BINGE EATING AND DRINKING IN YOUNG WOMEN: PERSONALITY CORRELATES AND PSYCHOPHYSIOLOGICAL INDICES OF EMOTION PROCESSING

by

Rachelle Dominelli

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Abstract

The disinhibited behaviours of binge eating and binge drinking are associated with significant negative consequences. Impulsivity and emotion dysregulation are commonly posited to underlie engagement in these behaviours. To advance our understanding of these behaviours in young women, the studies identified unique impulsive personality contributions and advanced emotion regulation theories of these behaviours through psychophysiological assessment. Study one examined unique relationships between binge behaviours, traits derived from Reinforcement Sensitivity Theory and those derived from the Urgency Premeditation Perseverance Sensation Seeking-Positive Urgency (UPPS-P) Impulsive Behavior Scale. Reward Sensitivity was associated with both behaviours while Punishment Sensitivity had differential relationships with the binge types. Negative Urgency was the greatest predictor of binge eating, Sensation Seeking had the strongest relationship with binge drinking, and Lack of Perseverance was a common predictor for both types of bingeing. These findings support trait emotion regulation conceptualizations. In study two, emotion reactivity and emotion regulation ability were examined within the context of a picture viewing startle blink paradigm. While a broad deficit in the ability to regulate emotional states across psychophysiological response systems was not supported, subtle differences in response duration, regulation of valence versus arousal and response coherence warrant further investigation. Study three examined emotion response coherence between the psychophysiological measures, (i.e. startle blink, corrugator activity, late positive potential), and subjective ratings of the emotion stimuli. Though stability of relationships was limited by small samples, results were suggestive of similar patterns of coherence amongst non-bingeing and binge drinking women with a possible alteration of coherence in binge eating women. Overall, the findings suggest that maladaptive affective

responses that are evident on trait-based assessments may not translate into deficits in the ability to regulate brief emotional states. Emotion dysregulation may be limited to interpersonally-relevant emotional states or specific emotion-evoking stimuli. Application of these psychophysiological methods in paradigms using these more binge-specific stimuli may prove more sensitive to potential deficits in emotion regulation ability. These studies highlight the importance of a multi-component assessment of emotional processing in those with disinhibited bingeing behaviours.

Preface

This dissertation is based on research conducted in Dr. Colleen Brenner's Clinical and Cognitive Neuroscience Lab, UBC, Vancouver campus. Rachelle Dominelli designed the studies described in this dissertation, collected and analyzed the data and wrote this manuscript. Dr. Colleen Brenner provided guidance at each stage and edited this manuscript. Dr. Scott Carlson assisted with development of the experimental task used in studies two and three. He assisted with the conceptualization and analysis approach for studies one and two, which are included in chapters two and three, and provided editorial feedback on manuscript drafts derived from those chapters. Brittany Speed and Lacey Grant assisted with data collection and participant debriefings. Brittany Speed also assisted with development of the experimental task used in studies two and three. Jo-Anne Kirk, Program Manager for Community Mental Health and Addictions, Vancouver Coastal Health (VCH) was the VCH collaborator for this research; her collaboration permitted us to advertise the research program at select VCH sites. The research program was approved by the UBC Behavioural Research Ethics Board (Certificate # H10-02157).

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AN = Anorexia Nervosa

BAS = Behavioural Approach System

BC = Binge Combined

BD = Binge Drinking

BE = Binge Eating

BED = Binge Eating Disorder

BIS = Behavioural Inhibition System

BN = Bulimia Nervosa

ED = Eating Disorder

EDDS = Eating Disorder Diagnostic Scale

EDE-Q = Eating Disorder Examination-Questionnaire

HC = Healthy Control

LP = Lack of Perseverance

LPM = Lack of Premeditation

NU = Negative Urgency

PS = Punishment Sensitivity

PU = Positive Urgency

RS = Reward Sensitivity

SP = Sensitivity to Punishment

SPSRQ = Sensitivity to Punishment and Sensitivity to Reward Questionnaire

SR = Sensitivity to Reward

SS = Sensation Seeking

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Dedication

To my husband (Giulio Dominelli), parents (Ron and Sheila Smith) and sister (Jocelyn Smith).

Chapter 1: Introduction

Though the majority of the population encounters food and alcohol on a fairly regular basis, a subset of the population develops problematic intake of these substances. One such maladaptive form of intake is that of bingeing behaviour wherein a large amount of a substance is consumed in a short timeframe. The focus of this dissertation is on two forms of binge behaviour, binge eating and binge drinking, in young women. Interest in studying these behaviours concurrently is driven by the frequent co-occurrence of binge eating and alcohol misuse in the community and, to a greater extent, in clinical samples (Bulik et al., 2004; Holderness, Brooks-Gunn, & Warren, 1994; Luce, Engler, & Crowther, 2007; von Ranson, Iacono, & McGue, 2002; Wolfe & Maisto, 2000). For example, binge drinking is more likely to occur in those who binge eat (Luce et al., 2007), and those who are at high risk for eating disorders tend to engage in high rates of binge drinking (Khaylis, Trockel, & Taylor, 2009).

Recent research has identified common frameworks for understanding the risk and maintenance factors underlying binge eating and binge drinking behaviours (Ferriter & Ray, 2011). Two common factors frequently associated with binge behaviour are impulsive personality traits and emotion dysregulation (Cassin & von Ranson, 2005; Ferriter & Ray, 2011). This dissertation aimed to identify unique personality contributions to binge behaviour and to inform emotion regulation theories of binge behaviour through the application of psychophysiological methods. The phenomena of binge eating and drinking are described first. The research questions addressed by this dissertation are then outlined along with a review of the relevant literature. Hypotheses are outlined in more detail in the research chapters that follow the introduction.

1.1 Binge Eating Definition

A food binge has been defined as eating a larger amount of food than normal in a short period of time and experiencing a lack of control over eating during the episode (American Psychiatric Association (APA), 2000). Binge eating may occur at subclinical levels and as part of an eating disorder (ED); either as a stand-alone behaviour in Binge Eating Disorder (BED) or in association with compensatory behaviour in Anorexia Nervosa (AN) or Bulimia Nervosa (BN) (APA, 2000; APA, 2013). This dissertation focused on women with BN, BED or subclinical binge eating meaning that the binge eating occurs at a lower frequency or in the absence of other criteria necessary for diagnosis; women with possible AN were excluded because of the potential cognitive deficits associated with starvation (Zakzanis, Campbell, & Polsinelli, 2010). Prevalence data and typical age of onset indicate that young adulthood is an important period during which to study disordered eating behaviour in women. Amongst a community sample of adolescent females, by age 20 the lifetime prevalence was 2.6% for BN, 4.4% for subthreshold BN, 3.0% for BED and 3.6% for subthreshold BED (Stice, Marti, & Rhode, 2013). The peak age of onset of (sub)threshold BN was 16-20 years and 18-20 years for BED (Stice, et al.); however, retrospective reports indicate that peak onset extends into the early 20s (Kessler et al., 2013). Therefore, the dissertation samples were limited to young women between 18/19 to 30 years of age who reported binge eating behaviours.

The importance of developing a greater understanding of binge eating at subclinical levels is supported by evidence of psychosocial impairment found in ED at subthreshold levels and a high progression from subthreshold to threshold levels of binge eating over time (Stice et al., 2013). A number of negative consequences are associated with binge eating, including perceived negative consequences in physical health, interpersonal relationships and life outlook

(Piran, Robinson, & Cormier, 2007), lower health-related quality of life (Mitchison, Mond, Stewa-Younan, & Hay, 2013), and high rates of co-morbid psychopathology (Agras, 2001). It is also important to consider binge eating from a trans-diagnostic perspective as crossover between diagnostic categories (e.g. BN versus BED) is commonly observed amongst prospective adolescent samples (Allen, Byrne, Oddy, & Crosby, 2013; Stice, et al.). The dissertation studies primarily focused on women with subclinical levels of binge eating with possible BN and BED diagnoses identified by self-report questionnaire.

1.2 Binge Drinking Definition

The standardized definition of an alcohol binge is a pattern of drinking which brings the blood alcohol concentration (BAC) to 0.08 gram percent or above; this corresponds to the consumption of an equivalent of four alcoholic drinks for women and five drinks for men within a two hour period (National Institute on Alcohol Abuse and Alcoholism (NIAAA), 2004). This definition of binge drinking, also termed heavy episodic drinking, was first employed in the Harvard School of Public Health College Alcohol Study (CAS; Wechsler, Davenport, Dowdall, & Moeykens, 1994) and has since been adopted by major national and international health organizations such as the NIAAA, the World Health Organization (WHO, 2004) and Health Canada (Statistics Canada Health Fact Sheet "Heavy drinking, 2013").

Canadian estimates of heavy drinking (four or more drinks on one occasion at least once a month in the past year) in young women are high at 28.2% amongst women aged 18-19 years and 24.2% amongst women aged 20-34 years (Statistics Canada Health Fact Sheet "Heavy drinking, 2013"). Surveys of colleges in the United States reveal that binge drinking is also prevalent at American post-secondary institutions, with approximately 40% of female students endorsing recent binge drinking (Wechsler et al., 2002). Similar to binge eating, binge drinking

has been linked to poorer health-related quality of life (Okoro et al., 2004; Tsai, Ford, Li, Pearson, & Zhao, 2010), and a higher likelihood of negative consequences in interpersonal and academic functioning even amongst occasional binge drinkers (i.e. once or twice in the past two weeks) compared to a non-bingeing pattern of alcohol consumption (Wechsler et al., 1994; Wechsler, Lee, Kuo, & Lee, 2000; Wechsler & Nelson, 2006). While some young adults "mature out" of this pattern of use, for others it prospectively predicts increased risk of later development of alcohol use disorders (Gotham, Sher, & Wood, 1997; Jennison, 2004; Sher, Grekin, & Williams, 2005). Therefore, this dissertation focused on young women with recent and repetitive binge drinking behaviour.

1.3 Personality Contributions to Binge Behaviour

Two related personality frameworks emphasize the role of impulsive personality facets in both binge eating and binge drinking behaviours: emotion-based dispositions to impulsive behaviour and Reinforcement Sensitivity Theory (RST). Research guided by these frameworks suggest that these two types of bingeing differ in their relationships with specific impulsivity facets. Furthermore, these frameworks and their supporting bodies of research emerged in parallel; therefore, the extent to which the impulsivity facets provide unique prediction of bingeing is currently unclear.

1.3.1 Emotion-based dispositions to impulsive behaviour

One personality framework used to conceptualize risk for binge eating and drinking behaviour focuses on the role of emotion-based dispositions to behaviours with a high potential for negative consequences (Cyders & Smith, 2008). This line of research followed from Whiteside and Lynam's (2001) factor analysis of commonly used impulsivity measures and the Five Factor Model of personality (Costa & McCrae, 1992). Four impulsivity facets were

identified: Urgency, Lack of Premeditation (LPM: acting without forethought or consideration of consequences), Lack of Perseverance (LP: difficulty maintaining focus on boring/difficult tasks) and Sensation Seeking (SS: tendency to enjoy and pursue exciting activities and openness to new, possibly dangerous, activities). The UPPS Impulsive Behaviour Scale was developed to assess these facets. The urgency facet of the original UPPS Impulsive Behavior Scale was later re-conceptualized and evidence from cross-sectional and prospective studies now supports a distinction between two facets of urgency: Negative Urgency (NU) and Positive Urgency (PU) (Cyders & Smith, 2007; Cyders et al., 2007; Cyders & Smith, 2008; Cyders & Smith, 2010). Whereas Negative Urgency refers to the tendency to engage in impulsive behaviours when in negative mood states, Positive Urgency refers to the tendency to engage in such behaviours when in positive mood states. These facets, Negative Urgency and Positive Urgency, are conceptualized as emotion-based dispositions to impulsive behaviour. Current evidence suggests that they have differential relationships with binge eating and drinking behaviour. While Negative Urgency is related to both types of bingeing behaviour, higher levels of Positive Urgency appear unique to problematic alcohol use (Cyders et al., 2007; Cyders & Smith, 2008).

Following Whiteside and Lynam's (2001) publication, a central role for Negative Urgency, which had previously been underrepresented in the impulsivity literature, began to emerge in relation to bulimic symptoms. As determined by meta-analysis, the largest effect size amongst Whiteside and Lynam's impulsivity facets in relation to BN symptoms is Negative Urgency (r=0.38) (Fischer, Smith, & Cyders, 2008). Consistent with this finding, there is substantial evidence from college student samples using summary measures of bulimic symptoms (Anestis, Selby, & Joiner, 2007; Fischer, Smith, & Anderson, 2003; Fischer, Smith, Anderson, & Flory, 2003) and from clinical samples (Anestis, Smith, Fink, & Joiner, 2009;

Claes, Vandereycken, & Vertommen, 2005) implicating Negative Urgency as the impulsivity facet of greatest relevance for bulimic symptoms. Negative Urgency is positively correlated with binge eating episodes (Fischer, Anderson, & Smith, 2004), accounts for unique variance in binge eating beyond other UPPS facets in cross-sectional studies (Fischer & Smith, 2008; Smith et al., 2007) and prospectively predicts binge eating in college samples (Davis & Fischer, 2013; Emery, King, Fischer, & Davis, 2013; Fischer, Peterson, & McCarthy, 2013). Recent integrative models of bulimic symptoms posit a trait-based pathway to eating disorder symptoms; individuals high in Negative Urgency are thought to binge eat in part due to the negative reinforcement (i.e. emotion regulatory effect) of the behaviour in reducing/distracting from distress (Cyders & Smith, 2008; Fischer, Settles, Collins, Gunn, & Smith, 2012; Pearson, Riley, Davis, & Smith, 2014).

Similar to its relationship with binge eating, Negative Urgency denotes risk for various alcohol outcomes (Cyders et al., 2007; Cyders, Flory, Rainer, & Smith, 2009; Shin, Hong, & Jeon, 2012). As such, Positive Urgency and Negative Urgency had the largest effect sizes amongst UPPS-P facets for endorsement of adolescent and adult problematic drinking in recent meta-analytic reviews (r=0.34) (Coskunpinar, Dir, & Cyders, 2013; Stautz & Cooper, 2013). However, evidence pertaining to the relationship between Negative Urgency and binge drinking specifically is limited to a few studies (e.g. Adams, Kaiser, Lynam, Charnigo, & Milich, 2012; Fernie, Cole, Goudie, & Field, 2010; Phillips, Hine, & Marks, 2009; Shin et al., 2012); effect sizes, though smaller than for the broader construct of problematic alcohol use, remain positive (r=0.13) (Coskunpinar et al., 2013; Stautz & Cooper, 2013).

Regarding Positive Urgency, women with eating disorders have comparable levels of Positive Urgency to healthy controls whereas women with alcohol abuse have significantly

higher levels of Positive Urgency compared to both eating disordered women and healthy controls (Cyders et al., 2007). Furthermore, Positive Urgency correlates with drinking quantity, frequency, alcohol-related problems, and highest alcohol use (Adams et al., 2012; Cyders et al., 2007) and prospectively predicts increased alcohol consumption per drinking session as well as negative consequences of drinking (Cyders et al., 2009). Self-report findings are further supported by a laboratory study in which increased alcohol consumption in an alcohol taste test following positive mood induction was positively predicted by Positive Urgency (Cyders et al., 2010). While these studies establish a link between Positive Urgency and general alcohol use, there is a relative paucity of research examining Positive Urgency and binge drinking as a specific alcohol outcome (Coskunpinar et al., 2013; Stautz & Cooper, 2013).

Of the other UPPS-P facets, binge drinking is further differentiated from binge eating in its association with high levels of Sensation Seeking. As such, the UPPS-P facet with the largest effect size in relation to binge drinking is Sensation Seeking (r=0.36, Coskunpinar et al., 2013; r=0.26, Stautz & Cooper, 2013) whereas the effect size for measures of Sensation Seeking for bulimic symptoms is small (r=0.09) (Fischer et al., 2008). This is reflected in part by the contexts in which these behaviours commonly occur (Birch, Stewart, & Brown, 2007). Individuals high in Sensation Seeking may tend to seek out social contexts in which binge drinking is likely to occur (Cyders et al., 2009). In contrast, binge eating most often occurs when the individual is alone (Polivy & Herman, 1993).

Altogether, current evidence suggests that trait impulsive emotion dysregulation in the presence of negative affect (i.e. Negative Urgency) pertains to both binge eating and binge drinking behaviour with a larger effect observed for binge eating. A tendency towards engaging in impulsive behaviours in a positive mood state (i.e. Positive Urgency) relates to problematic

alcohol use in general, although support for a specific relationship with binge drinking is limited. Sensation Seeking appears to further differentiate binge drinking from binge eating.

1.3.2 Reinforcement Sensitivity Theory and binge behaviour

The second personality framework used to conceptualize binge behaviour emphasizes motivational systems drawing on Gray's Behavioural Approach and Inhibition Systems (Reinforcement Sensitivity Theory; Gray, 1970; Corr, 2004; see Bijttebier, Beck Claes, & Vandereycken, 2009 for review). Reward Sensitivity (RS) and Punishment Sensitivity (PS) are proposed to play a key role in approach and avoidance behaviours associated with disordered consumption (Loxton & Dawe, 2001; Gray, 1991).[1] Individuals with higher Reward Sensitivity have a more reactive Behavioural Approach System (BAS) and are considered to be more likely to approach and experience higher levels of positive affect to signals of reward (Carver & White, 1994). Punishment Sensitivity is associated with greater Behavioural Inhibition System (BIS)/Fight-Flight-Freeze System (FFFS) co-activation, which confers greater responsiveness and higher negative affect to signals of punishment. Reinforcement Sensitivity Theory has been incorporated into models of disordered eating and alcohol use behaviours (e.g. Dawe, Gullo, & Loxton, 2004; Dawe & Loxton, 2004). Individuals at risk for disordered consumption are posited to have a heightened response to highly palatable (i.e. rewarding) substances and associated cues.

[1] Though revisions to Reinforcement Sensitivity Theory (Gray & McNaughton, 2000) have drawn further distinctions between BIS and what is referred to as the Fight-Flight-Freeze system (FFFS), well-validated measures of sensitivity to reward and sensitivity to punishment available at the time of study conception did not distinguish between these systems (e.g. Carver & White, 1994; Torrubia, Avila, Molto, & Caseras, 2001); rather, measures of punishment sensitivity were considered reflective of combined BIS/FFFS functioning (Corr, 2004). Therefore, the current study refers to Reward and Punishment Sensitivity with the acknowledgment that Punishment Sensitivity pertains to activation of BIS/FFFS; an approach that has been taken by other recent work (e.g. Tull, Gratz, Latzman, Kimbrel, & Lejuez, 2010; Hundt, Kimbrel, Mitchell, & Nelson-Gray, 2008). Since study conception new measures have been developed, e.g. Jackson-5 (Jackson, 2009), in an effort to better capture revised RST.

Two commonly used self-report measures whose development was guided by RST are Carver and White's (1994) Behavioural Inhibition System/Behavioural Activation System Scale (BIS/BAS Scale) and the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia et al., 2001). Both measures have a subscale designed to assess punishment sensitivity with items reflective of anxiety in the presence of punishment cues (BIS and Sensitivity to Punishment, respectively). In regards to reward sensitivity, the BAS has three subscales (Drive, Reward Responsiveness and Fun-Seeking) with items reflective of responses to general rewarding events whereas the SPSRQ Sensitivity to Reward scale pertains to responsiveness to specific rewarding stimuli.

Although evidence regarding the relationship between Reward and Punishment Sensitivity and ED diagnosis is somewhat mixed (Harrison, O'Brien, Lopez, & Treasure, 2010), the majority of studies using the BIS/BAS Scale or the SPSRQ, have documented higher Reward Sensitivity in individuals with ED characterized by binge eating behaviours (i.e. AN-Binge-Purge, BN, and BED) (e.g. Beck, Smits, Claes, Vandereycken, & Bijttebier, 2009; Davis et al., 2008; Kane, Loxton, Staiger, & Dawe, 2004; Schienle, Schäfer, Hermann, & Vaitl, 2009; but see Claes, Nederkoorn, Vandereycken, Guerrieri, & Vertommen, 2006; Harrison, Treasure, & Smillie, 2011). Higher sensitivity to palatable and potentially rewarding stimuli amongst binge eating individuals is also suggested by behavioural measures of reward responsiveness (Kane et al., 2004) and heightened response to food cues (e.g. Svaldi, Tuschen-Caffier, Peyk, & Blechert, 2010). In contrast, findings are mixed in regards to Punishment Sensitivity as measured by the BIS/BAS in comparisons between BN/BED and healthy controls with both higher Punishment Sensitivity and lack of significant differences noted (Beck et al., 2009; Claes et al., 2006; Harrison, et al., 2011; Kane et al, 2004; Schienle et al., 2009).

In subclinical populations, higher scores on disordered eating measures inclusive of striving for thinness and bulimic symptoms, are also associated with higher Reward Sensitivity and Punishment Sensitivity (Loxton & Dawe, 2001, 2006, 2007). While these findings do not allow for the attribution of a role for Reward Sensitivity or Punishment Sensitivity to a particular disordered eating behaviour, some researchers have speculated that Punishment Sensitivity may be more related to restricting behaviour with the goal towards avoiding weight gain while Reward Sensitivity may play a role in bingeing behaviour (e.g. Loxton & Dawe, 2001). Greater Punishment Sensitivity associated with disordered eating may further contribute to the negative reinforcing effect of the binge episode (i.e. negative affect is experienced as more aversive or at greater intensity thereby contributing to the urge to binge to relieve/distract from negative affect).

Similar to findings for disordered eating, higher Reward Sensitivity has been consistently associated with problematic alcohol use in college samples, and higher quantity and frequency of use in community samples (Franken & Muris, 2006; Gullo, Ward, Dawe, Powell, & Jackson, 2011; Hundt et al., 2008; Jorm et al., 1999; Kambouropoulos & Staiger, 2007; Kimbrel, Nelson-Gray, & Mitchell, 2007; Lyvers, Czerczyk, Follent, & Lodge, 2009; O'Connor, Stewart, & Watt, 2009). Of greatest relevance to the current study, Franken & Muris reported a positive relationship between BAS-Fun Seeking and binge drinking. Cue reactivity research has also documented increased responsiveness to alcohol cues in individuals who engage in heavy drinking (e.g. Field, Mogg, Zettler, & Bradley, 2004) again supportive of higher Reward Sensitivity to potentially rewarding stimuli. Individuals with high Reward Sensitivity may be more sensitive to the positive reinforcing effects of alcohol which in turn pertains to a heightened

risk of problematic use. However, the extent to which high Reward Sensitivity relates to binge drinking specifically remains relatively understudied.

In contrast to the positive findings for a role of Reward Sensitivity in problematic alcohol use, it is unclear whether low Punishment Sensitivity is associated with problematic alcohol use. As such, the majority of the studies which examined problematic drinking (e.g. Jorm et al., 1999, Hundt et al., 2008; Kambouropoulos & Staiger, 2007; Lyvers et al., 2009) did not find a significant relationship between low Punishment Sensitivity and problematic alcohol use. However, at least one study of problematic drinking (Kimbrel et al., 2007) and one study of quantity and frequency (Pardo, Aguilar, Molinuevo, & Torrubia, 2007) reported an association between low BIS and greater alcohol use. Of particular relevance to the current study, a negative association between BIS and binge drinking frequency has been reported (Franken & Muris, 2006). A recent prospective study provided preliminary evidence that the relationship between negative mood and negative drinking consequences decreases over time for individuals with high Punishment Sensitivity, suggesting that these individuals were more sensitive to the negative consequences associated with alcohol use as would be predicted by Reinforcement Sensitivity Theory (Wardell, Read, & Colder, 2013). Individuals who refrain from binge drinking or who engage in less bingeing over time may be more sensitive to the negative consequences associated with this pattern of use.

1.3.3 Bringing together emotion-based dispositions to impulsive behaviour and Reinforcement Sensitivity Theory

Taken together current evidence suggests a role for trait impulsive emotional dysregulation (conceptualized as the urgency facets) and differential sensitivity of motivational systems (as represented by Reward and Punishment Sensitivity) in disordered eating and alcohol

use. The evidence outlined above with regards to Positive Urgency and Negative Urgency and disordered eating and drinking behaviours suggests that the urgency facets are likely the conceptualizations of impulsive action most relevant for these disordered behaviours (Cyders & Smith, 2008). There appears to be considerable conceptual overlap between Negative Urgency and Punishment Sensitivity and between Positive Urgency, Sensation Seeking and Reward Sensitivity; therefore, clarification is required to determine whether all constructs provide meaningful contributions to binge behaviour (Gullo, Loxton, & Dawe, 2014). Given the supposition that individuals high in Negative Urgency binge eat to relieve distress due to negative and positive reinforcement pathways (Pearson et al., 2014) and that the urgency facets and problematic drinking are linked via coping and enhancement motives (Coskunpinar & Cyders, 2012), it follows that Reward and Punishment Sensitivity may also play an important role in determining who is at risk for binge behaviour due to underlying individual differences in reinforcement sensitivity.

1.4 Study One Research Questions

Study one aimed to bring together the parallel lines of research on emotion-based dispositions to impulsive behaviour and Reinforcement Sensitivity Theory. This study addressed the question of whether Reward Sensitivity and Punishment Sensitivity have unique associations with binge eating and binge drinking beyond the associations of these behaviours with impulsivity facets assessed by the UPPS-P Impulsive Behaviour Scale. Relationships between the facets and binge behaviour were considered at the level of zero-order correlation and at the level of unique partial relationships while accounting for the other facets.

1.5 Emotion Reactivity and Regulation Definitions

The emotion-based dispositions described in the preceding sections are indicative of a relationship between emotional states and binge behaviour. Several theories posit that emotional states and bingeing may be associated with one another because they both represent ways to regulate emotions (Ferriter & Ray, 2011). Prior to consideration of how emotion regulation may be affected in women with binge behaviour, a definition of emotion regulation is required.

