants' responses on their current emotional state (happiness, anxiety, sadness, distress, frustration, irritability) following completion of the task were conducted. Six separate ANCOVAs were conducted such that the initial rating of emotion was entered as the covariate to examine exit ratings by group.

Significant results demonstrated that binge eaters ($M = 41.42$) were more irritated at the end of the task compared to control subjects ($M = 22.34$) controlling for irritability scores prior to starting the task, $F(1,89) = 4.372$, $p = .039$, $r = .22$. Marginally significant results were found for ratings of Frustration between binge eaters ($M = 49.84$) and control subjects ($M = 33.98$), $F(1, 89) = 3.337$, $p = .071$, $r = .19$.

SST Results – Hypothesis 2c

The Mann-Whitney U test suggested there was no significant difference in number of commission errors between binge eaters ($Mdn = 8$) and control subjects ($Mdn = 7$), $U = 885$, $p = .177$, $r = -.01$. An independent samples t-test demonstrated that there was no significant difference in the time it took for binge eaters to respond ($M = 640.89$ ms) than control subjects ($M = 653.13$ ms), $t(90) = -.745$, $p = .458$, $r = .08$.

CHAPTER 4 DISCUSSION

Previous research has demonstrated the high comorbidity rates of eating disorders and substance use disorders (i.e. Hudson et al., 2007; Peveler & Fairburn, 1990). Clear parallels between these disorders including a similar developmental trajectory, repetitive maladaptive behaviors and biological system impairments (Goodman, 2008; Kaye, 2008) have been identified. Some have speculated that EDs should be considered behavioral addictions, while others maintain they are distinct. This study sought not to solve this debate but to highlight that the common deficits found in addiction including impaired motivation/reward, impaired affective regulation and impaired cognitive control are also present in eating disorders to help fill a gap in the literature.

The primary aim of experiment 1A was to demonstrate that the 3 putative addictive mechanisms (impaired reward/motivation processing, affect regulation and cognitive control) tapped into the construct of addiction vulnerability and subsequently examine whether the level of weight and shape concerns moderates the relationship between addiction vulnerability and binge eating behavior. It was hypothesized that the relationship between addiction vulnerability and binge eating behavior would be significantly related among individuals with high weight/shape concerns but not among individuals with low weight/shape concerns. Results from the current study support this hypothesis.

Findings from the study demonstrated that among individuals of both low and high weight/shape concerns, the putative addictive mechanisms – reward/motivation, affect regulation and cognitive control (specified as positive and negative urgency) all

significantly loaded onto the factor of addiction vulnerability and the factor structure was found to be identical between the two groups, consistent with the hypothesis. The modifications to the model that allowed select intercepts to be free simply correct for the differences seen in scores on each of the measures of the constructs. Letting the intercepts to be free simply allowed the model to incorporate that the overall means for each group differ; however, the constrained factor loadings signify the factor structure for addiction vulnerability is identical across the groups. This provides support for the proposed model by Eichen et al. (in prep).

Results examining the addition of the predictive path from addiction vulnerability to binge eating behavior showed that the relationship was significant among individuals with high weight/shape concerns. However, the relationship was not significant among individuals with low weight/shape concerns. These findings supported the hypothesis that weight/shape concerns moderates this stated relationship and provides further support for the relationship between addiction vulnerability and binge eating behavior (Eichen et al, in prep).

Taken together, these findings highlight that common putative addictive mechanisms are present in and related to individuals exhibiting binge eating behavior. Higher scores on each of the measures were found among the high weight/shape concerns group, which further supports that these constructs are more dysregulated in those with disordered eating. These preliminary findings appear to validate the construct of addiction vulnerability and suggest that those engaging in greater binge eating behaviors exhibit higher levels of impairment in reward sensitivity, emotion regulation and cognitive control.

The primary aim of experiment 1B was to demonstrate differences between individuals who binge eat and those who do not on behavioral tasks representing the three putative addictive mechanisms. Contrary to the hypothesis, on the delay discount task examining reward sensitivity, no difference on the discount function was found between the two groups. Furthermore, the indifference point was only significantly different at a delay of one day.

Similarly, results from the SST, measuring impulsivity suggested there was no difference in the number of commission errors between binge eaters and control subjects. Furthermore, there was no difference in the time it took for binge eaters to respond suggesting they did not have a faster reaction time. Overall these results did not support the hypothesis that differences would be seen between the two groups.

However, results of the PASAT-C showed that individuals who binge eat quit the task sooner than control subjects, supporting the hypothesis that they could not tolerate distress as well as control subjects. In further support, binge eaters were significantly more irritated upon quitting the task than control subjects while taking into account irritability scores prior to beginning the task. Taken together it is plausible that individuals may have quit sooner because they were more irritated.

