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Questionnaire and laboratory measures of eating behavior: Associations with energy intake and BMI in a community sample of working adults

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Abstract

Purpose—The present research compared a self-report measure of usual eating behaviors with two laboratory-based behavioral measures of food reward and food preference.

Methods—Eating behaviors were measured among 233 working adults. A self-report measure was the Three Factor Eating Questionnaire (TFEQ) Restraint, Disinhibition and Hunger subscales. Laboratory measures were the (RVF) and Explicit Liking (EL) and Implicit Wanting (IW) for high fat food. Outcome measures were body mass index (BMI), and energy intake measured using three 24-hour dietary recalls.

Results—Significant bivariate associations were observed between each of the eating behavior measures and energy intake, but only Disinhibition and Hunger were associated with BMI. Multiple regression results showed RVF and EL and IW predicted energy intake independent of the TFEQ scales but did not predict BMI.

Conclusion—Laboratory and self-report measures capture unique aspects of individual differences in eating behaviors that are associated with energy intake.

Introduction

Individual differences in stable eating behaviors are important influences on food choices, energy intake, and body mass index (BMI). In a high-risk food environment, most individuals will overeat to a certain extent. However, some individuals are more susceptible than others, and are at higher risk for excess energy intake and weight gain (French, Epstein, Jeffery, Blundell & Wardle, 2012; Blundell & Cooling, 2000; Blundell, Stubbs, Golding, Croden, Alam, Whybrow, et al., 2005). The ability to identify these susceptible individuals

would advance both theoretical development in eating behaviors research and the development of interventions to prevent obesity.

Several theories conceptualize susceptibility to overeating and have developed measures of individual differences in eating behaviors related to energy intake and body weight (see French et al., 2012 for a review). The particular measures considered in this paper were chosen as potential indicators of individual differences in susceptibility to overeating as part of a community-based randomized trial to examine the effects of chronic exposure to large portion sizes. One of the most often-used questionnaire measures is the Three Factor Eating Questionnaire (TFEQ) (Stunkard & Messick, 1985; Bryant, King, & Blundell, 2007; Hays & Roberts, 2008; Bellisle, Clement, Le Barzic, Gall, Guy-Grand & Basdevant, 2004; Dykes, Brunner, Martikainen, & Wardle, 2004; Lindroos, Lissner, Mathiassen, Karlsson, Sullivan, Bengtsson, et al., 1997). More recently, laboratory-based measures of food reward and food preference have been developed, including a measure of the reinforcing value of food (RVF) (Epstein, LeDdy, Temple, & Faith, 2007; Epstein, Temple, Naderhiser, Salis, Erbe, & LeDdy, 2007; Epstein, Carr, Lin, Fletcher, & Roemmich, 2012), and a measure of explicit liking (EL) and implicit wanting (IW) for food (Finlayson, King, & Blundell, 2008; Finlayson & Dalton, 2012). The laboratory measures consist of direct observation of behavior in the laboratory setting and theoretically measure somewhat different behavioral mechanisms believed to underlie susceptibility to overeating.

The TFEQ represents an empirical approach to develop a measure of eating behaviors that would distinguish normal weight from overweight and obese people (Stunkard & Messick, 1985). At the time this measure was developed, obese people were believed to have different eating behaviors and different behavioral and emotional responses to situations involving food choices compared to normal weight people. The TFEQ has an extensive research literature that includes large population-based cohorts, participants in clinical weight loss interventions, and college student samples across multi-country, prospective and cross-sectional studies (Barkeling, King, Naslund, & Blundell, 2007; Bellisle et al., 2004; Chambers & Yeomans, 2011; Dykes et al., 2004; Hainer, Kunesova, Bellisle, Parizkova, Braunerova, Wagenknecht, et al., 2006; Harden, Corfe, Richardson, Dettmar, & Paxman, 2009; Hays, Bathalon, McCrory, Roubenoff, Lipman, & Roberts, 2002; Lindroos et al., 1997; Ouwens, van Strien, & van der Staak, et al., 2003; Provencher, Drapeau, Tremblay, Despres, & Lemieux, 2003; Schubert & Randler, 2008; Borg, Fogelholm, & Kukkonen-Harjula, 2004; Drapeau, Provencher, Lemieux, Despres, Bouchard, & Tremblay, 2003; Levine, Klem, Kalarchian, Wing, Weissfeld, Qin, et al., 2007; McGuire, Wing, Klem, Lang, & Hill, 1999; Savage, Hoffman, & Birch, 2009; Teixeira, Silva, Coutinho, Palmeira, Mata, Vieira, et al., 2010; Vogels, Diepvens, & Westterterp-Plantenga, 2005; Wing, Fava, Phelan, McCaffery, Papandonatos, Gorin, et al., 2008).

The TFEQ consists of three distinct constructs: Restraint, Disinhibition and Hunger (Stunkard & Messick, 1985; Karlsson, Persson, Sjostrom, & Sullivan, 2000). Restraint reflects the degree to which a person exerts behavioral control over their own eating behavior. Disinhibition reflects a person's stable underlying readiness to eat in response to environmental triggers, such as the sight and smell of palatable food, social or emotional eating. Hunger reflects a person's stable underlying sensitivity to Hunger feelings and predisposition to eat. Of the three subscales, Disinhibition has been associated consistently with higher BMI and energy intake (Provencher et al., 2003; Bellisle et al., 2004; Dykes, et al., 2004; Bryant et al., 2007). Disinhibition may be most closely related to food sensitivity or factors that influence the onset of eating. However, the failure to inhibit eating, once started, could be related to weak satiety processes or to weaker volitional controls (cognitive or motivational) on eating behavior. Recently, some researchers have conceptualized Disinhibition as internal and external control of eating (Karlsson et al., 2000; Bond,

McDowell, & Wilkinson, 2001). However, most of the existing research retains the three-scale configuration of the questionnaire.

