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Review

Anhedonia in anorexia nervosa: a narrative review

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SUMMARY

Anhedonia, defined as the loss of pleasure or a lack of reactivity to pleasurable stimuli, is associated with depression, schizophrenia and also anorexia nervosa (AN). The inability to experience pleasure has its biological underpinnings in the mesolimbic dopamine system and is strongly implicated in the risk for a variety of addictive behaviors. In this article we describe the main questionnaires for the assessment of anhedonia and review the literature evidence regarding anhedonic symptomatology in patients diagnosed with AN. This narrative review, in agreement with previous literature, sheds light on the importance of considering anhedonia as a phenotypic biomarker and suggests implementing the development of targeted treatments.

Key words: anhedonia, anorexia nervosa, eating disorders, reward

Introduction

Anhedonia, defined as the inability or the reduced ability to experience pleasure [1], was first described in the previous century as a symptom of depression [2,3]. Reward induces subjective feelings of pleasure or positive emotional states promoting approach to pleasurable stimuli, consummatory behaviors and maintenance of rewarding behaviors. Anhedonia can result from impairments in different steps of reward processing, including reward desire, anticipation of pleasure, effort to achieve pleasure, consuming pleasure, learning from rewarding stimuli. The experience of pleasure can be induced by instinctual stimuli (e.g., food, sex) and non-instinctual stimuli (e.g., photography, reading); the former represent "primary" rewards (inherent rewards), while the latter are secondary rewards (without inherent reward in itself and for which reward value must be learned).

Anhedonia has been found to be a core symptom of several neuropsychiatric disorders, including major depressive disorder [4], schizophrenia [5], bipolar disorder, obsessive compulsive disorder [6], Parkinson's disease [7], eating disorders (EDs) and maladaptive behaviors and [8,9,2]. Anhedonia is associated also with multiple negative health behaviors, such as smoking, illicit drug use, and poor physical activity, even in the absence of psychiatric disorders [10,11]. In line with the Research Domain Criteria approach [12], state anhedonia can be measured and studied as a dimensional psychopathological trait. Moreover, anhedonia can be considered a stable personality trait, able to predict future psychopathology [13-15].

Recently, the role of anhedonia in EDs has been emphasized because of the more and more frequent evidence of alterations in reward processing in these disorders [16].

It is widely acknowledged that in AN anhedonia might play an important role in both the etiopathogenesis and maintenance of eating pathology. In support of this, it has been found that restrictive eating is maintained by deficits in positive emotions and that individuals with AN experience

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pleasure from restrictive eating behaviors but not from typically rewarding stimuli [17].

In this narrative review we briefly illustrate the psychometric instruments allowing the measurement of individual anhedonia levels and then review literature studies that assessed anhedonia in individuals with AN pointing to its clinical significance in both the presentation and the management of the EDs.

Assessment of anhedonia

The main methods for the assessment of anhedonia can be distinguished into "first generation" questionnaires and "second generation" anhedonia scales, which differ because the latter, developed more recently, are aimed at exploring all the different facets of reward functions [18].

The first-generation questionnaires mostly used in clinical research are the Snaith-Hamilton Pleasure Scale (SHAPS) [19], the Fawcett-Clark Pleasure Capacity Scale (FCPS) [20], the Revised Chapman Physical Anhedonia Scale (CPAS), and the Chapman Social Anhedonia Scale (CSAS) [21]. Different aspects of anhedonia are assessed by these four scales. The CPAS and CSAS measure various aspects of anhedonia (motivation, effort, and consummatory pleasure) in addition to personality traits, while both the FCPS and SHAPS focus exclusively on consummatory pleasure. All these scales incorporate questions relating to both primary and secondary reward. The SHAPS, in particular, devised items based on the domains of pastimes, social interaction, food/drink, achievement and sensory experience. This is in contrast to the CPAS and CSAS, which separate physical and social anhedonia. The revised version of the CSAS, namely the Revised Social Anhedonia Scale (RSAS) [22] ranks among the most widely used questionnaires. The RSAS is a 40-item true-false self-report questionnaire that assesses the ability to experience pleasure in social interactions.

