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Dimensional analysis of emotion trajectories before and after disordered eating behaviors in a sample of women with bulimia nervosa

Kendra R. Becker[a,*], Sarah Fischer[b], Ross D. Crosby[c], Scott G. Engel[c], Stephen A. Wonderlich[c]

[a] Eating Disorders Clinical and Research Program, Massachusetts General Hospital/Harvard Medical School, Boston, MA, USA
[b] Department of Psychology, George Mason University, Fairfax, VA, USA
[c] Center for Bio-Behavioral Research, Sanford Research, Fargo, ND, USA

ABSTRACT

There is an established relationship between increases in negative affect and engagement in binge eating and purging behaviors. Some evidence suggests that these behaviors may also be maintained via subsequent increases in positive affect. However, negative and positive affect are broad terms encompassing many emotions, and there is a theoretical speculation that every emotion consists of at least of three separate dimensions: valence, arousal, and approach/withdrawal. We conducted secondary analyses on a previously collected dataset using ecological momentary assessment in 133 women with bulimia nervosa. Participants rated their experience of discrete emotions and bulimic behaviors six times per day. Negative and positive emotions were organized within the 3-dimensional space characterized by valence, arousal, and approach/withdrawal. With multilevel modeling, we examined the trajectories of dimensionally defined emotion constructs prior and subsequent to bulimic behaviors as well as on days with and without bulimic behaviors. Negative valence, high arousal, and avoidance typified emotions that reached the highest levels before bulimic behaviors and were at the highest mean levels on days with bulimic behaviors. Arousal did not appear to moderate the trajectories of positive emotions. Application of a dimensional understanding of emotions may help elucidate the complex relationship between mood and disordered eating.

1. Introduction

Bulimia nervosa (BN) is robustly associated with mood disturbances (e.g., Haedt-Matt and Keel, 2011; Smyth et al., 2007). According to the affect regulation model, binge eating and purging are maintained because both are negatively reinforced via temporary relief of emotional distress (Hawkins and Clement, 1984; Polivy and Herman, 1993). Research utilizing ecological momentary assessment (EMA) methodology supports this hypothesis by demonstrating the trajectory of negative affect increases prior to and decreases following bulimic behaviors (e.g., Smyth et al., 2007; Berg et al., 2013).

Positive valence has not been extensively studied in relation to bulimic behaviors (Haedt-Matt and Keel 2011). However, there is some evidence that self-reported contentment may increase during and post binge-eating episodes while satisfaction ratings may continue to increase up to an hour after binge eating (Hetherington et al., 1994). It may be that during and following binge eating, positive emotions increase due to the ingestion of highly palatable foods, which act on the dopamine reward pathway in the brain (Small et al., 2003). EMA results also suggest an opposite trajectory to that of negative emotions, such that positive emotions decrease prior to, and increase after, binge eating and/or purging (e.g., Smyth et al., 2007; Engel et al., 2013).

EMA protocols are ideal for testing momentary relationships between mood and disordered eating, because the temporal order of emotions and behaviors can be determined from time-stamped momentary data with minimal influence from recall bias (Mehl and Conner, 2012). Previous EMA research has either assessed overall negative and/or positive affect (Haedt-Matt and Keel, 2011) or has studied discrete emotional states (Berg et al., 2013; Wegner et al., 2002) in relation to bulimic behaviors. However, negative and positive affect are broad terms encompassing multiple different emotions (Macht, 2008) and individual emotions are comprised of various dimensions including valence (pleasantness/unpleasantness), arousal (alert/lethargic), and motivational urges (approach/avoid; Morgan and Heise, 1988; Russell et al., 1989; Scherer, 2005). Heterogeneity in broad constructs like negative and positive affect may be obscuring how features of emotional experience both immediately and over-time differentially impact eating behaviors.

The most widely used dimensional model of emotions consists of two continua: emotional valence and emotional arousal (Morgan and Heise, 1988; Russell et al., 1989). Discrete emotions can be reliably mapped onto a theoretical space defined by these two dimensions (e.g., Posner et al., 2009,2005; Russell et al., 1989) and results from neurobiological studies provide further support for these dimensions. Findings suggest distinctive neural pathways for the processing of pleasant/unpleasant versus arousing stimuli: The amygdala responds to highly arousing stimuli (e.g., pictures, words) irrespective of valence (Kensinger and Schacter, 2006; Posner et al., 2005), the right

* Corresponding author.
E-mail address: krbecker@mgh.harvard.edu (K.R. Becker).

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dorsolateral prefrontal cortex appears to be involved in the processing of negative valence, and the left insular cortex may be important in processing positive valence (Posner et al., 2009). In addition, specific peripheral physiological responses correspond to self-reported valence and arousal levels (Posner et al., 2005,2009; vanOyen Witvliet and Vrana, 1995).

However, a two-dimensional emotional theory is not sufficient to map all aspects of emotional experience (e.g., Morgan and Heise, 1988). A motivation dimension consisting of approach and withdrawal actions (also termed "potency or "dominance" in other studies) is relevant in discriminating negative emotions, such as anger and fear, both high in arousal and negatively valenced (Carver and Harmon-Jones, 2009; Harmon-Jones and Harmon-Jones, 2010; Kreibig et al., 2010; Morgan and Heise, 1988). Opposite motivational systems are engaged during high approach (e.g., anger) versus high withdrawal (e.g., sadness, anxiety, guilt) emotional states (Kreibig et al., 2010). The approach/withdrawal dimension also receives support from neurobiological data, as results across EEG studies indicate that distinct cortical circuits are involved in organizing approach behaviors (left anterior cortical activation) versus avoidance behavior (elevated activity in the right anterior cortex; e.g., Carver and Harmon-Jones, 2009; Coan and Allen, 2004). Thus, each of the three dimensions appears relevant in understanding emotional experiences.

