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Perceived stress and anhedonia predict short-and long-term weight change, respectively, in healthy adults

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ABSTRACT

Objective: Perceived stress; emotional eating; anhedonia; depression and dietary restraint, hunger, and disinhibition have been studied as risk factors for obesity. However, the majority of studies have been cross-sectional and the directionality of these relationships remains unclear. In this longitudinal study, we assess their impact on future weight change.

Methods: Psychological predictors of weight change in short- (6 month) and long-term (>1 year) periods were studied in 65 lean and obese individuals in two cohorts. Subjects participated in studies of food intake and metabolism that did not include any type of medication or weight loss interventions. They completed psychological questionnaires at baseline and weight change was monitored at follow-up visits.

Results: At six months, perceived stress predicted weight gain ($r^2 = 0.23$, $P = 0.02$). There was a significant interaction ($r^2 = .38$, $P = 0.009$) between perceived stress and positive emotional eating, such that higher scores in both predicted greater weight gain, while those with low stress but high emotional eating scores lost weight. For long-term, higher anhedonia scores predicted weight gain ($r^2 = 0.24$, $P = 0.04$). Depression moderated these effects such that higher scores in both predicted weight gain but higher depression and lower anhedonia scores predicted weight loss.

Conclusion: There are different behavioral determinants for short- and long-term weight change. Targeting perceived stress may help with short-term weight loss while depression and anhedonia may be better targets for long-term weight regulation.

1. Introduction

Research into the causes of and risk factors for obesity has been pursued broadly, including genetic, environmental, lifestyle and psychosocial causes (Hebebrand & Hinney, 2009). Emotional states can influence eating behavior, which in turn, can result in weight change over time (Levitan & Davis, 2010). Some of the most commonly studied themes are the cross sectional relationships between stress (Buss, 2012; Chen & Qian, 2012), anhedonia (Komulainen et al., 2011; Shomaker, Tanofsky-Kraff, Zocca, Field, Drinkard and Yanovski, 2012), emotional eating (Geliebter & Aversa, 2003a; Bongers, Jansen, Havermans, Roefs, & Nederkoorn, 2013), depression (Atlantis & Baker, 2008; Luppino, de Wit, Bouvy, Stijnen, Cuijpers, Penninx, et al., 2010), restrained eating (De Lauzon-Guillain et al., 2006) and adiposity, while only a few have examined these as predictors of weight change. Several studies report a positive correlation between these emotions and unhealthy behaviors, such as quitting a weight loss program or decreased cardiorespiratory fitness (Chen & Qian, 2012; Komulainen et al., 2011; Geliebter & Aversa, 2003a). A recent meta-analysis of longitudinal studies reported a weak relationship between perceived stress and adiposity during long-term follow up (Wardle, Chida, Gibson, Whitaker, & Steptoe, 2011), yet other studies found that higher levels of perceived stress were associated with lower levels of eating awareness and physical activity, as well as higher consumption of fast foods (Barrington, Ceballos, Bishop, McGregor, & Beresford, 2012). In other studies, elevated levels of anhedonia were associated with an increased risk of quitting a weight loss program and lower fitness levels in obese participants (Komulainen et al., 2011; Shomaker et al., 2012). Additionally, studies have shown that emotional eating in response to both positive and negative moods predicted overeating and weight gain (Geliebter & Aversa, 2003a; Bongers, Jansen, Havermans, Roefs and Nederkoorn, 2013).

Only a small number of studies have extended the relationship between these factors and adiposity to examine mediating effects these factors may have on one another in relation to weight gain in a real-world setting. For instance, restrained and emotional eating have been shown to mediate the effects of stress, such that restrained or emotional eaters may become more hyperphagic in response to stress (Wardle, Steptoe, Oliver & Lipsey, 2000; Wallis & Hetherington, 2004). In a recent study of college freshmen, this main effect was qualified by an interaction between stress and BMI: students who entered university with high levels of stress gained weight if they also had high BMIs; if they

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had lower BMIs then they lost weight (Boyce & Kuijer, 2015). Anhedonia has been shown to increase in response to chronic stress in rat models (Pucilowski, Overstreet, Rezvani, & Janowsky, 1993), although food intake response is not as well studied, particularly in humans.

Behavioral attitudes toward food intake are known contributors to successful weight maintenance. Validated across gender, age, and BMI (Aurélie et al., 2012), the Three Factor Eating Questionnaire (TFEQ) is an effective indicator of dietary behaviors. The three factors (restraint, disinhibition, and hunger) of the TFEQ have all been positively correlated with BMI (Aurélie, Gilles, Jean-Jacques, Agathe, Sophie, Daniel, et al., 2012). Cognitive restraint has been validated as an indicator of dietary restraint (Rush, Giles, Schlesser, Fulton, Weissenburger and Burns, 1986). A longitudinal weight loss study demonstrated that those with high restraint are most successful at maintaining weight loss if they also have low disinhibition (Bryant, King, & Blundell, 2008). However, if restraint is disrupted by stress, exposure to palatable foods, or the perception of failure to maintain dietary restrictions, disinhibition and subsequent overeating may occur (Cools, Schotte, & McNally, 1992; Herman & Mack, 1975; Johnson, Pratt, & Wardle, 2012; Polivy & Peter, 1985; Wardle, et al., 2000). Individuals who maintain weight loss not only score higher on measures of dietary restraint but also demonstrate increased neural activity in regions responsible for executive function (DelParigi, Chen, Salbe, Hill, Wing, Reiman and Tataranni, 2007). In support of this notion, we recently found an interaction between perseveration and restraint was observed on 24 h food intake such that subjects with high perseveration and high restraint ate the least, whereas unrestrained subjects with high perseveration ate the most.