General emotional responses may be divided into emotion reactivity and emotion regulation (Lewis, Zinbarg, & Durbin, 2010). Emotion reactivity refers to the initial intensity of emotional activation in response to a stimulus, while emotion regulation refers to purposeful changes in various aspects of the activated emotion such as the latency, rise-time, intensity and duration of the response in experiential, physiological and behavioural response systems (Gross & Thompson, 2007). Though different definitions of emotion regulation have been put forth, arguably the most influential definition is that provided by Gross (1998, p. 275) which states that "emotion regulation refers to the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions." According to this definition, emotion regulation processes act to modulate responses across subjective experiential, physiological and behavioural response systems. The coupling, also termed coherence, between the various response systems may also be altered by psychopathology and emotion regulatory processes (Butler, Gross, & Barnard, 2014; Dan-Glauser & Gross, 2014; Eastabrook, Lanteigne, & Hollenstein, 2013; Gross, 1998). Therefore, a thorough investigation of emotion processing in relation to binge behaviours should include measurement of emotion reactivity, emotion regulation and coherence across response systems.

1.6 Emotion Regulation Theories of Binge Eating

Emotion regulation theories of binge eating purport that bingeing reduces or distracts from a negative emotional state considered intolerable by the individual (Wiser & Telch, 1999). Emotion regulation conceptualizations of binge eating are supported by motivational accounts (Jackson, Cooper, Mintz, & Albino, 2003), expectancy accounts (Hayaki, 2009), and functional accounts (Wedig & Nock, 2010) of binge eating. The frequent identification of negative affect as antecedent to binge eating in laboratory studies (Leehr et al., 2015), using ecological momentary assessment (EMA: Haedt-Matt & Keel, 2011) and in retrospective investigations (Alpers & Tuschen-Caffier, 2001; Lynch, Everingham, Dubitzky, Hartman, & Kasser, 2000; Smyth et al., 2007; Wolff, Crosby, Roberts, & Wittrock, 2000) also support emotion regulation theories of binge eating. Across emotion regulation conceptualizations, there is general agreement that a negative emotional state precedes the binge episode and the behaviour provides some form of relief or at least the expectation of relief (Wiser & Telch, 1999). However, the mechanism of emotion regulation is still unclear (Haedt-Matt & Keel, 2011; Polivy & Herman, 1993). It remains undetermined whether binge eating is effective in reducing the overall level of negative emotion during or after the binge episode, whether it acts to substitute different emotional states (e.g. anxiety versus depression) or whether it shifts the individual's focus from other life problems to concern regarding overeating. A recent investigation using EMA suggests that changes in the experience of guilt (encompassing feeling ashamed, dissatisfied with oneself, and angry at oneself) pre and post-binge eating may depend in part on diagnostic status and subsequent engagement in vomiting (De Young et al., 2013). Greater declines in guilt were observed amongst women with BN compared to AN and in women who did not engage in subsequent vomiting.

Within the overarching umbrella of emotion regulation, a variety of emotion regulatory mechanisms and emotional triggers have been put forth. For example, Heatherton and Baumeister (1991) proposed that binge eating serves to narrow the focus of attention away from aversive self-awareness. As reviewed by Polivy and Herman (1993), Johnson (1992) suggested that binge eating helps with "reorganization" when the individual feels overwhelmed, whereas Hawkins and Clement (1984) considered binge eating a way to distract from life problems or to reduce anxiety/tension. Based on recent EMA findings, Goldschmidt and colleagues (2014) speculated that certain types of stressors (e.g. interpersonal) negatively impact self-evaluation or result in an accumulation of distress leading to binge eating to cope with the associated negative affect. Emotion regulation theories of binge eating generally converge on the perspective that binge eating may be the result of a deficit in the ability to effectively regulate negative emotional responses through adaptive means (Birch et al., 2007; Wiser & Telch, 1999). It is this perspective that is examined in the second study of this dissertation.

Recent efforts to advance emotion regulation theories of binge eating have primarily relied on self-report measures to identify the specific aspects of emotion experience associated with binge eating behaviour. Reliance on self-report has some disadvantages; specifically, self-judgments about emotion regulation abilities may not map well onto actual abilities, and reports may be significantly influenced by high self-standards and negative mood states (Gardner, Quinton, & Qualter, 2014; Lundh, Johnsson, Sundqvist, & Olsson, 2002; Parling, Mortazavi, & Ghaderi, 2010). The self-report literature suggests that women who binge eat lack awareness of, and have low acceptance of, their emotional experiences (Gilboa-Schechtman, Avnon, Zubery, & Jeczmien, 2006; Gianini, White, & Masheb, 2013; Lafrance Robinson, Kosmerly, Mansfield-Green, & Lafrance, 2013; Legenbauer, Vocks, & Rüddel, 2008; Wheeler, Greiner, & Bolton,

2005; Whiteside et al., 2007). Binge eating women may also tend to experience certain emotions, such as disgust, shame, contempt and guilt, more frequently than non-eating disordered women (Overton, Selway, Strongman, & Houston, 2005); however, these emotions may be a reaction to the disordered eating rather than or in addition to acting as antecedents (Burney & Irwin, 2000).

Self-reported emotional reactions to emotion-eliciting stimuli in the laboratory suggests that women who binge eat may experience greater negative emotion reactivity to idiographic stimuli (Hilbert, Vogele, Tuschen-Caffier, & Hartmann, 2011), but not to normative negative emotional stimuli (Drobes et al., 2001; Mauler et al., 2006). However, self-report ratings of emotional experience lack precision regarding the intensity and duration of the emotional response and may be influenced by trait negative affect and demand characteristics (Lundh et al., 2002). Psychophysiological measures of general stress reactivity (e.g. cortisol, heart rate, skin conductance and blood pressure) help to address these shortcomings of self-report, but have produced mixed results (e.g. Ginty, Phillips, Heaney, & Carroll, 2012; Gluck, 2006; Hilbert et al., 2011; Messerli-Bürgy, Engesser, Lemmenmeier, Steptoe, & Laederach-Hofmann, 2010). The use of psychophysiological methods which are sensitive to emotional valence in addition to arousal, measure the time course of the emotional response, and tap multiple aspects of the response, such as experience and expression, may provide a richer picture of emotion reactivity in binge eating women. The startle eye-blink and corrugator muscle activity are psychophysiological methods that fulfill these requirements and are described in greater detail below.

In regards to emotion regulation, women who binge eat tend to either lack emotion regulation strategies or endorse strategies which are generally considered maladaptive (e.g. Danner, Evers, Stok, van Elburg, & de Ridder, 2012; Danner, Sternheim, & Evers, 2014; Gianini

et al., 2013; Lafrance et al., 2013; Svaldi, Griepenstroh, Tuschen-Caffier, & Ehring, 2012; Whiteside et al., 2007). They may rely on binge eating for immediate relief from distressing emotions in the absence of an ability to effectively regulate their emotional states through more adaptive means. Two specific emotion regulation strategies, expressive suppression, defined as concealment of facial emotional expressions, and cognitive reappraisal, defined as altering the interpretation of the emotion evoking stimulus (Gross & John, 2003), have received the most attention. Cognitive reappraisal is generally considered an adaptive strategy, whereas expressive suppression is considered less adaptive as it often has the unintended effect of increasing emotional arousal (Gross, 1998).

Amongst eating disordered women, the emotion regulation strategy of expressive suppression is commonly endorsed in self-report trait-based measures, whereas cognitive reappraisal is less frequently endorsed (Danner et al., 2012; Danner et al., 2014; Svaldi, Caffier, & Tuschen-Caffier, 2010; Svaldi et al., 2012; Svaldi, Tuschen-Caffier, Trentowska, Caffier, & Naumann, 2014). However, the ED groups are often characterized by higher levels of depression; therefore, the differences in endorsed strategies may be attributable to higher negative affect rather than uniquely associated with eating disorder pathology (Svaldi et al., 2010; Svaldi et al., 2012; Svaldi et al., 2014). Furthermore, these self-report measures do not address the question of which emotion regulation strategies binge eating women choose to implement when faced with an acute negative stimulus, nor do they identify whether the selected strategy is effective in reducing emotional arousal.

Laboratory studies have examined the effect of these emotion regulation strategies on self-reported emotional state, desire to binge and actual food intake. The effect of instructions to suppress emotional expressions during a sad film clip differed across three studies in women

with BED (Dingemans, Martijn, Jansen, & van Furth, 2009; Svaldi et al., 2010; Svaldi et al., 2014). Two of the studies found no difference in sadness between emotion regulation strategies whereas the third study found that reappraisal was associated with reduced sadness compared to suppression. Discrepant findings were also found regarding emotion regulation strategy and the desire to binge or actual food intake in a subsequent taste test. These studies also do not address the question of which emotion regulation strategy women would implement if given the option to choose their own strategy. As such, the ability to voluntarily regulate negative emotional states arising from acute emotional triggers amongst binge eating women remains unclear. If women who binge eat are unable to effectively regulate their emotions when instructed to do so in a standardized laboratory setting, then this fits well with a broad deficit in emotion regulation ability. If, however, they are able to effectively regulate their emotions in such a setting, then the interesting question arises of what leads to binge eating for emotional relief in daily life.

Dialectical Behaviour Therapy (DBT; Linehan, 1993), which addresses emotion dysregulation, has demonstrated efficacy in treating binge eating (Masson, von Ranson, Wallace, & Safer, 2013; Safer, Robinson, & Jo, 2010; Safer, Telch, & Agras, 2001; Telch, Agras, & Linehan, 2001; Wiser & Telch, 1999). Importantly, changes in emotion regulation predict binge abstinence up to six months post-treatment (Wallace, Masson, Safer, & von Ranson, 2014). However, in this study emotion regulation was measured as the total score on a self-report measure of emotion regulation. Therefore, it remains unclear whether reduced binge eating is attributable to a global change in emotion regulation or to change in a specific aspect such as an increased ability to identify emotions, to tolerate emotions or to apply appropriate emotion regulation strategies.

Psychophysiological indices of emotion present with several advantages for studying emotion processing in binge eating women. They can be used to help determine whether emotion reactivity and/or emotion regulation ability differ in women who binge eat. In regards to emotion reactivity, these measures allow for the assessment of intensity and duration of the emotional response. Higher intensity or longer duration emotional responses could help to explain the low tolerance for negative emotional states often endorsed by binge eating women.

Psychophysiological measures can also be used to differentiate emotion reactivity from effortful emotion regulation. These measures do not depend on the individual's ability to identify and report on their own experience and are less influenced by demand characteristics (Jackson et al., 2000; Piper & Curtin, 2006). Inquiry into the strategies that were used during these effortful emotion regulation attempts can also help determine whether binge eating women choose less adaptive strategies, such as expressive suppression. With measurement of psychophysiological responses, one can directly assess whether certain strategies are more or less effective in changing the physiological response.

1.7 Emotion Regulation Theories of Binge Drinking

Similar to emotion regulation theories of binge eating, emotion regulation theories of alcohol use posit that individuals engage in excessive consumption to reduce negative emotional states (Sher & Grekin, 2007). Such theories include those focused on the dampening effect of alcohol on tension/stress (Conger, 1956; Sher, 1987; Khantzian & Galatner, 1990 as cited in Sher & Grekin) and coping motivations for use (Cooper, 1994; Cooper, Frone, Russell, & Mudar, 1995; Cooper, Agocha, & Sheldon, 2000). However, these theories were not specifically conceptualized to account for a binge drinking pattern of alcohol use amongst young women. It is important to consider binge drinking amongst young women specifically, given prior findings

that peak time of heavy drinking in college and endorsed motivations for drinking may differ between men and women (McCabe, 2002; Nolen-Hoeksema, 2012). Therefore, where possible, evidence specific to this population and this form of drinking are reviewed below. Similar to binge eating, associations between negative emotional states and engagement in binge drinking have been examined to inform emotion regulation theories of alcohol use.

Ecological momentary assessments (EMA) provide a strong test of emotion-alcohol use associations as they are less influenced by recall biases (Simons, Gaher, Oliver, Bush, & Palmer, 2005). Studies using this methodology provide a complex picture of the relationship between negative emotional states and alcohol consumption in young women. As such, daytime negative emotional states have been directly linked to nighttime intoxication (Simons et al., 2005), indirectly linked via coping motives (Dvorak, Pearson, & Day, 2014), moderated by levels of Positive/Negative Urgency (Simons, Dvorak, Batien, & Wray, 2010) or have been found to depend on the discrete negative emotion assessed (e.g. anxiety versus sadness) (Dvorak & Simons, 2014; Simons et al., 2010). Using time to drink analyses, Littlefield and colleagues (2012) found that women who endorsed greater coping drinking motives were less likely to binge drink following periods of peak intensity negative emotional states than women endorsing lower levels of coping motivations. Taken together these findings suggest that the regulation of negative emotional states does not consistently underlie engagement in binge drinking behaviour in young women. However, moderation by coping motivations and the urgency facets, suggests that binge drinking may serve an emotion regulation function amongst a subset of young women. One such population is young women with binge eating behaviour who, as described in earlier sections, tend to be high in Negative Urgency. Indeed, young women with probable BED or BN tend to report coping motives for drinking and engage in higher rates of binge drinking (Luce et

al., 2007). This suggests that young women who engage in binge eating to regulate negative emotions in place of more adaptive strategies may engage in binge drinking for a similar purpose (Birch et al., 2007). However, the ability to voluntarily regulate emotional states amongst women with binge eating and binge drinking behaviour has yet to be assessed. This is important as such an examination may help identify the specific aspect of emotional processing that is disrupted in women with these binge behaviours. If they are able to voluntarily regulate their emotional states in the laboratory, then the question arises as to what undermines adaptive emotion regulation in daily life.

The relationship between Positive Urgency and alcohol use reviewed previously suggests that binge drinking may also be associated with the regulation of positive emotional states (Cooper et al., 1995; Cooper et al., 2000). This is supported by reports of a positive association between daytime positive emotions and nighttime drinking and intoxication amongst young women in EMA studies (Dvorak & Simons, 2014; Simons et al., 2005; Simons et al., 2010; but see Dvorak et al., 2014). This association may be explained by lowered perceptions of risk associated with alcohol use when in a positive emotional state; an effect which is stronger amongst individuals who are higher in trait impulsivity (Haase & Silbereisen, 2011). High unregulated positive emotional states may diminish the perceived risks of drinking and could result in excessive consumption in the form of binge drinking.

Emotion regulation ability has not been directly assessed in binge drinking young women. Based on the drinking motives, EMA and Positive Urgency literature, it is expected that binge drinking may be associated with difficulties regulating positive emotions. This could manifest as difficulty keeping positive emotions from reaching a high intensity that interferes with decision making or inhibitory control. Alternatively, difficulty regulating positive emotion

may manifest in a limited ability to maintain or enhance positive emotional states as suggested by enhancement drinking motives. The application of psychophysiological methods that are sensitive to the regulation of positive emotion would help to address whether there is a deficit in the regulation of positive emotions amongst binge drinking young women and whether this pertains to difficulty maintaining or reducing these states.

Similar to the binge eating literature, problematic alcohol use is also associated with difficulty identifying feelings (Vine & Aldao, 2014). In regards to binge drinking specifically, however, findings are mixed. As binge drinking college women do not generally endorse greater difficulty identifying feelings compared to non-binge drinking women (Bauer & Ceballos, 2014), difficulty identifying feelings may be limited to a subset of binge drinking young women such as those who are high in Positive or Negative Urgency (Shishido, Gaher, & Simons, 2013) or who endorse drinking to cope with negative affect (Lyvers, Hasking, Albrecht, & Thorberg, 2012). Given the possibility of difficulty identifying feelings in binge drinking young women, psychophysiological methods which are not reliant on an ability to identify emotional states may be important to further our understanding of emotion processes in this population.

1.8 Psychophysiological Measures of Emotion Reactivity

The application of psychophysiological methods to assess emotion reactivity and regulation presents the opportunity to further advance our understanding of emotion processes in women with binge behaviour. To measure emotion reactivity and emotion regulation ability, study two utilized two psychophysiological measures which have been demonstrated to distinguish between emotion reactivity to negative and positive emotions and have also been employed as an index of instructed emotion regulation: the startle blink and corrugator muscle activity. These methods help to overcome the inherent limitation of relying on subjective

experience reports amongst individuals who may have difficulty identifying and describing their emotional experiences (Lundh et al., 2002). They offer more precise measurement of the timing and magnitude of responses, are less affected by demand characteristics and can help differentiate whether regulation efforts alter valence or arousal dimensions of the response (Bernat, Cadwallader, Seo, Vizueta, & Patrick, 2011; Jackson, Malmstadt, Larson, & Davidson, 2000). They also allow for the assessment of both negative and positive emotional states. This is important as reactivity and regulation of positive emotions is often neglected in the literature.

The main advantage of using the startle blink paradigm in the study of emotion is that it allows for the distinction in emotional response between affectively positive and negative stimuli (Vrana, Spence, & Lang, 1988). In this paradigm, a blast of white noise is administered while the participant views images of differing valence. The startle magnitude in response to the noise blast is measured by recording activity of the orbicularis oculi muscle which is located below the eye. The noise blast (i.e. the startle probe) evokes an aversive defensive response (the startle blink) and whether the startle blink that is evoked is small or large depends on the match or mismatch between the aversive quality of the reflex and the emotional context in which it occurs (Lang, Bradley, & Cuthbert, 1990; Lang, 1995). When the probe is presented in a negative emotional context, there is a match between the aversive valence of the reflex and the aversive valence of the context. This results in an augmented (i.e. larger) startle response as indicated by greater activity in the orbicularis oculi muscle. Correspondingly, when the probe is presented in a positive emotional context, there is a mismatch between the valence of the reflex and the appetitive context and the startle response is inhibited (i.e. smaller). The startle response has been consistently shown to be augmented during the viewing of negatively valenced images and

inhibited during the viewing of positively valenced images (Bradley, Cuthbert, & Lang, 1990; Lang et al., 1990).

Corrugator muscle activity is another commonly used psychophysiological index of emotion experience and expression. This muscle draws the eyebrows in and down and is associated with expressions of distress (Lang, Greenwald, Bradley, & Hamm, 1993). Similar to the startle blink, the activity in this muscle is greater during negative emotional states and reduced during positive emotional states (Lang et al., 1993).

1.9 Psychophysiological Measures of Emotion Regulation

In addition to their use as indices of emotion reactivity, the startle blink and corrugator activity are also sensitive to instructed emotion regulation efforts. The examination of instructed emotion regulation efforts helps to strengthen the distinction between reactivity and regulation processes. Without the provision of an emotion regulation cue, the emotional response would be a combination of initial reactivity and automatic and effortful regulation attempts. By providing a cue instructing participants to regulate their emotional response, the timing of regulation efforts is held constant across participants and helps ensure that all participants attempt to regulate their emotional response. It removes the onus from the participants to decide when to regulate their response, thereby, helping to remove this as a factor in the subsequent success of their efforts. Thus, measured differences in emotion regulation success can be attributed to difficulty employing effective regulation strategies rather than to difficulty knowing when to apply these strategies. In terms of the startle paradigm, the startle magnitude evoked by the startle stimulus during negative image viewing can be reduced or enhanced by instructions to decrease or enhance the negative emotions elicited by the image (Jackson et al., 2000; Piper & Curtin, 2006). Importantly, this pattern of larger startle magnitudes following “increase emotion” instructions

compared to “decrease emotion” instructions is also found for the regulation of positive emotions (Bernat et al., 2011; Dillon & LaBar, 2005; Driscoll, Tranel, & Anderson, 2009). There are preliminary findings that corrugator muscle activity is sensitive to instructed regulation of positive emotion (Bernat et al., 2011) with more consistent evidence of regulation effects for negative emotions (Jackson et al.; Lee, Shackman, Jackson, & Davidson, 2009). Emotion regulation of the startle response typically follows the arousal dimension (i.e. the pattern of regulation efforts is the same for negative and positive emotions), while emotion regulation of corrugator muscle activity typically follows the valence dimension (i.e. “decrease” negative emotion instructions results in less corrugator activity whereas “decrease” positive emotion instructions results in greater corrugator activity) (Bernat et al., 2011).

1.10 Startle Blink & Corrugator Activity in Disordered Eating & Drinking Women

In regards to disordered eating and alcohol use, the majority of investigations have examined differences in reactivity to food or alcohol cues. Across startle and corrugator, food cues tend to be associated with a negative emotional response in women who binge eat (Altman, Campbell, Nelson, Faust, & Shankman, 2013; Drobes et al., 2001; Mauler et al., 2006). In contrast, self-reported valence of food images in binge eating women is more variable with both positive and negative valence classifications reported (Altman et al.; Drobes et al.; Mauler et al.). Images of contamination that are associated with bulimic behaviours, e.g. a toilet, also evoked greater negative emotion reactivity as indexed by the startle probe in women with binge eating (Altman et al.). When general negative and positive emotional stimuli (i.e. emotional pictures that do not focus on food or alcohol) were included in these investigations, group differences were not found (Drobes et al., 2001; Mauler et al., 2006).

In regards to reactivity to alcohol cues, an attenuated startle response and positive valence ratings have been demonstrated amongst heavy and light social drinkers (Drobes, Carter, & Goldman, 2009). However, this study failed to replicate the typical linear affective modulation of the startle response during viewing of general negative, neutral and positive images. Individuals with positive alcohol expectancies tended to rate unpleasant images as less unpleasant, suggesting a reduced sensitivity to negative emotional stimuli. Miranda and colleagues (2002) reported reduced startle potentiation during negative image viewing amongst individuals with a family history of alcoholism. However, in a second study, reduced potentiation was not found in men with alcoholism alone, rather, it was only found amongst men with co-morbid alcoholism and anti-social personality disorder (Miranda, Meyerson, Myers, & Lovallo, 2003). Thus, there is mixed evidence of a possible blunted emotional response to negative emotional stimuli in individuals at risk for problematic alcohol use.

These physiological methods have not been previously applied to study reactivity and voluntary emotion regulation ability in binge eating and drinking young women. They offer the opportunity to examine whether women with either type of bingeing have differences in reactivity patterns, or whether they exhibit difficulty regulating positive and negative emotional states. These methods are not reliant on the individual's ability to identify and describe their emotional state, and may be more sensitive to subtle differences in the evoked emotional response.

1.11 Study Two Research Questions

Study two applied the psychophysiological methods described in the preceding sections (i.e. startle blink and corrugator muscle activity) to provide a comprehensive examination of emotion processing in young women with binge behaviour. Such an approach has the advantage

of allowing us to identify acute changes in valence and arousal dimensions when an emotion is activated and as it is altered by effortful regulation attempts. The recording of the emotional response is less influenced by demand characteristics, emotional awareness, and trait negative affect (Jackson et al., 2000; Piper & Curtin, 2006). These methods will determine whether deficits in regulation ability, as suggested by the trait literature, are found when attempting to regulate a response to an acute negative emotional stimulus. This may inform whether the relationship between emotional states and bingeing behaviour is due, at least in part, to a deficit in the ability to voluntarily regulate the emotional state.

Emotion processing of general negative and positive emotional stimuli was examined in the context of a picture viewing paradigm. Emotion reactivity was investigated by comparison of group means on self-report ratings and psychophysiological indices of emotional response (startle blink magnitude, corrugator activity) to general emotion invoking images. The question of whether a broad deficit in emotion regulation ability is implicated in binge eating, binge drinking or co-morbid bingeing behaviour was also assessed in study two. Such a deficit would be evident as a lack of response differentiation between conditions where participants attempted to maintain and decrease their emotional responses. This was assessed through examination of:

1) Emotion reactivity in response to negative, neutral and positive images as measured by two psychophysiological indices (startle blink magnitude and corrugator activity) and self-report ratings of valence and arousal.
2) The ability to regulate the emotional response evoked by negative, neutral and positive images as measured by two psychophysiological indices (startle blink magnitude and corrugator activity).
3) Self-reported emotion regulation strategies utilized during the experimental task.

The sample consisted of young women with recurrent binge eating, binge drinking or both forms of behaviour and a non-bingeing comparison group. Motives for eating and drinking were examined in study two as a validation of group assignment. Replication of previously demonstrated differences in eating and drinking motives amongst eating disordered and heavy drinking women was anticipated.

1.12 Emotion Response Coherence

The measurement of startle blink and corrugator activity in addition to self-report ratings of emotional stimuli allows for the assessment of coherence across subjective and psychophysiological response systems, termed emotion response coherence or concordance (Hollenstein & Lanteigne 2014). This is defined as the extent of co-variation between subjective and psychophysiological response systems. The strength and direction of the association between different response systems may be impacted by psychopathology and emotion regulation processes (Butler et al., 2014; Dan-Glauser & Gross, 2014; Eastabrook et al., 2013; Gross, 1998). Low coherence amongst physiology and experience is generally implicated in psychopathology characterized by trait reports of low emotional awareness, such as alexithymia (Eastabrook et al., 2013), disordered eating (Hilbert et al., 2011; Tuschen-Caffier & Vogele, 1999) and borderline personality disorder (Elices et al., 2012; Hazlett et al., 2007). In contrast, greater coherence amongst response systems is generally identified in psychopathology characterized by intense fear or anxiety (e.g. Hubert & DeJong Meyer, 1990; Schaefer, Larson, Davidson, & Coan, 2014). Response coherence may also depend on which response systems are assessed (Evers et al., 2014) and trait negative affect or trait tendencies to utilize specific emotion regulation strategies (Lanteigne, Flynn, Eastabrook, & Hollenstein, 2014).

Coherence between subjective experience and the psychophysiological measures utilized in study two, namely startle blink magnitude and corrugator activity, and an additional measure (the late positive potential; LPP) has yet to be examined in young women with binge behaviour. Patterns of response coherence amongst bingeing and non-bingeing young women may help to explain low emotional clarity and may reveal discrepancies between experience and expression. Expected relationships between each of the psychophysiological measures and their subjective experience counterparts (i.e. rated valence or arousal) in non-bingeing young women are reviewed below. This is followed by consideration of how these relationships may be affected in women with binge behaviour.

In regards to the valence dimension of the emotional response, corrugator muscle activity appears to be sensitive to variations in the level of displeasure evoked by the stimulus (Lee et al., 2009). Small to medium associations between corrugator muscle activity and self-reported valence have been documented for specific emotions such as sadness, anger, and fear and for general negative and positive affect using a variety of emotion induction methods such as images, film clips, mental imagery, negative feedback, sounds and words (Brown & Schwartz, 1980; Jäncke, 1996; Johnson, Waugh, & Fredrickson, 2010; Lang et al., 1993; Larsen, Norris, & Cacioppo, 2003). A linear relationship between subjective valence ratings and corrugator activity was found in 81% of Lang et al.'s sample (1993) suggesting that this relationship is often evident within the context of a picture viewing paradigm. Corrugator activity tends to be greater for negative valence images compared to positive valence images even during attempts to voluntarily control these facial muscles (Dimberg, Thunberg, & Grunedal, 2002). As such, corrugator activity appears to reflect the degree of displeasure-pleasure evoked by the picture stimulus as well as facial emotional expression. Attenuated response coherence between valence

ratings and corrugator activity may, therefore, reflect a discrepancy between subjective experience and emotional expression.