Restraint has been associated inconsistently with BMI (French & Jeffery, 1994; French, Jeffery, Forster, McGovern, Kelder, & Baxter, 1994; French & Jeffery, 1997; Dykes et al., 2004; Williamson, Lawson, Brooks, Wozniak, Ryan, Bray, et al., 1995; Lindroos et al., 1997; Provencher, et al., 2003; Hays & Roberts, 2008). Both higher and lower energy intake has been observed among restrained eaters compared with those who are less restrained (French & Jeffery, 1994; French et al., 1994; French & Jeffery 1997; French, Jeffery, & Murray, 1999; Bellisle et al., 2004; Hays & Roberts 2008; Dykes et al., 2004; Williamson et al., 1995; Lindroos, 1997; Provencher et al., 2003). Associations tend to vary by age, gender and obesity status. Among younger college student women, higher Restraint scores tend to be associated with lower energy intake and body weight, while the opposite tends to be observed among overweight samples in clinical and community settings (French & Jeffery, 1994; French, Jeffery, & Wing, 1994; French & Jeffery, 1997).

A small but growing body of empirical data has revealed interactions between Disinhibition and Restraint in association with energy intake and body weight. For example, high Restraint combined with high Disinhibition attenuated weight gain over time (Hays & Roberts 2008; Williamson et al., 1995). In a laboratory experimental study, high Disinhibition with high Restraint was associated with higher energy intake in an ice cream preload paradigm (Westerhoefer, Broeckmann, Munch, & Pudel, 1994).

Hunger scores have shown fewer associations with outcomes in the literature to date, (Provencher et al., 2003 observed positive associations with energy intake). In theory, those who report chronically high levels of Hunger are more susceptible to overeating compared with those who do not report being often hungry. Correlations between Disinhibition and Hunger tend to be high (Bellisle et al., Dykes et al., 2004), while Restraint and Disinhibition and Restraint and Hunger tend to have lower correlations with each other (Williamson et al., 1995; Dykes et al., 2004).

More recently, the concept of RVF evolved from the theoretical literature on behavioral choice theory and applications to drug addiction (Epstein et al., 2007). Individuals for whom food has a high reward value are hypothesized to work harder to gain access to food compared to those who do not find food as reinforcing. In theory, compared to those for whom food is less reinforcing, those who find food highly reinforcing should be more responsive to food and eating opportunities in their environment, and as a result, may be more likely to be overweight or to have higher BMI. Epstein and colleagues have developed a measure of the RVF to quantify individual differences in RVF (Epstein et al., 2007; Epstein & Saelens, 2000; Epstein et al., 2011; Epstein et al., 2007; Epstein et al., 2004; Giesen, Remco, Douven, Tekelenburg & Jansen, 2010; Saelens & Epstein, 1996; Hill, Saxton, Webber, Blundell, & Wardle, 2009; Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008). RVF is measured using a laboratory-based computer task in which individuals have to “work” via computer clicks to gain access to food reinforcers. The RVF can be measured in an absolute sense by providing only access to food, or in a relative sense, in which two or more alternative reinforcers are available (food and non-food) to study how participants allocate time and effort for each alternative. It is also possible to study the RVF of different types of foods, rather than a food versus an alternative.

In cross-sectional studies, higher RVF scores have been observed among overweight compared with normal weight adults (Epstein et al., 2010; Epstein et al., 2007; Goldfield & Lumb, 2009). Higher energy intake in the laboratory setting has been observed among those with higher RVF compared to those with lower RVF (Epstein et al., 2011; Epstein et al.,

2007; Epstein et al., 2004). In addition, food reinforcement is positively associated with energy intake measured by repeated 24-hour recalls and food frequency questionnaires (Epstein, Carr, Lin, & Fletcher, 2012). One study examined the moderating effect of weight status on the Restraint-RVF association (Goldfield & Lumb, 2009). Those with high Restraint and low food reinforcement had lower BMI, and those with high Restraint and high food reinforcement had higher BMI (Goldfield & Lumb, 2009). In this study, food reinforcement was measured using a self-report questionnaire, not the laboratory behavioral measure (Epstein, Dearing, & Roba, 2010). Another study found higher BMI among those with high food reinforcement and high Disinhibition compared with low food reinforcement and low Disinhibition (Epstein, Linn, Carr, & Fletcher, (2012).

Recently, another laboratory behavioral measure of eating motivation has been developed. The concepts of liking and wanting of food in human appetite are based on theories related to hedonic processes involved in satiety (Blundell et al. 2005; Berridge, 2007) and distinct psychological components of food reward (Berridge, 1996). In humans, the construct of wanting is considered a motivational process that generates an impulsive attraction towards a specific food. Wanting independent from liking may refer to the compulsive element to eating. Liking represents the sensory pleasure-giving aspect of food. Liking may lead to wanting, but a food can also be liked in the absence of wanting (and sometimes wanted more than it is liked). As well as having separate meanings, further rationale for this distinction comes from behavioral neuroscience showing that liking (affective behavioral responses) and wanting (food motivation) have separate neural substrates in the brain (Berridge, 1996; Berridge, 2007). In humans, these same underlying neurochemical systems are implicated in the behavior of obese adults who binge eat (Davis, Levitan, Reid, Carter, Kaplan, Patte, et al., 2009) and possibly in other eating disordered behaviors (Berridge, 2009). The human constructs of liking and wanting recently have been operationalized for behavioral assessment in the laboratory using a photographic, visual analogue rating and choice reaction-time paradigm (Finlayson et al., 2008; Finlayson, King, & Blundell, 2007). As liking and wanting are theorized to be largely overlapping processes, it is expected that separate measures of liking and wanting will often covary under normal circumstances. Although liking is generally viewed as a more stable, persistent response for food, food wanting can more readily transfer from one food to another. In previous research, liking and wanting have been shown to similarly predict actual food choice and food intake under different laboratory and free-living situations (Griffioen-Roose, Finlayson, Mars, Blundell, & de Gaff, 2010; Griffioen-Roose, Finlayson, Mars, Blundell, & de Gaff, 2011; Dalton, Blundell, & Finlayson, in press). However, it is also of theoretical interest to examine whether and under what conditions liking and wanting might operate separately to influence eating behavior (Finlayson, Bordes, Griffioen-Roose, de Graaf, & Blundell, 2012; Finlayson and Dalton, 2012).

These six eating behavior measures are only a subset of those developed around various eating behavior theories in the research literature. Few studies have tried to examine the broader concept of “susceptibility to overeating” using eating behavior constructs from different theoretical perspectives within the same study (French, et al., 2012). If certain people are believed to be at higher risk in a “toxic” food environment, then having a measure or measures of susceptibility would be useful to develop research that better defines the specific aspects of the environment that are most risky for these individuals. Aside from a desire for theoretical integration, it is of interest to know whether more detailed, time and resource-intensive laboratory-based measures of food reward and food preference provide additional predictive ability beyond a self-report questionnaire for outcomes such as energy intake and BMI, and thus may add to the conceptualization of “susceptibility to overeating” in the research literature.