Second-generation scales include: 1) the Temporal Experience of Pleasure Scale (TEPS), with 18 items and two subscales designed to distinguish between anticipatory and consummatory pleasure [23]; 2) the Motivation and Pleasure Scale-Self Report (MAP-SR) to measure negative symptoms in schizophrenia [24]; 3) the Specific Loss of Interest Scale (SLIPS) [25]; 4) the Anticipatory and Consummatory Interpersonal Pleasure Scale (ACIPS) [26,27], a 17- item self-report scale that focuses on measuring anhedonia related to social interactions; 5) the Dimensional Anhedonia Rating Scale (DARS), a 17-item self-report questionnaire that was designed to assess anhedonia in Major Depressive Disorder [28]. The 18 TEPS items reflect only physical anhedonia, as the authors believed that this way the results would be more homogeneous and interpretable. The scale was validated using a population of students and has been employed, as far as we know, only in psychiatric populations with schizophrenia and bipolar disorder [29,30]. The MAP-SR contains 15 questions across four domains: social pleasure, recreational or work pleasure, feelings and motivations about close, caring relationships, motivation and effort to engage in activities. The questions are answered on a 4-point Likert scale, where a high score is indicative of low anhedonia. The SLIPS was primarily designed to measure levels of interest over time (a 2-week period). Each of the 23-items has a 3-point scale, with higher scores denoting increasing levels of anhedonia. The SLIPS demonstrated high reliability as well as convergent validity with the SHAPS, moderate correlation with the TEPS anticipatory scale and small correlation with the TEPS consummatory scale. As for the ACIPS, the focus on social anhedonia is derived from research reporting high levels of social anhedonia as risk factor for the development of schizophrenia-spectrum disorders. Although the revised CSAS measures the same construct of the ACIPS, it does not distinguish between anticipation and consummatory pleasure, and it is unclear whether the CSAS would be useful in youth or adolescent groups due to the age bias of the items. The ACIPS was specifically designed to address these limitations as well as to provide a shorter scale, which would be more useful in clinical settings.

In addition to the above-mentioned instruments, the Behavioral Inhibition System and the Behavioral Activation System (BIS/BAS) scale was developed to measure personality traits of behavioral approach and inhibition based on Gray's theory of behaviour, the concept being that there are two distinct neurological systems for aversive motivation and appetitive motivation [31].The BIS system is activated in response to non-rewarding, novel stimuli that can lead to negative outcomes and inhibits behavior towards these stimuli. The BAS system, in contrast, is activated by rewarding stimuli. The BIS/BAS is a 24-item self-report scale with 4 factors: one for the BIS and 3 subscales for the BAS (drive, reward response and fun seeking).

Anhedonia in anorexia nervosa

AN is an ED characterized by abnormally low body weight associated with intense fear of gaining weight and distorted cognitions regarding body weight and shape [32]. Although its etiology is still unknown, several pathogenetic models involving brain systems associated with cognitive self-regulation, motivation/reward processing, and appetite regulation have been proposed [33-43]. A key aspect of those models is a "top-down" versus "bottom-up" element, in which "top-down" modulatory mechanisms reflect the prefrontal cognitive control, while "bottom-up" limbic and intero-

ceptive processes reflect the integration of inputs from systems that regulate factors such as homeostatic need, reward responses, and motivational drive. It has been proposed that, in AN, hyperactivation of "top-down" cognitive control networks exerts control over "bottom-up" appetitive responses, and that this, symptomatically, emerges as a pathological desire to be thin, as elevated anticipatory anxiety when exposed to food, and as behavioral rigidity including excessive control over food intake [38,43-46].