Similar to corrugator activity, the magnitude of the startle blink reflex evoked by a sudden, abrupt stimulus is modulated by the valence of the image in the picture viewing paradigm. According to emotional priming theory (Lang et al., 1990), the startle blink is a defensive reflex and is, therefore, augmented when the aversive motive system is active at the time of startle probe presentation (i.e. during viewing of negative images) and inhibited when the appetitive motive system is active (i.e. during viewing of positive images). Beyond this distinction of augmentation and inhibition by valence, startle blink magnitude is also affected by arousal, which is considered indicative of the extent of activation in these motivational systems. Cuthbert, Bradley and Lang (1996) first demonstrated that startle blink modulation (potentiation for negative, inhibition for positive valence) was greatest for highly arousing images as indexed by both subjective report and skin conductance response. Bradley, Codispoti, Cuthbert and Lang (2001) replicated this effect and demonstrated that picture contents of the highest motivational relevance (e.g. direct threat and mutilation) evoked the largest startle potentiation and were the most arousing based on self-report and skin conductance.

Since both valence and arousal impact startle magnitude, some researchers have developed a method to measure the combination of these affective components, which they termed intensity (Bernat, Patrick, Benning, & Tellegen, 2006). Although intensity was found to correlate with startle blink magnitudes, the effect sizes were small and varied between image contents. In general, they were larger and more consistent within the negative valence condition compared to the positive valence condition. Taken together, these findings suggest that startle modulation within negative and positive valence conditions correlates with rated arousal.

Attenuated coherence between startle magnitude and arousal ratings may reflect discordance between activation of basic motivational systems and subjective experience.

The last index of coherence between physiological response and subjective experience examined in the third study is between an event-related potential (ERP) waveform termed the late positive potential (LPP) and self-reported arousal. The LPP is a positive-going centro-parietal waveform beginning 300-400 ms post-picture onset and extending up to five seconds into the picture viewing period (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000). The LPP is proposed to index motivational significance with greater activity observed for unpleasant and pleasant compared to neutral images; an effect which remains evident following repetitive picture viewing (Cuthbert et al., 2000; Codispoti, Ferrari, & Bradley, 2007; Lang & Bradley, 2009; Schupp et al., 2000). The LPP is larger for more arousing images as indexed by subjective arousal reports and sympathetic arousal (Cuthbert et al; Leite et al., 2012; Schupp et al., 2004). The LPP has been used to index motivational significance of disorder specific cues, such as food and alcohol images, in women with disordered eating and alcohol use (Blechert, Goltsche, Herbert, & Wilhelm, 2014; Svaldi et al., 2010).

The magnitude of the LPP is diminished by emotion regulatory efforts such as attention manipulation (Dunning & Hajcak, 2009; Hajcak, Dunning, & Foti, 2009) and cognitive reappraisal (see Hajcak, MacNamara, & Olvet, 2010 for review). The LPP is also reduced in individuals with Generalized Anxiety Disorder (GAD) in response to aversive stimuli; an effect which has been interpreted within the context of initial heightened vigilance followed by rapid avoidance (the vigilance-avoidance model; Mogg, Bradley, Miles, & Dixon, 2004; Weinberg & Hajcak, 2011). Results from functional magnetic resonance imaging investigations of the neural structures underlying the LPP have been interpreted to reflect elaborated processing in the extra-

striate visual cortex with re-entrant processing from the amygdala (see Lang & Bradley, 2010 for review). Attenuated coherence between LPP magnitude and rated arousal may, therefore, reflect attentional disengagement and decreased perceptual processing of arousing stimuli.

In regards to binge eating, greater self-reported negative affect in the absence of physiological response differences (cardiac reactivity and electrodermal activity) in interpersonal stressor tasks suggests a discrepancy between subjective and physiological response systems (e.g. Hilbert et al., 2011; Tuschen-Caffier & Vogele, 1999). However, emotion reactivity to general emotional stimuli indexed by startle blink, corrugator activity and self-report image ratings appears comparable between bingeing and non-bingeing women based on comparisons of group means (Drobes et al., 2001; Mauler et al., 2006). A dimensional approach may be more sensitive to alterations in response coherence that are not apparent in prior group comparisons. The tendency of eating disordered women to suppress emotional expression also suggests that coherence between corrugator activity and valence ratings may be attenuated (Danner et al., 2014; Svaldi et al., 2012). There are no reports examining response coherence between LPP to general emotional stimuli and arousal in binge eating women. However, as anxiety is often associated with disordered eating (Meng & D'Arcy, 2015), the association between LPP and arousal may be affected in this population given prior reports of decreased LPP amplitude in high anxiety groups (e.g. Weinberg & Hajcak, 2011).

There is limited evidence to inform expected patterns of emotion response coherence amongst young women with binge drinking behaviour. The two startle studies described previously provided mixed evidence of a possible attenuation of the relationship between startle responses and self-report (Miranda et al., 2002; 2003). Similar, to binge eating, there is a lack of

evidence to inform the expected coherence between LPP and arousal ratings in binge drinking young women.

1.13 Study Three Research Questions

Study three aimed to identify whether women with higher self-reported emotion reactivity to the picture stimuli also tended to show higher levels of activity in corresponding psychophysiological indices. To address this issue, using data from study two, correlations between the psychophysiological measures and subjective experience ratings outlined above were examined within non-bingeing women, binge eating women, binge drinking women and women with both binge eating and binge drinking behaviours.

Chapter 2: Study One

2.1 Introduction

The current study aimed to integrate two related frameworks, emotion-based dispositions to impulsive behaviour and Reinforcement Sensitivity Theory (RST), to identify common and unique personality correlates of binge eating and binge drinking behaviours. Amongst impulsivity facets, Negative Urgency (NU) or the tendency to experience strong impulses when experiencing negative affect (Whiteside & Lynam, 2001), is most highly correlated with bulimic symptoms (Fischer et al., 2008). Negative Urgency predicts, and accounts for unique variance in binge eating beyond other facets measured with the UPPS-P Impulsive Behavior Scale (Fischer et al., 2013; Fischer & Smith, 2008; Smith et al., 2007). Integrative models of bulimic symptoms posit that individuals high in Negative Urgency binge eat in part due to negative reinforcement (i.e. emotion regulatory effect) of the behaviour from distress relief (Pearson et al., 2014).

Negative Urgency and a complementary facet called Positive Urgency (PU), or the tendency to engage in impulsive behaviours when in positive affective states (Cyders & Smith, 2007), denote risk for various alcohol outcomes. Amongst the UPPS-P facets, the urgency facets had the largest relationships with problematic drinking in meta-analyses (Coskunpinar et al., 2013; Stautz & Cooper, 2013). Whereas Negative Urgency is related to both types of bingeing, high Positive Urgency appears unique to problematic drinking. Positive Urgency is higher in women with alcohol abuse than in women with ED and healthy controls, positively correlates with various alcohol outcomes and predicts alcohol consumption and negative drinking consequences (Cyders et al., 2007; Cyders et al., 2009). Evidence pertaining to the relationship between urgency facets and binge drinking specifically, is limited. Correlations, though smaller

than for the broader construct of problematic drinking, remain positive (e.g. Adams et al., 2012; Shin et al., 2012).

Of the other UPPS-P facets, binge drinking is further differentiated from binge eating in its association with high Sensation Seeking (SS). Amongst UPPS-P facets, Sensation Seeking, the tendency to enjoy and pursue new, exciting activities, has the largest relationship with binge drinking (Coskunpinar et al., 2013; Stautz & Cooper, 2013) whereas the relationship with bulimic symptoms is small (Fischer et al., 2008). In summary, Negative Urgency appears related to both types of bingeing and may reflect a general risk for under-controlled consumption, whereas Positive Urgency and Sensation Seeking are more strongly related to binge drinking and may differentiate this behaviour from binge eating.

Reinforcement Sensitivity Theory draws on Gray's motivational systems and provides another framework from which to understand binge behaviour (Corr, 2004; Gray & McNaughton, 2000). Individuals with high Reward Sensitivity (RS) have a reactive Behavioural Approach System and are more likely to approach and experience higher levels of positive affect to reinforcement and cues signaling probable reinforcement. Punishment Sensitivity (PS) pertains to co-activation of the Behavioural Inhibition System (BIS) and the Fight-Flight-Freeze System (FFFS). Individuals with high Punishment Sensitivity are more responsive and experience higher negative affect to signals of punishment. RST has been incorporated into models of addiction (Dawe & Loxton, 2004) with the systems proposed to play a key role in approach and avoidance behaviours associated with disordered consumption. Individuals at risk for disordered consumption are posited to demonstrate increased responsiveness to highly palatable (i.e. rewarding) substances and associated cues.

Higher self-reported and behavioral indicators of Reward Sensitivity have been documented in subclinical populations with dysfunctional eating (Loxton & Dawe, 2006, 2007) and in individuals with ED characterized by bingeing (e.g., Kane et al., 2004; Schienle et al., 2009). Whereas high Punishment Sensitivity has been consistently noted in subclinical populations (Loxton & Dawe, 2006, 2007), results from comparisons between bulimia nervosa (BN)/binge eating disorder (BED) and healthy controls have been mixed (Claes, et al., 2006; Harrison et al., 2011; Kane et al, 2004; Schienle et al., 2009). Given the use of summary measures of ED symptoms in subclinical populations, current evidence does not allow for the attribution of a role for Reward Sensitivity or Punishment Sensitivity to a particular disordered eating behaviour. Although some researchers have speculated that Punishment Sensitivity pertains to restricting behaviour with the goal towards avoiding weight gain while Reward Sensitivity plays a role in bingeing (Loxton & Dawe, 2001), these behaviours frequently co-occur within the same individual. Greater Punishment Sensitivity associated with disordered eating may also contribute to the negative reinforcing effect of the binge episode because of relief from more intense negative affect.

Although high Reward Sensitivity has been consistently associated with problematic drinking in college samples (Gullo et al., 2011; Hundt, at al., 2008), evidence of a relationship with binge drinking is limited (Franken & Muris, 2006). There is also limited evidence of a negative association between Punishment Sensitivity and binge drinking (Franken & Muris). Previous findings suggest that high Punishment Sensitivity individuals learn from the negative consequences of problematic drinking and over time engage in this behaviour less frequently when experiencing negative affect (Wardell et al., 2013).

Altogether, trait impulsive emotional dysregulation (i.e. the urgency facets) and differential sensitivity of motivational systems (i.e. Reward Sensitivity and Punishment Sensitivity) are implicated in disordered eating and drinking. While unique prediction of Reward Sensitivity beyond that provided by the UPPS-P facets has been reported for externalizing behaviours, such as substance abuse, anti-social behaviour and aggression (Carlson, Pritchard, & Dominelli, 2013), there is a paucity of work examining unique contributions to binge eating and drinking (Gullo et al., 2014). Given that individuals high in Negative Urgency may binge eat to relieve distress due to negative and positive reinforcement pathways (Pearson et al., 2014) and that coping and enhancement motives link the urgency facets with problematic drinking (Coskunpinar & Cyders, 2012), it follows that individual differences in reinforcement sensitivity may also be important in determining risk for binge behaviour.

The current study aimed to evaluate the unique contribution of the urgency facets and reinforcement sensitivity to binge eating and drinking in young women. An all-female sample was selected due to greater ED risk in women and gender differences in emotion-motivated drinking (Jacobi, Hayward, de Zwaan, Kraemer, & Agras, 2004; Nolen-Hoeksema, 2012). Negative Urgency, Reward Sensitivity and Punishment Sensitivity were hypothesized to be uniquely associated with binge eating frequency. Binge drinking frequency was hypothesized to be negatively related to Punishment Sensitivity and positively associated with Negative Urgency, Positive Urgency, Sensation Seeking and Reward Sensitivity.

2.2 Methods

2.2.1 Participants

The survey was completed by 1763 females[2], primarily university students, with a final sample of 1001 participants (age M=20.63, SD=1.62) following removal of nonsensical responders (n=62, i.e. impossible values for height, weight or birthdate), patterned responses (n=9, i.e. same response or alternating between same response options on all questions), inconsistent or impossible responses on binge frequency questions (n=606), duplicate participants (n=44, i.e. participants who completed the survey multiple times) and ineligible participants due to age <19 or >30 years (n = 29), neurological conditions (n=10) or possible anorexia nervosa diagnosis (AN; n=2). Women with possible AN were excluded to allow for consideration of findings alongside the results of the laboratory studies described in subsequent chapters, which excluded women with possible AN due to the potential detrimental effects of starvation on cognition (Zakzanis et al., 2010). Self-identified ethnicity was East Asian (52.7%), European (34.9%) and Indian-South Asian (9.2%); other categories were endorsed at <5% each. Forty-one participants endorsed current medication for depression/anxiety and 14 for attention deficit hyperactivity disorder. A minority of participants reported lifetime medication management of bipolar disorder (0.5%) or psychosis (0.3%). Based on the Eating Disorder Diagnostic Scale, 2.6% had BN and 4.0% had BED; however, diagnostic interviews were not conducted. Recruitment was via the University of British Columbia Psychology Department Human Subject Pool, a psychology study mailing list and posters in the university and

[2] The large sample size for study one resulted from extensive recruitment efforts for the laboratory studies described in studies two and three.

community. The majority of the sample consisted of university students (89.4 %) with a small percentage of participants from the community (10.6%).

2.2.2 Procedure

The UBC Behavioural Research Ethics Board approved study procedures and participants provided written informed consent. Participants completed questionnaires online and received Psychology course credit or remuneration.

2.2.3 Questionnaires

UPPS-P. The UPPS-P (Lynam et al., 2006) is a 4-point Likert response format ("Agree Strongly" to "Disagree Strongly") questionnaire with scales assessing personality pathways leading to impulsive behaviour. Items on the Positive Urgency scale pertain to one's own or others' perception of a tendency to engage in risky behaviours when feeling positively, e.g. "When I am very happy, I can't seem to stop myself from doing things that can have bad consequences" and "Others would say I make bad choices when I am extremely happy about something." One item may pertain directly to risk for binge behaviour "When I am very happy, I feel like it is ok to give in to cravings or overindulge." All fourteen items on this scale refer to a positive mood state. In contrast, all twelve items on the Negative Urgency scale do not explicitly refer to a negative mood state. Some items are similar in format to the Positive Urgency statements, e.g. "When I feel bad, I will often do things I later regret in order to make myself feel better now." However, the Negative Urgency scale also includes items assessing general difficulty inhibiting impulses, e.g. "I have trouble controlling my impulses" or controlling emotions, e.g. "I always keep my feelings under control." Items on this scale also relate to craving and loss of control inherent in binge behaviour, e.g. "I have trouble resisting my cravings (for food, cigarettes, etc.)" and "Sometimes when I feel bad, I can't seem to stop what I am doing

even though it is making me feel worse." The ten items comprising the Perseverance scale pertain to one's ability to concentrate on, think through and see a task to completion, e.g. "I finish what I start" and "I concentrate easily." Premeditation includes eleven items focused on a cautious, logical approach to thought and behaviour, e.g. "My thinking is usually careful and purposeful" and "I like to stop and think things over before I do them." Perseverance and Premeditation scales are scored to reflect a lack of these traits. Finally, the twelve items making up the Sensation Seeking scale reflect enjoyment of risk taking, e.g. "I quite enjoy taking risks" and anticipated enjoyment of specific thrilling activities, e.g. "I would enjoy parachute jumping." Internal consistency was good in the present sample (Cronbach's α=0.83-0.94) and comparable to published values (Cronbach's α=0.82-0.94; Cyders et al., 2007; Whiteside & Lynam, 2001).

One strength of the UPPS-P is that development of four of the facets (Negative Urgency, Sensation Seeking, Lack of Premeditation and Lack of Perseverance) was guided by a comprehensive model of personality, the Five Factor Model (FFM). The factor structure underlying the scales was replicated in questionnaire and interview response formats by Smith et al. (2007). Correlations between questionnaire and interview assessments were high (e.g. r=0.64 between Negative Urgency interview versus questionnaire). However, a replication of the factor structure of the original UPPS suggested that five of the items have poor factor loadings (Magid & Colder, 2007).

When developing the Positive Urgency scale, it was differentiated from the other four UPPS facets and from the BAS scale by factor analysis (Cyders et al., 2007). A limitation of the UPPS-P is inconsistent criterion validity for the Positive Urgency scale. Expected relationships with drinking measures have been primarily limited to research conducted by the group which

developed the Positive Urgency scale (e.g. Cyders et al., 2007; Cyders et al., 2009) whereas findings from other groups have been inconsistent (e.g. Adams et al., 2012; Simons et al., 2010).

BIS/BAS Scale. The BIS/BAS Scale (Carver & White, 1994) is a 4-point Likert response format ("Strongly Agree" to "Strongly Disagree") questionnaire, which assesses dispositional sensitivities of the Behavioral Inhibition System and Behavioral Approach System. It is composed of one BIS subscale (Cronbach's α=0.79 current sample; α=0.74 validation sample) and three BAS subscales (Cronbach's α=0.77-0.80 current sample; α=0.66-0.76 validation sample). The seven item BIS subscale reflects a tendency to experience fear, worry or feel upset in the face of criticism, failure, or the possibility of negative events, e.g. "I feel worried when I think I have done poorly at something." BAS-Drive consists of four items reflecting a persistent pursuit of goals, e.g. "When I want something, I usually go all-out to get it." The four item BAS-Fun Seeking subscale reflects a desire for new rewards and acting on the spur of the moment to approach a potentially rewarding event, e.g. "I'm always willing to try something new if I think it will be fun." The five items of the BAS-Reward Responsiveness subscale assess positive responses to the occurrence or anticipation of reward, e.g. "When good things happen to me, it affects me strongly."

Initial validation studies provided evidence of convergent and discriminant validity; BIS correlated positively with measures of negative affectivity/anxiety (e.g. r=0.42) while BAS scales correlated positively with positive affectivity/extraversion (e.g. r=0.41). Correlations with expected frequency of exposure to punishment and reward cues as well as between typical negative and positive affect were moderate suggesting that the scales assess related but distinct constructs (Carver & White, 1994). Construct validity was provided by the finding that high BIS scores were associated with greater nervousness to a laboratory punishment cue. Construct

validity for the BAS-Drive and BAS-Reward Responsiveness scales was evident in ratings of greater happiness to a laboratory reward in individuals with high scores on these scales. One limitation of the BIS/BAS scale is that on factor analysis, BAS-Fun Seeking crossloads with measures of rash impulsivity (i.e. acting without consideration of consequences) and with measures of reward sensitivity, leading some to argue that it is more related to rash impulsivity than to reward sensitivity (see Loxton et al., 2004 for review).

Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). The SPSRQ (Torrubia et al., 2001) is a yes-no response format questionnaire consisting of 48 items with items split evenly across two scales assessing functioning of the BIS and BAS: Sensitivity to Punishment (SP; Cronbach's α=0.84 present sample; α=0.82 validation sample), e.g. "Comparing yourself to people you know, are you afraid of many things?", "Do you often refrain from doing something because of your fear of being embarrassed?" and Sensitivity to Reward (SR; Cronbach's α=0.76 present sample; α=0.75 validation sample), e.g. "Do you like to compete and do everything you can to win?", "Do you often do things to be praised?" Convergent and discriminant validity as provided in the initial validation studies indicate that Sensitivity to Punishment positively correlates with Neuroticism (r=0.62) and negatively correlates with Extraversion (r=-0.53) while Sensitivity to Reward correlates positively with both Neuroticism (r=0.33) and Extraversion (r=0.41). Sensitivity to Punishment also correlates with trait anxiety (r=0.59) while Sensitivity to Reward does not (r=0.10, p>0.05). A strength of the SPSRQ is its convergent validity with a behavioural measure of Punishment Sensitivity in disordered eating and alcohol use samples; however, convergent validity with a behavioural measure of Reward Sensitivity was not supported (Loxton & Dawe, 2007). One limitation of this scale is that its two-factor structure has been questioned with some items demonstrated to have

poor factor loadings (Cogswell, Alloy, van Dulmen, & Fresco, 2006; O'Connor, Colder, & Hawk, 2004).

Eating Disorder Diagnostic Scale (EDDS). The EDDS (Stice, Telch, & Rizvi, 2000) was used as a self-report measure of ED diagnosis. This scale assesses the DSM-IV diagnostic criteria for AN, BN, and BED. Initial validity and reliability data comes from a study of 367 females between the ages of 13-65 (Stice et al.). The one-week test-retest reliability reported in Stice and colleagues' study was $\kappa = 0.95$ for AN, $\kappa = 0.71$ for BN, and $\kappa = 0.75$ for BED. Criterion validity was established by comparing the EDDS to diagnoses from the Eating Disorder Examination interview (Fairburn & Cooper, 1993). Agreement between the EDDS and EDE appeared to be adequate: $\kappa = 0.93$ (AN), $\kappa = 0.81$ (BN) and $\kappa = 0.74$ (BED). Sensitivity and specificity were also adequate with values greater than 0.93 for AN, 0.81 for BN and 0.77 for BED. Evidence of convergent validity was provided by their finding that the identified eating disorder groups scored higher on several other well-established measures of eating pathology than the non-eating disordered controls.

Eating Disorder Examination Questionnaire (EDE-Q 6.0). The EDE-Q (Fairburn & Bèglin, 1994) is a self-report measure derived from the EDE interview (Fairburn & Cooper, 1993). This scale provides frequency ratings for laxative misuse, self-induced vomiting and binge eating in the past 28 days. In an undergraduate female sample, the two-week test-retest reliability has been reported as $r = 0.68$ for the frequency of binge eating (Luce & Crowther, 1999). The EDE-Q item pertaining to the number of objective binge days in the past month was used as the binge eating measure ("Over the past 28 days, on how many *days* have such episodes of overeating occurred, i.e., you have eaten an unusually large amount of food *and* have had a sense of loss of control at the time?").

Alcohol Binge Frequency. The NIAAA definition of a binge for females, which is the consumption of four or more drinks within a two hour period, was used (NIAAA, 2004). A drink was defined as half an ounce (15 ml) of absolute alcohol (e.g. a 12 ounce/355 ml can or glass of beer or cooler, a 5 ounce/ 150 ml glass of wine, or a drink containing 1 shot of liquor). Participants provided an estimate of past month alcohol binge frequency.

2.3 Results

2.3.1 Psychometrics & data reduction

A principal components analysis with direct oblimin rotation (delta=0) was completed using the BIS/BAS Scale and the SPSRQ to derive a comprehensive measure of Reward Sensitivity and Punishment Sensitivity for use in subsequent analyses. An oblimin rotation was selected to account for the possible interdependence between the reward and punishment sensitivity measures postulated by the joint-subsystems conceptualization of the BIS/BAS systems (Corr, 2001, 2002). A square-root transform was applied to BAS Reward Responsiveness to adjust for negative skew. A two-component solution explained 63.70% of the variance with a correlation of -0.02 (Table 2.1).

Table 2.1 Reinforcement Sensitivity Measures PCA

		Component Loadings (n=1001)	
Subscales	M (SD)	Reward Sensitivity	Punishment Sensitivity
SP SPSRQ	13.09 (5.31)	-0.13	**0.85**
BIS	22.29 (3.43)	0.13	**0.87**
SR SPSRQ	10.36 (4.12)	**0.68**	0.13
BAS Drive	10.91 (2.21)	**0.75**	-0.19
BAS Fun-Seeking	11.35 (2.37)	**0.74**	-0.20
BAS Reward Responsiveness	17.47 (2.17)	**0.76**	0.24
eigenvalue		2.20	1.63
% of variance		36.58	27.12

Note: BAS = Behavioural Approach System; BIS = Behavioural Inhibition System scale from BIS/BAS Scale; SP SPSRQ = Sensitivity to Punishment scale from Sensitivity to Punishment and Sensitivity to Reward Questionnaire;

SR = Sensitivity to Reward scale from SPSRQ. Bolded items reflect the PCA component on which the scales had primary loadings.

Means and standard deviations for the UPPS-P and correlations between the UPPS-P, the separate Reinforcement Sensitivity Theory measures and PCA components are presented in Table 2.2. The BAS Fun-Seeking scale was moderately associated with Negative and Positive Urgency and Lack of Premeditation and had a large association with the UPPS-P Sensation Seeking scale in line with prior criticism of this scale tapping both rash impulsiveness and reward sensitivity. A large association between the Reward Sensitivity component and Sensation Seeking as well as medium associations with Negative and Positive Urgency were also evident and suggestive of construct overlap.