In accordance with previous research, results of experiment 1A reveal that greater reward sensitivity (Harrison et al., 2010), greater emotion dysregulation (Harrison et al., 2009) and greater levels of urgency (Fischer et al., 2008) were found among the high weight/shape concerns group which was more likely to engage in binge eating. Previous research demonstrated individuals with problematic alcohol and substance use also endorse greater reward sensitivity (Kambouropoulos & Staiger, 2007), greater emotion

dysregulation (Fox et al., 2007; Fox, Hong, & Sinha, 2008), and greater levels of urgency (Fischer & Smith, 2008; Cyders, Flory, Rainer & Smith, 2009). As such, the results of experiment 1A provide some evidence that similar deficits are identified among individuals who binge eat and those who engage in addictive behaviors.

Whereas the self-report data was consistent with the study's hypotheses and previous data, the behavioral measures provided less consistent results. One possibility for this was that these deficits may be highlighted during periods of emotional distress. Previous research has suggested that individuals with disordered eating experience rapidly shifting affective states which make them at risk for engaging in disordered eating by acting more impulsively and losing cognitive control (Anestis, Selby, Crosby, Wonderlich, Engel, & Joiner, 2010; Svaldi, Caffer, Blechert, & Tuschen-Caffier, 2009). A recent study utilizing ecological momentary assessment (EMA) found that individuals engaging in binge eating experienced a breakdown of emotion regulation in the 30 minutes preceding a binge (Munsch, Meyer, Quartier & Wilhelm, 2012). This follows the logic that binge eaters exhibit impulsiveness following a change in mood. Our results showed that during the PASAT-C test individuals in the binge eating group exhibited impulsivity by choosing to quit the task faster and that they experienced greater irritability at the end of the task than the control participants, controlling for their original mood. One possible explanation for why results were not significant in the other two behavioral tasks could be that binge eaters only display these impulsive tendencies during an activated negative mood. Additionally, the PASAT-C was the only task that was correlated with the self-report measure of its construct. As such, another reason for the non-significant findings may be that the behavioral tasks used did not map onto the same

construct identified in the self-report measure. Prior research has illuminated the poor correlation between self-report measures of impulsivity and behavioral tasks (Cyders & Coskunpinar, 2011; 2012) providing some support to this idea.

As stated, several theories posit that disordered eating behavior, including binge eating occurs following the initiation of negative mood (Cooper et al., 2004; Heatherton & Baumeister, 1991). The link between impulsivity and emotion is identified in the construct of urgency. Urgency was initially defined as the tendency to act rashly under extreme distress (Whiteside et al., 2005). However, increasing evidence has demonstrated that positive urgency, or the tendency to act rashly while in an extremely positive mood, is a valid construct (Cyders et al., 2007). Now it is generally accepted that positive and negative urgency are two separate constructs under the general umbrella of urgency (Cyders & Smith, 2007). Previous research has identified the role of negative urgency in binge eating (Fischer, Anderson & Smith, 2004; Fischer, Settles, Collins, Gunn & Smith, 2012). The newer construct of positive urgency has predicted illegal drug use, risky sexual behavior and problem drinking behavior (Cyders et al., 2007; Zapolski, Cyders & Smith, 2009). However, in one study it did not differentiate disordered eating individuals from healthy controls (Cyders et al., 2007). Our study suggests that positive urgency was related to addiction vulnerability and remained significant when examining how addiction vulnerability predicted binge eating. As such, future research on positive urgency among individuals with disordered eating is suggested.

Previous research has highlighted that individuals with disordered eating report higher levels of sensitivity to reward and that this sensitivity is related to the amount of disordered eating exhibited (Farmer, Nash & Field, 2001; Loxton & Dawe, 2007).

Significant biological evidence has demonstrated that individuals who engage in disordered eating exhibit similar biological deficits in the dopaminergic system as substance abusers which suggest their ability to perceive reward is blunted (Wagner et al., 2010; Wagner et al., 2007). Individuals with these biological deficits, making them hyposensitive to reward, are more likely to engage in extreme impulsive behaviors like bingeing and abusing substances to experience the positive reward and boost in affect by activating the dopaminergic system. Thus, reward sensitivity is also intertwined with impulsive behavior and affect regulation.

These three putative mechanisms have been identified in eating disorders, addictive disorders and several other psychopathological disorders. For example, one study demonstrated emotion regulation difficulties are comparable among individuals with anorexia nervosa, bulimia nervosa and binge eating disorder (Svaldi, Griepenstroh, Tuschen-Caffier, & Ehring, 2012). However, these difficulties were also comparable among individuals with borderline personality disorder and major depressive disorder and all of these groups differed from healthy controls (Svaldi et al., 2012). Thus, it was posited that emotion regulation may not be disorder specific but may be a risk factor for several disorders and maintains several disorders.