Studies have shown that weight is gradually regained 6 months after weight loss efforts, owing to decreases in time and effort spent on weight control, perceived inadequate long-term rewards for weight control behaviors, as well as differences in eating habit behaviors in short- and long-term time periods (Gibbs, Kinzel, Gabriel, Chang, & Kuller, 2012; Jeffery, Kelly, Rothman, Sherwood, & Boutelle, 2004; Kruger, Blanck, & Gillespie, 2008). In addition, other efforts have been made to assess differences that lead to weight loss versus long-term weight maintenance (Sciamanna, Kiernan, Rolls, Boan, Stuckey, Kephart, et al., 2011). Therefore, it is plausible that there may also be different behavioral contributors to short-term versus long-term weight change but this hypothesis has not yet been fully explored. We hypothesized that psychological constructs including perceived stress; positive and negative emotional eating; anhedonia; depression; and dietary restraint, hunger and disinhibition would be related to either short-term (6 months) or long-term (greater than 1 year) weight changes and that interactions between constructs may exist. We further hypothesized that associated constructs would likely differ between short-term and long-term weight changes.

2. Methods

2.1. Study design

Sixty-five non-diabetic, healthy volunteers were recruited from the Phoenix area by means of newspaper advertisements and flyers to participate in one of two inpatient studies (NCT00523627; NCT00342732). Both were observational studies of the effects of overconsumption and different diets on energy expenditure, as well as exploring food intake preference as risk factors for obesity. Neither study included any type of medication or weight loss intervention. Baseline measures were collected on the Clinical Research Unit of the National Institute of Diabetes and Digestive and Kidney Diseases — Phoenix (NIDDK). Inclusion criteria for all studies consisted of healthy adults, between the ages of 18–55, with no evidence of illness by history, physical or basic laboratory measures. No subjects were taking medication. Exclusion criteria included evidence of substance abuse (positive urine test), nicotine use, or reported excess alcohol use (>3 drinks/day). Prior to participation, all subjects were informed of the nature, purpose and risks of the study they participated in and written informed consent was obtained. The experimental protocols were approved by the Institutional Review Board of the NIDDK.

The first week of both studies was identical. The decision to combine data from these studies to assess the impact of psychosocial measures on body weight was pre-planned as these studies were all relatively small. Upon admission, subjects were given a standard weight maintaining diet (20%, 30%, and 50% of daily calories provided as protein, fat and carbohydrate, respectively) for the first 3 days. Weight maintaining energy needs were calculated for each subject based on weight, gender and BMI as previously described (Ferraro, Boyce, Swinburn, De Gregorio, & Ravussin, 1991). Body composition was determined by dual-energy x-ray absorptiometry (LUNAR Prodigy, GE). Within the first 2 days after admission, subjects completed a variety of self-report psychological questionnaires that were subsequently scored by a trained staff member. After 3 days of the weight maintaining diet, a 75 g oral glucose tolerance test was done to exclude individuals with diabetes mellitus (American Diabetes Association, 2010).

2.2. Psychological questionnaires

Participants completed 5 questionnaires:

1. Physical Anhedonia Scale (PAS) (Chapman, Chapman, & Raulin, 1976): assesses the capability to experience pleasure from typically pleasurable physical stimuli and the extent individuals are motivated to engage in these stimuli. This questionnaire consists of 61 True or False statements, with each anhedonic response given a score of 1. Higher scores indicate an increasing presence of anhedonic symptoms. The Cronbach α for this measure is 0.82 for males and 0.78 for females.
2. Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983): assesses different facets related to stress such as unpredictability, lack of control, burden overload, and stressful life circumstances in the last month. This survey consists of 14 questions with responses scored on a 0–5 Likert scale ("never" to "very often") and scores range from 0–56, with higher scores indicating a higher degree of perceived stress. The Cronbach α for this measure is 0.85.
3. Emotional Appetite Questionnaire (EMAQ) (Geliebter & Aversa, 2003b): measures eating responses to various positive and negative emotions and situations. Subjects answer their eating response to 22 emotions or situations on a Likert scale from 1–9. Example emotions include boredom, anxiety, frustration, happiness; examples of situations include after an argument and after receiving good news. Choices 1–4 coincide with "eating much less", 5 with "the same" and 6–9 with "eating much more." Scores can then be separated into eating in response to positive emotions/situations versus eating in response to negative emotions/situations. The Cronbach α for positive emotions/situations is 0.78 and 0.75 for negative emotions/situations.
4. Inventory for Depressive Symptomatology (IDS) (Rush et al., 1986): assesses signs and symptoms of depression. It consists of 30 questions that measure the degree of depression on a scaled score from 0–3, where 0 indicates least severe and 3 as most severe. Scores range from 0–90 and scores below 14 indicate no evidence of depression. The Cronbach α for this measure is 0.85.
5. Three-Factor Eating Questionnaire (TFEQ) (Stunkard & Messick, 1985): has 3 subscales assessing cognitive restraint, disinhibition and hunger. Restraint refers to control of eating behavior, disinhibition measures the degree to which individuals have an uncontrolled response to food and hunger measures an individual's inclination to eat in response to subjective feelings of hunger. Each subscale has a number of "true/false" or multiple-choice questions. Higher scores indicate greater disruptions in eating behavior. The Cronbach α for this measure ranged from 0.82–0.90 for each subscale.