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The role of anxiety sensitivity in daily physical activity and eating behavior

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A B S T R A C T

Anxiety sensitivity (AS), or the fear of somatic arousal, has been linked to both maladaptive eating behavior as well as exercise avoidance in both self-report and laboratory-based experiments. The current pilot study sought to extend these finding to the naturalistic setting. A sample of 32 adults completed affect and dietary monitoring and wore actigraphs across a three-day monitoring period. Results indicated that high AS was associated with greater calorie consumption overall in women and less consumption in men, and high AS predicted an increase in calories consumed following participants' greatest increase in negative affect in both sexes. For physical activity, results indicated an AS by BMI interaction such that obese individuals with high AS engaged in less moderate-intensity physical activity, whereas the opposite was true for normal weight individuals. These results indicate that AS may represent a double-edged risk factor for obesity contributing to both exercise avoidance and calorie consumption.

1. Introduction

Overweight and obese status has reached epidemic proportions in the United States with approximately two-thirds of the American population falling into an unhealthy weight category (CDC, 2012). Such staggering obesity rates highlight the need for research to better understand factors contributing to this epidemic.

Weight gain and maintenance of overweight/obese status can be understood in terms of both the over-consumption of calories and insufficient physical activity to balance caloric intake. As a potential boon to the development of targeted interventions, there is preliminary evidence to suggest that a single variable, anxiety sensitivity (AS), may contribute to our understanding of both maladaptive eating and avoidance of physical activity.

Broadly defined, AS refers to the fear of anxiety-related symptoms caused by a belief that somatic arousal and anxiety itself have catastrophic consequences (McNally, 2002). When individuals experience emotional distress, they are more likely to prioritize short-term affect regulation (i.e. indulge immediate impulses) rather than attending to longer-term self-regulatory goals (e.g., Tice, Batslavsky, & Baumeiser, 2001), and AS predicts heightened sensitivity to negative affective states (Ehlers, 1995; Otto, Pollack, Fava, Uccello, & Rosenbaum, 1995; Reiss, 1991; Schmidt, Lerew, & Jackson, 1997). Therefore, AS may lower an individual's threshold for tolerating negative affect or somatic distress such that she is (1) more likely to eat when confronted by negative affect, and (2) fail to persist or engage in physical activity that causes somatic or affective discomfort.

Thus far, AS has been associated with maladaptive eating behavior in studies using self-report measures (Anestis, Selby, Fink, & Joiner, 2007; Anestis, Holm-Denoma, Gordon, Schmidt, & Joiner, 2008; Fulton et al., 2012) as well as objectively-assessed eating in the context of experimentally-induced negative affect (Hearon, Utschig, Smits, Moshier, & Otto, 2013). Regarding exercise, AS has been linked to distress during and avoidance of physical activity, based on self-reported physical activity and laboratory-based studies (McWilliams & Asmundson, 2001; Moshier et al., 2013; Sabourin, Hilchey, Lefaivre, Watt, & Stewart, 2011; Smits, Tart, Presnell, Rosenfield, & Otto, 2010).

In the current study, we extend this research by examining the role of AS in predicting eating and exercise behaviors in a naturalistic setting, across a three-day monitoring period. We hypothesized that AS and BMI would interact to predict greater calories consumed across the monitoring period as well as greater calories consumed in the context of negative affective shifts in obese but not normal weight participants. We also hypothesized that AS and BMI would interact to predict less physical activity for obese but not normal-weight participants. Finally, we examined sex differences in the context of eating behaviors.

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2. Methods

2.1. Participants

Participants were recruited from the community. Only those with a body mass index (BMI) within the ranges of 18.5–24.9 (normal weight) or 30.0 or greater (obese), and an Anxiety Sensitivity Index Score (ASI; Peterson & Reiss, 1992) score of less than 12 (normal AS) or greater than 20 (elevated AS) were included. This allowed for the recruitment of 32 participants split by ASI score and BMI into four groups. Exclusion criteria included pregnancy, self-reported restrictions on physical activity, and difficulty reading forms such as those provided in a doctor's office. Participants who completed the study received $150 in compensation. Boston University's Institutional Review Board approved all study procedures.

2.2. Procedures

Participants attended two appointments, the first on Monday and the second the following Friday. After completing informed consent, participants completed self-report questionnaires. They were then given instructions for daily monitoring procedures including completion of affect monitoring at five times each day (upon awakening, noon, 4:00 PM, 7:00 PM and 10:00 PM), food intake and physical activity. On Friday, participants returned the monitoring devices and self-report measures and were debriefed and compensated.

2.3. Measures

2.3.1. Activity monitoring device

The Actigraph ActiTrainer is an activity monitor weighing 0.05 kg that is held in a holster at the waist. Raw data was analyzed using the ActiLife 5 software package.