The results of this study highlight the importance of examining the newly validated construct of addiction vulnerability which takes into account the contributions of reward sensitivity, emotion regulation and cognitive control to the development of addictive behaviors. These impairments have been identified in a number of psychological disorders and although they are labeled as distinct constructs, they are interrelated and may affect one another. For instance urgency is defined as being mood-

based (positive or negative) rash action (Cyders & Smith, 2007; Whiteside et al., 2005). This study further demonstrated the interrelatedness of these constructs by the significant correlations on all four facets found among both the low and high weight/shape concerns groups.

Substantial research in the addictions field has identified that these three putative mechanisms play a significant role in the development and maintenance of addictions (e.g. Goodman, 2008). Past studies have revealed there is a significant relationship between self-report measures of reward sensitivity with problem drinking (Loxton & Dawe, 2007). Recent studies suggested that individuals with BED endorse greater sensitivity to reward than healthy controls and individuals with BN (Davis et al., 2008; Schienle, Schafer, Hermann & Vaitl, 2009). Moreover, studies utilizing the DERS have identified difficulties with emotion regulation among individuals with substance use disorders and eating disorders. For example, alcoholics endorse greater emotion regulation difficulties than social drinkers (Fox et al., 2008) and scores on the DERS have predicted the number of binges in college students with BED (Whiteside et al. 2007). Likewise, the Urgency scale of the UPPS was significantly related to problem drinking, binge eating and pathological gambling demonstrating that urgency is the common cognitive control impairment found among individuals who exhibit disordered eating and other addictive behaviors (Fischer & Smith, 2008).

Although still in the nascent stages of review, neurobiological evidence has demonstrated similar dysfunction among individuals with addictions and EDs particularly in the dopaminergic and serotonergic systems (Goodman, 2008; Kaye, 2008). These biological impairments have consistently been linked to impairments of the 3 putative

mechanisms identified in addiction vulnerability. For example, Broft et al. (2012) utilized PET imaging to detect abnormalities in DA in the brain of patients with BN when compared to healthy controls that mirror abnormalities found in individuals with substance use disorders. As such, there is plausible reason to believe similar etiological factors may contribute to the development of EDs and addictions.

Alcohol and substance use problems are the most common addictive behaviors. Growing research has suggested that other impulse control disorders (i.e. pathological gambling, compulsive shopping) represent behavioral addictions (Sussman et al., 2011). The common link between these behavioral addictions and substance use disorders has been identified as impairments in the 3 putative mechanisms examined in this paper. The contributing biological imbalances (blunted DA response) and parallels between disordered eating and these other behaviors related to the impairments denoted in addiction vulnerability are beginning to be identified as well.

With the growing problem of obesity, the debate of whether “food addiction” exists has become increasingly salient. There is some indication of common mechanisms as some research suggests that palatable foods affect the brain similarly as drugs of abuse. However, much debate about this construct still exists and the research is in its early stage. This study does not speak directly to the issue “food addiction” as it does not focus on whether or not an individual could become physically addicted to certain foods. However, our results highlight the parallel behavioral deficits present among both individuals who engage in disordered eating behavior as well as those identified in substance use addictions.

Continued research on examining the addiction vulnerability construct across all of the aforementioned behavioral addictions is necessary to fully validate this construct. The high degree of comorbidity found among EDs and addictions, namely substance and alcohol disorders, paired with biological evidence of similar brain chemistry abnormalities suggests these parallel mechanisms may exist. However, research has not yet examined why certain people only develop an ED or substance use and why some people develop both.

Weight and shape concerns have been posited to moderate the relationship between these three putative mechanisms and disordered eating behavior (Eichen et al. in prep). Results from this study demonstrate that weight and shape concerns do moderate the relationship between addiction vulnerability and disordered eating behavior. A strong tenet in the widely accepted cognitive behavioral theory of eating disorders is that the overevaluation of weight and shape is a central mechanism that contributes to the development and maintenance of all EDs (Fairburn et al., 2003). As stated before, individuals with BED do appear to demonstrate these concerns as well (Ahrberg et al., 2011; Eldredge & Agras 1996, Goldschmidt et al., 2010; Grilo et al., 2010; Striegel-Moore et al., 2000). This study provides further evidence that weight and shape concerns may be the distinguishing factor that contributes to the development of disordered eating as opposed to other addictive disorders. This is in accordance with other research that demonstrated the link between certain maladaptive emotion regulation strategies, negative body image thoughts and bulimic symptomatology (Hughes & Gullone, 2011). The current study suggested that the presence of high weight/shape concerns differentiates the presence of disordered eating in the form of binge eating. Future studies

should seek to confirm that weight and shape concerns are not present in those who do not develop EDs and determine the levels present in those with co-morbid substance use problems. Also additional research should be aimed at identifying other factors that may interact with addiction vulnerability to dictate which disorder or disorders would likely manifest.