The present study examined these measures of eating behaviors that were developed from three different theoretical perspectives. The constructs were Disinhibition, Hunger and Restraint; RVF; and liking and wanting for high fat food. The measures of these constructs were collected as part of a larger study on long-term exposure to large portion sizes in the free-living environment, and resultant changes in energy intake and weight over time. Each measure was examined in relation to each other, and with BMI and energy intake in a sample of working adults. It was hypothesized that each of the constructs would be significantly positively correlated with each other, and with BMI and with energy intake. Study questions were: 1) How do each of the variables correlate with each other? Are they distinct variables?; 2) Are each of the variables correlated with usual energy intake and with BMI?; 3) Do methods that measure an individual's eating behavior in a single, laboratory setting provide additional information to self-report measures of typical eating behaviors?

METHODS

Study Sample and Recruitment

Data for the present analysis were collected at baseline prior to randomization in a community intervention trial to examine the effects of chronic exposure to different meal sizes on body weight and energy intake. The study was conducted at a large urban medical center that employed over 2,000 people of diverse demographic backgrounds. Eligibility criteria were: 1) age 18–55 yrs; 2) nonsmoker; 3) not taking medications that affect appetite or body weight; 4) full time employment at the medical center; 5) not allergic to the foods in the study lunches; 6) willing to eat the foods in the study lunches (examples were provided of the types of foods); 7) not moving from the area during the next six months; 8) not currently taking part in another research study; 9) not currently dieting to lose weight; 10) no history of a diagnosed eating disorder; 11) not currently pregnant or pregnant in the past year; and 12) read and speak English. Data collection took place from September 2011 through February 2013. The study was approved by the University of Minnesota Institutional Review Board.

Measures

Trained research staff followed a standardized protocol for all data collection procedures. Data were collected at a University research building located about a mile from the medical center.

Eating Behavior Constructs

Three Factor Eating Questionnaire: Disinhibition, Hunger, Restraint

Subscales—The TFEQ was developed to capture stable psychological and behavioral responses to food and eating (Stunkard & Messick, 1985; Karlsson, et al., 2000). Respondents self-report their typical eating-related behaviors. The TFEQ consists of three distinct constructs: Restraint, Disinhibition and Hunger (Stunkard & Messick, 1985; Karlsson et al., 2000). The subscales have high internal reliability, stability (test-retest reliability), construct validity and predictive validity for eating behaviors in both laboratory and observational settings (Stunkard & Messick, 1985; Karlsson et al., 2000; French et al 2012).

Food Reinforcement—The RVF was measured using a computer-administered behavioral choice task that followed the standard protocol for the measurement of this construct in the laboratory (Epstein et al., 2007; Epstein, Wright, Paluch, Leddy, Hawk, Jaroni, et al., 2004). Participants completed the task during the lunch hour and were instructed not to eat three hours prior to the measurement visit. All participants consumed a 150 kcal cereal bar preload prior to engaging in the task. Participants were instructed to click

a mouse on either of two computers. On one computer, participants worked for a pizza reinforcer (100 kcal slice). On the other computer, participants worked for access to reading popular magazines (90 seconds). The reinforcement schedule was a progressive variable ratio for both the pizza reinforcer and for the magazines reinforcer. Reinforcers earned were delivered to and consumed by participants immediately after earning throughout the task. Participants were instructed that the task was finished when they no longer wanted to keep doing it. The Pmax of a reinforcer is the largest number of clicks completed to earn the reinforcer. RVF (pizza) was computed as the ratio of Pmax (pizza) to the sum of the Pmax (pizza) plus the Pmax (reading) (Epstein et al., 2007; Epstein et al., 2004).

Explicit Liking and Implicit Wanting for high fat food—Explicit Liking (EL) and Implicit Wanting (IW) for high fat food were measured using a computer-administered task (Finlayson et al., 2008; Finlayson et al., 2007). The task was administered on a different day than the RVF task. Participants were presented with an array of pictures of individual food items common in the North American diet. Foods in the array were chosen by the experimenter to be either predominantly high (>50% energy) or low (<20% energy) in fat but similar in familiarity, protein content, sweet or non-sweet taste and palatability. To measure EL, the participant rated the extent to which they liked each food, using a Likert scale. To measure IW, participants were presented with 96 pairs of foods of different types (high fat or low fat). They were instructed to respond as quickly as they could to indicate the food they wanted to eat the most at that time. Reaction times for all responses were recorded and used to compute mean response times for each food type after adjusting for frequency of selection and overall mean response time. For EL and IW measures, mean low fat scores were subtracted from the mean for high fat scores to provide two individual variables representing EL or IW for high fat food (relative to low fat food).

Body weight and height—All anthropometric measures were conducted by trained and certified research staff according to standardized protocols (Lohman, Roche, & Martorell, 1988). Body weight was measured to the nearest .1 kg using a calibrated electronic scale (Befour Inc, Saukville, WI). Height was measured to the nearest .1 cm with a wall-mounted stadiometer. Body weight was measured with participants in light clothing and without shoes. All measures were performed in duplicate. If there was greater than or equal to 1 cm or .5 kg deviation between the two measures, a third measurement was taken. The mean values of the two measures in closest agreement were used in analysis.

Dietary intake—Energy intake was measured using three telephone-administered 24-hour dietary recalls (Johnson, Driscoll, & Goran, 1996; Beaton, Milner, McGuire, Feather, & Little, 1983). Dietary recalls were conducted by trained and certified staff at the University of Minnesota Nutrition Coordinating Center (NCC) using the Nutrition Data Systems for Research (NDSR) software and standardized protocols.

Demographic variables—Demographic variables were self-reported and included household income, age, sex, Hispanic ethnicity, race, education level, and marital status.

Statistical Analysis

Regression analyses were conducted using the R (R Development Core Team, 2012) and SAS statistical software programs (Cary, NC). Bivariate correlations were examined to evaluate the extent to which the eating behaviors were related to each other. Correlations between each eating behavior measure and the outcome variables of interest were examined. Linear regression models were used to estimate covariate-adjusted associations between eating behavior measures and outcomes, and to examine the additional explanatory abilities of the laboratory measures (RVF and EL and IW) beyond the three TFEQ subscales.