2.3.2. Food diaries and nutrition data analysis

Participants used these forms to record time, place, content and portions of food. 2D Food Portion Visuals (*Nutrition Consulting Enterprises*, Framingham, MA) were used to increase accuracy of estimates as well as three-dimensional food models (Combo Food Model Kits; NCES, Inc., Olathe, KS). Dietary intake data were analyzed using Nutrition Data System for Research software version 2011, developed by the Nutrition Coordinating Center (NCC), University of Minnesota, Minneapolis, MN.

2.3.3. Anxiety Sensitivity Index (ASI)

The ASI is a 16-item self-report questionnaire designed to assess tendency to respond fearfully to anxiety-related symptoms (Peterson & Reiss, 1992), and demonstrates sound psychometric properties (Peterson & Reiss, 1992; Reiss, Peterson, Gursky, & McNally, 1986).

2.3.4. Positive and Negative Affectivity Scale (PANAS)

The PANAS was developed as a brief measure of affect and yields the factors of positive and negative affectivity (Watson, Clark, & Tellegen, 1988). Internal consistency of these factors is acceptably high (Positive Affect alpha coefficient: .86-.90, Negative Affect alpha coefficient: .84-.87).

2.4. Consolidation of food and affect data

We operationalized affect worsening as the participant's greatest shift on the PANAS negative affect scale with a minimum change of 3 points (representing a 0.5 change in SD units based on norms established by Crawford & Henry, 2004) as compared to the participant's average negative affect scores (i.e. mean of all PANAS negative scales completed over the course of the study). We then examined calories consumed in the 2 hours following the greatest negative affect shift and compared this to consumption on the remaining days when such a shift did not occur.

2.5. Data analysis

Given evidence in support of AS as a taxonomic as well as continuous variable (Broman-Fulks et al., 2010; Zvolensky, Forsyth, Bernstein, & Leen-Feldner, 2007), we complemented categorical analyses of AS (using previously established norms to determine a score of 20 representing the cutoff for "high" versus "low" AS; Reiss, Peterson, Taylor, Schmidt, & Weems, 2008) with an examination of similar effects when AS scores were examined continuously. Regression models were then examined for each hypothesis first including AS as a categorical variable and then repeated with AS examined as a continuous variable. BMI was mean centered for all analyses, as was ASI total score.

3. Results

3.1. Preliminary analyses

All data was examined for outliers with none detected. Sample demographics are displayed in Table 1. Chi-squared analyses revealed no differences between the four AS by BMI groups on any demographic characteristics nor were differences observed on measures of negative affect.

3.2. Anxiety sensitivity and total calories consumed

We first examined the effects of AS and BMI on total calories consumed across the monitoring period with no significant predictors identified both when AS was examined as a categorical and continuous variable.

In a regression examining the effects of sex, AS, and their interaction on total calories consumed, the model examining AS as a continuous variable revealed both a significant effect for sex ($\beta = .49$; $df = 1, 28$; $t = 3.30$; $p < .01$, $d = 1.25$) as well as a significant interaction of ASI total score and sex ($\beta = -.74$; $df = 1, 28$; $t = -2.24$; $p = .03$, $d = 0.85$) such that greater AS predicted greater calorie consumption in women and less in men (see Fig. 1).

3.3. Anxiety sensitivity and calories consumed in the context of negative affect

When examining number of calories consumed following the greatest shift to negative affect, AS category, BMI, and their interaction were entered into a regression. AS category approached significance at a trend level, ($\beta = .39$; $df = 1, 19$; $t = 1.89$; $p = .07$, $d = .80$). When the same model was run replacing BMI with sex, AS category emerged as a significant predictor of calories consumed ($\beta = .43$; $df = 1, 19$; $t = 2.05$; $p < .05$; $d = .94$) with an effect size in the large range. Given that selection of co-variates appeared to influence significance of AS main effects, we examined AS category independently. When

Table 1
Demographic information for the sample.

Variable	N	Mean (Std. Dev.)/ %
Age	32	43 (15.4)
Sex (% female)	32	62.5%
Ethnicity (% non-Hispanic)	32	96.9%
Race	32	
% Caucasian		59.4%
% African-American		31.3%
% Asian		6.3%
% Other		3.1%
BMI	32	28.5 (7.3)
ASI total score	32	20.8 (11.1)

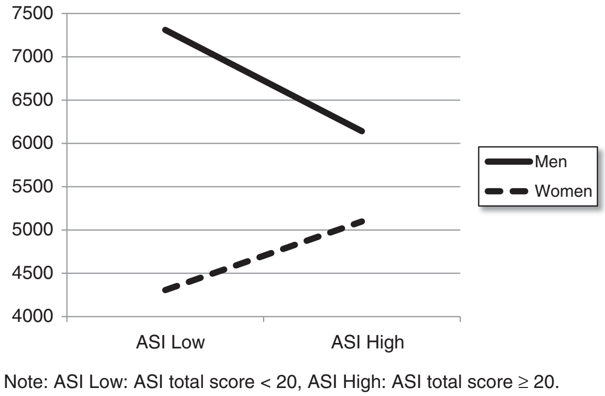

Fig. 1. The effect of the AS by sex interaction predicting calories consumed over the three-day monitoring period.

considered alone, the difference between AS categories was significant (t (21) $= -2.13$, $p < .05$; $d = .93$), such that those with high AS *increased* their intake following their worst episode of negative affect an average of 171 calories ($SD = 381$) whereas those with low AS *reduced* their intake by an average of 120 calories ($SD = 258$).

