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Affect, Reward, and Punishment in Anorexia Nervosa: A Narrative Overview

Margarita Sala^a, Amy H. Egbert^b, Jason M. Lavender^c, Andrea B. Goldschmidt^d

^aDepartment of Psychology, Southern Methodist University, Dallas, TX

^bDepartment of Psychology, Loyola University Chicago, Chicago, IL

^cDepartment of Psychiatry, University of California, San Diego, La Jolla, CA

^dDepartment of Psychiatry and Human Behavior, Alpert Medical School of Brown University, Weight Control & Diabetes Research Center/The Miriam Hospital, Providence, RI

Abstract

Introduction: Anorexia nervosa (AN) is a serious psychiatric disorder that is difficult to treat and often follows a protracted course. A number of theoretical models have been proposed for the etiology and maintenance of AN. Two domains that have received substantial attention in the literature on AN are affect and reward/punishment processes. However, despite an overlap in the nature and implications of these processes, studies of AN addressing these constructs have typically investigated them independently.

Purpose: The purpose of this narrative review is to integrate the literature on the role of affect, reward, and punishment in AN.

Method: We provide a focused narrative overview of the literature relating to the affect, reward, and punishment in AN via a synthesis of recent reviews and meta-analyses.

Results: We first describe several prominent affect and reward/punishment-based conceptualizations of AN, followed by a brief overview of the existing empirical literature in these domains.

Conclusion: We provide a critical discussion of the disparate nature of these literatures in AN, including associated limitations. We then conclude with an extensive discussion of directions for future research that integrate the study of affect and reward/punishment processes in AN.

Keywords

reward; punishment; affect; emotion; anorexia nervosa

* Correspondence to: Margarita Sala, Department of Psychology, Southern Methodist University, PO Box 750442, Dallas, TX 75206. Phone: 972-369-4267, msala@smu.edu.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical Approval:

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Anorexia nervosa (AN) is a serious psychiatric disorder characterized by restriction of energy intake resulting in significantly low body weight, fear of weight gain, and disturbances in body image [1]. There are two diagnostic subtypes of AN: AN-restricting subtype (AN-R) and AN-binge eating/purging subtype (AN-BP), with only the latter subtype involving recurrent binge eating and/or purging behavior [1]. AN is associated with severe medical complications and psychiatric comorbidities [2,3], as well as high rates of mortality from suicide and medical complications [4,5]. Despite the seriousness of AN, effective treatment options are lacking, particularly for adults, and there are high rates of premature treatment termination [6] which may be due in part to the ego-syntonic nature of the disorder. Elucidating the factors that are most relevant to the onset and/or maintenance of AN may aid in the development of more effective prevention and intervention programs.

The etiology of AN involves multiple intersecting biological, psychological, and sociocultural factors [7]. Of particular note, evidence from traditionally separate literatures within the eating disorder field suggests that both affect (i.e., the experience of emotion, either positively or negatively valenced) and reward/punishment (i.e., relating to the positive or negative value that one ascribes to a stimulus, associated with approach or avoidance behaviors, respectively) processes play a crucial role in the onset and maintenance of AN. However, despite an intrinsic link between affect and reward/punishment processes, studies of AN have typically examined these processes separately.

Purpose

The purpose of this review is to provide a narrative overview of research and theory on the role of these processes in AN, and to suggest directions for future research that integrate the study of affect and reward/punishment processes in AN.

Method

We first provide an overview of affect and reward/punishment processes, followed by a description of several prominent theories of AN that relate to these processes. As several recent qualitative and quantitative reviews separately address affect [8,9] and reward/punishment (10–12) processes in AN, we provide a focused narrative summary of the literature in these domains via a synthesis of these recent reviews. We include any reviews or meta-analyses of affect, reward, or punishment in anorexia nervosa. Finally, we discuss the disparate nature of these literatures in AN, including associated limitations, and offer suggestions for future investigations that integrate the study of affect and reward/punishment processes in AN.