Regression analyses of BMI were adjusted for age, sex, job type, and education, because these variables were thought to be potential confounders due to their correlation with the outcomes in the present study. Analyses of energy intake were additionally adjusted for BMI. Interactions between the TFEQ subscales, RVF, and EL and IW were investigated using a series of multiple regression analyses. Each of the seven possible pairwise interactions (TFEQ-R*RVF, TFEQ-D*RVF, TFEQ-H*RVF, TFEQ-R*LW, TFEQ-D*LW, TFEQ-H*LW, and RVF*LW) was considered in a separate model including the two main effects, the interaction term, and the adjustment variables listed above.

To further explore the inter-relationship between the eating behavior variables and identify population subgroups defined by particularly low or high outcome values, a series of conditional regression tree analyses were conducted using the ‘party’ package in R Party (A Laboratory for Recursive Part(y)itioning) (Strasser & Weber, 1999; Hothorn, Hornik, van de Wiel, & Zeileis, 2006; Hothorn, Hornik, & Zeileis, 2006). A traditional (i.e., unconditional) regression tree separates individuals into groups with differing values of the outcome, with the groups being defined by a sequence of binary “splits” on predictor variables. Splits are determined by searching across all predictors to find the split that results in the largest mean difference on the outcome between the resulting predictor-split groups. The algorithm terminates when there are no remaining splits yielding significant mean differences within any subsets defined by previous splits in the tree. A conditional regression tree uses a slightly more restrictive algorithm that only considers splits on the predictors that are most strongly associated with the outcome in any given subgroup. Conditional regression trees therefore have slightly lower predictive power, but are much more interpretable than traditional regression trees since they yield valid, adjusted p-values for the association between predictor variables and outcomes within the subgroups defined by the tree.

Conditional regression trees were created for the two outcomes, BMI and energy intake. In each case, covariate-adjusted outcome values were defined by adding residuals from a linear regression model including age, sex, job type, and education (+ BMI for the energy intake outcome) to the overall fitted mean. The six eating behavior predictor variables (Restraint, Hunger, Disinhibition, RRVF, EL and IW) were candidates to be used as splitting points in the conditional regression tree. The tree was restricted to a maximum depth of 3 (i.e., each subgroup could be defined by at most three splits), and each terminal node (i.e., subgroup) was required to contain a minimum of 25 subjects. These settings were chosen to increase the stability and interpretability of the conditional regression trees.

Results

Demographic variables, eating constructs and eating behaviors

Table 1 shows means, standard deviations or percents for the demographic variables, eating constructs and eating behaviors in the study sample. The sample was about one third men and one third racial/ethnic minority. Average age was 44 yrs. About half the sample had less than a college degree, and income was distributed fairly evenly across a broad range. Participants were employed in a broad variety of work positions, with about a third in patient care and a third in clerical/technical positions. Seventy-seven percent were overweight or obese (BMI ≥ 25 kg/m²).

Are eating behaviors distinct? Intercorrelations

Table 2 shows the unadjusted intercorrelations for the eating behavior variables. Correlations among most variables were modest but significant. The strongest correlations were between the EL and IW variables, and the TFEQ Hunger and Disinhibition scales. Restraint was significantly inversely correlated with each of the eating behavior variables

except Disinhibition. Food reinforcement, Disinhibition and Hunger were modestly correlated with the liking and wanting measures. Food reinforcement was not significantly associated with Disinhibition.

Do eating behaviors correlate with BMI and energy?

Table 2 shows unadjusted correlations between each eating behavior variable, BMI and energy intake. Disinhibition was most strongly associated with BMI. Hunger was the only other eating behavior significantly associated with BMI. The same pattern of significance was observed when correlation with body weight was examined. Each of the eating behavior variables was significantly associated with energy intake. Hunger, RVF, and IW showed the strongest correlations with energy intake. Restrained eating was significantly inversely associated with energy intake. In this sample, energy intake was significantly associated with body weight, but not BMI.

Do laboratory-based eating behavior measures provide additional explanatory variance beyond self-report eating behavior measures of usual eating behaviors?

Table 3 shows the results of covariate-adjusted regression models for BMI where the predictor variables of interest are RVF, EL, IW, and the TFEQ subscales. Disinhibition was the only eating behavior variable significantly predictive of BMI. A marginally significant interaction was observed between Disinhibition and RVF on BMI, though this finding should be interpreted with caution given the number of interaction terms tested. Those high in Disinhibition had higher BMI than those low in Disinhibition. Adjusted mean (se) BMIs were as follows: high RVF/high Disinhibition: 30.9 (.68); low RVF/high Disinhibition: 32.6 (.86); high RVF/low Disinhibition: 28.0 (.74); low RVF/low Disinhibition: 27.9 (.90).

Table 4 shows the results of the covariate-adjusted regression models for energy intake. Hunger, RVF, EL and IW were independently associated with energy intake. In a model that included all of the eating behavior variables, Hunger and RVF were significantly associated with energy intake. No significant or marginally significant interactions were observed between any of the eating behavior variables on energy intake.

Tree analysis: joint assessment of eating behavior construct associations with energy intake and BMI

The conditional regression tree for energy intake is shown in Figure 1. The tree identifies subgroups defined by various levels of the eating behavior variables. The subgroups are defined by the splits in the tree, denoted by ovals in the figure. Each split corresponds to a particular eating behavior variable (Restraint, Disinhibition, Hunger, RVF, EL, IW), and the p-value is the adjusted univariate association between that eating behavior variable and the outcome within the subgroup defined by previous splits. The numbers on the branches below a split define the value of the variable on which the split was identified. The boxplots at the bottom of tree summarize the (covariate-adjusted) outcome values for the subgroups defined by the tree splits. The number in parentheses gives the size of each subgroup. The eating behavior variable most strongly correlated with energy intake was TFEQ Hunger (Figure 1). Hunger scores above 10 ($n=16$) (sample median was 4) were associated with significantly higher energy intake (mean 2864 kcal/day) compared with those less than or equal to 10. Among those scoring ≤ 10 on the Hunger variable, a second significant split was observed on the EL variable. Those with EL scores below ≤ -13 ($n=87$) reported significantly lower energy intake (mean 1733 kcal/day) compared with those who scored higher on the EL variable ($n=123$; mean 2106 kcal/day). No other eating behavior variables significantly correlated with energy intake. For BMI (Figure 2), Disinhibition was the only eating behavior variable that significantly split the sample. High Disinhibition (>6 ; $n=87$)

was associated with higher BMI (32.6 kg/m²) compared with lower Disinhibition (≤ 6 ; $n=139$; BMI = 28.1 kg/m²).