Strengths, Limitations and Future Directions

The most notable strength of the present study is that it is the first to examine the integrative relationships between reward sensitivity, affect regulation and cognitive control in the context of disordered eating. While several studies have examined these constructs independently (eg. Boeka & Lokken, 2006; Munsch et al. 2012; Kemps & Wilsdon, 2010), no study to date has examined them concurrently. Furthermore, this study utilized both self-report and behavioral measures to examine these constructs.

Despite these strengths, the current study is not without limitations. First, the sample utilized all undergraduate students. As such, it is premature to generalize these findings to the general adult population. Future studies should examine these constructs in a sample that can better be generalized to the adult population. Next, likely due to the administration of the self-report measures online, some appeared to haphazardly answer questions by endorsing conflicting responses or did not complete the actual surveys making their data invalid and creating a large number of people whose data needed to be excluded from all analyses. Future studies requiring the completion of self-report measures in the laboratory may reduce the number of individuals who may respond randomly due to lack of motivation or distractions in their environment.. Additionally, in the current study there was no way to clarify any of the self-report questions should

somebody not understand how they are worded. This may have led to more people skipping questions or endorsing conflicting responses than had they been in the presence of an investigator. As mentioned earlier there was a significant number of people excluded for endorsing conflicting responses on the EDE-Q. If some people had clarification from a research staff member it is possible this number could have been reduced. Furthermore, this study was only able to utilize the self-report and behavioral measures of females. As such, it remains to be seen whether this model can be applied to males and distinguish males with eating disorders. To examine this, more males demonstrating higher weight and shape concerns would be needed. However, these concerns may likely be seen in a more clinical population. As diagnostic information was not gathered for all individuals included in the model, it would be beneficial to see if the model could predict to individuals with the diagnosis of an eating disorder. Relatedly, only binge eating was examined in this study. This was primarily done because binge eating was likely to be the most prevalent behavior in the college population. Examining other behaviors like purging, laxative and diet pill use, and extreme starvation would help solidify whether this model can predict to all disordered eating behaviors. Lastly, although measures were taken to consider ethnicity differences in the sample, the study population was heavily Caucasian. In sum, future studies should take into account trying to examine these concerns in an ethnically and gender diverse population. It is important to examine these constructs collectively in a clinical population to determine if there is clinical utility to this model and to examine whether these deficits should be addressed in a clinical context.

With respect to the behavioral tasks, participants ultimately included in the binge eating group did not necessarily meet criteria for binge eating disorder. The participants needed to endorse four binges in the past month but they did not necessarily have to endorse distress, rapid eating or other criteria outlined for the disorder. Only 3 individuals met current DSM-IV-TR criteria for binge eating disorder and 3 for BN. An additional 3 people met criteria for BN in partial remission. Future study comparing clinical participants to healthy controls may result in significant findings. Also, the behavioral tasks for the current study were selected because they were believed to represent the putative mechanisms. However, a previous study also questioned a behavioral measure of reward sensitivity as it demonstrated that correlation between self-report measures and behavioral tasks meant to measure reward sensitivity did not exist (Loxton & Dawe, 2007). The authors proposed that the incentives offered may not have matched the expectancies of participants and they became discouraged as other studies have noted that expectancies interact with self-reported measures of reward sensitivity and the performance on the behavioral task (Corr, 2002; Kambouropoulos & Staiger, 2004). Debate exists regarding the delay discount task whether the task measures impulsivity, future orientation, abstract reasoning and future orientation or a combination of the aforementioned constructs (McClure, Laibson, Lowenstein & Cohen, 2004). Similarly, recent reviews suggesting that impulsivity tasks do not accurately map onto a single facet of impulsivity such as urgency explain discrepancies found among behavioral and self-report measures of the “same” construct. It is possible that differences on the delay discount task and the SST were not seen because these measures do not tap the same constructs identified by the self-report measure and the reward sensitivity and lack of

cognitive control demonstrated in binge eaters. This is supported by the lack of correlation found in this study between the behavioral and self-report measures of reward sensitivity and cognitive control. Future studies should try to utilize behavioral tasks that correlate highly with the self-report measures used in this study.

Finally, as stated previously, significant findings were found during the PASAT-C, the task that demonstrated a negative mood inducement. As binge eating (and sometimes subsequent purging) has been demonstrated to occur following the presence of a negative mood, (i.e. Grilo et al. 1994), it may be that the impairments in reward sensitivity and cognitive control would only be seen following the immediate induction of negative mood. Future studies should consider utilizing a mood induction immediately preceding the completion of individual behavioral tasks.