Table 2.2 Correlations between Personality Measures

Subscales	M (SD)	Pearson Correlation Coefficients (n=1001)							
		BIS	BAS-FS	BAS-D	BAS-RR	SP SPSRQ	SR SPSRQ	PS	RS
NU	2.27 (0.57)	0.15**	0.31**	0.18**	0.11**	0.25**	0.42**	0.21**	0.34**
PU	1.78 (0.57)	-0.10**	0.31**	0.20**	0.03	0.17**	0.42**	0.02	0.30**
SS	2.55 (0.61)	-0.25**	0.55**	0.33**	0.18**	-0.32**	0.35**	-0.34**	0.49**
LPM	1.92 (0.42)	-0.26**	0.34**	0.12**	-0.09*	-0.25**	0.18**	-0.32**	0.18**
LP	2.05 (0.47)	0.03	0.05	-0.20**	-0.18**	0.28**	0.10*	0.16**	-0.10**

Note. NU = Negative Urgency; PU = Positive Urgency; SS = Sensation Seeking; LPM = Lack of Premeditation; LP = Lack of Perseverance; BIS = Behavioural Inhibition System scale from BIS/BAS Scale; BAS-FS = Behavioral Approach System Fun Seeking subscale; BAS-D = BAS Drive subscale; BAS-RR = BAS Reward Responsiveness subscale; SP SPSRQ = Sensitivity to Punishment scale from Sensitivity to Punishment and Sensitivity to Reward Questionnaire; SR = Sensitivity to Reward scale from SPSRQ; PS = Punishment Sensitivity Component; RS = Reward Sensitivity Component

*p<0.05

**p<0.001

2.3.2 Binge analyses

The analysis approach involved the computation of Pearson correlation coefficients to identify zero-order relationships between the personality facets and bingeing behaviours. Hierarchical multiple linear regression was then conducted with the personality facets entered as predictors of the binge behaviours. This allowed us to determine partial relationships between each personality facet and the binge behaviours while taking into account relationships with the other personality facets. The UPPS-P facets were entered in the first block (Model 1) with the RST components entered in the second block (Model 2). Analyses were first conducted across the entire sample (i.e. all participants were included irrespective of endorsement of binge behaviour). Given that the majority of the sample did not endorse any binge behaviour, this analysis primarily reflected differences between bingeing and non-bingeing women. To characterize the relationship between the personality facets and frequency of binge behaviour, analyses were then run using data limited to participants who endorsed two or more food (binge eating group; n=249) or alcohol (binge drinking group; n=249) binge days in the past 28 days. A threshold of two or more binge days was selected to identify participants with recent, repetitive bingeing behaviour. This more focused analysis aimed to identify the contribution of each personality facet to the frequency of engagement in the behaviour amongst those with recurrent episodes. Ninety-three participants fell in both the binge eating and binge drinking groups, indicating they endorsed recent engagement in both behaviours. The entire sample analysis included women who binged in the past month, any time prior to the past month and those that have never binged, whereas the current bingeing group analysis only included those women that binged in the past 28 days. Correlation and regression analyses were completed with natural log transformed binge data given positive skew.

Descriptive statistics and correlations are presented in Table 2.3. Food binge frequency (range: zero to daily) was positively correlated with all personality facets with the largest association observed for Negative Urgency. In the current binge eating group, binge eating frequency had small to medium positive correlations with Negative Urgency, Sensation Seeking, Lack of Perseverance and Reward Sensitivity.

Alcohol binge frequency (range: zero to 16) had the largest positive correlations with Sensation Seeking and Reward Sensitivity and small to medium positive correlations with the remaining personality facets with the exception of Punishment Sensitivity with which it had a small negative association. In the current binge drinking group, alcohol binge frequency had small, positive associations with Negative Urgency, Positive Urgency, Lack of Premeditation and Lack of Perseverance.

Table 2.3 Descriptive Statistics

				Bivariate Correlations						
	n	M	SD	NU	PU	SS	LPM	LP	PS	RS
Food Binges										
Entire Sample	1001	1.50	3.52	0.35**	0.24**	0.11**	0.12**	0.20**	0.16**	0.19**
Current Binge	249	5.73	5.08	0.17*	0.003	0.14*	0.04	0.23**	0.07	0.16*
Alcohol Binges										
Entire Sample	1001	1.17	2.20	0.23**	0.15**	0.29**	0.22**	0.14**	-0.11*	0.26**
Current Binge	249	4.22	2.60	0.16*	0.16*	0.03	0.22**	0.24**	-0.03	0.07

Note. Entire Sample=all participants; Current Binge=participants with two or more binges of the specified type in the past 28 days; NU=Negative Urgency; PU=Positive Urgency; SS=Sensation Seeking; LPM=Lack of Premeditation; LP=Lack of Perseverance; PS=Punishment Sensitivity Component; RS=Reward Sensitivity Component.

*p<0.05

**p<0.001

Hierarchical multiple linear regression analyses with UPPS-P facets entered in the first block (Model 1) and RST components entered in the second block (Model 2) identified unique

contributions to food and alcohol binge behaviours. Results of regression analyses with 4000 bootstrap samplings, VIF <2.5 and tolerance >0.10 are presented in Table 2.4. Across the sample, the addition of Reward Sensitivity/Punishment Sensitivity accounted for significantly more variance in binge eating beyond that accounted for by the UPPS-P facets. Significant positive predictors in the entire sample were Negative Urgency, Lack of Perseverance, Reward Sensitivity and Punishment Sensitivity. In the current binge eating group, the addition of Reward Sensitivity/Punishment Sensitivity to the model approached significance (p=0.072); Negative Urgency became non-significant whereas Positive Urgency emerged as a significant negative predictor with the addition of Reward Sensitivity/Punishment Sensitivity to the model.

In the entire sample, Reward Sensitivity and Punishment Sensitivity accounted for additional variance in alcohol binge frequency beyond the UPPS-P facets. Negative Urgency, Lack of Perseverance, Sensation Seeking and Reward Sensitivity were significant positive predictors. Punishment Sensitivity was a negative predictor and counter to expectation, Positive Urgency also emerged as a negative predictor. Amongst the current binge drinking group, Model 2, with the addition of Reward Sensitivity/Punishment Sensitivity did not account for significantly more variance than Model 1. Lack of Perseverance and Lack of Premeditation were the only significant predictors in Model 1.

Table 2.4 Regression Summary

	Food Binge Frequency											
	Entire Sample[2] (n=1001)						Current Binge[2] (n=249)					
			BCa 95% CI						BCa 95% CI			
Predictors	B	SE	LL	UL	AdjR^2	ΔR^2	B	SE	LL	UL	AdjR^2	ΔR^2
NU	0.35**	0.06	0.23	0.48	0.14**	0.02**	0.15	0.08	-0.02	0.31	0.11**	0.02
PU	-0.01	0.06	-0.14	0.12			-0.17*	0.08	-0.33	-0.02		
LPM	0.00	0.07	-0.14	0.14			-0.16	0.10	-0.36	0.06		
LP	0.17*	0.07	0.04	0.31			0.37**	0.10	0.18	0.56		
SS	0.03	0.05	-0.06	0.13			0.13	0.08	-0.03	0.28		
RS	0.08*	0.03	0.03	0.14			0.10*	0.04	0.01	0.18		
PS	0.08*	0.03	0.02	0.13			0.01	0.04	-0.08	0.10		
	Alcohol Binge Frequency											
	Entire Sample[2] (n=1001)						Current Binge[1] (n=249)					
Predictors												
NU	0.19*	0.06	0.08	0.30	0.14**	0.02**	0.04	0.06	-0.08	0.14	0.07**	
PU	-0.14*	0.06	-0.24	-0.03			0.02	0.05	-0.09	0.11		
LPM	0.11	0.07	-0.03	0.24			0.14*	0.07	0.00	0.26		
LP	0.18*	0.06	0.07	0.29			0.15*	0.06	0.04	0.27		
SS	0.18**	0.04	0.11	0.26			-0.02	0.05	-0.10	0.07		
RS	0.11**	0.03	0.06	0.16								
PS	-0.05*	0.02	-0.10	-0.01								

Note. [1]Model 1=UPPS-P facets; [2]Model 2=UPPS-P facets + RS/PS components; ΔR^2=change in variance accounted for with the addition of RS and PS to the regression model; Adj=Adjusted; B=Unstandardized b value; SE=standard error; BCa CI=bias corrected and accelerated confidence interval; LL=lower limit; UL=upper limit; Entire Sample=all participants; Current Binge=participants with two or more binges of the specified type in the past 28 days; NU=Negative Urgency; PU=Positive Urgency; SS=Sensation Seeking; LPM=Lack of Premeditation; LP=Lack of Perseverance; RS=Reward Sensitivity; PS=Punishment Sensitivity.

*p<0.05

**p<0.001

2.4 Discussion

In line with our hypotheses and past work, Negative Urgency significantly correlated with and remained a significant predictor of bingeing when the other UPPS-P facets were considered concurrently. Relationships with Positive Urgency were more complex. Positive Urgency had significant zero-order correlations with bingeing in the entire sample; however, a negative partial relationship with binge drinking unexpectedly emerged. The negative

relationship may be attributable to the loss of meaningful variance due to dispersion of positive affect across facets with stronger binge drinking correlations (i.e. Sensation Seeking and Reward Sensitivity). However, prior evidence of a negative relationship between Positive Urgency and intoxication amongst moderate to heavy drinkers suggests that the relationship between Positive Urgency and drinking requires further consideration (Simons et al., 2010). Interestingly in the current binge eating group, Positive Urgency emerged as a negative predictor and Negative Urgency and Punishment Sensitivity became non-significant predictors of binge eating. This is consistent with recent findings of Negative Urgency prospectively predicting classification into a binge eating group but failing to predict increases in binge frequency amongst binge eaters (Fischer et al., 2013). Individuals with high Negative Urgency may binge eat in an attempt to regulate negative affect (Cyders & Smith, 2008; Pearson et al., 2014), while another factor may better account for the frequency of this behaviour. Positive Urgency may function as a proxy for another factor such as low positive affect; this correlate may more directly confer risk for bingeing rather than low Positive Urgency. As the Positive Urgency findings were unexpected, replication will be required to further elucidate the unique role of Positive Urgency in bingeing.

Lack of Perseverance was a significant predictor of binge eating and drinking across the broader sample and amongst individuals with current bingeing. Susceptibility to boredom and distraction is associated with binge risk and severity. Lack of Perseverance and Lack of Premeditation, which has been previously linked to bulimic symptoms (Fischer et al., 2004; Smith et al., 2007), load together on a higher order factor reflective of lack of conscientiousness (Cyders & Smith, 2007; Smith et al., 2007). Thus, a broader deficit in conscientiousness may contribute to bingeing. Low conscientiousness may reflect, in part, poor executive control resulting in disinhibited behaviour, especially in the presence of reinforcers like food or alcohol,

or it may reflect the use of food or alcohol as reinforcers in place of those requiring sustained focus (e.g., academic or occupational pursuits) (Magid & Colder, 2007). Lack of Perseverance may also be indicative of boredom intolerance due to its perception as a negative emotional state. There appears to be an association between bulimic symptoms and low distress tolerance (Anestis, Selby, Fink, & Joiner, 2007). Further work is needed to clarify the association between Lack of Perseverance/Lack of Premeditation and bingeing.

As expected, Reward Sensitivity and Punishment Sensitivity accounted for additional variance in bingeing, indicating that motivational sensitivities also play an important role beyond that of the UPPS-P facets. Negative Urgency and Positive Urgency had moderate correlations with Reward Sensitivity in line with the involvement of Reward Sensitivity in both active avoidance and approach. BAS Fun Seeking and Sensation Seeking were also highly correlated (r=0.55); thus, the inclusion of BAS Fun Seeking in the composite measure of Reward Sensitivity may have attenuated the amount of variance attributable to Reward Sensitivity in the regression model. While the variance attributable to the RST-derived traits was small, it was evident even in the presence of the moderate correlations between UPPS-P facets and the Reinforcement Sensitivity components, suggesting that there is meaningful variance that is not fully captured by the UPPS-P. Reward Sensitivity predicted binge eating across the broader sample and in the current binge eating group, suggesting that increased sensitivity to highly palatable substances may further contribute to the likelihood that individuals will rely on binge eating to regulate affect. The binge types differed in their relationships with Punishment Sensitivity. High Punishment Sensitivity predicted binge eating whereas low Punishment Sensitivity predicted binge drinking.

As anticipated, binge drinking, but not binge eating, was predicted by Sensation Seeking in the entire sample. Higher Reward Sensitivity predicted binge drinking beyond the positive prediction of the highly-related trait of Sensation Seeking, suggesting the seeking out of exciting experiences represents something more than the rewarding aspects of a stimulus (Carlson et al., 2013). Individuals high in Sensation Seeking may tend to seek out social contexts in which drinking occurs and heightened Reward Sensitivity may connote risk for higher levels of consumption in those contexts. Previous reports of partial mediation between high Sensation Seeking and problematic drinking by reinforcing efficacy (Kiselica & Borders, 2013) and behavioural reward response bias (Castellanos-Ryan, Rubia, & Conrod, 2011) reflect the current findings of a role for both Sensation Seeking and Reward Sensitivity in binge drinking.

The results from the entire sample were considered in light of emotion regulation conceptualizations of binge behaviour as this analysis was thought to reflect more stable individual differences in bingeing versus non-bingeing individuals. Whereas the frequency of bingeing behaviour amongst bingeing individuals captured by the current bingeing analysis may be more susceptible to fluctuations in binge frequency over time. Overall, the results from the entire sample support emotion regulation conceptualizations of binge behaviour. Increased sensitivity to rewarding stimuli may contribute to binge eating due to positive reinforcement (i.e. a desire for high caloric binge foods) and negative reinforcement (i.e. distraction from negative affect) effects. Punishment Sensitivity and Negative Urgency may be generally elevated across binge eaters as suggested by the decrease in variance accounted for amongst the binge eating sample compared to the entire sample. Individuals with heightened Punishment Sensitivity may be prone to higher or more frequent negative affect when faced with aversive cues (i.e. weight gain, criticism, rejection) (Loxton & Dawe, 2001). High Negative Urgency may contribute to

loss of control over intake during negative affective states regardless of the person's level of Punishment Sensitivity resulting in rapid overconsumption (Cyders & Smith, 2008) when negative affect is experienced even in the absence of elevated Punishment Sensitivity. Thus, individuals with more reactive motivational systems or higher Negative Urgency may learn a pattern of repetitive bingeing to alleviate distress (Fischer et al., 2004).

Findings also support emotion regulatory models of binge drinking with implications for the regulation of negative and positive affect (Cooper et al., 1995; 2000). Higher Negative Urgency may confer risk to engage in hasty attempts to decrease negative affect through alcohol use (Cyders & Smith, 2008). Our results, together with prior findings of partial mediation of the relationship between Sensation Seeking and drinking outcomes by enhancement motives, suggest that Sensation Seeking may be relevant to positive emotion regulatory efforts while the involvement of Positive Urgency is less clear (Adams et al., 2012). Heightened sensitivity to the rewarding and negative reinforcement effects of alcohol may predispose individuals to learn to utilize alcohol for positive mood enhancement and coping motives, respectively. Lower Punishment Sensitivity may further contribute to this risk due to diminished motivation to avoid negative consequences associated with this pattern of drinking.

2.4.1 Limitations

Causal relationships cannot be determined from our cross-sectional data. However, risk for disordered consumption conferred by Negative Urgency, Reward Sensitivity and Punishment Sensitivity is suggested by prior work in samples of young girls (Fischer et al., 2012; Loxton & Dawe, 2001). Research that includes measures of typical affect is needed to further inform the extent to which Negative Urgency and Positive Urgency are distinct facets beyond a sensitization of reward pathways by negative affect (Gullo et al., 2014). A small proportion of variance was

accounted for in the current binge drinking group suggesting that other variables such as drinking contexts or peer group may be of greater relevance in predicting binge drinking severity amongst university-age women. Our sample was limited to females due to higher rates of binge eating and an emerging emphasis on binge drinking in this demographic. Replication and extension in mixed gender samples will be required.

2.4.2 Conclusions

This is the first study using a large sample to examine unique and common influences of emotion-based impulsivity and Reinforcement Sensitivity Theory-derived traits on bingeing. The sample focused on a demographic at risk for developing eating and alcohol use disorders, a subset of whom endorsed binge behaviours suggesting these findings may have potential clinical relevance. Negative Urgency, Lack of Perseverance and Reward Sensitivity were common predictors of both binge eating and drinking. Punishment Sensitivity and Sensation Seeking differentiated between bingeing types with Punishment Sensitivity higher amongst binge eating women and Sensation Seeking higher amongst binge drinking women compared to non-bingeing women. The relationship between Positive Urgency and bingeing was complex and warrants further study. The study provides a significant contribution through examination of unique partial relationships and the use of discrete behavioural outcomes. Comprehensive models of bingeing should incorporate UPPS-P facets and reinforcement sensitivity.

Chapter 3: Study Two

3.1 Introduction

Binge eating and binge drinking frequently co-occur and represent significant health concerns amongst young women (Khaylis et al., 2009; Luce et al., 2007). Emotion dysregulation is commonly purported to underlie these maladaptive behaviours (see Ferriter & Ray, 2011 for review). The course of an emotional response can be differentiated into emotion reactivity, which refers to the initial intensity of emotional activation and emotion regulation, which refers to purposeful changes in the activated emotion (Gross & Thompson, 2007). These processes occur across subjective, behavioural and physiological response systems. As such, a comprehensive conceptualization of emotion processing in women with binge behaviour should include reactivity and regulation across response systems. Currently, support for emotion regulation theories of binge behaviour is mainly limited to the behavioural and experiential components of the emotional response. The current study examined psychophysiological emotion reactivity to normative emotional stimuli and conscious emotion regulatory ability amongst women who endorse binge behaviour.

Two main lines of evidence support emotion regulation theories of binge behaviour: emotions as antecedents of binge episodes and self-reported emotion regulation skill. In regards to binge eating, negative emotional states commonly precede binge episodes in daily life (see Haedt-Matt & Keel, 2011 for review) and experimentally-induced negative emotional states are associated with the desire to binge eat, increased food consumption and loss of control over eating in the laboratory (see Leehr et al., 2015 for review). In accordance with motivational accounts of alcohol use (Cooper et al., 1995), evidence suggests that both positive and negative emotional states may act as triggers for heavy alcohol consumption (Dvorak & Simons, 2014;

Simons et al., 2005). Amongst young people, positive emotion enhancement tends to play a greater role in heavy drinking as opposed to attempts to reduce negative emotions (Kuntsche, Knibbe, Gmel, & Engels, 2005). In support of the primacy of drinking to increase positive emotion in this age group, heavy drinking frequently occurs in celebratory contexts (e.g. Klein, 1992; Kairouz, Gliksman, Demers, & Adlaf, 2002) and enhancement motives are a strong predictor of hazardous drinking (Lyvers, Hasking, Hani, Rhodes, & Trew, 2010) whereas evidence of a link between heavy episodic drinking and coping motives is mixed (e.g. Rutledge & Sher, 2001; McCabe, 2002). Positive emotions may also contribute to binge drinking risk due to the interference of high unregulated positive affect on inhibitory control mechanisms or decreased perception of risks from heavy drinking, resulting in rapid, disinhibited consumption of alcohol (Haase & Silbereisen, 2011).

Research on competence to effectively regulate emotions also supports emotion regulation theories of binge behaviour. Based on self-report, women who binge eat tend to lack adaptive emotion regulation strategies, such as cognitive reappraisal (Svaldi et al., 2012; Whiteside et al., 2007) and may rely on maladaptive strategies such as the suppression of emotional expression (termed expressive suppression; Danner et al., 2014; Svaldi et al., 2012). This strategy may result in increased physiological arousal rather than the intended effect of decreasing arousal (Gross, 1998). There is also preliminary evidence that expressive suppression is associated with higher caloric intake; participants trained to use expressive suppression during an experimentally induced sad mood consumed more calories in a subsequent food tasting task than participants who were trained to use cognitive reappraisal (Svaldi et al., 2014).

The ability to accurately identify feelings and describe emotional experiences helps with the selection of appropriate regulation strategies; difficulties in these aspects of emotion

regulation predict binge eating in women with eating disorders and in non-clinical samples with bulimic symptoms (Vine & Aldao, 2014; Wheeler et al., 2005; Whiteside et al., 2007). Moreover, treatments targeting emotion regulation skills, such as dialectical behaviour therapy (DBT) for binge eating disorder (BED), are associated with improvement in self-reported emotion regulation skill and abstinence from binge eating (Wallace et al., 2014).

Similar to the findings for binge eating, self-reported lack of emotional clarity also predicts problematic alcohol use (Vine & Aldao, 2014) and, in combination with a lack of adaptive emotion regulation strategies, mediates the relationship between higher self-reported negative emotional intensity and coping drinking motives (Veilleux, Skinner, Reese, & Shaver, 2014). Given these findings of difficulties self-identifying emotional experiences, psychophysiological measures of emotion processes are particularly important to further understand the emotional experience and ability to regulate emotional intensity in women who binge eat or drink.

The current study aimed to test the hypothesis that women engage in binge behaviour in an attempt to regulate their emotional intensity due to deficits in regulatory ability. This was evaluated using two psychophysiological measures, the startle blink and corrugator muscle activity, that allow for the assessment of reactivity to emotional stimuli and regulation of negative and positive emotional states. In the startle blink paradigm, the size of a defensive blink reflex elicited by an abrupt stimulus (i.e. an aversive sound blast) is augmented when an aversive emotional state is active and decreased in magnitude when an appetitive emotional state is active (Lang, et al., 1990; Lang, 1995; Vrana, et al., 1988). This paradigm has been used to study the voluntary regulation of positive and negative emotions with measurable changes in startle magnitude associated with explicit instructions to alter the intensity of the emotional response in

non-clinical samples (e.g. Bernat et al., 2011; Dillon & LaBar, 2005; Driscoll et al., 2009; Jackson et al., 2000), in dependent smokers (Piper & Curtin, 2006) and based on type of emotion regulation strategy (Asnaani, Sawyer, Aderka, & Hofman, 2013). The resulting pattern of blink magnitudes indicates that the response is altered along the arousal rather than the valence dimension (i.e. larger blink magnitudes are observed when enhancing and smaller blink magnitudes are observed when decreasing emotional intensity of both negative and positive valence).

Similar to startle blink magnitude, corrugator supercilii muscle activity varies with intensity of negative and positive affect (Lang et al., 1993). Corrugator muscle activity occurs with facial expressions of distress, that is the drawing in and down of the eyebrows associated with frowning, and is sensitive to subtle emotional expressions that are not observable (Lang et al., 1993). Activity is greatest with negative emotional states and lowest with positive emotional states. In contrast to the startle blink, voluntary attempts to regulate emotion are associated with changes in corrugator activity along the valence dimension (i.e. corrugator activity is greater with attempts to enhance negative emotion and activity is lower with attempts to enhance positive emotion; Baur, Conzelmann, Wieser, & Pauli, 2015; Bernat et al., 2011).

Startle blink and corrugator activity have been used previously to study emotion reactivity to disorder specific and general emotional stimuli in bingeing populations. These studies reported normative responses to general affective images and negative responses to food images in women with bulimic symptoms (Altman et al., 2013; Drobes et al., 2001; Mauler et al., 2006). Positive responses to alcohol images were demonstrated in college age drinkers (Drobes et al., 2009). The effect of alcohol on emotion reactivity has also been examined using the startle probe. At high levels of alcohol intoxication, the startle response is reduced during viewing of

negative images with no effect on response during positive image viewing (Donohue, Curtin, Patrick, & Lang, 2007). A reduction in negative emotional reactivity as indexed by startle magnitude and/or corrugator has also been found at more moderate levels of intoxication under conditions of anxiety (Hefner et al., 2013) and under conditions of threat with competing cognitive demands (Curtin, Lang, Patrick, & Stritzke, 1998; Curtin, Patrick, Lang, Cacioppo, & Birbaumer, 2001). Interestingly, the effect of dampening anxiety was lower in binge drinking individuals. These studies provide support for emotion regulation theories of alcohol use by demonstrating the ability of alcohol to alter evoked emotional responses. However, to our knowledge no prior studies have applied these psychophysiological methods to conscious emotion regulatory attempts in women who engage in either binge eating or binge drinking.

In the current study, emotion reactivity and regulation to normative emotional stimuli was examined in four groups of young women: binge eating, binge drinking, binge-combined (endorsement of binge eating and binge drinking) and non-bingeing control women. No group differences were hypothesized in emotion reactivity based on prior work using similar methodology. Emotion regulation ability was hypothesized to differ between groups as follows:

1) Women who endorsed binge eating would demonstrate difficulty decreasing negative emotions relative to non-bingeing women.
2) Women who endorsed binge drinking would demonstrate difficulty regulating positive emotion compared to non-bingeing women. This would be evident as difficulty either maintaining or decreasing positive emotion.
3) Women who endorsed both binge eating and binge drinking would have greater emotional dysregulation than all other groups with difficulty decreasing both negative and positive emotion.

Emotion regulation strategies were also assessed and it was hypothesized that the Binge Eating and Binge-Combined groups would rely more on expressive suppression strategies. Eating and drinking motives were evaluated to characterize the motivations behind the different groups' eating and drinking habits. In accordance with the negative emotion regulatory deficits hypothesized for Binge Eating and Binge-Combined groups, these groups were predicted to endorse higher coping motives for eating. In accordance with the difficulties regulating positive emotions hypothesized for the Binge Drinking and Binge-Combined groups, these groups were predicted to endorse higher enhancement motives for drinking.

3.2 Methods

3.2.1 Power analysis

Based on an examination of the literature, a medium effect size of *f*=.25 was selected for the power analysis to determine the required number of participants to have power of .80 with an alpha of .05. As such, a study by Drobes and colleagues (2001) which compared the startle magnitude to food and affective pictures between binge eaters, deprived, restrained and control participants reported a medium effect size of d = .55 for the difference between binge and deprived compared to restrained and control participants in their startle magnitude to food pictures. Mauler et al. (2006) reported significantly larger startle responses elicited to food cues in those with bulimia than for control participants with an eta of .52. The effect size for the difference between suppress and maintain negative emotion conditions at a 7 second probe time was d = .57 (Jackson et al., 2000). The effect size for affective modulation at a 3 second probe time (unpleasant versus neutral) was d =1.17.

Since emotion regulatory ability is hypothesized to differ between groups depending on the image valence, the sample size to obtain an effect size of f =.25 at power of .80 and alpha of

.05 for a repeated measures ANOVA between-within interaction (Group x Regulation Condition) was calculated using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) for four groups (binge eating, binge drinking, combined bingeing and non-bingeing) with two measurements (decrease and maintain emotion), giving a total sample size of 72 (18 women per group). A study which used a similar design to examine emotion regulation in smokers in withdrawal had 24 participants per group (Piper & Curtin, 2006). Their post-hoc power analysis revealed that this gave them power of .98 to detect a medium effect size.