DISCUSSION

This study examined associations between three self-reported measures of stable eating behaviors, and three laboratory-based measures of eating behaviors. The purpose was to examine the extent to which these measures were associated with each other and with energy intake and BMI. Results showed that the eating behavior measures were significantly correlated with each other and, in analyses adjusted for each other, independently associated with energy intake. In adjusted analyses, only Disinhibition was significantly associated with BMI.

A limited number of previous studies have observed interactions between the TFEQ subscales, Disinhibition, and Restraint, in association with weight gain over time in a population-based cohort (Hays & Roberts, 2008; Williamson et al., 1995) and energy intake in the laboratory setting (Westerhoefer et al., 1994). Other studies have found significant interactions between Restraint and food reinforcement (Goldfield & Lumb, 2009), and Disinhibition and food reinforcement (Epstein et al., 2012) on laboratory energy intake. However, in the present study, no significant two-way interactions were observed between any two of the eating behavior constructs for prediction of energy intake or BMI. A marginally significant interaction was observed between food reinforcement and Disinhibition on BMI. In the present study, highest BMI was observed among those high in Disinhibition and low in food reinforcement. The pattern of the interaction was different from the, Linn et al 2012 study, above, who found highest energy intake among those highest in both Disinhibition and food reinforcement. The reasons for this are not clear. Epstein et al., 2012 found the significant interaction on laboratory energy intake, not BMI. The measure of food reinforcement was different than that used in the present study. Epstein et al., 2012 used the maximum number of clicks for the food reinforcement (Pmax). The present study used the proportion of clicks for the food reinforcer, the measure of food reinforcement commonly used by Epstein's program of research (French et al., 2012). The outcome in the present study for the marginally significant interaction was BMI, not laboratory energy intake. Other possible reasons include the small sample size and thus low power for detecting interaction effects, or the absence of a true interactive association between food reinforcement and Disinhibition on BMI.

The present study observed a high correlation between EL and IW ($r=.83$). This observation is consistent with the theory that the two processes are highly correlated in a general population-based sample of adults. However, specialized populations, such as those with eating disorders, may show more distinctive EL and IW processes that influence energy intake. IW and EL correlated moderately with RVF, Disinhibition and Hunger in the present study, which seems consistent with their theorized conceptualization as motivational processes related to food choice and eating. These measures were correlated with energy intake, but not with BMI in the present study, presenting mixed results with respect to the idea that free-living, middle-aged adults who are high in motivation to eat or hedonic attraction to food are habitually susceptible to overeating and excess weight gain. Further research is needed to better describe the similarities and differences between EL, IW, RVF, Disinhibition and Hunger, and the circumstances under which they are expected to predict energy intake and BMI in population-based samples.

The study had several strengths and limitations. To our knowledge, this is the first study that has explored the joint associations between TFEQ subscales and laboratory-based eating behaviors variables in the same sample, using a heterogeneous community-based sample of

working adults. The findings represent a first step in the effort to understand the unique and overlapping dimensions of eating susceptibility, and how they are related to energy intake, BMI and other eating behaviors. The findings also highlight challenges in the extent to which constructs measured in the laboratory using unique behavioral paradigms can be used to examine eating behaviors and BMI in free-living participants. Although the mean BMI was high in this sample, the full range of BMI was represented and was typical of the US population, and the sample size was large relative to previously published laboratory studies of eating behaviors. Study limitations included the cross-sectional analysis, and the inclusion of only the TFEQ as a self-report measure of stable eating behaviors. The RVF measure has theoretical and practical limitations because it is a measure designed to assess the reinforcing strength of a particular food, but not food in general. Thus, empirical evaluation of the theory can only be interpreted with respect to the particular food used in the experimental test. It would be helpful to develop a more generalized measure of the construct of food reinforcement.

The present findings suggest that the theoretical approaches to understanding susceptibility to overeating and obesity still need further development. For example, a reasonable hypothesis is that people high in Restraint would be protected from the effects of high RVF, high EL or IW or high Disinhibition on overeating and weight gain. Another theoretically logical hypothesis is that individuals high on Disinhibition, RVF and EL and IW would be the most susceptible to overeating and weight gain. These hypotheses could be explored using laboratory paradigms, cohort studies and community-based interventions. Creative statistical techniques such as the regression trees reported here would also contribute to defining multivariable measures of susceptibility to overeating.

Overall, for practical purposes, the TFEQ appears to yield high value in terms of its ability to identify high BMI and energy intake in population-based samples. Its limitations include its length and questions about the distinctiveness of the Disinhibition and Hunger subscales. The RVF, EL and IW for high fat food measures seem to be useful additional predictors of energy intake, and provide information beyond the TFEQ subscales. Their use in community-based intervention studies could be enhanced by the development of a self-report measure that is practical for administration in large community-based samples.

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References

- Barkeling B, King NA, Naslund E, Blundell JE. Characterization of obese individuals who claim to detect no relationship between their eating pattern and sensations of Hunger and fullness. *International Journal of Obesity*. 2007; 31:435–439. [PubMed: 16953260]
- Beaton G, Milner J, McGuire V, Feather T, Little A. Sources of variance in 24-hour dietary recall data: Implications for nutrition study design and interpretation. Carbohydrate sources, vitamins and minerals. *American Journal of Clinical Nutrition*. 1983; 37:986–995. [PubMed: 6846242]
- Bellisle F, Clement K, Le Barzic ML, Le Gall A, Guy-Grand B, Basdevant A. The eating inventory and body adiposity from leanness to massive obesity. A study of 2509 adults. *Obesity Research*. 2004; 12:2023–2030. [PubMed: 15687404]
- Berridge KC. Food reward: Brain substrates of wanting and liking. *Neuroscience and Biobehavioral Reviews*. 1996; 20:1–25. [PubMed: 8622814]
- Berridge, KC. Brain reward systems for food incentives and hedonics in normal appetite and eating disorders. In: Kirkham, TC.; Cooper, SJ., editors. *Progress in brain research: Appetite and body weight*. Academic Press; 2007. p. 191-216.

