



## Physical activity as a moderator of the association between anxiety sensitivity and binge eating

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### ABSTRACT

Individuals with elevated anxiety sensitivity (AS; i.e., fear of somatic arousal) may binge eat to reduce emotional distress. Because physical activity reduces stress reactivity, we predicted that: (1) the relation between AS and binge eating would be moderated by physical activity and (2) coping motives for eating would mediate the association between AS and binge eating such that the relation would be stronger for those low in physical activity. Participants ( $N = 167$ ) completed online self-report measures. Regression analyses revealed that moderate-intensity physical activity (MPA) moderated the relation between AS and binge eating such that AS was not related to binge eating among those who frequently engaged in MPA but was related to binge eating among those who did not report engaging in MPA. Vigorous-intensity physical activity (VPA) moderated in the opposite direction such that the relation between AS and binge eating was significant among persons reporting high levels of VPA but less strong among persons reporting low levels of VPA. The mediation model was also significant, but was not moderated by MPA or VPA. Theoretical and clinical implications are discussed.

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## 1. Introduction

### 1.1. The problem of binge eating

Binge eating is defined by consuming an unusually large amount of food in a short period of time while experiencing a lack of control over eating. Binge eating is common, with lifetime prevalence estimates in United States (US) adults as high as 22.5% (American Psychiatric Association, 2000; Bushnell, Wells, Hornblow, Oakley-Browne, & Joyce, 1990). Approximately 2–5% of people in the US have a six-month or longer history of binge eating at least twice a week, thereby meeting criteria for binge eating disorder (BED; American Psychiatric Association, 2000; Hudson, Hiripi, Pope, & Kessler, 2007; Johnson, Spitzer, & Williams, 2001). Furthermore, BED tends to increase with age, with rates as high as 8% among women 46–55 years old (Johnson et al., 2001).

Regardless of whether it is frequent enough for a BED diagnosis, binge eating is associated with significant physical and psychological problems (Crow, Agras, Halmi, Mitchell, & Kraemer, 2002; Ricca et al., 2009; Striegel-Moore, Wilson, Wilfley, Elder, & Brownell, 1998; Striegel-Moore et al., 2000). For example, binge eating has been associated with

higher body mass index (BMI) and thus greater obesity severity and increased risk for obesity-related chronic illnesses (Manson, Skerrett, Greenland, & VanItallie, 2004; Striegel-Moore et al., 2000; Wilfley, Wilson, & Agras, 2003). Additionally, BED is associated with greater prevalence of health problems, such as insomnia, gastrointestinal problems, shortness of breath, chest pain, and diabetes, as well as poorer physical, social, and role functioning (Johnson et al., 2001).

The psychological sequelae of binge eating include lower self-esteem and greater negative affect (Ricca et al., 2009; Striegel-Moore et al., 1998, 2000; Wilfley et al., 2003) as well as increased prevalence of anxiety disorders, alcohol use disorders, and major depressive disorder (Johnson et al., 2001). Similarly, individuals who binge eat report substantially more psychosocial stressors (e.g., lack of social support, relationship and sexual difficulties, financial problems) and greater overall psychiatric distress than those who do not binge eat (Johnson et al., 2001; Ricca et al., 2009; Striegel-Moore et al., 2000). Given the prevalence and psychological and physical toll associated with binge eating, it is important to identify factors that contribute to its development and maintenance. Indeed, such efforts can ultimately guide the prevention and treatment of binge eating.

### 1.2. Binge eating to reduce emotional distress

Early reinforcement theories (Conger, 1956) and Chapman's experiential avoidance model of deliberate self-harm (Chapman, Gratz, & Brown, 2006) posit that harmful behaviors are maintained through

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negative reinforcement in the form of avoidance or reduction of aversive emotions. Wedig and Nock (2010) have further described two dimensions along which the functions of self-injurious or maladaptive behaviors can vary, namely negative versus positive reinforcement and intrapersonal versus interpersonal focus. They found that binge eating served as intrapersonal negative reinforcement (i.e., behavior is maintained via removal of negative affect) significantly more than it served any of the other functions: intrapersonal positive reinforcement (i.e., behavior is maintained because it elicits a positive internal state), social negative reinforcement (i.e., behavior is engaged in to avoid social interactions or tasks), and social positive reinforcement (i.e., behavior is engaged in to gain attention from or communicate with others). This research suggests that, in addition to other important influences such as dietary restraint (see Racine, Burt, Iacono, McGue, & Klump, 2010; Stice, 2001), a primary reason people binge eat may be to reduce negative affective states (Wedig & Nock, 2010).

Consistent with this theory, studies accumulated over the past two decades have shown that individuals who binge eat often do so to reduce negative emotions (Arnold, Kenardy, & Agras, 1995; Hohlstein, Smith, & Atlas, 1998; Kenardy, Arnold, & Agras, 1996; Polivy & Herman, 1993; Ricca et al., 2009; Wedig & Nock, 2010). For example, individuals who expect eating to reduce their feelings of distress are more likely to report disinhibited eating patterns than those who do not associate eating with reductions in negative affect (Hohlstein et al., 1998). Similarly, the presence and severity of binge eating is positively correlated with eating in response to all three of the emotional categories assessed by the Emotional Eating Scale: anger/frustration, anxiety, and depression (Arnold et al., 1995; Ricca et al., 2009). Further, there is evidence that binge eating results in temporary relief from negative mood (Deaver, Miltenberger, Smyth, Meidinger, & Crosby, 2003), and Kenardy et al. (1996) found that binge eaters reported a “trade-off” of one aversive emotional state for a less aversive emotional state as a result of their binges. Interestingly, binge-eaters in this study reported a range of negative emotions as more distressing relative to non-binge eaters, suggesting that those who are particularly sensitive to negative affect may be even more likely to engage in binge eating in order to reduce their distress (Kenardy et al., 1996).