Conclusions and Clinical Implications

In conclusion, this study was the first of its kind to demonstrate the proposed model, in which weight and shape concerns moderates the relationship between addiction vulnerability and disordered eating, is supported among undergraduate females. This study demonstrated that the 3 putative mechanisms commonly identified with addiction are shared with individuals engaging in binge eating, a form of disordered eating. As such, this study provides further evidence of the shared commonalities between eating disorders and addiction. This study only examined these mechanisms with regards to disordered eating behavior. It is important that future studies consider including individuals with just substance use problems and those with co-morbid substance and eating disorders and replicate these findings in a diverse clinical sample.

While promising, it is important to treat these findings as preliminary. However, should these findings be replicated, this can inform future assessment and treatment of disordered eating. To date, affect dysregulation has already been addressed in several treatments of eating disorders including cognitive behavioral therapy for eating disorders (CBT-E; Fairburn, 2008) and dialectical behavior therapy for binge eating and bulimia (DBT; Safer, Telch & Chen, 2009) applied to eating disorders. However, there is currently little understanding of the effects that reward sensitivity and cognitive control may have on the development and maintenance of EDs and subsequently their potential impact on treatment outcome. Should research continue to identify deficits in these areas, specific incorporation of psychoeducation and skill promoting more adaptive reward sensitivity and cognitive control, particularly urgency may help improve the effectiveness of treatment. The study also affirms the presence of higher weight and shape concerns among individuals engaging in disordered eating, and suggests continuing to address these concerns in eating disorder treatment.

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APPENDIX
SELF-REPORT MEASURES

SPSRQ

Directions: Please read the following questions carefully. Then give an answer to each question by marking one of the options. Because people are different, there are no right or wrong answers to these questions. Choose only one response for each item. Do not leave any items blank.

- Very untrue of me
 - Somewhat untrue of me
 - Neither untrue nor true of me
 - Somewhat true of me
 - Very true of me
-

1. I refrain from doing something because I am afraid of it being illegal.
2. The high probability of making money motivates me strongly to do some things.
3. I prefer not to ask for something when I am not sure I will get it.
4. The possibility of being valued in my work, in my studies, with my friends, or with my family encourages me to do certain things.
5. I am afraid of new or unexpected situations.
6. I meet people that I find physically attractive.
7. It is difficult for me to call someone on the telephone that I do not know.
8. I like to take some drugs because of the pleasure I get from them.
9. I give up my rights in order to avoid a fight with a person or an organization.
10. I do things to be praised.
11. As a child, I was very bothered by punishments at home or in school.
12. I like being the center of attention at a party or a social gathering.
13. I think a lot about the possibility of failure when engaging in tasks that I am not prepared for.
14. I spend a lot of my time on obtaining a good image.
15. I am easily discouraged in difficult situations.
16. I need people to show their affection for me all the time.
17. I am a shy person.
18. When I am in a group, I try to make my opinions the most intelligent or the funniest.
19. I avoid demonstrating my skills for fear of being embarrassed.
20. I take the opportunity to pick up people I find attractive.
21. When I am with a group, I have difficulties selecting a good topic to talk about.
22. As a child, I did a lot of things to get people's approval.
23. It is difficult for me to fall asleep when I think about things I have done or must do.
24. The possibility of social advancement moves me to action, even if this involves not playing fair.
25. I think a lot before complaining in a restaurant if my meal is not well prepared.
26. I prefer activities that lead to an immediate gain.

27. I would be bothered if I had to return to a store when I noticed I was given the wrong change.
28. I have trouble resisting the temptation of doing forbidden things.
29. Whenever I can, I avoid going to unknown places.
30. I like to compete and do everything I can to win.
31. I worry about things that I said or did.
32. It is easy for me to associate tastes and smells to very pleasant events.
33. It would be difficult for me to ask my boss for a raise (salary increase).
34. There are a large number of objects or sensations that remind me of pleasant events.
35. I avoid speaking in public.
36. When I start playing a slot machine, it is difficult for me to stop.
37. I think that I could do more things if it was not for my insecurity or fear.
38. I do things for quick gains.
39. Compared to people I know, I am afraid of many things.
40. I am easily distracted in the presence of an attractive stranger.
41. I find myself worrying about things so much that my ability to perform other mental tasks is impaired.
42. I am interested in money to the point of being able to do risky jobs.
43. I refrain from doing something I like in order to not be rejected by or disapproved of by others.
44. I like to make a competition out of all of my activities.
45. I pay more attention to threats than to pleasant events.
46. I would like to be a socially powerful person.
47. I refrain from doing something because of my fear of being embarrassed.
48. I like displaying my physical abilities even though this may involve danger.