- Berridge KC. 'Liking' and 'wanting' food rewards: Brain substrates and roles in eating disorders. *Physiology & behavior*. 2009; 97(5):537. [PubMed: 19336238]
- Blundell JE, Cooling J. Routes to obesity: Phenotypes, food choices and activity. *British Journal of Nutrition*. 2000; 83:S33–S38. [PubMed: 10889790]
- Blundell JE, Stubbs RJ, Golding C, Croden F, Alam R, Whybrow S, et al. Resistance and susceptibility to weight gain: Individual variability in response to a high-fat diet. *Physiology and Behavior*. 2005; 86:614–622. [PubMed: 16225895]
- Bond MJ, McDowell AJ, Wilkinson JY. The measurement of dietary Restraint, Disinhibition and Hunger. An examination of the factor structure of the Three Factor Eating Questionnaire (TFEQ). *International Journal of Obesity and Related Metabolic Disorders*. 2001; 25:900–906. [PubMed: 11439306]
- Borg P, Fogelholm M, Kukkonen-Harjula K. Food selection and eating behavior during weight maintenance intervention and 2-year follow-up in obese men. *International Journal of Obesity and Related Metabolic Disorders*. 2004; 28:1548–1554. [PubMed: 15543160]
- Bryant EJ, King NA, Blundell JE. Disinhibition: its effects on appetite and weight regulation. *Obesity Reviews*. 2007; 9:409–419. [PubMed: 18179615]
- Chambers L, Yeomans MR. Individual differences in satiety response to carbohydrate and fat. Predictions from the Three Factor Eating Questionnaire (TFEQ). *Appetite*. 2011; 56:316–323. [PubMed: 21219950]
- Dalton M, Blundell J, Finlayson G. Effect of BMI and binge eating on food reward and energy intake: further evidence for a binge eating subtype of obesity. *Obesity Facts*. In press.
- Davis CA, Levitan RD, Reid C, Carter JC, Kaplan AS, Patte KA, et al. Dopamine for “wanting” and opioids for “liking”: a comparison of obese adults with and without binge eating. *Obesity*. 2009; 17(6):1220–1225. [PubMed: 19282821]
- Drapeau V, Provencher V, Lemieux S, Despres JP, Bouchard C, Tremblay A. Do 6-year changes in eating behaviors predict change in body weight? Results from the Quebec Family Study. *International Journal of Obesity*. 2003; 27:808–814. [PubMed: 12821966]
- Dykes J, Brunner EJ, Martikainen PT, Wardle J. Socioeconomic gradient in body size and obesity among women: the role of dietary Restraint, Disinhibition and Hunger in the Whitehall II study. *International Journal of Obesity*. 2004; 28:262–268. [PubMed: 14647173]
- Epstein LH, Carr KA, Lin H, Fletcher KD. Food reinforcement, energy intake and macronutrient choice. *American Journal of Clinical Nutrition*. 2011; 94:12–18. [PubMed: 21543545]
- Epstein LH, Carr KA, Lin H, Fletcher KD, Roemmich JN. Usual energy intake mediates the relationship between food reinforcement and BMI. *Obesity*. 2012; 20:1815–1819. [PubMed: 22245983]
- Epstein LH, Linn H, Carr KA, Fletcher KD. Food reinforcement: Psychological moderators. *Appetite*. 2012; 58:157–162. [PubMed: 22005184]
- Epstein LH, Dearing KK, Roba LG. A questionnaire approach to measuring the relative reinforcing efficacy of snack foods. *Eating Behaviors*. 2010; 11:67–73. [PubMed: 20188288]
- Epstein LH, Leddy JJ, Temple J, Faith M. Food reinforcement: A multilevel analysis. *Psychological Bulletin*. 2007; 133:884–906. [PubMed: 17723034]
- Epstein, LH.; Saelens, BE. Behavioral economics of obesity. Food intake and energy expenditure. In: Bickel, WK.; Vuchinich, RE., editors. *Reframing health behavior change with behavioral economics*. Mahwah, NJ: Erlbaum; 2000. p. 293-311.
- Epstein LH, Temple JL, Neaderhiser BJ, Salis RJ, Erbe RW, Leddy JJ. Food reinforcement, the dopamine D2 receptor genotype and energy intake in obese and nonobese humans. *Behavioral Neuroscience*. 2007; 121:877–886. [PubMed: 17907820]
- Epstein LH, Wright SM, Paluch RA, Leddy J, Hawk LW Jr, Jaroni JL, et al. Food hedonics and reinforcement as determinants of laboratory intake in smokers. *Physiology and Behavior*. 2004; 81:511–517. [PubMed: 15135024]
- Finlayson G, Bordes I, Griffioen-Roose S, de Graaf C, Blundell JE. Susceptibility to overeating affects the impact of savoury or sweet drinks on satiation, reward, and food intake in nonobese women. *Journal of Nutrition*. 2012; 142(1):125–130. [PubMed: 22131553]