Overview of Affect and Reward/Punishment

Broadly, affect encompasses the experience of emotion, which can be either positively or negatively valenced. Positive affect is conceptualized as a subjective experience of pleasant emotions, and is associated with reward-seeking behaviors [13]. Furthermore, high trait positive affect is associated with higher reward sensitivity (i.e., the degree to which rewards lead to positive emotion) [14]. In contrast, negative affect involves states such as fear and

anxiety, and high trait negative affect is associated with high punishment sensitivity and avoidance behaviors [14].

The reward system is composed of three distinguishable components, all of which are interlinked with affect: the anticipation of reward (wanting), the consumption of reward (liking), and the learning of reward (learning) [15]. Wanting involves motivation, desire, or craving for reward [15]. Liking involves pleasure experienced during reward consumption [15], and most directly describes affect [16]. Learning involves the formulation of reward-based associations, which ultimately results in habit formation [15]. Pleasure experienced during the consumption of reward directly impacts learning, as individuals learn to continue engaging in behaviors that are pleasurable, and cease behaviors that are not pleasurable or are aversive.

As evidenced by the brief descriptions above, affect, reward, and punishment processes are not entirely distinct. Two core systems have been identified which incorporate these processes: (1) the approach system (i.e., the positive valence system), which motivates actions towards rewards and produces *positive affective states*, and (2) the avoidance system (i.e., the negative valence system), which motivates punishment avoidance and is linked *with negative affective states* [17]. It has been argued that positive affect and negative affect are self-reported dimensions of the behavioral approach and inhibition systems (BAS/BIS) [18]. Whereas negative affective states promote avoidance of punishment, positive affective states promote approach behaviors toward potential rewards [18]. For example, when an individual experiences positive affect, he/she is motivated to continue engaging in the activity that results in pleasure/reward, which result in further increases in positive affect [14]. Behavior intended to attain reward and avoid punishment is critical in regulating affect, with rewards and punishers eliciting corresponding emotions [19]. For example, receiving a reward (e.g., food) might result in an increase in positive affective states (e.g., pleasure). Similarly, the removal of punishment (e.g., a painful stimulus) might result in a decrease in negative affective states (e.g., fear).

Affect and Reward/Punishment-Based Theories of AN

Affect-Based Theories of AN

Several theories are focused primarily on the role of eating disorder behaviors in AN as a response to emotions, particularly those that are negatively valenced. For instance, the functional model of emotion avoidance in AN, similar in concept to Heatherton and Baumeister's (1991) [20] escape theory of binge eating, proposes that individuals with AN tend to experience emotions as aversive and uncontrollable, prompting a desire to avoid the experience of these negative affective states. Individuals with AN learn that engaging in disordered eating symptoms can help facilitate such emotion avoidance [21]. Additionally, the transactional model of emotional dysregulation, originally developed for borderline personality disorder [22,23] has been applied to AN [24] and proposes that individuals with the disorder experience both general emotional vulnerabilities and specific vulnerabilities to food and body-related stimuli and to their starved state. When an individual with AN experiences an emotional event, he/she responds with heightened emotional arousal, and to regulate that emotional state, the individual engages in disordered eating behaviors that

temporarily reduce emotional arousal. This model is similar in form to the affect regulation model underlying Cognitive-Emotional-Behavioral Therapy for eating disorders [25], which addresses the contribution of an invalidating environment and primary emotional experiences to beliefs about emotions, which in turn produce secondary emotions that promote maladaptive behaviors to regulate emotions. Of note, the major concepts of these theories have been supported by recent reviews and meta-analyses that address the maladaptive nature of emotion generation and regulation in AN [8,9].

Another affect-based model of AN was described by Selby et al. (2014) [26] and focuses on positive emotion differentiation. According to this model, when individuals with AN initiate weight-loss and achieve their goals, they experience positive emotions which motivate further weight loss. The effect of weight loss on positive emotions is stronger in individuals with low positive emotion differentiation (i.e., low ability to distinguish between different positive emotions) because several additional positive emotions (e.g., happiness, confidence) in addition to any positive emotion that may naturally result from weight loss (e.g., pride) may be triggered after engaging in eating disorder behaviors, thus positively reinforcing weight loss. In contrast, gaining or failing to lose weight increases negative emotions. Over time, weight-loss behaviors become conditioned to elicit positive emotions, even when the effects of the weight-loss become harmful.