DERS

Please indicate how often the following statements apply to you by writing the appropriate number from the scale below on the line beside each item:

1-----2-----3-----4-----5-----

almost never almost always (0-10%)	sometimes (11-35%)	about half the time (36-65%)	most of the time (66-90%)	(91- 100%)
--	-----------------------	---------------------------------	------------------------------	---------------

- | | |
|--|-------|
| 1) I am clear about my feelings. | _____ |
| 2) I pay attention to how I feel. | _____ |
| 3) I experience my emotions as overwhelming and out of control. | _____ |
| 4) I have no idea how I am feeling. | _____ |
| 5) I have difficulty making sense out of my feelings. | _____ |
| 6) I am attentive to my feelings. | _____ |
| 7) I know exactly how I am feeling. | _____ |
| 8) I care about what I am feeling. | _____ |
| 9) I am confused about how I feel. | _____ |
| 10) When I'm upset, I acknowledge my emotions. | _____ |
| 11) When I'm upset, I become angry with myself for feeling that way. | _____ |
| 12) When I'm upset, I become embarrassed for feeling that way. | _____ |
| 13) When I'm upset, I have difficulty getting work done. | _____ |
| 14) When I'm upset, I become out of control. | _____ |
| 15) When I'm upset, I believe that I will remain that way for a long time. | _____ |
| 16) When I'm upset, I believe that I'll end up feeling very depressed. | _____ |
| 17) When I'm upset, I believe that my feelings are valid and important. | _____ |
| 18) When I'm upset, I have difficulty focusing on other things. | _____ |
| 19) When I'm upset, I feel out of control. | _____ |
| 20) When I'm upset, I can still get things done. | _____ |

- 21) When I'm upset, I feel ashamed with myself for feeling that way. _____
- 22) When I'm upset, I know that I can find a way to eventually feel better. _____
- 23) When I'm upset, I feel like I am weak. _____
- 24) When I'm upset, I feel like I can remain in control of my behaviors. _____
- 25) When I'm upset, I feel guilty for feeling that way. _____
- 26) When I'm upset, I have difficulty concentrating. _____
- 27) When I'm upset, I have difficulty controlling my behaviors. _____
- 28) When I'm upset, I believe that there is nothing I can do to make myself feel better. _____
- 29) When I'm upset, I become irritated with myself for feeling that way. _____
- 30) When I'm upset, I start to feel very bad about myself. _____
- 31) When I'm upset, I believe that wallowing in it is all I can do. _____
- 32) When I'm upset, I lose control over my behaviors. _____
- 33) When I'm upset, I have difficulty thinking about anything else. _____
- 34) When I'm upset, I take time to figure out what I'm really feeling. _____
- 35) When I'm upset, it takes me a long time to feel better. _____
- 36) When I'm upset, my emotions feel overwhelming. _____
- 37) I feel that if I started crying I would never stop. _____
- 38) If I had to think about the sad and tragic things in my life, I would never recover. _____
- 39) I have to keep tight control over my emotions or else I will be engulfed by sadness. _____

UPPS-P

Below are a number of statements that describe ways in which people act and think. For each statement, please indicate how much you agree or disagree with the statement. If you **Agree Strongly** circle **1**, if you **Agree Somewhat** circle **2**, if you **Disagree somewhat** circle **3**, and if you **Disagree Strongly** circle **4**. Be sure to indicate your agreement or disagreement for every statement below. Also, there are questions on the following pages.

	Agree Strongly	Agree Some	Disagree Some	Disagree Strongly
1. I have a reserved and cautious attitude toward life.	1	2	3	4
2. I have trouble controlling my impulses.	1	2	3	4
3. I generally seek new and exciting experiences and sensations.	1	2	3	4
4. I generally like to see things through to the end.	1	2	3	4
5. When I am very happy, I can't seem to stop myself from doing things that can have bad consequences.	1	2	3	4
6. My thinking is usually careful and purposeful.	1	2	3	4
7. I have trouble resisting my cravings (for food, cigarettes, etc.).	1	2	3	4
8. I'll try anything once.	1	2	3	4
9. I tend to give up easily.	1	2	3	4
10. When I am in great mood, I tend to get into situations that could cause me problems.	1	2	3	4
11. I am not one of those people who blurt out things without thinking.	1	2	3	4
12. I often get involved in things I later wish I could get out of.	1	2	3	4
13. I like sports and games in which you have to choose your next move very quickly.	1	2	3	4
14. Unfinished tasks really bother me.	1	2	3	4
15. When I am very happy, I tend to do things that may cause problems in my life.	1	2	3	4
16. I like to stop and think things over before I do them.	1	2	3	4
17. When I feel bad, I will often do things I later regret in order to make myself feel better now.	1	2	3	4
18. I would enjoy water skiing.	1	2	3	4
19. Once I get going on something I hate to stop.	1	2	3	4
20. I tend to lose control when I am in a great mood.	1	2	3	4
21. I don't like to start a project until I know exactly how to proceed.	1	2	3	4