- Finlayson G, Dalton M. Hedonics of food consumption: Are food “Liking” and “Wanting” viable targets for appetite control in the obese? *Current Obesity Reports*. 2012; 1:42–49.
- Finlayson G, King NA, Blundell JE. Liking vs. wanting food: Importance for human appetite control and weight regulation. *Neuroscience & Biobehavioral Reviews*. 2007; 31(7):987–1002. [PubMed: 17559933]
- Finlayson GS, King NA, Blundell JE. The role of implicit wanting in relation to explicit liking and wanting for food: implication for appetite control. *Appetite*. 2008; 50:120–127. [PubMed: 17655972]
- French SA, Epstein LH, Jeffery RW, Blundell JE, Wardle J. Eating behavior dimensions: Conceptualization, measurement and evidence: A review. *Appetite*. 2012; 59:541–549. [PubMed: 22796186]
- French SA, Jeffery RW. The consequences of dieting to lose weight: Effects on physical and mental health. *Health Psychology*. 1994; 13:195–212. [PubMed: 8055855]
- French SA, Jeffery RW. Current dieting, weight loss history, and weight suppression: Behavioral correlates of three dimensions of dieting. *Addictive Behaviors*. 1997; 22:31–44. [PubMed: 9022870]
- French SA, Jeffery RW, Forster JL, McGovern PG, Kelder SH, Baxter J. Predictors of weight change over two years among a population of working adults: The Healthy Worker Project. *International Journal of Obesity*. 1994; 18:145–154. [PubMed: 8186811]
- French SA, Jeffery RW, Murray D. Is dieting good for you? Prevalence, duration and associated weight and behavior changes for specific weight loss strategies over four years in US adults. *International Journal of Obesity*. 1999; 23:320–327. [PubMed: 10193879]
- French SA, Jeffery RW, Wing RR. Sex differences among participants in a weight control program. *Addictive Behaviors*. 1994; 19:147–158. [PubMed: 8036962]
- Giesen JCAH, Remco RC, Douven A, Tekelenburg M, Jansen A. Will work for snack food. The association of BMI and snack reinforcement. *Obesity*. 2010; 18:966–970. [PubMed: 20150901]
- Goldfield GS, Lumb A. Effects of dietary Restraint and body mass index on the relative reinforcing value of snack food. *Eating Disorders*. 2009; 17:46–62. [PubMed: 19105060]
- Griffioen-Roose S, Finlayson G, Mars M, Blundell JE, de Graaf C. Measuring food reward and the transfer effect of sensory specific satiety. *Appetite*. 2010; 55(3):648–655. [PubMed: 20870002]
- Griffioen-Roose S, Mars M, Finlayson G, Blundell JE, de Graaf C. The effect of within-meal protein content and taste on subsequent food choice and satiety. *British Journal of Nutrition*. 2011; 106(5): 779–788. [PubMed: 21736849]
- Hainer V, Kunesova M, Bellisle F, Parizkova J, Braunerova R, Wagenknecht M, et al. The Eating Inventory, body adiposity and prevalence of diseases in a quota sample of Czech adults. *International Journal of Obesity*. 2006; 30:830–836. [PubMed: 16418762]
- Harden CJ, Corfe BM, Richardson JC, Dettmar PW, Paxman JR. Body mass index and age affect Three Factor Eating Questionnaire scores in male subjects. *Nutrition Research*. 2009; 29:379–382. [PubMed: 19628103]
- Hays NP, Bathalon GP, McCrory MA, Roubenoff R, Lipman R, Roberts SB. Eating behavior correlates of adult weight gain and obesity in healthy women aged 55–65 y. *American Journal of Clinical Nutrition*. 2002; 75:476–483. [PubMed: 11864852]
- Hays NP, Roberts SB. Aspects of eating behaviors “Disinhibition” and “Restraint” are related to weight gain and BMI in women. *Obesity*. 2008; 16:52–58. [PubMed: 18223612]
- Hill C, Saxton J, Webber L, Blundell J, Wardle J. The relative reinforcing value of food predicts weight gain in a longitudinal study of 7–10 yr old children. *American Journal of Clinical Nutrition*. 2009; 90:276–281. [PubMed: 19535428]
- Hothorn T, Hornik K, van de Wiel MA, Zeileis A. A Lego system for conditional inference. *American Statistician*. 2006; 60:257–263.
- Hothorn T, Hornik K, Zeileis A. Unbiased recursive partitioning: A conditional inference framework. *Journal of Computational and Graphical Statistics*. 2006; 15:651–674.
- Johnson RK, Driscoll P, Goran MI. Comparison of multiple-pass 24-hour recall estimates of energy intake with total energy expenditure determined by the doubly labeled water method in young children. *Journal of the American Dietetic Association*. 1996; 96:1140–1144. [PubMed: 8906138]

- Karlsson J, Persson LO, Sjostrom L, Sullivan M. Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. *International Journal of Obesity and Related Metabolic Disorders*. 2000; 24:1715–1725. [PubMed: 11126230]
- Levine MD, Klem ML, Kalarchian MA, Wing RR, Weissfeld L, Qin L, et al. Weight gain prevention among women. *Obesity*. 2007; 15:1267–1277. [PubMed: 17495203]
- Lindroos A, Lissner L, Mathiassen ME, Karlsson J, Sullivan M, Bengtsson C, Sjostrom L. Dietary intake in relation to restrained eating, Disinhibition, and Hunger in obese and nonobese Swedish women. *Obesity*. 1997; 5:175–182.
- Lohman, TG.; Roche, AF.; Martorell, R., editors. *Anthropometric Standardization Reference Manual*, Abridged Edition. Champaign, IL: Human Kinetics Books; 1988.
- McGuire MT, Wing RR, Klem ML, Lang W, Hill JO. What predicts weight regain in a group of successful weight losers? *Journal of Consulting and Clinical Psychology*. 1999; 67:177–185. [PubMed: 10224727]
- Ouwens MA, van Strien T, van der Staak CPF. Tendency toward overeating and Restraint as predictors of food consumption. *Appetite*. 2003; 40:291–298. [PubMed: 12798787]
- Provencher V, Drapeau V, Tremblay A, Despres J, Lemieux S. Eating behaviors and indexes of body composition in men and women from the Quebec Family Study. *Obesity Research*. 2003; 11:783–792. [PubMed: 12805400]
- R Development Core Team. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing; Vienna, Austria: 2012. URL <http://www.R-project.org/>
- Saelens BE, Epstein LH. Reinforcing value of food in obese and nonobese women. *Appetite*. 1996; 27:41–50. [PubMed: 8879418]
- Savage JS, Hoffman L, Birch LL. Dieting, Restraint and Disinhibition predict women's weight change over 6 yrs. *American Journal of Clinical Nutrition*. 2009; 90:33–40. [PubMed: 19439461]
- Schubert E, Randler C. Association between chronotype and the constructs of the Three Factor Eating Questionnaire. *Appetite*. 2008; 51:501–505. [PubMed: 18479778]
- Strasser H, Weber C. On the asymptotic theory of permutation statistics. *Mathematical Methods of Statistics*. 1999; 8:220–250.
- Stunkard A, Messick S. The three-factor eating questionnaire to measure dietary Restraint, Disinhibition and Hunger. *Journal of Psychosomatic Research*. 1985; 29:71–83. [PubMed: 3981480]
- Teixeira PJ, Silva MN, Coutinho SR, Palmeira AL, Mata J, Vieira PN, et al. Mediators of weight loss and weight loss maintenance in middle-aged women. *Obesity*. 2010; 18:725–735. [PubMed: 19696752]
- Temple JL, Legierski CM, Giacomelli AM, Salvy S, Epstein LH. Overweight children find food more reinforcing and consume more energy than do nonoverweight children. *American Journal of Clinical Nutrition*. 2008; 87:1121–1127. [PubMed: 18469229]
- Vogels N, Diepvens K, Westerterp-Plantenga S. Predictors of long-term weight maintenance. *Obesity Research*. 2005; 13:2162–2168. [PubMed: 16421351]
- Westerhoefer J, Broeckmann P, Munch A, Pudel V. Cognitive control of eating behavior and the Disinhibition effect. *Appetite*. 1994; 23:27–41. [PubMed: 7826055]
- Williamson DA, Lawson OJ, Brooks ER, Wozniak PJ, Ryan DH, Bray GA, et al. Association of body mass with dietary Restraint and Disinhibition. *Appetite*. 1995; 25:31–41. [PubMed: 7495325]
- Wing RR, Fava JL, Phelan S, McCaffery J, Papandonatos G, Gorin AA, et al. Maintaining large weight losses. The role of behavioral and psychological factors. *Journal of Consulting and Clinical Psychology*. 2008; 76:1015–1021. [PubMed: 19045969]