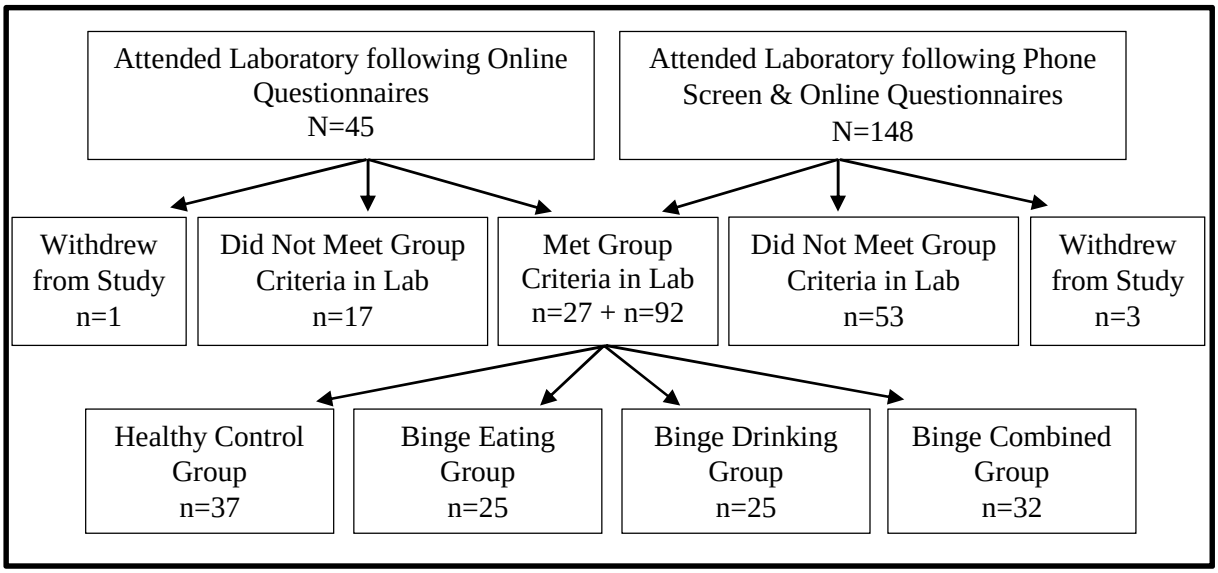
3.2.2 Participants

Female participants were recruited from the University of British Columbia Psychology Department Human Subject Pool, a psychology study list-serve and through posters on campus and in the community. An all-female sample was selected due to greater eating disorder risk in women and gender differences in emotion-motivated drinking (Jacobi, et al., 2004; Nolen-Hoeksema, 2012). Participants were invited to participate based on their responses to online or telephone screening questions pertaining to binge eating and drinking frequency in the past month and past year and contraindicators for EEG recording (i.e. head injury, neurological or cardiac conditions, bipolar disorder or psychotic illness, anti-psychotic or mood stabilizer use). Exclusion criteria included age <18 or >30 years, endorsement of EEG contraindications, or a possible anorexia nervosa diagnosis based on the Eating Disorder Diagnostic Scale (BMI cut-off of less than 17.5 as per EDDS; Stice et al., 2000) due to the potential detrimental effects of starvation on cognition (Zakzanis et al., 2010).

One-hundred nineteen university-age females met group inclusion criteria in the laboratory (See Figure 3.1 for participant selection flowchart). Participants received course credit

or remuneration for their participation. A list of community resources was provided to participants if requested.

Figure 3.1 Participant Flowchart



Note: Phone screen initially assessed for general eligibility criteria. Binge frequency questions were subsequently added to improve the efficiency of recruitment.

3.2.3 Procedure

Participants provided informed consent and study procedures were approved by the University of British Columbia Behavioural Research Ethics Board. Participants were screened using a brief telephone questionnaire if they were recruited from the community or several online questionnaires if they were student participants. Responses were used to invite those who potentially fell within our pre-defined groups for further testing with group assignment confirmed in the laboratory. The online battery was completed by all participants and also included assessment of eating (Eating Motives Questionnaires, EMQ; Jackson et al., 2003) and drinking motives (Drinking Motives Questionnaire, DMQ; Cooper, 1994). Participants were instructed to eat a minimum of two hours prior to the testing session and to abstain from alcohol

and illicit substances for 24 hours prior to the study. Participants who endorsed alcohol use in the past 24 hours were invited to participate on an alternate day. During set-up for EMG and EEG recording, participants completed the Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995).

Participants were provided with written examples of different eating scenarios to help them identify binge eating episodes (Goldfein, Devlin, & Kamenetz, 2005), which were defined as eating what other people would regard as an unusually large amount of food given the circumstances while feeling a loss of control (feeling that they could not stop eating or control what they were eating) at the time they were eating. Participants were also given examples to help them identify binge drinking episodes (four or more drinks within a 2-hour period; NIAAA, 2004), i.e. drinking the equivalent of at least 4 12-ounce/355 ml cans or bottles of beer, 4 five ounce/150 ml glasses of wine, or 4 drinks each containing one shot of liquor or spirits. Separate questionnaires assessed binge eating and drinking in the past 28 days (open-ended response), the past three and six months (weekly averages), and the past year (response options: “0 times in the past year”, “1 to 2 times in the past year”, “3 to 11 times in the past year”, “once a month”, “2 to 3 times a month”, “once a week”, “twice a week”, “3-4 times a week”, “5-6 times a week” and “Everyday”). The questions pertaining to frequency of objective binge eating episodes were drawn from the Eating Disorder Examination-Questionnaire (EDE-Q 6.0; Fairburn & Bèglin, 1994) and Eating Disorder Diagnostic Scale (EDDS; Stice et al., 2000) and the binge drinking questions were administered in a similar format. Participant responses were clarified as required. Group assignment to one of four groups was determined based on the binge behaviour questionnaires completed in the laboratory. Participants in the Binge Eating and Binge Drinking groups were permitted up to two binges of the other type within the past year and none in the

past month. Given the high rate of binge drinking in the student population (Wechsler et al., 2002), two binge drinking episodes in the past year were permitted in the Healthy Control group so as not to overly restrict recruitment. Multiple time frames were assessed to select participants with both recent and recurrent binge behaviour. Group criteria were as follows:

- Binge Eating (BE): a pattern of repetitive food binges over the past year as indicated by one or more food binge episodes in the past month and a minimum of weekly episodes in the past 3 or 6 months, or monthly food binge episodes in the past year.[3]

- Binge Drinking (BD): a pattern of repetitive alcohol binges as indicated by one or more alcohol binges in the past month and a minimum of weekly binges in the past 3 or 6 months, or monthly alcohol binge episodes in the past year.

- Binge-Combined (BC): fulfilled both the BE and BD criteria (i.e. endorsement one or more episodes of both types in the past month and a minimum of weekly episodes of both types in the past 3 or 6 months, or monthly episodes in the past year).

- Healthy Control (HC): no current bingeing behavior and two or less binges in the past year.

The binge drinking frequency criteria align with those used by the Canadian Community Health Survey (Statistics Canada Health Fact Sheet "Heavy Drinking, 2013") to assess prevalence of heavy drinking. The binge eating frequency criteria are similar to those used in a prospective examination of binge eating and depressive symptoms (Skinner, Haines, Austin, & Field, 2012).

3.2.3.1 Emotion regulation task

Nine practice trials preceded the start of the task to allow for initial habituation to the startle probe. The startle probe consisted of a 50 ms burst of 95 db white noise with near

[3] The criteria for BE were expanded to include: Two participants with only one past month alcohol binge and a repetitive pattern of binge eating in the past year, three participants with three to four alcohol binges in the past year (none in the past month) and a pattern of repetitive binge eating in the past year and one participant with no past month food binges, but weekly food binges in the past 3, 6 and 12 months.

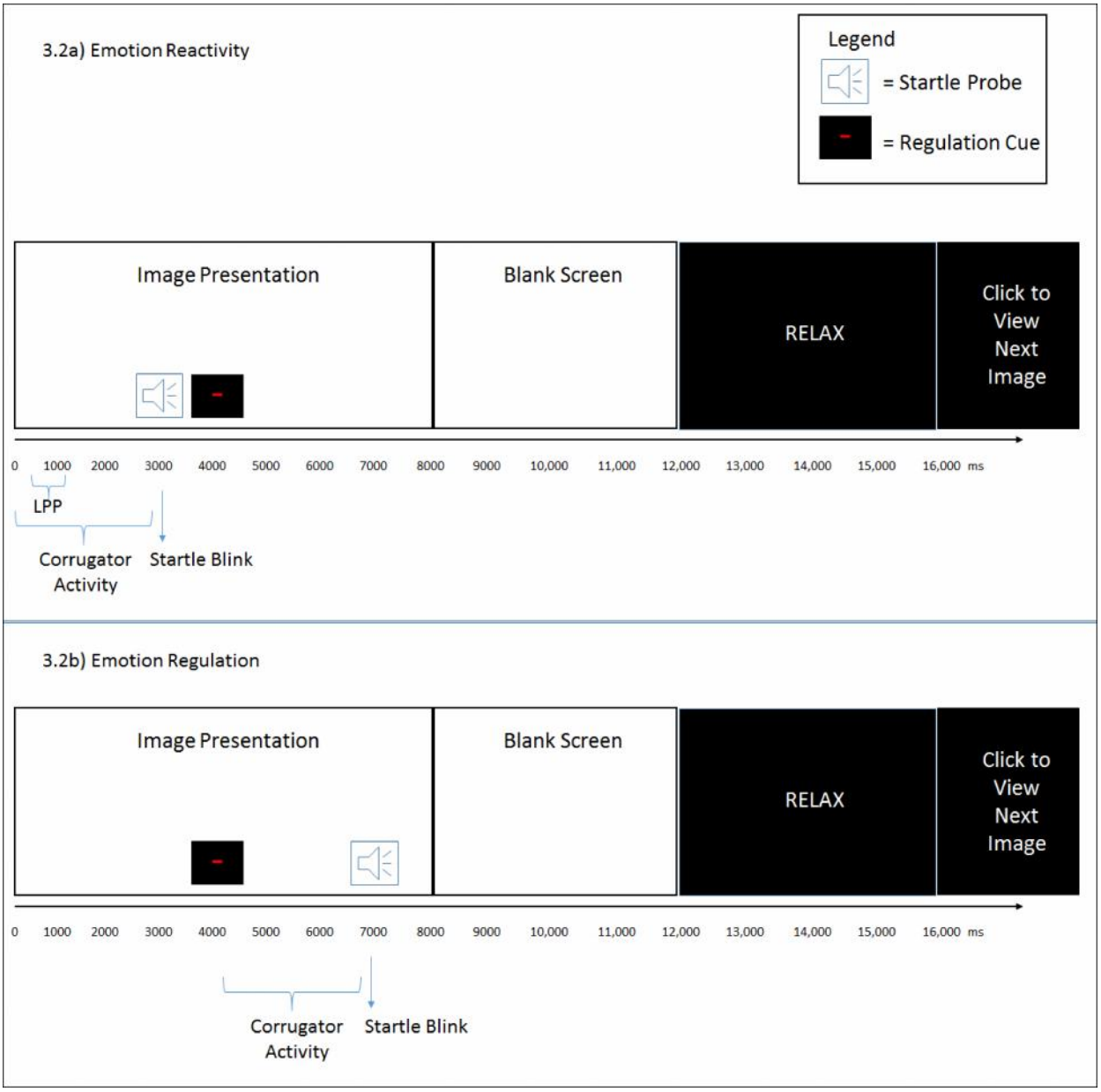
instantaneous rise-time generated using Audacity 1.3 Beta (Unicode) software. The startle probe was presented binaurally through ear insert head phones.

Ninety-six images (32 of each valence: positive, neutral and negative) from the International Affective Picture System (IAPS; Center for the study of emotion and attention [CSEA-NIMH], 1999) were presented in pseudo-random order separated into two blocks of 48 pictures[4]. Normative valence ratings significantly differed between valence categories (Positive M=7.56, SD=0.61; Neutral M=5.00, SD=0.23; Negative M=2.16, SD=0.61). The block order was counterbalanced across participants with a short break between blocks. The negative and positive valence conditions were matched for arousal within each block (Block 1 $t(30)=1.74$, $p=0.092$; Block 2 $t(30)=1.71$, $p=0.097$). The three picture valences (negative, neutral, positive) were crossed with two regulation instructions (decrease and maintain) and three probe conditions (no probe, 3 s and 7 s). The 3 s probe time assessed emotion reactivity and the 7 s probe time assessed emotion regulation. Figure 3.2 depicts the timeline of a typical trial, including the timing of emotion reactivity and regulation assessment. Each trial consisted of picture presentation (8 s duration) with a 100 ms visual regulation cue appearing at 4 s post-image onset, which consisted of a solid black box with a central red minus sign (decrease emotion) or a white equal sign (maintain emotion). Each picture presentation was followed by a blank screen (4 s duration; a startle probe occurred during four of these screens to increase startle

[4] **Block 1**: 7100^{M},1120^{D}, 7235^{D}, 1280^{M}, 3030^{M}, 4538^{D}, 9910^{M}, 7053^{M}, 2071^{M}, 8200^{D}, 9561^{M}, 1525^{D}, 7037^{D}, 5910^{D}, 5621^{M}, 9600^{M}, 2383^{D}, 1205^{D}, 8186^{M}, 7170^{D}, 5629^{M}. 3068^{M}, 3301^{D}, 7041^{M}, 4680^{D}, 7040^{M}, 6821^{D}, 6300^{M}, 4626^{M}, 4695^{M}, 7031^{D}, 7705^{M}, 7175^{D}, 6313^{D}, 7500^{D}, 7034^{M}, 2191^{M}, 7502^{D}, 6230^{M}, 8185^{D}, 3150^{D}, 8502^{D}, 2102^{M}, 2215^{D}, 4645^{M}, 2040^{M}, 4572^{D}, 9050^{D}; **Block 2**: 7059^{D}, 9250^{M}, 7056^{M}, 4689^{M}, 2345^{D}, 8030^{M}, 9181^{D}, 2100^{M}, 6150^{M}, 1300^{M}, 4677^{M}, 8540^{M}, 8210^{D}, 2575^{D}, 1270^{D}, 2305^{M}, 6550^{D}, 3100^{M}, 8370^{D}, 1710^{D}, 7020^{M}, 7547^{M}, 3000^{D}, 7010^{D}, 6571^{D}, 4542^{M}, 2190^{M}, 1463^{D}, 8490^{D}, 1220^{M}, 3101^{M}, 7036^{D}, 3160^{D}, 1930^{D}, 7550^{M}, 7030^{D}, 7050^{M}, 2070^{M}, 7052^{D}, 9611^{M}, 4608^{D}, 1440^{M}, 7025^{D}, 4533^{M}, 9435^{D}, 6260^{M}, 4660^{D}, 7140^{D}; M=Maintain Emotion; D=Decrease Emotion;

unpredictability), a screen with the word “RELAX” (4 s duration) and a screen prompting participants to push a button to view the next picture. There were four of each type of trial per block (e.g., four negative images, decrease emotion cue, 7 s probe time per block) for a total of eight trials of each type across the experiment. The number of trials per condition, duration of picture presentation and timing of startle probes were selected to reflect prior investigations, which reported significant emotion reactivity and regulation effects amongst healthy controls using these parameters (Jackson et al., 2000; Piper & Curtin, 2006). At the start of the task, the emotion regulation instructions were displayed on the computer screen and read aloud by the experimenter. Participants were free to choose their own regulation strategy with the exception that they were asked not to think of a different emotion or of something unrelated to the picture.

Figure 3.2 a) Emotion Reactivity Assessment b) Emotion Regulation Assessment



No subjective ratings of the images were recorded during the startle task; after the startle task was completed, participants viewed the images a second time and provided ratings for each image using a nine-point visual analogue scale with figures depicting displeasure to pleasure (valence rating) and calm to aroused (arousal rating) (IAPS Self-Assessment Manikin [SAM]: Bradley & Lang, 1994). Participants completed an emotion regulation strategy questionnaire

consisting of open-ended questions regarding strategies used for each of the regulation conditions (similar to that described by Jackson et al., 2000; see Appendix A).

3.2.3.2 Electromyographic recording: startle blink and corrugator activity

Electromyographic (EMG) data was acquired with a Brain Products Inc, QuickAmp 72 System. Data was recorded with Brain Vision Recorder and was processed offline with Brain Vision Analyzer (Brain Products, GmbH, Munich, Germany). The ground electrode was placed at the AFz site. Two Ag-AgCl 4-mm electrodes were placed on the *orbicularis oculi* muscle below the left eye to measure the startle blink response, and two were placed on the *corrugator supercilii* muscle above the left eye to measure corrugator activity. Data was sampled at 1000 Hz; target impedance was below 20kΩ (e.g. Larson, Ruffalo, Nietert, & Davidson, 2000); however, for participants for which this was unattainable, the study proceeded so long as there was a detectable signal. Signals were digitally filtered offline with butterworth zero phase filters with 30 Hz low cut off and 500 Hz high cut off, (startle: 48dB/octave roll-off startle; corrugator 24 dB/octave roll-off) with a 60 Hz Notch filter.

3.2.3.3 Data processing

Startle EMG was rectified then smoothed with a 20 ms moving average window. The startle data was baseline corrected using 50 ms prior to the startle probe. Startle magnitudes were manually scored as the peak activity between 15 and 120 ms after the startle probe. Trials were excluded if the blink began prior to 15 ms following the probe, if there was visible artifact, or if excessive noise was present during the baseline period or during the trial either obscuring accurate detection of the startle peak or resulting in failure of baseline correction. Trials with no detectable startle were scored as zero. Participants were excluded if there were <4 useable startle trials in each condition. Raw startle blink magnitudes were converted to within subject z-scores

prior to statistical analysis (Blumenthal et al., 2005). Any differences between the z-score and raw startle results are noted.

Corrugator EMG was rectified and visually inspected for artifact. Emotion reactivity was calculated as the mean activity (μV) in the 3 s post-image onset minus the mean activity 1 s preceding image onset. Emotion regulation was calculated as the mean activity in the 3 s post-emotion regulation cue minus the mean activity 1 s preceding image onset. Trials with a pre-emotion regulation cue startle probe were excluded from the corrugator emotion regulation analysis to prevent interference of the startle probe on the ongoing emotional response.

3.3 Results

3.3.1 Demographics

After removal of participants with unusable data due to startle non-response (Healthy Control group=1, Binge Eating group=3, Binge-Combined group=1), less than four startle trials per condition (Healthy Control group=6, Binge Eating group=6, Binge Drinking group=1, Binge-Combined group=1), computer error (Healthy Control group=2), corrugator recording issues (Healthy Control group=3), fatigue/inattention (Healthy Control group=3, Binge Eating group=1), and task confusion (Binge-Combined group=1), the final sample consisted of 90 participants (Healthy Control group=23, Binge Eating group=15, Binge Drinking group=24 and Binge-Combined group=28). Self-identified ethnicity was 58.9% European, 31.1% East Asian, 8.9% Indian-South Asian, and <5% African, Middle Eastern, Latin American-Hispanic; age M=21.33 years, SD=1.87. Based on the EDDS, in the Binge Eating group possible diagnoses were as follows: BN n=1; subthreshold BN n=10; BED n=1; subthreshold BED n=1; missing data n=2. In the Binge-Combined group: possible BN n=5; subthreshold BN n=18; possible BED n=2; subthreshold BED n=2; missing data n=1 (See Table 3.1 for binge endorsement). Separate

ANOVAs with significant effects followed up with pairwise comparisons were conducted using data from the EDE-Q, DASS-21, DMQ and EMQ to evaluate for potential group differences. EDE-Q scores tended to be higher in the Binge Eating and Binge-Combined groups compared to the Healthy Control and Binge Drinking groups (See Table 3.2). Body Mass Index (BMI), based on self-reported height and weight, was significantly higher in the Binge-Combined group compared to all other groups.

Table 3.1 Binge Data

Group (n)	Binge Days			
	Past Month		Past Year	
	Food M (SD)	Alcohol M (SD)	Food M (SD)	Alcohol M (SD)
Healthy Control (23)	0	0	0.52 (0.73)	0.20 (0.52)
Binge Eating (15)	7.47 (6.03)	0.20 (0.41)[1]	129.53 (98.75)	1.73 (2.25)
Binge Drinking (24)	0	3.58 (2.04)	0.31 (0.62)	42.92 (31.73)
Binge-Combined (28)	5.50 (5.65)	5.00 (2.91)	75.25 (66.82)	65.89 (49.56)

[1]Two participants endorsed one past month alcohol binge.

Table 3.2 Eating Disorder Examination-Questionnaire Scores

EDE-Q Scales M(SD)	Group			
	Healthy Control (n=23)	Binge Eating (n=13)	Binge Drinking (n=24)	Binge-Combined (n=28)
BMI (kg/m^2)[1]	20.86 (3.20)	19.72 (3.15)	20.32 (2.07)	23.65 (5.66)[4]
Restraint[2]	0.71 (1.11)	1.88 (1.73)	0.93 (1.18)	2.65 (1.84)
Eating Concern[3]	0.44 (0.73)	2.00 (1.90)	0.31 (0.62)	2.22 (1.55)
Shape Concern[3]	1.59 (1.34)	3.31 (1.58)	1.67 (1.46)	4.23 (1.51)
Weight Concern[3]	1.34 (1.37)	2.66 (1.91)	0.98 (1.20)	3.74 (1.54)
EDE-Q Total[3]	1.02 (1.00)	2.46 (1.62)	0.97 (0.98)	3.21 (1.42)

[1]Group Main Effect, $p<0.05$, Binge-Combined > Healthy Control, Binge Eating & Binge Drinking.

[2]Group Main Effect, $p<0.05$, Binge Eating>Healthy Control; Binge-Combined>Healthy Control & Binge Drinking.

[3]Group Main Effect, $p<0.05$, Binge Eating & Binge-Combined > Healthy Control & Binge Drinking.

[4]BMI data missing for two Binge-Combined participants.

In the final sample, one participant from the Binge Eating group and two from the Binge-Combined group endorsed anti-depressant/anti-anxiety medication use. As assessed by the

DASS-21, the Healthy Control group and the Binge Drinking group tended to score lower on Depression, Anxiety and Stress compared to the Binge Eating and Binge-Combined groups. Lower stress endorsed by the Healthy Control group compared with the Binge Drinking group approached significance, p=0.074 (see Table 3.3).

Table 3.3 DASS-21 Scores

	Group			
DASS Scale M (SD)	Healthy Control (n=23)	Binge Eating (n=15)	Binge Drinking (n=24)	Binge-Combined (n=28)
Depression[1]	7.22 (7.97)	12.40 (10.37)	5.33 (4.89)	11.00 (10.03)
Anxiety[2]	4.26 (4.80)	10.00 (7.64)	4.00 (3.37)	10.21 (8.75)
Stress[2]	8.17 (8.28)	17.60 (8.63)	12.42 (6.78)	17.14 (8.46)

[1]Main effect of Group, p=0.029, Binge Drinking < Binge Eating & Binge-Combined.

[2]Main effect of Group, p<0.001, Healthy Control & Binge Drinking < Binge Eating & Binge-Combined.

. See Table 3.4 for consumption motives. Groups with binge eating (Binge Eating and Binge-Combined) endorsed higher levels of coping and conformity eating motives compared to the non-binge eating groups (Healthy Control and Binge Drinking). The binge drinking groups (Binge Drinking and Binge-Combined) endorsed greater coping, social and enhancement drinking motives compared to the non-binge drinking groups (Healthy Control and Binge Eating). Within the binge drinking groups (Binge Drinking and Binge-Combined), social and enhancement motive endorsement was significantly greater than coping and conformity motives.