The valence dimension is usually the only dimension of emotional experience considered in empirical investigations of affect regulation in BN. However negative emotions that are also high in arousal may be the most aversive and associated with the greatest distress and, therefore, extremely difficult to tolerate (Chapman et al., 2006). Support for exploring a dimensional model of emotional experience in relation to maladaptive behaviors is evident in the nonsuicidal self-injury (NSSI) literature. In experimental studies of individuals who engage in NSSI, participants described reductions in anxiety following proxies for self-harm, and demonstrated reduced physiological arousal (e.g., heart rate, skin resistance level, blood volume, respiration rate) post imagined NSSI or pain (for a review see Klonsky, 2007). Arousal level may also be important in positive reinforcement from maladaptive behaviors, as low arousal positive emotions such as calmness are the most common affect states reported after engaging in NSSI (Klonsky, 2009). Additionally, positive emotions identified as low arousal emotions showed the largest pre- to post-change scores (i.e., increased markedly) following NSSI (Claes et al., 2010) and self-reported increases in these emotions, along with decreases in high arousal negative emotions, strongly predicted frequency of lifetime skin-cutting (Klonksy, 2009).

In this study, we re-organized negatively and positively valenced emotion-based descriptors according to three theorized underlying dimensions of emotional experiences (valence, arousal, and approach/avoidance). We classified discrete emotion words into five dimensionally-defined constructs: high arousal negative emotions that promote avoidance behaviors, high arousal negative emotions that promote approach behaviors, low arousal negative emotions that promote avoidance behaviors, high arousal positive emotions that promote approach behaviors, and low arousal positive emotions that promote approach behaviors (see Table 1). We chose to explore our hypotheses in relation to binge eating only, purging only, and combined binge eating and purging, because there is some evidence that individual emotions differentially impact eating behaviors (e.g., Macht, 1999) and, therefore, perhaps different bulimic behaviors serve to regulate different dimensions of emotions.

Because we were interested in understanding what features of emotional experiences momentarily prompt and are regulated by bulimic behaviors as well as what emotions typify days that include bulimic behaviors, we chose to conduct within-day and between-day analyses. Trajectory analyses of emotion constructs before and after engagement in binge and/or purging (i.e., within-day analyses) answer the question: On days with bulimic behaviors, what features of emotions are most related to engagement in bulimic behaviors? Analyses comparing average levels of emotional constructs on days with and without binge eating and/or purging (i.e., between-day analyses) answer the question: On days that include symptoms, which emotion constructs are most likely to be elevated?

Table 1
PANAS and POMS items categorized by Valence, Arousal, and Approach/Avoidance.

Dimensional-Defined Emotion Constructs	PANAS and POMS emotion words
Negative Valence, High Arousal,Avoidant (Cronbach's α = 0.91)	Distressed (PANAS) Disgusted (PANAS) Afraid (PANAS) Ashamed (PANAS) Nervous (PANAS) Jittery (PANAS) Angry at Self (PANAS) Dissatisfied with Self (PANAS)
Negative Valence, High Arousal, Approach (Cronbach's α = 0.81)	Angry (POMS) Irritable (PANAS) Annoyed (POMS) Peeved (POMS)
Negative Valence, Low arousal, Avoidant (Cronbach's α = 0.89)	Sad (PANAS) Lonely (PANAS)
Positive Valence, High Arousal, Approach (Cronbach's α = 0.89)	Enthusiastic (PANAS) Alert (PANAS) Determined (PANAS) Attentive (PANAS)
Positive Valence, Low Arousal, Approach (Cronbach's α = 0.88)	Calm (PANAS) Happy (PANAS) Proud (PANAS) Relaxed (PANAS) Cheerful (PANAS) Confident (PANAS)

Note: The five dimensionally-defined emotion constructs were developed according to previously published empirical work and consultation with experts.

1.1. Hypotheses

1.1.1. Within-day hypotheses for negatively valenced emotion constructs

Given findings with NSSI (Claes et al., 2010; Klonsky, 2007,2009), we expected that a pattern of emotional experience characterized by negative valence, high arousal, and avoidance motivations would be the most aversive, urgent, and challenging to regulate and, thus, be the most associated with bulimic behaviors compared to negative emotions characterized by either lower arousal or an approach-orientation. Previous studies utilizing this sample have shown that all negative emotions rise preceding bulimic behaviors (Smyth et al., 2007; Berg et al., 2013). However, we further hypothesized that high arousal avoidance-promoting negative emotions would show the greatest increases (i.e., steepest positive linear slope) and reach the highest peak values (i.e., highest magnitude) prior to binge and/or purge behaviors compared to high arousal approach-promoting and low arousal avoidance-promoting negative emotions. We also hypothesized that the trajectories of high arousal and approach-promoting negative emotions would demonstrate significant and positive quadratic and cubic estimates prior to each behavior, representing an acceleration of emotion change prior to behaviors.

Similarly, we hypothesized that all negative emotions would show significant decreases subsequent to all disordered eating behaviors, as previously shown in this sample (Smyth et al., 2007; Berg et al., 2013). We further expected that the consequent trajectories of high arousal and avoidance-promoting negative emotions would be distinct from high arousal approach-promoting and low arousal avoidance-promoting negative emotions, because emotions characterized by heightened physiological arousal and avoidance urges show the largest reduction pre- to post- NSSI (Claes et al., 2010). We hypothesized that high arousal, avoidance-promoting negative emotions would decrease