### 1.3. Anxiety sensitivity and binge eating

Anxiety sensitivity (AS) is an individual difference variable characterized by a fear of anxiety and related sensations, which is often fueled by catastrophic interpretations (Reiss & McNally, 1985). AS is distinct from trait anxiety (Taylor, Koch, & Crockett, 1991), and it plays a role in the development and maintenance of anxiety problems, particularly panic attacks and panic disorder (Brown, Smits, Powers, & Telch, 2003; Ehlers, 1995; Schmidt, Lerew, & Jackson, 1997; Smits, Powers, Cho, & Telch, 2004; Taylor, 1999), exacerbates preexisting anxiety (Reiss, 1991), and has also been associated with depression (Otto, Pollack, Fava, Uccello, & Rosenbaum, 1995; Schmidt et al., 1997) and substance use problems (Comeau, Stewart, & Loba, 2001; Stewart & Zeitlin, 1995). Because individuals with high AS experience increased levels of negative affect and are especially sensitive to this negative affect (Ehlers, 1995; Otto et al., 1995; Reiss, 1991; Schmidt et al., 1997; Taylor, 1999; Taylor, Koch, Woody, & McLean, 1996), they may be more likely to make behavioral attempts to reduce their negative affect relative to persons with normative or low AS levels.

Support for this hypothesis comes from the substance use literature. Specifically, a number of studies have demonstrated that people with high AS often turn to substance use in an effort to reduce their negative emotional states (Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001; DeHaas, Calamari, Blair, & Martin, 2001; Lejuez, Paulson, Daughters, Bornoalova, & Zvolensky, 2006; Novak, Burgess, Clark, Zvolensky, & Brown, 2003; Stewart & Zeitlin, 1995; Zvolensky et al., 2004). For example, cigarette smokers with high AS are more likely than those with low AS to smoke as a means of decreasing negative affect, and they tend to

relapse sooner after attempting to quit (Brown et al., 2001; Zvolensky et al., 2004). Additionally, individuals with high AS are more likely to use alcohol to cope with negative emotions than those less sensitive to anxiety (DeHaas et al., 2001; Novak et al., 2003; Stewart & Zeitlin, 1995), and high coping motives for drinking predict future problems with alcohol (Cooper, Russell, & George, 1988; Cooper, Russell, Skinner, & Windel, 1992). This relationship between AS and coping motives for substance use has also been observed for marijuana (Bonn-Miller, Zvolensky, & Bernstein, 2007; Comeau et al., 2001; Mitchell, Zvolensky, Marshall, Bonn-Miller, & Vujanovic, 2007; Smits, Bonn-Miller, Tart, Irons, & Zvolensky, 2011), suggesting that the relation is not specific to a particular substance and therefore indicates that a link may also exist between AS and coping motives for eating (i.e., the expectancy that eating can reduce negative affect).

There is some evidence suggesting that AS is implicated in binge eating. Specifically, a recent study showed that AS predicted bulimic symptoms (i.e., binge eating combined with inappropriate compensatory behaviors), even after accounting for the influence of other relevant variables, such as trait anxiety, depression, and impulsivity (Anestis, Holm-Denoma, Gordon, Schmidt, & Joiner, 2008). However, Anestis and colleagues only examined the relationship between AS and the bulimia subscale from the Eating Disorder Inventory (Garner, Olmstead, & Polivy, 1983). Because this subscale measures both binge eating and compensatory behaviors, these study findings do not speak to the AS–binge eating relation per se. The present study will extend this research by examining the relationship between AS and binge eating, with coping motives for eating as a potential mediator of this relationship.

### 1.4. Physical activity as a moderator of the AS–binge eating relation

Recent work indicates that the strength of the AS–binge eating relation may vary as a function of physical activity (PA). Specifically, data from animal and human studies converge to suggest that individuals who are physically active show reduced physiological (i.e., blood pressure, heart rate) and psychological (e.g., anxiety, depressed mood) reactivity to stress relative to individuals who are inactive (Forcier et al., 2006; Sothmann, 2006). These data are consistent with the cross-stressor adaptation hypothesis, which posits that cardiovascular and neuroendocrine adaptations that have resulted from regular PA (a stressor) also manifest themselves in an individual's responses to non-PA stressors, including psychosocial stressors (Sothmann, 2006). Accordingly, PA may serve as a buffer against stress, thereby protecting people from developing associated psychological problems (e.g., depression, anxiety, maladaptive behavioral action tendencies; Salmon, 2001). Indeed, PA has been linked to greater psychological wellbeing (Stathopoulou, Powers, Berry, Smits, & Otto, 2006) and reduced coping motives for substance use (Medina et al., 2011; Smits, Bonn-Miller, Tart, Irons, & Zvolensky, 2011).

Protection from stress is particularly relevant for individuals who are sensitive to stress or at risk to respond to stress with negative affect and associated maladaptive action tendencies. Accordingly, it is possible that the risk conferred by AS may be modulated by PA, such that individuals with elevated AS who are physically active experience fewer psychological problems relative to individuals with elevated AS who are physically inactive. Support for this hypothesis comes from a recent study (Smits, Tart, Rosenfield, & Zvolensky, 2011). In this study, higher levels of self-reported PA were related to significantly lower carbon dioxide (CO<sub>2</sub>) challenge reactivity (a predictor of the development of panic attacks) for those with elevated levels of AS, but not for those with low AS. Importantly, among participants with high levels of PA, there was no difference in CO<sub>2</sub> challenge reactivity between those with high levels of AS and those with normal levels of AS. These results imply that regular PA may reduce the risk of developing problems associated with AS such as coping motives for both binge eating and other maladaptive behaviors.

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