Table 3.4 Eating and Drinking Motives

	Group			
EMQ M (SD)	Healthy Control (n=23)	Binge Eating (n=13)	Binge Drinking (n=24)	Binge-Combined (n=28)
Coping[1]	1.78 (0.78)	2.98 (1.27)	1.93 (0.68)	3.18 (0.90)
Social	3.07 (1.20)	3.42 (0.81)	3.30 (0.86)	3.16 (1.02)
Conformity[2]	1.38 (0.55)	2.14 (1.14)	1.40 (0.64)	2.10 (0.90)
Pleasure	2.96 (1.06)	3.38 (0.77)	3.17 (0.69)	3.49 (0.75)
DMQ	(n=13)	(n=10)	(n=23)	(n=28)
Coping[3]	1.15 (0.23)	1.34 (0.44)	2.06 (0.72)	2.79 (0.88)
Social[4]	2.12 (0.89)	2.64 (0.95)	3.61 (0.69)	3.72 (0.94)
Conformity	1.26 (0.44)	1.68 (1.26)	1.59 (0.71)	1.73 (0.79)
Enhancement[4]	1.29 (0.47)	1.46 (0.72)	3.50 (0.91)	3.46 (0.89)

[1]Main Effect of Group, $p<0.001$; Binge Eating & Binge-Combined > Healthy Control & Binge Drinking

[2]Main Effect of Group, $p=0.002$; Binge Eating & Binge-Combined > Healthy Control & Binge Drinking

[3]Main Effect of Group, $p<0.001$; Binge-Combined > Binge Drinking > Healthy Control & Binge Eating

[4]Main Effect of Group, $p<0.001$; Binge-Combined & Binge Drinking > Healthy Control & Binge Eating

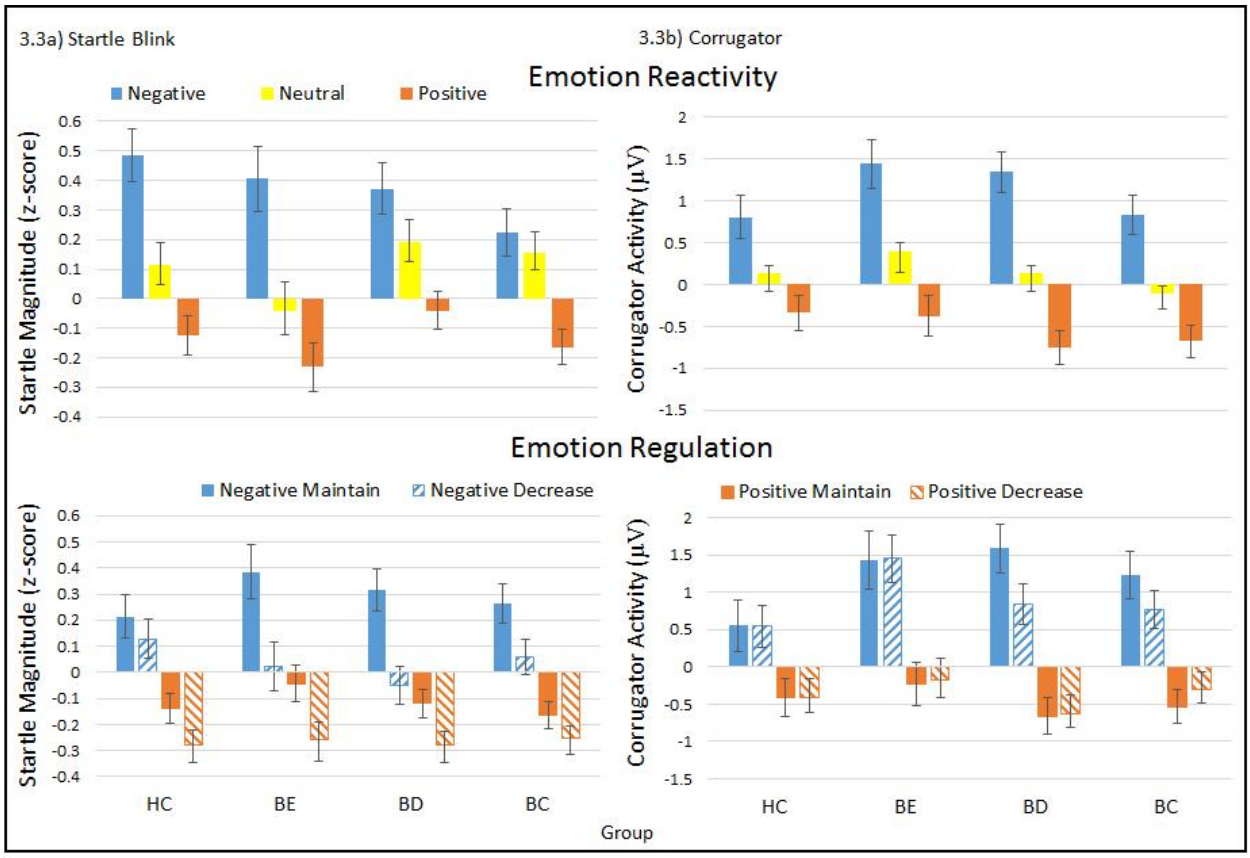
3.3.2 Emotion reactivity

To examine emotion reactivity within and across groups, two separate mixed design ANOVAs with Valence (Negative, Neutral, Positive) as the within subject factor and Group (Healthy Control, Binge Eating, Binge Drinking, Binge-Combined) as the between subject factor were conducted with z-score startle (from 3s probe) and mean corrugator activity (from the 3s period post-image onset)[5] as the respective dependent variables. In both analyses, there was a significant main effect of Valence, Startle: Wilk's lambda=0.51, $F(2,85)=40.19$, $p<0.001$, $\eta_p^2=0.49$; Corrugator: Wilk's lambda=0.49, $F(2,76)=40.37$, $p<0.001$, $\eta_p^2=0.52$. Pairwise

[5] Corrugator outliers, defined as raw data scores greater than three times the inter-quartile range, were excluded from all corrugator analyses (HC=3, BD=2, BC=4).

comparisons for both dependent measures were significant between Valence conditions, with Negative>Neutral>Positive, $p<0.001$, (See Figure 3.3 top panels). The main effects of Group and the Group by Valence interactions were non-significant, $p>0.05$.[6]

Figure 3.3 a) Startle Blink b) Corrugator Activity



Note: HC=Healthy Control group; BE= Binge Eating group; BD=Binge Drinking group; BC=Binge-Combined group. Error bars represent standard error. Significant Valence main effect for both Startle and Corrugator Emotion Reactivity: Negative>Neutral>Positive. Significant Regulation main effect for Startle: Maintain Emotion > Decrease

[6] There were no outliers for the z-score startle analysis. For the raw startle analysis with exclusion of startle outliers, final n=84, there was a significant main effect of Group for emotion reactivity, $F(3,80)=2.72$, $p=0.05$, $\eta_p^2=0.09$, and emotion regulation, $F(3,80)=2.67$, $p=0.05$, $\eta_p^2=0.09$. Follow-up tests indicated that BE and BD had larger raw startle responses compared to HC.

Emotion; Significant Regulation by Valence interaction for Corrugator: Maintain Negative Emotion > Decrease Negative Emotion. No significant Group main or interaction effects for Reactivity or Regulation measures.

3.3.3 Emotion regulation

Two three way mixed-design ANOVAs were conducted to evaluate the effect of Group (Healthy Control, Binge Eating, Binge Drinking, Binge Combined), Valence (Negative, Positive) and Regulation Condition (Decrease, Maintain) on emotion regulation as assessed by the z-score startle (7 s probe) and mean corrugator activity (3 s period post-regulation cue). The neutral valence condition was excluded as, across participants, responses on the emotion regulation strategy questionnaire reflected confusion about how to regulate a neutral emotion. For the startle analysis, there was a significant main effect of Valence, Wilk's lambda=0.47, $F(1,86)=98.68$, $p<0.001$, $\eta_p^2=0.53$, with Negative>Positive, $p<0.001$. The main effect of Regulation was also significant, Wilk's lambda=0.77, $F(1,86)=25.86$, $p<0.001$, $\eta_p^2=0.23$. Pairwise comparison revealed that Maintain>Decrease, $p<0.001$ (See Figure 3.3a bottom left panel). There were no significant main or interaction effects with Group. For the corrugator analysis, the main effect of Valence was also significant, Wilk's lambda=0.57 $F(1,77)=58.89$, $p<0.001$, $\eta_p^2=0.43$, with Negative>Positive, $p<0.001$. The main effect of Regulation was non-significant, $p>0.05$. There was a significant Valence by Regulation interaction, Wilk's lambda=0.93, $F(1,77)=5.44$, $p=0.022$, $\eta_p^2=0.07$. A follow-up ANOVA within Negative Valence revealed a significant main effect of Regulation, Wilk's lambda=0.93, $F(1,77)=5.94$, $p=0.017$, $\eta_p^2=0.07$ with Maintain>Decrease (see Figure 3.3b bottom right panel). The main effect of Group and Group by Regulation interaction were non-significant. A follow-up ANOVA within Positive Valence had no significant main or interaction effects.

3.3.4 Regulation strategies

The open-ended responses on the emotion regulation strategy questionnaire were classified into the following categories: visual attention (e.g. focusing visual gaze on more/less salient aspects of image, looking at details versus taking in the whole image), looking away/closing eyes, cognitive reappraisal (e.g. changing self-relevance, changing perspective, objectifying image, imagining outcome), focusing on emotions/thoughts (e.g. labelling emotions, thinking of cause of emotions, repetition of thoughts pertaining to the emotion), ignoring/suppressing emotions/thoughts, manipulating facial expression, breathing, other (e.g. self-talk, self-calming without specifying specific strategy) or none (e.g. continuing to respond naturally). As the ability to decrease negative emotions or maintain positive emotions pertained to our hypotheses, strategies for these conditions are presented in Table 3.5. For Decrease Negative, chi-square tests indicated that strategies did not significantly differ between groups; cognitive reappraisal was most often endorsed followed by visual attention and breathing. For Maintain Positive, chi-square tests indicated that strategies did not significantly differ between groups, focusing on the emotion/thought followed by visual attention were the main strategies identified.

Table 3.5 Emotion Regulation Strategies

	Healthy Control (n=23)	Binge Eating (n=15)	Binge Drinking (n=24)	Binge-Combined (n=28)
Strategy	Decrease Negative Emotion			
Visual Attention	5	5	11	10
Look Away	3	2	3	1
Cognitive Reappraisal	11	10	11	15
Focused on Emotion or Thought	0	0	0	2
Ignored / Suppressed Emotion or Thought	2	2	8	6
Facial Expression	2	2	1	0
Breathing	5	2	7	9
Other	4	1	0	2
Strategy	Maintain Positive Emotion			
Visual Attention	7	5	11	10
Cognitive Reappraisal	3	3	2	4
Focused on Emotion or Thought	8	5	13	11
Facial Expression	1	2	3	4
Breathing	1	0	0	0
Other	1	2	0	1
None	5	1	1	5

Note: Values represent the number of participants endorsing that strategy. Participants could provide multiple responses.

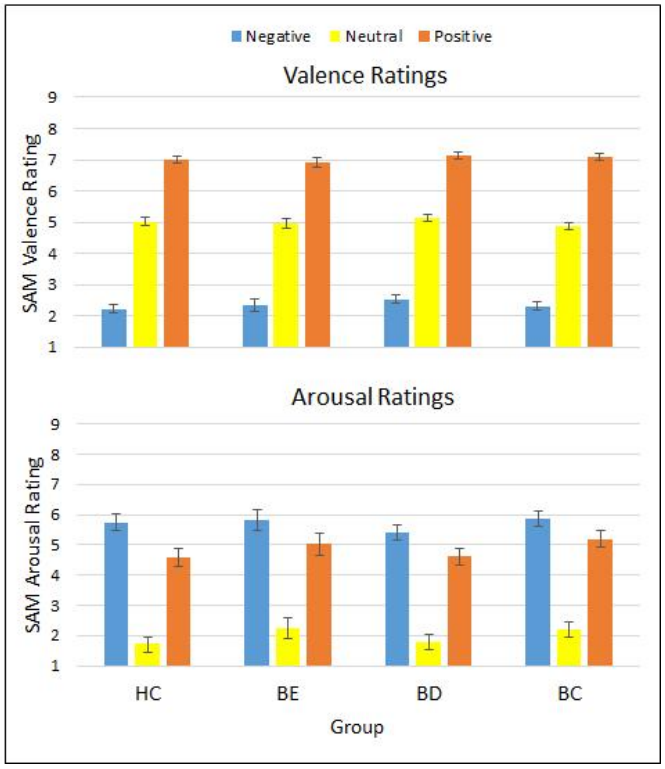
3.3.5 Image ratings

Valence and arousal ratings were examined with two separate two-way mixed-design ANOVAs to evaluate the effect of Group (Healthy Control, Binge Eating, Binge Drinking, Binge Combined) and Valence (Negative, Neutral, Positive) for both dependent variables (valence and arousal).[7] There was a main effect of Valence on valence ratings, Wilk's lambda=0.05, $F(2,84)=764.44$, $p<0.001$, $\eta_p^2=0.95$. There were no significant Group main or interaction effects. Across groups, valence ratings followed the expected pattern of Negative<Neutral<Positive (see

[7] Image rating data was missing for one BE participant who completed the SAM ratings incorrectly, marking valence and arousal ratings on the same scale.

Figure 3.4 upper panel). The main effect of Valence on Arousal ratings was also significant, Wilk's lambda=0.12, $F(2,84)=315.28$, $p<0.001$, $\eta_p^2=0.88$, with Negative>Positive>Neutral (Figure 3.4 lower panel).

Figure 3.4 Image Ratings



Note: HC=Healthy Control group; BE=Binge Eating group; BD=Binge Drinking group; BC=Binge-Combined group

3.4 Discussion

The current study aimed to elucidate emotion reactivity and regulation in response to general emotional stimuli in women with binge behaviours. Self-reported levels of recent depression, anxiety and stress indicated that the groups characterized by binge eating (Binge Eating & Binge-Combined) tended to have a higher level of affective distress compared to the non-binge eating groups (Binge Drinking & Healthy Control). This is in line with prior reports of

higher trait neuroticism in college students who binge eat with/without co-morbid binge drinking compared to binge drinking and non-bingeing individuals (Rush, Becker & Curry, 2009).

Differences in general distress did not translate into differences in level of evoked negative emotion in the current study. As predicted, emotion reactivity was comparable across groups on psychophysiological measures and self-report. Startle blink magnitudes and corrugator activity followed a linear pattern with the largest responses to images of negative valence and the smallest for images of positive valence. Similarly, valence ratings were lowest for negative images and highest for positive images. These findings are in line with prior reports in eating disordered and college drinking samples (Drobes et al., 2001; Drobes et al., 2009; Mauler et al., 2006) and indicate that women with bingeing behaviour demonstrate comparable intensity of emotional response to general emotional stimuli in physiological and subjective domains. This suggests that the lack of emotional clarity identified in eating disordered and problematic drinking samples in prior work may pertain to a deficit in labelling of emotional experience beyond the general categorization of degree of pleasure versus displeasure (Kashdan, Feldman Barrett, & McKnight, 2015). Alternatively, the lack of clarity may be limited to emotional states generated by internal phenomena such as rumination or those evoked in interpersonal situations.

Hypothesized group differences in emotion regulation ability were not supported; emotion regulation ability as indexed by startle blink magnitude, corrugator activity or self-reported strategy did not differ between groups. The pattern of startle blink regulation followed the arousal dimension with larger startle magnitudes observed for Maintain versus Decrease trials for negative and positive valence images in line with prior work (Bernat et al., 2011; Dillon & LaBar, 2005). For corrugator activity, across groups successful regulation was limited to negative valence images; regulation of positive emotion was not supported. Limited prior work

using the corrugator to assess positive emotion regulation suggests that a larger discrepancy in evoked emotion (i.e. a comparison between an enhanced and suppressed emotional state) may be required for detectable differences (Baur et al., 2015; Bernat et al., 2011; Reynaud, El-Khoury-Malhame, Blin, & Khalfa, 2009). Emotion elicitation methods that evoke a greater level of positive emotion in the laboratory may be needed to help overcome this limitation in the use of corrugator as a measure of positive emotion regulation.

Contrary to expectation, emotion regulation strategies also did not differ between groups, with cognitive reappraisal endorsed most frequently followed by visual attention and breathing strategies for the down-regulation of negative emotion. In contrast to the trait-based literature on emotion regulation strategies, expressive suppression was not favoured by the binge groups. This suggests that the strategies utilized in our laboratory task may have limited generalizability or may pertain to different emotions than those implicated in binge behaviour. It is also possible that the overall level of psychopathology in our primarily sub-clinical sample was insufficient to impact regulation strategy choice. Greater recent distress was endorsed by the groups with binge eating compared to the other groups, and their overall level of eating pathology was also higher. However, with the exception of anxiety in the Binge Eating group (with 53% of participants endorsing Moderate to Extremely Severe levels of anxiety), the majority of participants within the disordered groups scored within the normal to mild range on the DASS scales. Though the majority of participants fell below the clinical cut-off of 4 on the EDE-Q Total scale (Luce, Crowther, & Pole, 2008), within the Binge-Combined group, 64% scored above the cut off on Shape Concern and 57% were above the clinical cut off on Weight Concern, suggesting the presence of significant ED pathology in this group. However, averages for all groups were below clinical levels for Depression. Therefore, if severity of depressive symptoms, rather than

symptoms of eating pathology, had a greater influence on emotion regulation strategies, then our sample would not be expected to demonstrate group differences. Further work is needed to identify the relative contributions of depression versus eating pathology on self-reported emotion regulation strategies. Furthermore, an experience sampling methodology may also provide information about the type of strategies used in daily life (rather than in the lab) and the extent to which strategy choice is affected by depression versus eating pathology (Brans, Koval, Verduyn, Lim, & Kuppens, 2013; Heiy & Cheavans, 2014).

In contrast to the lack of group differences in emotion regulation strategies and psychophysiological emotion regulation indices, hypotheses for eating and drinking motives were supported. In line with expectation, the binge eating groups endorsed greater coping and conformity motives. While the endorsement of coping motives is in keeping with emotion regulation theories of binge eating, the lack of other significant group differences in emotion regulation variables in the current study suggests that future psychophysiological investigations should consider emotion type and the context of regulation efforts. In keeping with prior work (Kunstche et al., 2005), the binge drinking groups tended to endorse social and enhancement motivations for drinking; however, these differences did not translate into positive emotion regulation differences in the laboratory.

3.4.1 Limitations and future directions

Significant variability in startle magnitude and corrugator activity within groups, and startle data loss due to excessive blinking, movement, high impedance and non-response may have limited our ability to detect significant group differences. Examination of group means suggest two avenues to be explored in future research. First, as evident in Figure 3.3, the binge groups appeared to retain emotional intensity from the emotion reactivity assessment (at 3 s) to

the Maintain Negative emotion assessment (at 7 s) whereas in the Healthy Control group there was a large decline in intensity of response between the 3 and 7 second probes. As such, the Healthy Control group appeared to experience a natural attenuation of emotional intensity over the course of the trial while the response duration was extended in binge groups. If this speculation is supported, while the intensity of *initial* response may not differ by binge status, women who binge may experience more enduring emotional responses. The natural decline in emotional intensity in the Healthy Control group likely limited our ability to detect group differences in effortful regulation later in the course of the picture viewing period. Therefore, future work should systematically vary the startle probe times and use more fine-grained subjective ratings presented at multiple time points following image onset to ascertain the duration of response and timing of emotion regulation efforts.

Second, given previous findings that startle regulation follows the arousal dimension and corrugator regulation follows the valence dimension (Bernat et al., 2011; Dillon & LaBar, 2005), the different patterns between startle and corrugator regulation suggest that binge eating women may differ in their ability to specifically regulate the arousal compared to the valence dimension of emotional response. As such, negative emotion regulation as assessed by corrugator was suggestive of a lack of regulation in the Healthy Control group and in the two groups with binge eating. As mentioned above, we speculate that in the Healthy Control group this likely reflects a floor effect due to a natural decrease in intensity over time such that there was minimal emotion to be regulated by the time of the regulation probe. In the binge eating groups, it appears that they were able to effectively regulate their negative emotional responses on the arousal dimension (based on their startle regulation) whereas the level of negative valence as measured by corrugator remained high across Maintain and Decrease negative emotion conditions. Future

work should examine the natural time course of valence and arousal response in binge eating groups and how these dimensions are altered by voluntary emotion regulation attempts.

The lack of group differences may also have been due to the type of emotion elicited and the absence of food or alcohol as an alternate means of regulating the evoked emotional states. The startle blink is considered most useful for the assessment of highly arousing emotional states, particularly fear and disgust (Bernat et al., 2006). Other emotional states, which were not likely elicited by the picture viewing task, such as anger, guilt, shame, or loneliness may have a more prominent role in eating disorder pathology (Overton et al., 2005; Zeeck, Stelzer, Linster, Joos, & Hartman, 2011). Future work focused on these emotional states using different emotion elicitation methods may identify disruption in conscious emotion regulation as indexed by psychophysiological measures. The lack of group differences in emotion regulation may also indicate that the binge stimulus (food or alcohol) may need to be present in concert with a negative or positive mood state to create a desire to binge and disrupt or subvert adaptive emotion regulation strategies. This speculation is supported by prior findings of an increase in self-reported urge to eat following negative mood induction that was only found when a favourite food was presented following mood induction in women with a disinhibited eating style (Loxton, Dawe, & Cahill, 2011). In regards to binge drinking, the interaction between emotional state and the physiological effect of consuming alcoholic beverages may be required to disrupt cognitive processes (Curtin & Lang, 2007), possibly including cognitive regulation strategies. Thus, future work should explore the ability to continue to engage in cognitive reappraisal strategies when the binge stimulus is administered or is available as an alternate method to regulate emotional state.

Finally, the current study did not track visual gaze, therefore, the extent to which emotion activation may have been reduced during the Maintain emotion condition due to deliberate or inadvertent shifting of gaze from arousing aspects of negative images is undetermined (Urry, 2010). Unaccounted for differences in visual gaze may have resulted in smaller differences in response magnitudes between maintenance and emotion reduction conditions; however, there is no a priori reason to expect that gaze would differ across groups.

3.4.2 Conclusion

The current study utilized a previously validated paradigm to examine emotion reactivity and regulation in young women with binge eating and drinking behaviour. Results suggest that intensity of emotional response is not affected in women who binge; however, the duration of response warrants further investigation. A broad deficit in emotion regulation ability was not supported. Future work should employ more finely grained timing of psychophysiological probes and emotion elicitation materials associated with interpersonally-relevant emotions and higher intensity positive emotion, to ascertain whether, and under what circumstances, emotion regulation is disrupted in women with binge behaviour.

Chapter 4: Study Three

4.1 Introduction

Emotions are conceptualized as coordinated responses across behavioural, experiential and physiological systems. Response coherence amongst these systems has been investigated in relation to psychopathology such as alcohol use (Chaplin, Hong, Bergquist, & Sinha, 2008; Glautier et al., 2001; Miranda et al., 2002; Miranda et al., 2003), disordered eating (Hilbert et al., 2011; Tuschen-Caffier & Vogele, 1999), borderline personality disorder (Elices et al., 2012), alexithymia (Eastabrook et al., 2013), generalized anxiety disorder (GAD; Hubert & DeJong Meyer, 1990), major depressive disorder (Gehricke & Shapiro, 2000), phobic fear (Schaefer et al., 2014) and internalizing symptoms (Lanteigne et al., 2014). Response coherence varies by type of psychopathology and the response systems assessed. Whereas low coherence between experience and physiology is implicated in alexithymia (e.g. Eastabrook et al., 2013), disordered eating (Hilbert et al., 2011; Tuschen-Caffier & Vogele, 1999) and borderline personality disorder (Elices et al., 2012), greater coherence amongst response systems is implicated in psychopathology characterized by intense fear or anxiety (e.g. Hubert & DeJong Meyer, 1990; Schaefer et al., 2014). Strength of coherence may also pertain to trait tendencies to utilize specific emotion regulation strategies or to experience negative affect (Lanteigne et al., 2014). These findings suggest that examination of response coherence in young women with binge behaviour may help to clarify the relationship between emotional states and engagement in these behaviours.

Coherence between subjective experience and the psychophysiological measures utilized in study two, namely startle blink magnitude and corrugator activity, and an additional measure (the late positive potential; LPP) has yet to be examined in young women with binge behaviour.

The current study investigated response coherence between these psychophysiological measures, and their subjective experience counterparts of self-reported pleasure-displeasure (i.e. valence) and intensity of activation (i.e. arousal) in this population. Prior work utilizing autonomic reactivity measures or trait-based assessments of emotional awareness and expression suggest that emotion response coherence may be disrupted in women who engage in binge eating episodes (e.g. Danner et al., 2014; Hilbert et al., 2011; Whiteside et al., 2007). A lack of coherence between subjective experience and psychophysiological processes could help explain the commonly reported difficulty identifying feelings in this population and contribute to susceptibility to engage in maladaptive behaviour during negative affective states (Whiteside et al., 2007). Anticipated relationships amongst psychophysiology and subjective experience in binge drinking young women are less clear due to mixed findings in this population. As emotion induction context and measurement technique influence response coherence (Bradley & Lang, 2007), the current study examined coherence within the context of a picture viewing paradigm. This paradigm is one of the most frequently utilized in prior studies of response coherence. Anticipated relationships amongst the psychophysiological measures and subjective experience are reviewed in the subsequent sections.

In regards to the valence dimension of the emotional response, corrugator muscle activity has small to medium associations with self-reported valence across a variety of emotional stimuli (Brown & Schwartz, 1980; Jäncke, 1996; Johnson, et al., 2010; Lang et al., 1993; Larsen et al., 2003). Corrugator activity appears to reflect the degree of displeasure-pleasure evoked by the picture stimulus and emotional expression (Dimberg et al., 2002; Lee et al., 2009). Attenuated response coherence between valence ratings and corrugator activity may, therefore, reflect a discrepancy between subjective experience and emotional expression.

Similar to corrugator, image valence modulates the startle blink response. However, startle blink magnitude is also affected by arousal, which is considered indicative of the extent of activation in aversive and appetitive motivational systems (Bradley et al., 2001; Cuthbert et al., 1996). Intensity, a combination of rated valence and arousal, was developed by some researchers (Bernat et al., 2006). Associations between intensity and startle blink were generally small, but tended to be larger and more consistent within the negative valence condition than within the positive valence condition. Overall, these findings suggest that startle modulation within negative and positive valence conditions correlates with rated arousal. Therefore, attenuated coherence between startle magnitude and arousal ratings may reflect low coherence between subjective experience and activation of basic motivational systems.

The third index of response coherence examined in this study is between arousal ratings and a positive-going centro-parietal ERP waveform beginning 300-400 ms post-picture onset termed the LPP (Cuthbert et al., 2000). The LPP is thought to be an index motivational significance as it is larger for emotional compared to neutral stimuli and for images which are associated with higher arousal ratings and sympathetic arousal (Codispoti et al., 2007; Cuthbert et al., 2000; Lang & Bradley, 2009; Leite et al., 2012; Schupp et al. 2000). Neuroimaging findings suggest that the LPP may reflect elaborated processing in the extra-striate visual cortex with re-entrant processing from the amygdala (see Lang & Bradley, 2010 for review). LPP magnitude is affected by emotion regulation efforts (see Hajcak et al., 2010 for review) and is reduced in individuals with heightened anxiety in response to aversive stimuli, which is thought to reflect avoidance of the aversive stimulus (vigilance-avoidance model; Mogg et al.; Weinberg & Hajcak, 2011). Attenuated coherence between LPP magnitude and rated arousal may,

therefore, reflect attentional disengagement and decreased perceptual processing of arousing stimuli.

Findings from self-report and autonomic reactivity measures suggest that coherence amongst measures reviewed in the preceding sections may be attenuated in women who engage in binge eating behaviour. Trait-based questionnaires indicate that women who engage in binge eating have difficulty identifying and describing their emotional experiences (Vine & Aldao, 2014; Wheeler et al., 2005; Whiteside et al., 2007). This suggests that they may have difficulty interpreting and imputing meaning to the physiological changes associated with emotional responses. Studies utilizing interpersonal stressor tasks have reported a divergence between physiological response (cardiac reactivity and electrodermal activity) and self-reported feelings in eating disordered populations; eating disordered women tended to provide higher ratings of negative affect while their physiological responses generally did not differ from non-eating disordered women (e.g. Hilbert et al., 2011; Tuschen-Caffier & Vogele, 1999). An attenuation of coherence between corrugator activity and valence rating is also suggested by prior findings of a tendency to suppress emotional expression in women who binge eat (Danner et al., 2014; Svaldi et al., 2012).

Contrary to the findings reviewed above, emotion reactivity indexed by startle response, corrugator activity and self-report image ratings has not been found to differ between bingeing and non-bingeing women based on comparisons of group means (Drobes et al., 2001; Mauler et al., 2006; study two). Such group comparisons may lack sensitivity to detect alterations in coherence. A correlational approach rather than a group-based comparison may provide a more sensitive method to examine coherence.

The evidence for emotion response coherence amongst young women with binge drinking behaviour is mixed. Findings from two prior startle blink investigations provide discrepant accounts of response coherence and alcohol use based on comparisons of group means. In a university sample, Miranda and colleagues (2002) found that participants with a positive family history of alcoholism had reduced startle potentiation during negative image viewing compared to participants with a negative family history. In contrast, subjective reports of valence and arousal were similar across family history status. The lack of startle potentiation in family history positive participants was partially accounted for by self-reported psychological distress. A second study comparing men without alcohol dependence to men with alcohol dependence with and without co-morbid anti-social personality disorder found that startle potentiation during negative image viewing was reduced only in the group with alcohol dependence and co-morbid personality disorder (Miranda et al., 2003). No group differences in self-reported valence or arousal were found suggesting low coherence between startle response and subjective experience only in men with greater psychopathology.