Finally, other theories include affect as one of multiple interacting factors that initiate and/or maintain AN. For example, the cognitive interpersonal maintenance model of AN proposes that avoidance of the experience and expression of intense negative emotions, particularly those related to social encounters, is one of the key factors in maintaining AN [27]. Further, the transdiagnostic model of eating disorders proposes that mood intolerance is one of several potential maintaining factors across the eating disorders spectrum, including in AN [28].

Reward/Punishment-Based Theories of AN

Various reward/punishment-related theories of AN have been proposed, many of which emphasize the role of reinforcement processes. For example, Bergh and Södersten (1996) proposed that AN is first initiated because individuals with AN find it reinforcing to eat less and exercise more given the effects of these behaviors on body weight and shape [29]. Over time, cue-conditioning (i.e., conditioning to the stimuli that provide reward) becomes the main mechanism responsible for the maintenance of AN. Furthermore, Park et al. (2014) suggest that weight-loss behaviors are initially rewarding and positively reinforced, but over time become compulsive and negatively reinforced [30]. Similarly, Steinglass and Walsh (2016) proposed a model whereby dieting behavior is initially rewarding in AN, leading to repeated practice, which results in the dieting behavior becoming automatic and less dependent on the receipt of reward (i.e., habitual) [31].

Other theories in this domain have been more focused on the underlying neurobiology of reward-related abnormalities in AN. For instance, Davis and Woodside (2002) proposed that individuals with AN exhibit hypo-responsive dopamine function, which results in a reduced capacity to experience reward [32]. Zink and Weinberger (2010) proposed that stressors (e.g., social rejection) can promote food restriction in certain individuals (e.g., those

genetically predisposed to AN or exposed to certain environments), with restriction and associated weight loss promoting alterations in the dopamine-ventral striatal reward system that reinforces self-starvation by associating restriction cues with motivational value. [33] These neurobiological alterations thus reinforce the desire to not eat, resulting in a cycle of starvation. Furthermore, in conceptualizing the neurobiology underlying reward processes in AN, Keating (2010) describes the tendency of individuals with AN to confuse aspects of reward with punishment, including a common transition from the experience of disorder-related behaviors as rewarding to punishing over time [34]. These abnormalities are subsequently conceptualized within a framework emphasizing the potential salience of anterior cingulate cortex hypoactivity with respect to altered reward processing in AN.

Synthesizing Recent Reviews on Affect and Reward/Punishment in AN

Affect

Two recent reviews/meta-analyses related to affect have been conducted in AN [8,9]. Oldershaw et al. (2015) conducted a review and meta-analysis on emotion generation and regulation processes in individuals with AN [9], framed around Gross' process model of emotional regulation (1998) [35]. They found that individuals with AN reported: (1) more maladaptive schemata (i.e., more negative beliefs about oneself / others / the environment, which can give rise to negative affect); (2) poorer emotional awareness and recognition; (3) higher negative emotions and lower positive emotions; and (4) a greater use of maladaptive emotion regulation strategies than healthy controls [9]. In contrast, Lavender et al. (2015) used Gratz & Roemer's (2004) [36] multidimensional model of emotion regulation and dysregulation as a framework to review the literature on emotion regulation processes in AN [8]. They found that individuals with AN have emotion regulation deficits across the four dimensions identified by Gratz and Roemer (2004) [36]: (1) the flexible use of situation adaptive and appropriate strategies to modulate emotion duration / intensity; (2) the ability to successfully inhibit impulsive behavior and maintain goal-directed behavior when distressed; (3) emotional awareness, clarity and acceptance; and (4) the willingness to experience emotional distress to pursue meaningful activities.

Taken together, evidence from both reviews suggests that individuals with AN exhibit a pattern of broad emotion regulation deficits, tend to utilize more maladaptive and less adaptive emotion regulation strategies than healthy controls, and commonly display reduced emotional self-awareness. Further, both reviews noted that, although there are some improvements in emotion regulation among individuals recovered from AN, there is evidence that some difficulties may persist into remission from the illness.