3.4. Anxiety sensitivity and physical activity

As only four participants completed any measurable vigorous activity, moderate-intensity activity was examined. AS category, BMI and their interaction were used to predict percentage of time spent engaged in moderate physical activity across the monitoring period. Results revealed no significant effects for AS category or BMI, but the interaction was significant ($\beta = -.41$; $df = 1, 28$; $t = -2.41$; $p = .02$, $d = .91$). To better understand the nature of this interaction, we split the sample by weight groups. Results indicated that in normal weight individuals, high AS was associated with greater moderate physical activity ($M = 3.38$, $SD = 1.77$) than low AS ($M = 2.0$, $SD = 1.31$; t (14) $= -1.77$, $p = .10$; $d = .95$), whereas in the obese sample, high AS was associated with less moderate activity ($M = 1.89$, $SD = 1.69$) than low AS ($M = 3.14$, $SD = 1.21$; t (14) $= 1.65$, $p = .12$; $d = .88$) reflecting effect sizes in the large range for both differences.

4. Discussion

As interest has grown in understanding factors that predict weight gain, AS has emerged as one such factor that could explain both eating behaviors and exercise avoidance in a subset of the population. In the current study, we were able to extend these findings beyond the constraints of self-report and laboratory settings by examining AS in eating behavior and exercise avoidance in a naturalistic setting.

Consistent with our hypotheses, we found a significant sex by AS interaction such that high AS predicted greater calories consumed over the monitoring period in women. We also found that AS was associated with calorie consumption following the greatest negative affect shift such that those with high AS reported consuming significantly more calories, increasing their intake by approximately 170 calories in the two hours following the affect shift. One way to interpret these findings is in terms of self-control fatigue: specifically, that self-control over behaviors an individual wishes to regulate is finite and can become increasingly fatigued by stressors over the course of the day (Baumeister, Vohs, & Tice, 2007; Muraven & Baumeister, 2000). Such stressors may be even more taxing on the self-control system if amplified by AS. Accordingly, the loss of dietary restraint could be viewed as a self-control lapse to which women, who endorse greater dieting and restrained eating (Bish et al., 2005), may be most susceptible. Our data are also consistent with an affect-regulation model of eating behavior (Hawkins & Clement, 1984) in which individuals purposely seek out comfort from food. With this model, individuals who experience an amplification of negative affect due to elevated AS may purposely use eating as a means of actively coping with negative affect.

With regard to the role of AS in physical activity, we found that obese individuals with high AS engaged in less moderate physical activity. This suggests that AS can help identify those obese individuals who find physical activity particularly distressing and engage in less physically demanding activity overall. However, we also unexpectedly found a large effect for high AS predicting greater moderate-intensity activity in the normal weight group, indicating that among normal-weight individuals, AS may drive some health behaviors. One possible explanation for this finding relates to the association between AS and health anxiety. AS has emerged as a significant predictor of hypochondria, and an even better predictor of attentional bias toward health-related threat cues than specific measures of health anxiety (Lees, Mogg, & Bradley, 2005; Otto et al., 1995; Otto, Demopulos, McLean, Pollack, & Fava, 1998). As such, high AS may drive attention to relevant health behaviors such as moderate activity. Nonetheless, the fear of symptoms may become salient at higher levels of exertion, particularly for obese individuals. Notably, avoidance of exercise is evident more generally when vigorous levels of exercise are examined (Moshier et al., 2013).

There were several limitations in the current study that warrant further discussion. First, our sample size was relatively small limiting our power to detect effects below a moderate-to-large range. Also, although we were able to avoid some of the limitations associated with self-reported and laboratory-based eating behavior, it is still possible that asking participants to record food consumed and complete affect monitoring throughout the day may have increased awareness and changed subsequent eating behavior.

4.1. Conclusions

In summary, we have provided evidence that AS is linked to the two major contributors to weight management difficulties, increased consumption of calories and lack of sufficient physical activity. As AS can be modified relatively rapidly with cognitive-behavior therapy emphasizing interoceptive exposure (see Craske et al., 2006; Smits et al., 2008), if our findings are further replicated, integration of such interventions in weight management programs may be warranted for these individuals.

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Contributors

All authors contributed to preparation of the manuscript and approved the final version. Bridget Hearon and Michael Otto designed the study and wrote the protocol. Paula Quatromoni contributed her expertise to coding and analysis of food consumption data. Joshua Mascoop contributed to recruitment tasks and running participants. Bridget Hearon also ran participants and performed data analyses.

Conflict of interest

The authors have no conflicts of interest to report.

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