Regarding coherence between corrugator and self-reported valence, Glautier and colleagues (2001) found a trend for greater corrugator activity in participants classified as heavy drinkers compared to light drinkers with comparable self-reported valence across groups. Turning to the trait-based literature, alexithymia, which includes difficulty identifying feelings, has been inconsistently associated with binge drinking in young college-age women. Bauer and Ceballos (2014) did not find a difference in alexithymia between college women who frequently versus infrequently binge drank. It has also been suggested that binge drinking and alexithymia may only be associated in a subset of young women, such as those who are high in positive or

negative urgency (Shishido et al., 2013) or who endorse drinking to cope with negative affect (Lyvers et al., 2012).

In study two, we did not find evidence of dissimilarity in psychophysiological or subjective report of emotion reactivity between groups based on examination of group means. As well, endorsement of inhibition of facial expressions of emotion as an emotion regulation strategy did not differ by binge group. However, the extent of dimensional association between subjective experience and emotional reactivity and the spontaneous inhibition of facial expressions is unclear from the results of study two. As such, the current study aimed to identify whether women who provided higher valence or arousal ratings also tended to show higher levels of activity in corresponding psychophysiological indices. To address this issue, correlations between the psychophysiological measures and subjective experience ratings outlined above were examined within the four groups described in study two. Specifically, non-bingeing healthy control women, binge eating women, binge drinking women and women with both binge eating and binge drinking behaviour (binge-combined). Within the Healthy Control group, the following hypotheses were put forth:

1) Corrugator activity would be negatively associated with valence ratings within valence categories (i.e. larger corrugator activity would be associated with higher unpleasantness ratings and smaller corrugator activity would be associated with higher pleasantness ratings).
2) Startle activity would be positively associated with arousal ratings within valence categories (i.e. larger startle responses would be associated with higher arousal ratings).
3) The late positive potential evoked during viewing of negative and positive valence images would positively correlate with arousal ratings within negative and positive

valence categories (i.e. higher arousal ratings would be associated with greater LPP magnitudes).

Given previous reports of lack of emotional clarity in binge eating women, it was hypothesized that the correlations between self-report ratings of emotional experience and psychophysiological emotion measures outlined above would be attenuated in women with binge eating compared to non-bingeing women. For binge drinking women, it was hypothesized that only the association between startle and arousal ratings would be attenuated based on the prior startle findings in young adults with a family history of alcoholism (Miranda et al., 2002).

4.2 Methods

4.2.1 Participants

Data from the 90 participants meeting criteria for one of the four groups (Healthy Control, Binge Eating, Binge Drinking or Binge-Combined) with useable startle and corrugator data in study two was evaluated for inclusion in the current study. After removal of corrugator outliers (Healthy Control group=3; Binge Drinking group=1), bivariate outliers (Healthy Control group=1; Binge Drinking group=1; Binge-Combined group=1), image rating outliers (Binge Drinking group=1), incorrectly completed image ratings (Binge Eating group=1), and EEG recording issues (Binge Eating group=1; Binge-Combined group=1), the final sample consisted of Healthy Control group=19, Binge Eating group=13, Binge Drinking group=21 and Binge-Combined group=25. The mean age of the sample was 21.35 years (SD=1.92). Endorsed ethnicity was 60.3% European, 33.3% East Asian, 9% Indian-South Asian, other ethnicities (Middle Eastern, Latin American-Hispanic) were endorsed at <5%. Based on the EDDS (Stice et al., 2000), in the Binge Eating group possible diagnoses included: BN n=0; subthreshold BN n=10; BED n=1; subthreshold BED n=1 and missing data n=1. In the Binge-Combined group

possible diagnoses were as follows: BN n=4; subthreshold BN n=16; BED n=2; subthreshold BED n=2 and missing data=1.

4.2.2 Procedure

The experimental procedure was the same as described in study two (section 3.2.3 and 3.2.3.1). In brief, participants completed a startle probe picture viewing task consisting of ninety-six images (32 of each valence: positive, neutral and negative) from the International Affective Picture System (IAPS; Center for the study of emotion and attention [CSEA-NIMH], 1999). The startle probe consisted of a 50 ms burst of 95 db white noise with near instantaneous rise-time generated using Audacity 1.3 Beta (Unicode) software. The startle probe was presented binaurally through ear insert head phones. The three picture valences (negative, neutral, positive) were crossed with two emotion regulation instructions (decrease and maintain) and three probe conditions (no probe, 3 s and 7 s). The 3 s probe time assessed emotion reactivity and the 7 s probe time assessed emotion regulation. Only the 3 s emotion reactivity probe was evaluated in the current study. Nine practice trials preceded the start of the task to allow for initial habituation to the startle probe. Each trial consisted of picture presentation (8 s duration) with a 100 ms visual regulation cue appearing at 4 s post-image onset, which consisted of a solid black box with a central red minus sign (decrease emotion) or a white equal sign (maintain emotion). Each picture presentation was followed by a blank screen (4 s duration; a startle probe occurred during four of these screens to increase startle unpredictability), a screen with the word “RELAX” (4 s duration) and a screen prompting participants to push a button to view the next picture. See Figure 3.2 for a sample trial sequence. Corrugator electromyography and electroencephalography were recorded during the picture viewing task.

No subjective ratings of the images were recorded during the startle task; after the startle task was completed and psychophysiological recording equipment removed, participants viewed the images a second time and provided ratings for each image using a nine-point visual analogue scale with figures depicting displeasure to pleasure (valence rating) and calm to aroused (arousal rating) (IAPS Self-Assessment Manikin [SAM]: Bradley & Lang, 1994).

4.2.2.1 Psychophysiological Recording

Corrugator EMG and startle blink data were recorded and processed as described in chapter three sections 3.2.3.2 and 3.2.3.3. The startle blink z-score data was transformed to T-scores (T=(z*10)+50) to allow for clearer interpretation of correlations (e.g. Bernat et al., 2006). EEG data was acquired with a Brain Products Inc, QuickAmp 72 System (Brain Products, GmbH, Munich, Germany) with Brain Vision Recorder and Brain Vision Analyzer used for recording and processing, respectively. Brain activity was recorded using Ag/Ag Cl electrodes from the F3, FZ, F4, CZ, P3, PZ, P4 and Oz scalp sites with the ground at the AFz site. Impedance was kept under 5kΩ and recordings were referenced offline to averaged mastoids. Electrooculographic (EOG) data was recorded with Ag/Ag Cl electrodes, placed above and below the right eye to detect blinks, and placed to the side of each eye to detect horizontal eye movement. Impedance was kept under 10kΩ. Both EEGs and EOGs were sampled at 1000 Hz continuously, between 0.01-499 Hz with a 60 Hz Notch filter. Data reduction offline consisted of filtering (Butterworth zero order 0.01 high pass, 30 Hz low pass filters), correction for ocular movement (Gratton, Coles & Donchin, 1983), baseline correction (i.e. subtraction of the average value of the 500 ms baseline period prior to each image from all time points in the segment), and automatic artifact rejection. The LPP was scored as the mean amplitude over 600-1000 ms post-picture onset. Mean amplitude was averaged across electrode sites Cz, Pz, P3 and P4, as LPP

amplitude was maximal at these centro-parietal sites, in line with other studies employing similar paradigms (e.g. Cuthbert et al., 2000).

4.3 Results

The event-related potentials across scalp sites for the Healthy Control group are depicted in Figure 4.1. As the LPP is maximum at centro-parietal sites, the average LPP amplitude across Cz, Pz, P3 and P4 was used in all subsequent analyses.

An ANOVA was conducted with LPP as the dependent measure, Valence as the within subject factor and Group as the between subject factor prior to evaluation of the correlations to determine whether there were overall group differences in LPP based on binge status. See Figure 4.2 for ERP waveforms for each group. Differences were not anticipated based on the similarity of responses between groups on the other emotion reactivity measures (self-report, startle and corrugator) in study two. There was a significant main effect of Valence, Wilk's lambda=0.24, $F(2,73)=115.83$, $p<0.001$, $\eta_p^2=0.76$. The main effect of Group and Group by Valence interaction were non-significant. Pairwise comparisons indicated that LPP was largest for negative valence (M=12.82, SE=0.71), intermediate for positive valence (M=10.96, SE=0.59) and smallest for neutral valence (M=5.72, SE=0.61) images.

Figure 4.1 ERP Waveforms in the Healthy Control Group

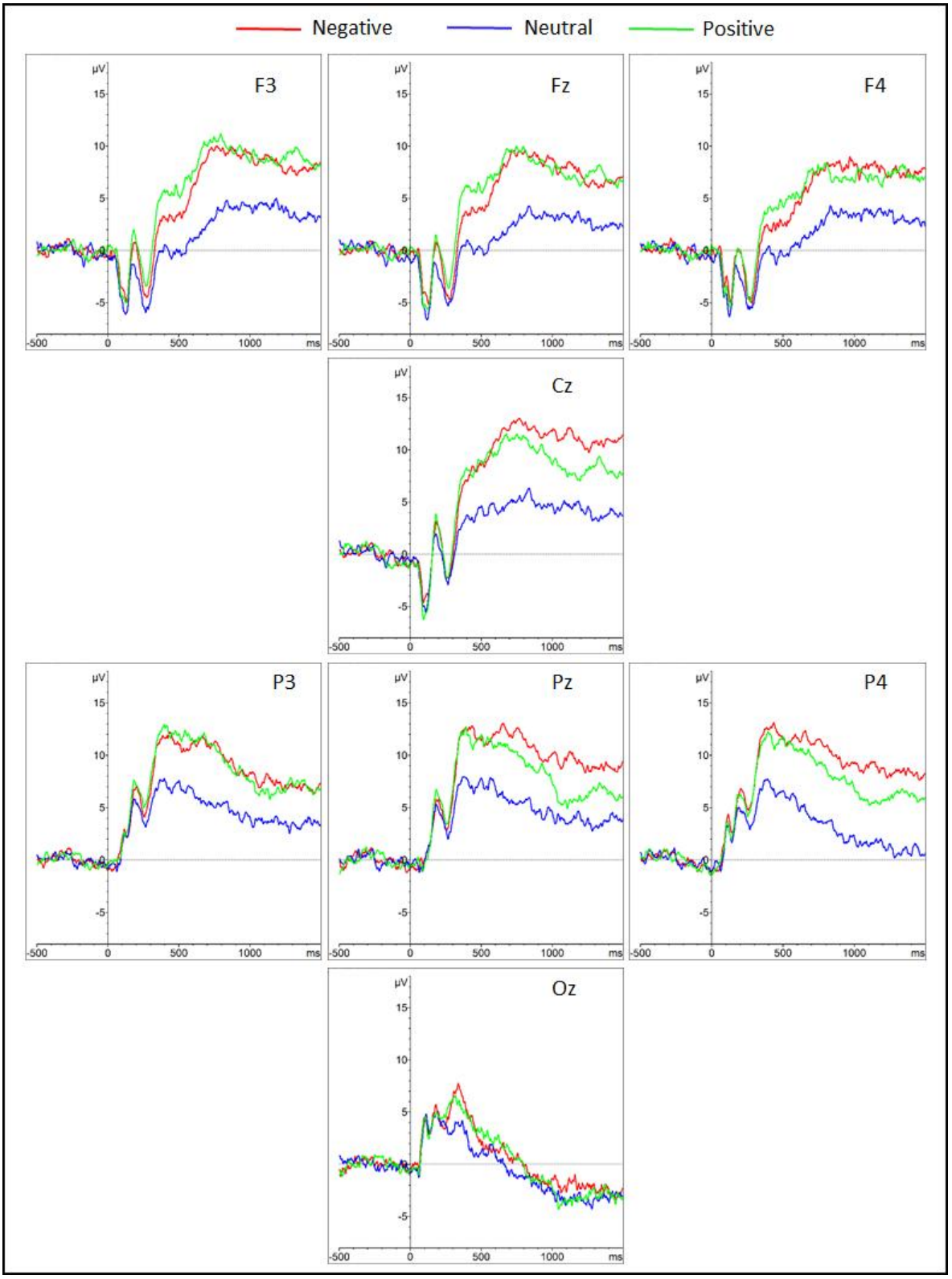
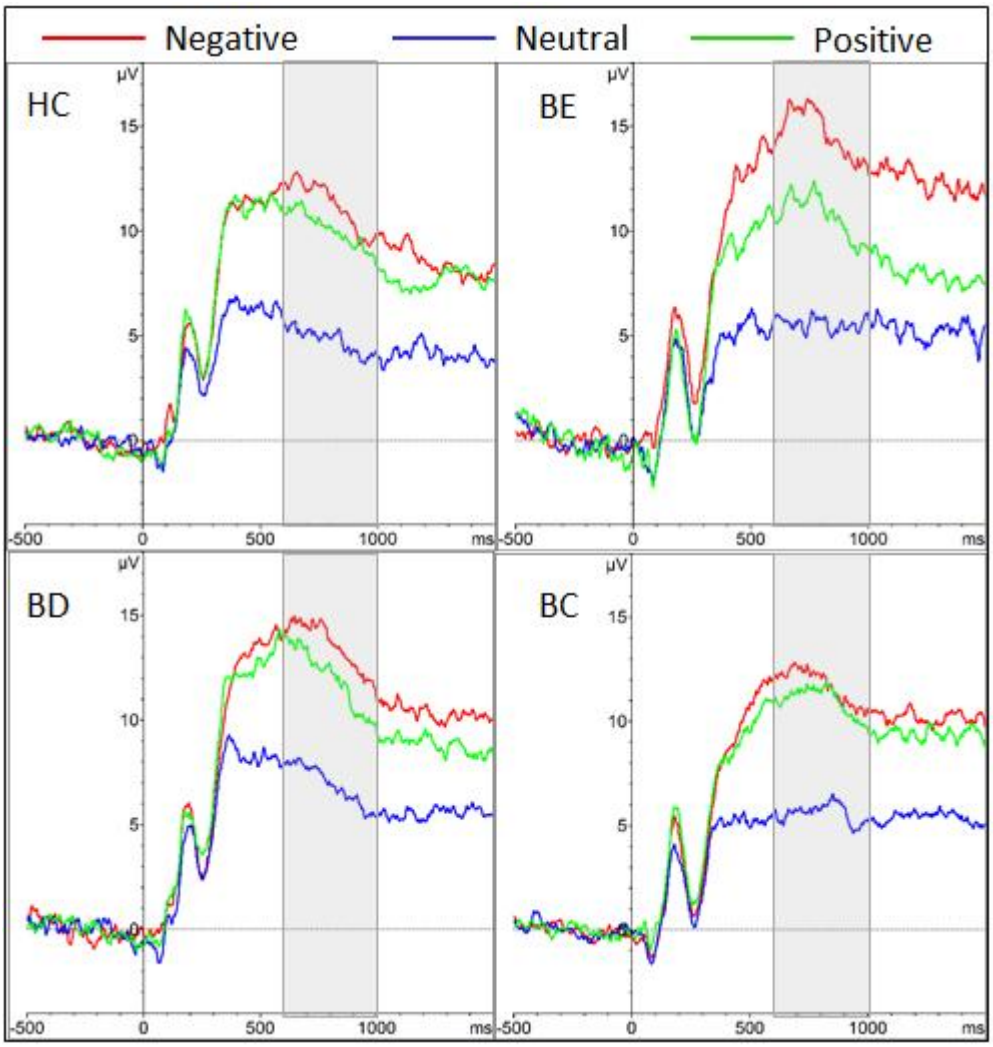


Figure 4.2 Late Positive Potential Pooled Across Cz, Pz, P3 & P4 Electrode Sites



Note: HC = Healthy Control; BE = Binge Eating; BD = Binge Drinking; BC = Binge-Combined

Within negative and positive valence image categories separately, between subject Pearson correlation coefficients were computed between startle magnitude and arousal ratings, corrugator activity and valence ratings, LPP and arousal ratings. Correlations for negative valence images are presented in Table 4.1. Significant positive correlations between startle magnitude and arousal ratings were observed in the Binge Eating group and Binge-Combined group, indicating that participants in these groups who rated the images as more arousing tended to have larger blink magnitudes. These correlations were near zero and non-significant in the

Healthy Control group and Binge Drinking group. Corrugator activity and valence ratings were significantly negatively correlated in the Healthy Control and Binge Eating groups, indicating that participants in these groups who rated the images as more unpleasant tended to have larger corrugator activity. A negative relationship was also observed in the Binge Drinking group; however, it was non-significant. LPP and arousal ratings were positively correlated though non-significant in the Healthy Control group and Binge Drinking group, suggesting that participants who rated the images as more arousing tended to have larger LPP activity. Correlations were negative and non-significant in the Binge Eating and Binge-Combined groups.

Table 4.1 Correlation Summary: Negative Valence Images

	Healthy Control (n=19)	Binge Eating (n=13)	Binge Drinking (n=21)	Combined Binge (n=25)
Startle & Arousal	-0.08	0.58*	-0.08	0.43*
Corrugator & Valence	-0.47*	-0.70*	-0.28	0.22
LPP & Arousal	0.42^{+}	-0.25	0.35	-0.21

$^{+}p=0.07$
*$p<0.05$

Correlations within the positive valence image category are presented in Table 4.2. None of the correlations were significant within any of the groups.

Table 4.2 Correlation Summary: Positive Valence Images

	Healthy Control	Binge Eating	Binge Drinking	Binge Combined
Startle & Arousal	0.13	-0.23	0.36	0.28
Corrugator & Valence	0.02	-0.01	0.22	-0.30
LPP & Arousal	-0.19	0.18	-0.04	-0.04

4.4 Discussion

The current study examined emotion response coherence amongst psychophysiological measures and subjective experience in women with binge eating, binge drinking or both forms of bingeing behaviour. The pattern of associations were compared with a group of non-bingeing women. The first hypothesis that startle magnitudes would be associated with arousal ratings within the Healthy Control group was not supported. The association between these variables was near zero in the negative valence condition for the Healthy Control and Binge Drinking groups. The lack of coherence between startle magnitudes and arousal ratings is in keeping with our hypothesis for the Binge Drinking group; however, the similarity of coherence with the control group suggests that this low coherence does not underlie the association between emotional states and binge drinking behaviour previously reported in the literature.

In contrast, and contrary to our hypotheses, there was a significant positive association between rated arousal and startle blink magnitude in the two groups with binge eating (Binge Eating and Binge Combined). Examination of the range of startle magnitudes within each group suggests that a restricted startle response range in the Healthy Control and Binge Drinking groups may, in part, account for the lack of significant correlations in these groups (range Healthy Control=12.67, Binge Drinking=11.48 whereas Binge Eating=18.47 and Binge-Combined=20.31). The greater levels of anxiety endorsed in the Binge Eating and the Binge-Combined groups (as reported in study two) may also account for the greater response coherence in binge eating women. A prior study reported greater response coherence amongst individuals with generalized anxiety disorder compared to healthy controls (Hubert & DeJong Meyer, 1990). Therefore, greater responsivity of the motivational systems indexed by startle magnitude may confer stronger coherence between psychophysiological reactivity and self-reported arousal. This

is in fitting with prior reports that coherence tends to be greater for emotions of higher intensity (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005).

The second hypothesis that corrugator activity would be associated with valence ratings in the Healthy Control group was supported for negative valence images. Non-bingeing women who rated the images as more negative also tended to have greater corrugator activity. Counter to expectation this effect was also observed in the Binge Eating group and to a lesser extent the Binge Drinking group. This indicates that for women in these groups their perceived emotional experience was reflected in their facial expressions to negative stimuli. The opposite direction of effect was found in the Binge-Combined group though it was non-significant. Replication of this finding for the combined binge group would help to elucidate whether this pattern of coherence reflects a tendency for women with more disordered consumption (binge eating and drinking behaviour) to spontaneously suppress expressions of negative emotions.

The final index of coherence was the association between LPP and subjective arousal. The expected positive correlation was found in the Healthy Control and the Binge Drinking groups (though non-significant) whereas the two groups with binge eating behaviour (Binge Eating and Binge-Combined) had associations in the opposite direction. We speculate that the binge eating women who found the images more arousing (i.e. gave them higher SAM arousal ratings) may have disengaged from further elaborative perceptual processing of the negative stimuli resulting in a smaller LPP. This is consistent with the vigilance-avoidance model found in individuals with higher levels of anxiety. Reduced cognitive processing of aversive stimuli by binge eaters may negatively impact their ability to describe the emotional experience and respond in an adaptive manner. However, this interpretation is offered with caution as the correlations were non-significant and were observed in groups with small sample sizes.

None of our hypotheses were supported in relation to positive valence images as none of the correlations were significant. These findings are in keeping with a prior report of variability in coherence between image intensity and startle magnitudes during viewing of positive images (Bernat et al., 2006). The lack of coherence amongst indexes for positive emotion highlights the issue previously raised in study two regarding the intensity and reliability of positive affect elicited in laboratory picture viewing tasks. This difficulty has lead other researchers to exclude positive affect from their investigations (e.g. Jackson et al., 2000). Future work should explore alternate positive emotion induction methods such as imagery or film clips.

4.4.1 Limitations and future directions

Replication will be important to determine the robustness of observed relationships given that the relatively small sample size may limit the stability of observed correlations. It should be noted, however, that prior work has examined coherence within samples of similar size (e.g. n=12, Hubert & DeJong Meyer, 1990). The intensity of emotions evoked by a picture viewing task may also limit the amount of coherence that may be detected. Greater coherence is anticipated with emotions of higher intensity (Mauss et al., 2005; Reisenzein, Studtmann, & Horstmann, 2013).

As is standard practice with this experimental paradigm (e.g. Jackson et al., 2000), subjective ratings were acquired upon a second viewing of the images so as not to interfere with initial emotion induction. Therefore, the full intensity of the initial response that is indexed by the psychophysiological measures may not be fully captured by the subjective ratings. However, prior work found comparable ratings when obtained immediately after initial viewing or after second viewing (Mauss et al., 2005), suggesting that this procedural issue likely did not have a significant impact on the patterns of response coherence. Finally, due to the method of

psychophysiological data collection, correlations could only be computed between-individuals. This likely attenuated the ability to detect coherence between psychophysiological and self-report measures as this method of analysis is generally considered less sensitive compared to within-individual associations (Hollenstein & Lanteigne, 2014; Mauss et al., 2005). Future work should extend the examination of response coherence in this population to other emotion induction contexts.

4.4.2 Conclusion

The present findings suggest binge drinking young women have similar patterns of response coherence as non-bingeing women. In contrast, response coherence appeared to differ in binge eating women compared to non-bingeing women. If replicated, this may help to explain previously documented lack of clarity of emotional responding and maladaptive responses to emotions in a subset of this population. Replication and extension to other emotion induction contexts is required to determine the robustness of these findings and their potential clinical significance.

Chapter 5: General Discussion

5.1 Summary of Results

The overall aim of this dissertation was to identify unique personality contributions to binge eating and drinking behaviour and to apply psychophysiological methods to inform emotion regulation theories of these behaviours. Study one addressed the question of whether Reinforcement Sensitivity Theory (RST)-derived traits (Reward Sensitivity and Punishment Sensitivity) have unique associations with binge eating and binge drinking beyond the associations of these behaviours with impulsivity facets assessed by the UPPS-P Impulsive Behaviour Scale (Negative Urgency, Positive Urgency, Sensation Seeking, Lack of Perseverance and Lack of Premeditation). Differential relationships between the traits and the two types of binge behaviors were found. Regarding the RST-derived traits, Reward Sensitivity had a positive relationship with both types of bingeing. Whereas, Punishment Sensitivity differed in its relationship with the two types of bingeing; it had a positive relationship with binge eating while it was negatively associated with binge drinking. As anticipated, Negative Urgency was the strongest predictor of binge eating while Sensation Seeking was the greatest predictor of binge drinking across the entire sample. Relationships with Positive Urgency were more complex and suggested that further consideration of this facet may be required. When only women with binge eating or binge drinking were considered (i.e. when non-bingeing women were excluded), Lack of Perseverance was uniquely associated with both types of bingeing behaviour.

Study two study addressed the question of whether binge eating, binge drinking or combined bingeing women differ from non-bingeing women in emotion reactivity and emotion regulation in response to general emotional stimuli. Emotion reactivity was comparable across groups in terms of response intensity based on the startle blink, corrugator and self-report ratings

of valence and arousal. However, the results suggested that bingeing women may experience more enduring emotional responses to negative emotional stimuli. In regards to emotion regulation, the pattern of startle blinks did not differ between groups. Larger startle magnitudes were observed for maintenance compared to decrease emotion conditions for negative and positive valence images; this indicates that emotion regulation efforts followed the arousal dimension in line with previous reports (Bernat et al., 2011; Dillon & LaBar, 2005). For corrugator activity, emotion regulation efforts resulted in a measurable change in response to negative emotional stimuli only; larger responses were noted for the maintain emotion conditions compared to the decrease emotion condition. Although the interaction effect with group was non-significant, the pattern of results suggested that the regulation effect was driven primarily by the binge drinking group. It was speculated that the lack of regulation in non-bingeing women likely reflected a floor effect due to a natural decrease in emotional intensity over time such that there was minimal emotion to be regulated by the time of the emotion regulation assessment period. The binge eating groups appeared able to effectively regulate their negative emotional responses along the arousal dimension (based on their startle blink responses) whereas the level of displeasure as measured by corrugator activity remained high across negative emotion regulation conditions. Across all groups, corrugator activity was not sensitive to regulation of positive emotions. Counter to expectation, similar emotion regulation strategies, as assessed via self-report, were implemented across groups.