Reward/Punishment

Three recent reviews/meta-analyses related to reward /or punishment have been conducted in AN [10–12]. In a meta-analysis, Harrison et al. (2010) examined reward and punishment sensitivity in AN, reporting that currently ill and recovered individuals with AN display reduced reward sensitivity / novelty seeking than healthy controls. However, whereas AN-R patients consistently demonstrated lower reduced reward sensitivity / novelty seeking versus healthy controls, results for mixed and recovered AN groups were more variable [10]. They

also found that individuals currently ill with or recovered from AN-R or AN-BP exhibited increased sensitivity to punishment, suggesting that there may be a preexisting dispositional bias towards punishment that contributes to AN.

O'Hara et al. (2015) examined reward processes in AN through a narrative review, concluding that the reluctance to gain weight in AN promotes an aversive appraisal of food-stimuli and subsequent overvaluation of rewards that are related to pursuit of the thin ideal (e.g., thinness, exercise) [12]. They further proposed a model in which aberrant cognitions related to eating, weight and shape alter the functioning of reward systems in AN. Finally, Keating et al. (2012) provided a qualitative review of reward processing in AN, with a focused on taste-based reward [11]. The authors suggest that the tendency of individuals with AN to exhibit a limited response to typically rewarding stimuli (food) is due to weight/caloric-related fears versus more basic deficits in the experience of reward. As such, the abnormalities are viewed as deficits in wanting versus liking, characterized by an impaired motivational salience for food-related stimuli.

Overall, findings from these three reviews thus support the notion that AN is characterized by a complex pattern of abnormalities in reward and punishment processes. In particular, individuals with AN appear to experience reduced reward responding to conventional rewards, but also overvalue rewards that are related to the thin ideal. Along with this altered reward sensitivity, individuals with AN also seem to exhibit an increased sensitivity to punishment.

Discussion

Disparate Literatures

Despite a strong theoretical interlink between affect and reward/punishment, the empirical and theoretical literature in AN has most commonly investigated these processes separately. Several general characteristics of the disparate literatures may represent factors contributing to this separate focus. Perhaps most notably, reward-based research on AN has tended to be more neurobiologically focused, with an emphasis on underlying structural and/or functional abnormalities in brain regions and networks associated with reward processing. In contrast, affect-focused in AN has been more behaviorally focused, emphasizing subjective experience and clinical phenomenology. Further, the role of reward/punishment in AN has most often been investigated from a more static trait/dispositional perspective (e.g., using trait-based self-report measures, or one-time administration of reward tasks), whereas there has been more consistent variability in the approach to investigating affect processes in AN from diagnostic comorbidities (e.g., mood disorders), to dispositional perspectives (e.g., trait anxiety), to state-based perspectives (e.g., momentary emotional precipitants of eating disorder behaviors). As such, the general dissociation of these literatures is likely due to a combination of heterogeneity in methodologies (e.g., clinical interview, questionnaire, computerized task, neuroimaging), level and focus of investigation (e.g., personality, subjective experience, brain function), and underlying conceptualization (e.g., state versus trait).

Clinical Implications

A more integrated conceptualization of affect and reward/punishment processes may have clinical implications for AN. For instance, most affect-focused psychotherapies for AN primarily emphasize the reduction of negative affect [37]. However, interventions that also focus directly on both enhancing responsivity to adaptive rewards and increasing the frequency and/or intensity of positive affective states (e.g., behavioral activation) could be particularly beneficial, as increases in hedonic behavior are associated with successful treatment outcomes in AN [38]. For instance, treatments could leverage social activity and adaptive/healthy exercise - which have been shown to be particularly important to positive affect [14] - to increase positive emotions in individuals with AN (see Cook et al. (2016) [39] for guidelines on the use of exercise in treating eating disorders). Additionally, strategies focused on reducing emotional and behavioral avoidance tendencies and encouraging individuals with AN to identify and work toward meaningful and valued goals other than the pursuit of thinness may also have promise, as adaptive goal striving can be rewarding and increase positive affect and well-being [40,41].