Please go to the next page

	Agree Strongly	Agree Some	Disagree Some	Disagree Strongly
22. Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse.	1	2	3	4
23. I quite enjoy taking risks.	1	2	3	4
24. I concentrate easily.	1	2	3	4
25. When I am really ecstatic, I tend to get out of control.	1	2	3	4
26. I would enjoy parachute jumping.	1	2	3	4
27. I finish what I start.	1	2	3	4
28. I tend to value and follow a rational, "sensible" approach to things.	1	2	3	4
29. When I am upset I often act without thinking.	1	2	3	4
30. Others would say I make bad choices when I am extremely happy about something.	1	2	3	4
31. I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional.	1	2	3	4
32. I am able to pace myself so as to get things done on time.	1	2	3	4
33. I usually make up my mind through careful reasoning.	1	2	3	4
34. When I feel rejected, I will often say things that I later regret.	1	2	3	4
35. Others are shocked or worried about the things I do when I am feeling very excited.	1	2	3	4
36. I would like to learn to fly an airplane.	1	2	3	4
37. I am a person who always gets the job done.	1	2	3	4
38. I am a cautious person.	1	2	3	4
39. It is hard for me to resist acting on my feelings.	1	2	3	4
40. When I get really happy about something, I tend to do things that can have bad consequences.	1	2	3	4
41. I sometimes like doing things that are a bit frightening.	1	2	3	4
42. I almost always finish projects that I start.	1	2	3	4
43. Before I get into a new situation I like to find out what to expect from it.	1	2	3	4
44. I often make matters worse because I act without thinking when I am upset.	1	2	3	4
45. When overjoyed, I feel like I can't stop myself from going overboard.	1	2	3	4

Please go to the next page

	Agree Strongly	Agree Some	Disagree Some	Disagree Strongly
46. I would enjoy the sensation of skiing very fast down a high mountain slope.	1	2	3	4
47. Sometimes there are so many little things to be done that I just ignore them all.	1	2	3	4
48. I usually think carefully before doing anything.	1	2	3	4
49. Before making up my mind, I consider all the advantages and disadvantages.	1	2	3	4
50. When I am really excited, I tend not to think of the consequences of my actions.	1	2	3	4
51. In the heat of an argument, I will often say things that I later regret.	1	2	3	4
52. I would like to go scuba diving.	1	2	3	4
53. I tend to act without thinking when I am really excited.	1	2	3	4
54. I always keep my feelings under control.	1	2	3	4
55. When I am really happy, I often find myself in situations that I normally wouldn't be comfortable with.	1	2	3	4
56. I would enjoy fast driving.	1	2	3	4
57. When I am very happy, I feel like it is ok to give in to cravings or overindulge.	1	2	3	4
58. Sometimes I do impulsive things that I later regret.	1	2	3	4
59. I am surprised at the things I do while in a great mood.	1	2	3	4

Scoring Instructions

This is a revised version of the UPPS Impulsive Behavior scale (Whiteside & Lynam, 2001). This version, UPPS+P, assesses an additional personality pathway to impulsive behavior, Positive Urgency (Cyders & Smith, 2007), in addition to the four pathways assessed in the original version of the scale-- Urgency (now Negative Urgency), (lack of) Premeditation, (lack of) Perseverance, and Sensation Seeking. The scale uses a 1 (agree strongly) to 4 (disagree strongly) response format. Because the items from different scales run in different directions, it is important to make sure that the correct items are reverse-scored. We suggest making all of the scales run in the direction such that higher scores indicate more impulsive behavior. Therefore, we include the scoring key for, (Negative) Urgency, (lack of) Premeditation, (lack of) Perseverance, Sensation Seeking, and Positive Urgency. For each scale, calculate the mean of the available items; this puts the scales on the same metric. We recommend requiring that a participant have at least 70% of the items before a score is calculated.

(Negative) Urgency (all items except 1 are reversed)

items 2 (R), 67(R), 12 (R), 17 (R), 22 (R), 29 (R), 34 (R), 39 (R), 44 (R), 51 (R), 54, 58 (R)

(lack of) Premeditation (no items are reversed)

items 1, 6, 11, 16, 21, 28, 33, 38, 43, 48, 49.

(lack of) Perseverance (two items are reversed)

items 4, 9 (R), 14, 19, 24, 27, 32, 37, 42, 47 (R)

Sensation Seeking (all items are reversed)

items 3 (R), 8 (R), 13 (R), 18 (R), 23 (R), 26 (R), 31 (R), 36 (R), 41 (R), 46 (R), 52 (R), 56 (R)

Positive Urgency (all items are reversed)

items 5 (R), 10 (R), 15 (R), 20 (R), 25 (R), 30 (R), 35 (R), 40 (R), 45 (R), 50 (R), 53 (R), 55 (R), 57 (R), 59 (R)

(R) indicates the item needs to be reverse scored such 1=4, 2=3, 3=2, and 4=1.