Study three examined emotion response coherence between the psychophysiological indices of emotional reactivity and subjective ratings of valence or arousal. Non-bingeing women and women who binge drink had similar patterns of correlations across measures of negative emotion. This consisted of a lack of association between startle blink magnitude and

arousal rating, greater corrugator activity associated with higher unpleasantness ratings and larger LPP associated with higher arousal ratings. Binge eating women had a different pattern of response; women who rated the images as more arousing tended to have greater startle magnitudes. Binge eating women with higher arousal ratings also tended to have smaller amplitude LPP though this effect was non-significant. A speculative interpretation of this finding is that the women who found the images more arousing may have disengaged from elaborative perceptual processing of the negative stimuli, as indexed by the late positive potential. This is consistent with the vigilance-avoidance model of information processing in individuals with anxiety. However, the stability of this association may be limited given that these correlations were non-significant and observed in a small sample. Finally, amongst women endorsing both types of bingeing, the relationship between corrugator activity and valence ratings was attenuated. If replicated, this finding could be indicative of a tendency for women with greater levels of disinhibited behaviours to mask their facial expressions of negative emotion. There was a lack of significant coherence across measures for positive emotional stimuli for all groups.

5.2 Personality Contributions to Binge Behaviour

The results from study one support trait emotion regulation conceptualizations of binge eating through negative and positive reinforcement pathways (Pearson et al., 2014). Prior trait conceptualizations have tended to focus on either the role of Negative Urgency (Cyders & Smith, 2008; Fischer et al., 2012; Pearson et al., 2014) or Reward Sensitivity and Punishment Sensitivity (Loxton & Dawe, 2001, 2006, 2007). For example, in a recent model of bulimic symptoms proposing state and trait-based pathways, the trait-based pathway focused solely on Negative Urgency (Pearson et al., 2014). Study one suggests that this model is incomplete as RST-derived traits also provide small, but significant contributions to binge eating behaviour.

High Reward Sensitivity may confer a desire for high caloric foods and high Punishment Sensitivity/Negative Urgency may confer a tendency to engage in binge eating to distract from negative emotional states. The amount of variance accounted for by Negative Urgency and Punishment Sensitivity decreased when the sample was limited to women with binge eating behaviour, suggesting that these facets are commonly elevated across women who endorse binge eating. High Punishment Sensitivity may reflect a tendency to experience heightened or more frequent negative affect when aversive cues are encountered such as undesired weight gain, criticism or social rejection (Loxton & Dawe, 2001). Binge eating may be an expression of high Negative Urgency, such that the young woman loses control over her food intake during states of heightened negative affect resulting in rapid overconsumption (Cyders & Smith, 2008). In this way, young women with more reactive motivational systems or higher Negative Urgency may learn to use binge eating to reduce their emotional distress (Fischer et al., 2004).

In keeping with motivational accounts of alcohol use, the binge drinking results supported trait emotion regulation models for negative and positive emotions (Cooper, Agocha, & Sheldon, 2000). The current study helps to address a gap in the literature by identifying a unique role for Negative Urgency in alcohol consumption in the form of binge drinking specifically. Similar to binge eating, binge drinking may be an expression of high Negative Urgency such that the young woman loses control over alcohol consumption during negative emotional states. However, others have argued that high Negative Urgency may be a consequence rather than a cause of alcohol use (Gullo et al., 2014). They suggest that negative affect is increased due to problems arising from heavy alcohol use. There is limited prospective work examining the relationship between drinking and Negative Urgency while also accounting for the effects of the other UPPS-P facets (Cyders et al., 2009; Settles, Cyders, & Smith, 2010;

Stojek & Fischer, 2013). Cyders and colleagues (2009) found that Negative Urgency did not predict significant increases in drinking frequency or quantity over the first semester of college. As well, increases in alcohol use disorder symptoms were best predicted by baseline alcohol dependence symptom levels whereas Negative Urgency was only predictive in those with high coping motives for drinking (Stojek & Fischer, 2013). Neither of these studies included RST-derived traits. As study one is the first to identify unique associations with binge drinking and Reward Sensitivity and Punishment Sensitivity beyond Negative Urgency, prospective research incorporating all of these traits is required to clarify whether Negative Urgency is a contributor to and/or consequence of binge drinking.

The relationships between binge drinking and impulsivity facets associated with positive emotions differed from expectation. Whereas unique positive associations with Sensation Seeking and Positive Urgency were expected, such a relationship was only found for Sensation Seeking. When relationships with the other facets were accounted for, the positive bivariate relationship with Positive Urgency became negative. Others have drawn distinctions between Sensation Seeking and Positive Urgency in terms of risk for increased frequency of consumption and increased quantity of consumption, respectively (Cyders et al., 2009). Our binge drinking measure does not differentiate between these aspects of drinking behavior making it difficult to directly compare the present results with prior work. However, it is likely that prior findings of a positive relationship between Positive Urgency and drinking outcomes may be accounted for, in part, by conceptual overlap with Sensation Seeking, Negative Urgency and Reward Sensitivity. Sensation Seeking may be of greater relevance than Positive Urgency for the regulation of positive emotions by binge drinking. This is in keeping with prior findings of partial mediation of the relationship between Sensation Seeking and drinking outcomes by enhancement motives

in the absence of a significant positive relationship with Positive Urgency (Adams et al., 2012). Sensation Seeking may confer risk to seek out stimulating social contexts or activities where alcohol consumption is more likely to occur (Cyders et al., 2009). Higher Reward Sensitivity may be associated with increased risk of excessive alcohol consumption whether the binge drinking episode occurs in negative or positive emotional contexts through sensitized reward pathways (Gullo et al., 2014). Women with low Punishment Sensitivity may have decreased motivation to avoid the negative consequences, which may occur with this form of drinking.

Lack of Perseverance was uniquely associated with both forms of bingeing across the entire sample and when analyses were restricted to women with binge behaviour. Thus, Lack of Perseverance appears to pertain to both risk of engagement and frequency of engagement in bingeing. In the presence of potentially reinforcing substances like food and alcohol, young women who are low in conscientiousness may experience disinhibited behaviour reflective of poor executive control. Alternatively, this may reflect a tendency to consume these substances as a form of immediate reinforcement in place of reinforcers requiring sustained, long-term focus (e.g., academic or occupational pursuits) (Magid & Colder, 2007). Women who lack perseverance may be more susceptible to boredom, which may be experienced as an intolerable negative emotional state (Anestis et al., 2007; Wiser & Telch, 1999). Bingeing may be the result of attempts to reduce this perceived negative emotional state in individuals high in Negative Urgency or to increase stimulation in individuals high in Sensation Seeking.

As reflected in our findings and in the literature more broadly, there is some inconsistency regarding the direction of the relationship between Positive Urgency and disinhibited behaviour. There is a high amount of overlap between Negative Urgency and Positive Urgency ($r > 0.60$ in our sample; >0.70 in other prior work, e.g. Carlson et al., 2013).

This has led some researchers to exclude one or the other facet from their analyses. However, this is problematic if both facets are considered necessary to fully capture the impulsivity construct as conceptualized by the emotion-based disposition framework. It has led others to question the necessity and utility of the Positive Urgency construct (e.g. Gullo et al., 2014). The results of study one suggest that in the absence of a measure of positive affect, Positive Urgency may act as a proxy for this variable. Therefore, future work should include the UPPS-P facets, RST-derived traits and a measure of negative and positive affect to further delineate the role of Positive Urgency. Given that positive and negative emotional states may tend to be associated with contexts in which eating or drinking behaviour are likely to occur (i.e. positive emotional states may be associated with drinking/eating in social settings whereas negative emotional states may be associated with drinking/eating alone; Birch et al., 2007; Cooper, 1994; Mohr et al., 2001), the addition of the context of the behaviour (e.g. alone versus in social settings) to trait-based models may also prove useful in further clarifying the construct of Positive Urgency.

5.3 Implications for Emotion Regulation Theories of Binge Eating

Studies two and three examined emotional processes in the laboratory to inform emotion regulation theories of binge eating. In regards to emotion reactivity, the magnitude of the emotional response based on startle blink, corrugator and self-report ratings did not differ in binge eating women. This is in line with prior studies using similar methodology (Drobes et al., 2001; Mauler et al., 2006). However, the laboratory findings were suggestive of a longer duration emotional response to negative emotional stimuli in bingeing women; this novel finding fits with the relationship between Punishment Sensitivity and binge eating found in study one. Heightened Punishment Sensitivity may present as a lingering of emotional arousal. This is also in keeping with prior findings of a positive relationship between long lasting feelings of distress

and binge eating on self-report (Whiteside et al., 2007). This underscores the importance of evaluating different aspects of emotion reactivity (i.e. rise time, magnitude, duration) to identify how the emotional experience of binge eating women may differ from non-binge eating women. A more fine-grained analysis of the rise time, magnitude, and duration of the response may help to further elucidate what underlies greater self-reported emotion intensity on trait measures in women with ED (Svaldi et al., 2012).

Emotion regulation theories of binge eating suggest that women binge eat to reduce emotional distress in place of more adaptive emotion regulation strategies (Telch & Wiser, 1999). An emotion regulation account of binge eating was supported by the trait-based measures in study one. In contrast, the results of study two suggest that women with binge eating behaviour are able to generate and apply emotion regulation strategies to effectively reduce their emotional arousal to acute negative stimuli in a laboratory setting. As effortful emotion regulation ability has not been previously examined in this way in bingeing women, this novel finding identifies a potential discrepancy between trait-level endorsements and actual ability to regulate physiological responses. This discrepancy is reflective of a previously reported divergence between a trait-based self-report assessment (Multidimensional Emotional Intelligence Assessment; Tett, Fox, & Wang, 2005) and an ability-based emotion regulation assessment (Mayer–Salovey–Caruso Emotional Intelligence Test Version 2.0 (MSCEIT); Mayer, Salovey, & Caruso, 2002). In this study, the trait-assessment predicted subclinical binge eating while the ability measure did not (Gardner et al., 2014). The laboratory task used in our second study differed from the ability measure used by Gardner et al. in that our participants were actively involved in regulating their physiologically-based emotional response whereas Gardner et al.'s ability measure assessed participants' knowledge of the efficacy of different actions for

regulating specific emotional states given hypothetical scenarios. This raises the question of what might underlie the discrepancy between trait-based assessments and ability measures of emotion regulation. Four possible explanations are discussed below.

The first possibility is that the measures assess different types of emotions. A variety of emotional triggers have been associated with binge eating behaviour (Wiser & Telch, 1999). However, negative emotions pertaining to interpersonal situations may be of particular relevance based on the emotions identified as preceding binge eating episodes (e.g. Zeeck et al., 2011) and the efficacy of interpersonal treatment approaches (e.g. Hilbert et al., 2012). EMA investigations have suggested that interpersonal stressors lead to increases in negative affect and subsequent binge eating amongst women with BN (Goldschmidt et al., 2014). As well, changes in guilt over the binge cycle remain even when controlling for other negative emotions (e.g. fear, hostility, and sadness), suggesting that self-relevant emotions may play a more central role in binge behaviour (Berg et al., 2013). The emotions evoked by our negative emotional images were likely predominantly fear, disgust and sadness. The advantage of using these stimuli is the availability of normative ratings and the large body of empirical work measuring psychophysiological responses to these stimuli. The disadvantage is that the emotions evoked by these stimuli may differ from emotions typically preceding binge episodes. On questionnaire measures, participants may draw from emotional experiences that are qualitatively different from those tapped by our laboratory task and ability measures such as that used by Gardner and colleagues. Stimuli that evoke interpersonally-relevant emotions such as anger, guilt, shame, or loneliness may, therefore, be more sensitive to physiological differences in emotion reactivity and regulation in binge eating.

The second possibility is that trait-based reports are influenced to a greater extent by stable elevations in negative affect, such as anxiety and depression, than measures assessing physiological changes in emotional response. In this case, questionnaire measures may be biased by an overall negative self-evaluation, leading to an underestimation of emotion regulation ability (Lundh et al., 2002). This is supported by prior findings of correlations between depression and endorsement of specific emotion regulation strategies (Danner et al., 2014), the loss of significant differences in emotional awareness between ED groups when controlling for depression and anxiety (Corcos et al., 2000; Gilboa-Schechtman et al., 2006) and highly similar endorsement of emotion regulation difficulties across diagnoses of ED, major depression and borderline personality disorder (Svaldi et al., 2012). Thus, the perception of emotion regulation ability may be reduced in women with binge eating while their actual ability to regulate reactions to acute emotional stimuli remains preserved.

The third possibility is that women who binge eat have knowledge of different emotion regulation strategies and can implement them effectively when asked to do so, but have difficulty implementing the strategies during daily life. This possibility is supported by the trait findings from study one and the similarity of emotion regulation strategies endorsed across groups in the second study. Heightened reward sensitivity in combination with lack of perseverance may thwart adaptive emotion regulation efforts when food is available as an immediate negative reinforcer. This would not be reflected in our laboratory task as food was unavailable as an alternate emotion regulation method. Low emotional awareness may also make it difficult for binge eating women to identify when to utilize emotion regulation strategies (Whiteside et al., 2007).

The fourth possibility is that emotion regulation efforts may not be effective in altering the emotional response across different response systems in women who binge eat. While regulation efforts resulted in changes in the magnitude of the startle blink, corrugator activity remained high across maintain and decrease emotion conditions. This suggests that binge eating women were able to effectively lower their emotional arousal, but their level of displeasure remained high. Their regulation efforts may have moved them from a high arousal, highly unpleasant negative emotional state to a low arousal, highly unpleasant negative emotional state. If this finding is replicated and found to be significant in a larger sample, it could provide support for a more nuanced deficit in emotion regulation ability in binge eating women. Women who binge eat may be able to divert their attention from negative emotional events resulting in a partial decrease in emotional response, but they may continue to experience significant displeasure.

5.4 Implications for Emotion Regulation Theories of Binge Drinking

Studies two and three examined emotional processes in the laboratory to inform emotion regulation theories of binge drinking. In regards to emotion reactivity, the magnitude of the emotional response based on startle blink, corrugator and self-report ratings did not differ in binge drinking women compared to non-bingeing and binge eating women. This informs prior work which reported a relative lack of potentiation of the startle blink in individuals with a family history of alcoholism (Miranda et al., 2002) and typical potentiation of the startle blink in individuals with alcohol dependence with co-morbid anti-social personality disorder (Miranda et al., 2003).

In regards to emotion regulation, binge drinking women were able to effectively regulate their emotional responses to negative stimuli as indexed by the startle blink and by corrugator

activity. This suggests that women who binge drink without significant co-morbid psychopathology may be able to effectively regulate their emotions to acute negative stimuli. The association of binge drinking with Negative Urgency in study one may pertain to co-morbidity with binge eating or may, as previously speculated, reflect an elevation of negative emotion in binge drinkers who have experienced problems associated with their use. The findings from study two did not support a deficit in the ability of binge drinking women to regulate reactions to positive emotional stimuli. Binge drinking women were able to effectively regulate their responses to positive emotional stimuli based on startle blink responses. The lack of corrugator regulation for positive images was found across groups and was not specific to binge drinkers. We did not assess the ability to enhance positive emotion beyond the level originally evoked by the image. Therefore, it remains possible that women who binge drink may do so due to difficulty increasing positive emotion through more adaptive means. The findings of significant prediction from Sensation Seeking in study one and the high endorsement of social drinking motives in study two suggest that the tendency to seek out social drinking contexts may be of greater relevance for binge drinking in this young sample, than a specific deficit in the ability to regulate positive emotions. This is in line with prior findings of high endorsement of social drinking motives amongst young adults who binge drink more than once a month (Van Damme et al., 2013) and higher rates of binge drinking during specific occasions (Beets et al., 2009).

The level of overall recent distress, as assessed by the DASS-21, did not differ between binge drinking and non-binge drinking women. Therefore, binge drinking does not appear to typically be associated with significant distress in young college-aged women. When binge drinking co-occurred with binge eating, however, distress tended to be higher. Moreover, women

with combined binge behaviour tended to endorse coping motives for eating and drinking in line with prior work (Birch et al., 2007; Luce et al., 2007). The women who endorsed binge eating and drinking tended to appear more similar to the women who endorsed only binge eating in terms of their pattern of responses on individual psychophysiological measures (e.g. corrugator) and in the relationships between psychophysiology and self-report. Overall, while binge drinking may put women at risk for immediate negative consequences (Wechsler et al., 1994; 2000), in a primarily student sample such as ours it does not appear to be associated with significant distress in the absence of other psychopathology.

5.5 Clinical Implications

Clinical implications of these studies are offered with caution due to the subclinical level of disordered behaviour in our sample. Overall, the results support emotion regulation treatment approaches to binge eating, such as DBT. The personality findings suggest that helping individuals to identify their negative emotional states and the corresponding impulsive urges may help to break the link between negative emotions and binge eating. Behavioural chain analysis as in DBT appears to address this (Wiser & Telch, 1999). Given heightened reward and punishment sensitivity, identification of alternate reinforcing activities may be helpful, particularly self-soothing techniques that are not associated with negative consequences. In our subclinical sample, binge eating women were able to implement what are considered to be adaptive emotion regulation strategies in the context of the laboratory task. This suggests that support may be needed in helping to determine when to implement adaptive strategies in everyday life rather than the teaching of strategies per se. However, this may not extend to women with a higher level of psychopathology who may also benefit from learning new emotion regulation strategies.

At the level of binge drinking assessed in these studies, school interventions aimed at providing alternate means of increasing arousal or social engagement that do not involve the consumption of alcohol appear indicated. Increasing the salience of potential negative consequences may also be an effective approach, given lower punishment sensitivity in binge drinking individuals. The small amount of variance accounted for in regards to binge drinking in study one and the lack of significant findings for emotion reactivity and regulation in study two, suggest that situational factors may play a greater role in binge drinking amongst young college-age women. Taken together the findings for binge drinking add to a growing body of literature that endorsement of binge drinking amongst college populations may not be a sensitive indicator of problematic alcohol use (Alexander & Bowen, 2004; Moorhouse, Soule, Hinson, & Barnett, 2014; Read, Beattie, Chamberlain, & Merril, 2008). Other indices of alcohol use in addition to assessment of binge drinking, such as the occurrence of problems associated with use, may prove more useful in prediction of those at risk for progression to a clinical level of disordered consumption (Moorhouse et al.).

5.6 Limitations

Although this dissertation had several strengths, there are some limitations that need to be taken into consideration. Limitations regarding the sample and experimental design are outlined below.

The sample was restricted to young women who endorsed primarily subclinical levels of engagement in the disordered behaviours, thereby limiting the generalizability of the studies' findings to this demographic. The extent to which the findings generalize to men, other age groups and individuals with clinically diagnosed eating or alcohol use disorders will need to be determined. Generalizability to diagnosed alcohol use disorders is likely limited given the

differential endorsement of binge drinking in situations involving relief from negative emotions in clinical versus non-clinical samples (Birch et al., 2007; Carrigan, Samoluk, & Stewart, 1998). Women with possible AN were excluded from the dissertation studies; therefore, future work will need to address the relationship between emotion regulation and binge behaviour within the context of AN. The small sample size of studies two and three likely limited the power to detect group effects. Although the size of the sample was within range of prior startle studies (e.g. Dillon & Labar, 2005; Driscoll et al., 2009; Piper & Curtin, 2006) and the sample size calculated a priori to detect a medium effect (n=18 per group), significant variability on response measures and data loss due to psychophysiological recording issues contributed to lower than expected power to detect group effects. Finally, while significant group differences on measures of general distress and motives for the two types of consumption support a differentiation between the groups based on the binge behaviours of interest, use of a standardized, structured clinical interview to assess disordered eating, alcohol use and co-morbid depressive and anxious psychopathology would increase the reliability of assessment. This may be of particular importance for binge eating given the well-replicated finding that binge eating prevalence differs between self-report versus interview-based assessment (e.g. Black & Wilson, 1996). In an effort to address this issue, participants were provided with examples of binge eating episodes. Provision of these examples was previously demonstrated to improve reliability of binge eating assessment amongst a sample with BED (Goldfein et al., 2005).

Studies two and three utilized a picture viewing paradigm with normative visual stimuli. While this approach has strong empirical support, the findings may be limited to similar emotion induction contexts (Bradley & Lang, 2007). Replication and extension to other emotions and induction procedures is important. Idiographic stimuli are likely of greater relevance to the

individual and may produce higher intensity emotional responses. As such, they may have higher sensitivity to detect emotion regulation deficits. Use of such stimuli could be advantageous for the examination of response coherence in particular, as it may allow for a greater range of emotion intensity, and should be considered in future work. Given the diversity of potential emotional triggers associated with binge behaviour, the studies undertaken in this dissertation approached emotion regulation from a dimensional rather than discrete emotion perspective. Dimensional (or biphasic) approaches consider emotions as ranging in valence (the degree of pleasantness-unpleasantness) and arousal (calm-excited/agitated) whereas discrete emotion perspectives focus on specific emotional states, such as fear, sadness, or disgust (Bradley & Lang, 2007). A focus on discrete emotional states which have been consistently identified as antecedents of binge behaviour may reveal unique relationships with bingeing that are not detected by a dimensional approach.

A prior investigation into the test-retest reliability of corrugator activity and the startle blink indicate that replication of emotion regulation effects will be important. Test-retest reliability is high for corrugator activity, while the reliability of the startle response as a measure of emotion regulation is less consistent (Lee et al., 2009). Using the startle blink, emotion regulation effects are detectable across multiple testing sessions; however, the stability of the amount of change in physiological response brought about by regulation efforts may be low (Lee et al.).

In regards to disordered eating behaviour, the current dissertation focused specifically on binge eating and its possible role in emotion regulation. However, other aspects of disordered eating behaviour, such as dieting and purging, have also been associated with emotion regulation processes. Some have suggested that a larger cycle of restraint, binge eating and purging may

serve to regulate emotions (Haedt-Matt & Keel, 2011). As a pure dietary restraint pathway to binge eating has also been proposed (Stice, 2001), sample selection based on endorsement of negative mood states as antecedents to binge episodes may increase sensitivity to detect alterations in emotion regulation processes. Therefore, future work should incorporate other aspects of disordered eating behaviour to develop a more in-depth conceptualization of potential intersections between these behaviours and different aspects of emotional experience. As pertains to binge drinking, our sample was selected based on binge drinking frequency. A more stringent selection process including only those with binge drinking *and* endorsement of problems associated with their alcohol use, may result in a different pattern of findings.

The amount of variance accounted for by the impulsivity facets was relatively small in the first study. While the findings were in line with prior work and advanced our understanding of the unique influence of different impulsivity facets on binge behaviours, other variables such as other eating disorder pathology, peer group, context for the behaviours and ethnicity may play a greater role in determining risk for bingeing. As well, the questionnaire measures used were guided by the former conceptualization of Reinforcement Sensitivity Theory. Therefore, replication using measures developed in line with revised-Reinforcement Sensitivity Theory, such as the Jackson-5 (Jackson, 2009) will be important to determine whether the relationships identified by the old and new measures remain consistent.

5.7 Conclusions and Future Directions

Future work should extend the current findings by using the startle blink, corrugator activity and LPP to examine emotion reactivity and regulation of discrete emotional states that have been implicated in binge eating. For example, film clips depicting social rejection or loss could be used to induce interpersonally-relevant emotional states (Tuschen-Caffier & Vogele,

1999). Another approach would be to use mental imagery to invoke these more complex emotional states in a personally-relevant manner. Different timing of the emotion regulation cue is also indicated to allow for more sensitive measurement of the latency and duration of the emotional response. For example, the emotion regulation cue could be administered prior to the commencement of the trial as has been done in prior work (Bernat et al., 2011). Replacement of the "Maintain" emotion condition with "Enhance" and "Respond Naturally" conditions would broaden the range of regulated responses that could be assessed (Bernat et al). Such alterations of procedures will likely increase the sensitivity to detect the subtle differences in emotion regulation and response coherence suggested by the current studies.

In regards to binge drinking, future work should include a broader assessment of the contexts and consequences of binge drinking. As the link between positive emotional states and binge drinking does not appear to pertain to a deficit in maintenance or down-regulation of positive emotion, the ability to enhance positive emotions beyond the level naturally evoked could be explored. Examination of the influence of positive emotional states on inhibitory control and decision making processes may help to identify a mechanism linking these states with binge drinking behaviour (Xiao et al., 2013).

Overall, this dissertation extended prior work by identifying unique contributions of impulsive personality traits to binge eating and drinking behaviour. The trait findings supported emotion regulation models of these behaviours. The psychophysiological measures did not support a deficit in emotion regulation ability across emotion response systems to general emotional stimuli. However, subtle, mainly non-significant, differences in emotional response, such as the response duration, response coherence and a potential differential effect of emotion regulation on arousal versus valence dimensions were observed. These differences may

contribute to the link between negative emotional states and binge eating. The binge drinking women in our sample appeared fairly similar to non-bingeing women with the exception of those who also had disordered eating. Binge drinking in a primarily student sample such as ours appears more reflective of a tendency to drink in social situations to enhance stimulation. Binge drinking was not associated with significant distress whereas women who binged on food endorsed greater distress compared to binge drinking and non-bingeing women in this study, and reported being motivated to eat to relieve distress. The results highlight the importance of assessment of both trait and ability measures of emotion regulation and the need for further consideration of potential discrepancies between assessment methods.

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Appendix A: Emotion Regulation Strategy Questionnaire

Subject ID:_____

Strategy Questionnaire

During the task you just completed you viewed pictures and while viewing the pictures, you were asked to alter your emotional response by either decreasing the intensity of the emotion you were feeling or by keeping the intensity at about the same level. We are interested in the ways in which you tried to follow these instructions. In other words, we would like to find out the strategies you used to try follow the instructions to decrease or maintain the intensity of the emotion you felt while viewing the pictures. Decrease is what you did in response to the red minus sign. Maintain is what you did in response to the white equal sign.

1. Please describe the strategies you used to **decrease your negative emotions**. If you used more than one strategy, please indicate the percentage of time you used each strategy.

2. Please describe the strategies you used to **maintain your negative emotions**. If you used more than one strategy, please indicate the percentage of time you used each strategy.

3. Please describe the strategies you used to **decrease your positive emotions**. If you used more than one strategy, please indicate the percentage of time you used each strategy.

4. Please describe the strategies you used to **maintain your positive emotions**. If you used more than one strategy, please indicate the percentage of time you used each strategy.

5. Please describe the strategies you used to **decrease your emotions for pictures that evoked minimal or no emotional response**. If you used more than one strategy, please indicate the percentage of time you used each strategy.

6. Please describe the strategies you used to **maintain your emotions for pictures that evoked minimal or no emotional response**. If you used more than one strategy, please indicate the percentage of time you used each strategy.

7. If you used different strategies for the **first set of images compared to the second set**, please describe.