Highlights

- Food reinforcement, liking and wanting explain unique variation in energy intake.
- Disinhibition was significantly associated with BMI.
- Food Reinforcement, Liking and Wanting were not associated with BMI.

Figure 1. Conditional regression tree for Total Energy
Adjusted for age, sex, BMI, job type, and education

Figure 2. Conditional regression tree for BMI
Adjusted for age, sex, job type, and education

Table 1

Demographic and eating behavior variables in a worksite population (N=233)

Demographic Variables	Mean (sd)	Percent
Age (yrs)	42.6 (11.2)	
Sex (%female)		67
Household Income (%)		
\$40,000		21
\$40,000–\$ 80,000		42
>\$80,000		37
Education (%)		
High school/vocational		15
Some college		33
College degree		33
Beyond college		18
Married (%)		52
Job Type (%)		
Patient care		36
Administration		11
Clerical		38
Service		5
Other		9
Race (%white)		69
General Health (%)		
excellent/good		58
fair/poor		42
Body Mass Index (kg/m²)	29.8 (6.4)	
Body Mass Index Category (%)		
Normal (< 25)		25.3
Overweight (25 – 29)		30.9
Obese (≥ 30)		43.8
Energy Intake (kcal/day)	2012 (679)	
Eating Behaviors		
Three Factor Eating Questionnaire		
Restraint	6.0 (3.5)	
Disinhibition	8.2 (4.4)	
Hunger	4.6 (3.3)	
Reinforcing Value of Food (Pmax pizza/Pmax pizza + Pmax reading)	0.54 (0.34)	
PmaxPizza	211.4 (334.7)	
Pizza number of rounds completed	3.5 (1.8)	
PmaxReading	291.8 (498.9)	
Reading number of rounds completed	3.2 (2.3)	
Explicit Liking	–8.6 (18.9)	

Demographic Variables	Mean (sd)	Percent
Implicit Wanting	−17.9 (40.1)	

Table 2

Unadjusted correlations between eating behavior measures

	Pmax Pizza	N Rounds Pizza	Pizza	Restraint	Disinhibition	Hunger	Liking	Wanting	BMI	Weight	Energy
RVF	.35	.53		-.19	-.02	.17	.24	.28	-.11	.03	.34
Pmax Pizza		.76		-.18	-.01	.14	.19	.21	-.12	.01	.33
N Rounds Pizza				-.23	.06	.23	.26	.32	-.12	.04	.39
Restraint					.11	-.14	-.19	-.23	.01	-.08	-.21
Disinhibition						.53	.24	.26	.36	.29	.14
Hunger							.23	.38	.16	.18	.34
Liking								.83	.09	.14	.26
Wanting									.07	.13	.30
BMI										.88	.07
Weight											.21
Energy											

Note: **BOLD** p < .05

RVF: relative reinforcing value of food

PmaxPizza: maximum number of clicks for pizza reinforce

N Rounds Pizza: number of rounds clicked for pizza

rest: TFEQ Restraint subscale score

dis: TFEQ Disinhibition subscale score

hun: TFEQ Hunger subscale score

like: Explicit Liking score

want: Implicit Wanting score

BMI: body mass index

Energy (kilocalories/day; 3–24 hr dietary recalls)

Table 3

Associations between BMI and eating behaviors

BMI (kg/m ²)	TFEQ Estimate (95% CI) <i>p-value</i>	RRV Estimate (95% CI) <i>p-value</i>	Liking Estimate (95% CI) <i>p-value</i>	Wanting Estimate (95% CI) <i>p-value</i>	All Estimate (95% CI) <i>p-value</i>
TFEQ1 (Restraint)	-0.11 (-0.29, 0.072) <i>0.24</i>				-0.12 (-0.31, 0.063) <i>0.18</i>
TFEQ2 (Disinhibition)	0.6 (0.34, 0.87) <i><0.001</i>				0.6 (0.31, 0.87) <i><0.001</i>
TFEQ3 (Hunger)	-0.071 (-0.35, 0.21) <i>0.62</i>				-0.004 (-0.31, 0.3) <i>0.85</i>
RRV Food		-0.55 (-3.1, 2.0) <i>0.67</i>			-1.2 (-3.7, 1.3) <i>0.34</i>
Liking Score			0.031 (-0.01, 0.072) <i>0.14</i>		0.023 (-0.051, 0.098) <i>0.54</i>
Wanting Score				0.014 (-0.06, 0.034) <i>0.17</i>	-0.012 (-0.049, 0.025) <i>0.53</i>

Note: Adjusted for age, sex, job type, and education

Table 4

Associations between energy intake and eating behaviors

Energy Intake (kcal)	TFEQ Estimate (95% CI) <i>p-value</i>	RRV Estimate (95% CI) <i>p-value</i>	Liking Estimate (95% CI) <i>p-value</i>	Wanting Estimate (95% CI) <i>p-value</i>	All Estimate (95% CI) <i>p-value</i>
TFEQ1 (Restraint)	-19 (-38, 0.13) 0.053				-13 (-32, 6.3) 0.19
TFEQ2 (Disinhibition)	14 (-15, 43) 0.36				6.2 (-23, 36) 0.68
TFEQ3 (Hunger)	53 (24, 82) <0.001				48 (17, 79) 0.0026
RRV Food		470 (210, 730) <0.001			280 (24, 540) 0.034
Liking Score			8.2 (4, 13) <0.001		3.9 (-3.7, 12) 0.32
Wanting Score				4.4 (2.3, 6.4) <0.001	0.38 (-3.4, 4.2) 0.85

Note: Adjusted for BMI, age, sex, job type, and education