Treatments for AN that focused on the characteristic nature of reward and punishment processes in the disorder have also begun to emerge. For example, Kaye et al. (2015) describe a temperament-based treatment for AN that targets neurobiologically-based traits and temperament variables including anxiety/harm avoidance, reward insensitivity, and interoceptive awareness [42]. Given the empirical evidence supporting the role of such constructs in AN, an increased focus on targeting these processes in the treatment of AN may be warranted. Finally, as novel and/or adapted interventions based on affect and reward/punishment domains are developed and empirically evaluated, including measures of these processes at multiple time points will be important for examining them as predictors, moderators, and mediators of treatment outcome.

Future Directions

There are a number potential areas for future integrated investigations of affect and reward/punishment processes in AN. Promising directions may focus on methodological approaches that address gaps in the current literature (e.g., use of prospective and/or longitudinal approaches, applying integrative and multi-method study designs), or on further characterizing the nature of these processes in AN (e.g., exploring between- and within-person variability, exploring transdiagnostic empirical classifications based on these domains). Below we discuss several possible examples for future research in these domains.

One important area for future research is to utilize prospective or longitudinal methods to investigate patterns of dysfunction in affect and reward/punishment processes over time, as the majority of existing studies have been cross-sectional in nature. Longitudinal research would provide the potential for understanding the extent to which abnormalities in these domains (independently or interactively) function as predisposing factors for AN, consequences of the disorder, or perhaps both. Such research would also allow for an evaluation of the extent the role of these processes in relation to eating disorder symptomatology various across the duration of AN illness. For instance, it is possible that certain processes within these domains are more salient earlier versus later in the course of

illness (or vice versa) [31]. Furthermore, studies of mechanisms that maintain maladaptive affective and reward-based reinforcement processes in AN are needed. For example, it is possible that individuals with AN exhibit certain attentional biases that underlie the discrepancy in reward salience between disorder-specific and non-specific stimuli. Additionally, it is likely that these processes interact with other important factors (e.g., culture, personality, cognitions) in their association with eating disorder symptoms. For example, individuals predisposed to AN may have certain personality traits (e.g., perfectionism, obsessiveness; [43]) and affective characteristics (e.g., anxiety proneness; [44]) that might enhance the reinforcing nature of restriction.

A second promising direction is the use of multi-method study designs incorporating neurobiological, psychological, and behavioral assessment methods. Studies can integrate functional neuroimaging methods and real-world, real-time assessment approaches (e.g., ecological momentary assessment) to explore how individual differences in neural activity associated with reward processes relate to the naturalistic experience of affect and eating disorder behaviors in AN [45]. For instance, such individual differences in brain function could be related to other traits (e.g., attachment style) [46], affective reactivity to certain stimuli in AN (e.g., meals, social encounters), or with degree of affect-based reinforcement of eating disorder behaviors (e.g., restrictive eating). Such research will be helpful in further elaborating how reward-based propensities relate to the momentary affective experiences in naturalistic settings in AN.

A third key area of future research will be to characterize individual variability in affect- and reward/punishment-based tendencies within the diagnosis of AN, as well as investigating possible empirical classifications based on these processes. Preliminary research suggests that affect intensity and frequency varies depending on AN diagnostic subtype and recovery status, with individuals with AN-BP typically reporting more problematic affect than those with AN-R [47,48]. There is also evidence suggesting interdiagnostic differences in reward and punishment processes [49,50]. Moreover, individuals with current AN experience more problematic affect than recovered individuals [51]. There is also evidence for a similar pattern of findings for reward and punishment processes [52]. Finally, given evidence supporting the validity and utility of personality-based subtypes of AN [53,54], establishing empirically-derived subtypes of AN based on propensities within the affect and reward/punishment domains may hold promise (e.g., as potential predictors of treatment response and/or relapse).

Conclusion

The aim of the present article was to demonstrate the disparate nature of the literatures on affect and reward/punishment processes in AN, as well as to discuss related implications and directions for future integrative research on these domains among individuals with AN. Despite an inherent overlap in the nature of affect and reward/punishment processes, the empirical and theoretical literature in AN has most commonly addressed these domains independently. Theoretical conceptualizations and empirical studies that investigate processes across these domains will help to provide a more comprehensive understanding of

their role in the development and maintenance of AN, and may also provide guidance on the development or refinement of interventions that will result in better AN treatment outcomes.

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