EDE-Q

EATING QUESTIONNAIRE

Instructions: The following questions are concerned with the past four weeks (28 days) only. Please read each question carefully. Please answer all the questions. Thank you.

Questions 1 to 12: Please circle the appropriate number on the right. Remember that the questions only refer to the past four weeks (28 days) only.

On how many of the past 28 days	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
1 Have you been deliberately <u>trying</u> to limit the amount of food you eat to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
2 Have you gone for long periods of time (8 waking hours or more) without eating anything at all in order to influence your shape or weight?	0	1	2	3	4	5	6
3 Have you <u>tried</u> to exclude from your diet any foods that you like in order to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
4 Have you <u>tried</u> to follow definite rules regarding your eating (for example, a calorie limit) in order to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
5 Have you had a definite desire to have an <u>empty</u> stomach with the aim of influencing your shape or weight?	0	1	2	3	4	5	6
6 Have you had a definite desire to have a <u>totally flat</u> stomach?	0	1	2	3	4	5	6
7 Has thinking about <u>food, eating or calories</u> made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?	0	1	2	3	4	5	6
8 Has thinking about <u>shape or weight</u> made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?	0	1	2	3	4	5	6
9 Have you had a definite fear of losing control over eating?	0	1	2	3	4	5	6
10 Have you had a definite fear that you might gain weight?	0	1	2	3	4	5	6
11 Have you felt fat?	0	1	2	3	4	5	6
12 Have you had a strong desire to lose weight?	0	1	2	3	4	5	6

Questions 13-18: Please fill in the appropriate number in the boxes on the right. Remember that the questions only refer to the past four weeks (28 days).

Over the past four weeks (28 days)

-
- 13 Over the past 28 days, how many times have you eaten what other people would regard as an unusually large amount of food (given the circumstances)?
-
- 14 On how many of these times did you have a sense of having lost control over your eating (at the time that you were eating)?
-
- 15 Over the past 28 days, on how many **DAYS** have such episodes of overeating occurred (i.e., you have eaten an unusually large amount of food and have had a sense of loss of control at the time)?
-
- 16 Over the past 28 days, how many times have you made yourself sick (vomit) as a means of controlling your shape or weight?
-
- 17 Over the past 28 days, how many times have you taken laxatives as a means of controlling your shape or weight?
-
- 18 Over the past 28 days, how many times have you exercised in a “driven” or “compulsive” way as a means of controlling your weight, shape or amount of fat, or to burn off calories?
-

Questions 19 to 21: Please circle the appropriate number. Please note that for these questions the term “binge eating” means eating what others would regard as an unusually large amount of food for the circumstances, accompanied by a sense of having lost control over eating.

19 Over the past 28 days, on how many days have you eaten in secret (ie, furtively)? Do not count episodes of binge eating	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
	0	1	2	3	4	5	6
20 On what proportion of the times that you have eaten have you felt guilty (felt that you've done wrong) because of its effect on your shape or weight? Do not count episodes of binge eating	None of the times	A few of the times	Less than half	Half of the times	More than half	Most of the time	Every time
	0	1	2	3	4	5	6
21 Over the past 28 days, how concerned have you been about other people seeing you eat? Do not count episodes of binge eating	Not at all	Slightly		Moderately		Markedly	
	0	1	2	3	4	5	6

Questions 22 to 28: Please circle the appropriate number on the right. Remember that the questions only refer to the past four weeks (28 days).

Over the past 28 days	Not at all	1	Slightly 2	3	Moderate -ly 4	5	Markedly 6
22 Has your <u>weight</u> influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6
23 Has your <u>shape</u> influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6
24 How much would it have upset you if you had been asked to weigh yourself once a week (no more, or less, often) for the next four weeks?	0	1	2	3	4	5	6
25 How dissatisfied have you been with your <u>weight</u> ?	0	1	2	3	4	5	6
26 How dissatisfied have you been with your <u>shape</u> ?	0	1	2	3	4	5	6
27 How uncomfortable have you felt seeing your body (for example, seeing your shape in the mirror, in a shop window reflection, while undressing or taking a bath or shower)?	0	1	2	3	4	5	6
28 How uncomfortable have you felt about <u>others</u> seeing your shape or figure (for example, in communal changing rooms, when swimming, or wearing tight clothes)?	0	1	2	3	4	5	6

What is your weight at present? (Please give your best estimate.)

What is your height? (Please give your best estimate.)

If female: Over the past three-to-four months have you missed any menstrual periods?

If so, how many?

Have you been taking the "pill"?

THANK YOU