The influence of motivation on eating behaviors suggested that dysfunctional neural circuits involved in reward and punishment processing contribute to the development and maintenance of AN and other EDs [47-50]. Abnormalities in reward and punishment processing have been framed neurobiologically in the mesolimbic dopamine (DA) reward system [49-52]. DA has certainly been the most studied candidate as associated with reward in AN. Increased binding of D2 and D3 receptors in the striatum of women with AN compared to healthy controls has been reported by a positron emission tomography study [53]. In addition, central dopaminergic activity [54], peripherally measured by means of spontaneous eye blink rate, has been shown to be abnormally elevated in AN patients compared to healthy controls [55]. Most studies suggest that DA is primarily involved in the "desirable" component of reward, that is, in the attribution of motivational salience to reward-related stimuli. In AN a sensitization of the DA reward system may occur, thus enabling the amplification of the incentive value of stimuli/behaviors compatible with disease goals (e.g., thinness and exercise). Furthermore, similarly to drug addiction, it has been proposed that in AN dietary restriction and elevated drive to exercise are rewarding behaviors associated with addiction, as they persist despite their negative physical, emotional, and social consequences [32,56-59]. Therefore, the existence of DA-mediated neural mechanisms underlying the reinforcing values of aberrant eating behaviors similarly to the aberrant behaviors of individuals with drug abuse has been hypothesized [60].

The role of a dysfunctional DA system in AN is further corroborated by studies in which individuals with AN appeared ascetic and anhedonic [61], and anhedonia results from impairments in various aspects of reward processing and is associated with poorer recovery and/or a more severe clinical presentation of AN. Moreover, anhedonia should not be seen only as an inducible state, dependent upon malnutrition and/or concomitant depressive symptomatology, but also as an innate character trait. Indeed, it seems that anhedonia reflects a weakness of physiological positive reinforcers and that within the general population, reward capacity exists as a normally distributed dimension [8].

In AN, primary rewards are frequently described as unpleasant and are avoided by AN patients. These features have been seen as an anhedonia-like phenotype [62,63], suggesting that patients have an impaired ability to experience pleasure or reward. The anhedonic construct includes physical anhedonia, an inability to experience physical pleasure, and social anhedonia, a decreased ability to take pleasure in social activities [21]. Physical anhedonia can be measured by items such as "*I would like to have a cup of tea or coffee or my favorite beverage*" or "*I would be able to enjoy a beautiful landscape or view*" [19], while social anhedonia can be measured by items such as "*Just being with friends makes me feel very good*" and "*I have always enjoyed looking at photographs of friends*" [21]. Both components of anhedonia have been explored in people with AN. Moreover, according to the above-mentioned Gray's theory of behaviour [31] some studies have assessed also aversive and appetitive motivation of people with AN by means of the BIS/BAS scale (Tab. I).

TABLE I. *Summary of studies assessing physical and social anhedonia in people with anorexia nervosa.*

Author	year	Assesment scale	Subjects	Main results
Davis and Scott-Robertson [72]	2000	CPAS	46 subjects with AN-R 22 bodybuilders	Both the bodybuilders and the AN patients had very high anhedonia scores, although these did not significantly differ.
Eiber et al. [64]	2002	CPAS, CSAS	20 subjects with AN-R 20 subjects with AN-BP 20 subjects with BN	Scores on the Social and Physical Anhedonia Scales did not differ significantly among diagnostic groups. Although not significant, scores on the Physical Anhedonia Scale were approximately 20 points higher in ED patients than in control subjects (assessed in a previous study).

continues

TABLE I. *Follows.*

Davis and Woodside [61]	2002	CPAS	78 subjects with AN-R 76 subjects with BN 32 subjects with ED not otherwise specified (EDNOS) who no longer met weight criteria for AN (but who had had a previous diagnosis of AN-R) and had no binge-purge symptomatology Patients were dichotomized according to their exercise status	Patients with AN-R showed higher levels of anhedonia compared to those with BN. BN patients who did not exercise excessively had significantly lower anhedonia scores than the other groups, which did not differ from each other. The non-exercising EDNOS group had significantly lower anhedonia scores than the AN non-exercisers.
Claes et al. [79]	2002	BIS/BAS	20 subjects with AN-R 14 subjects with AN-BP 22 subjects with BN 83 healthy controls	AN-BP, BN and HC individuals scored higher on the BIS-BAS-Fun Seeking than AN-R individuals. AN-R individuals were more behaviorally inhibited (BIS-BAS-Behavioral inhibition) than AN-BP, BN and HC individuals.
Beck et al. [80]	2009	BIS-BAS	32 subjects with AN-R 17 subjects with AN-BP 35 subjects with BN 15 subjects with EDNOS	The different types of ED patients did not significantly differ from each other with respect to BIS reactivity. AN-R individuals scored significantly lower in BAS- Fun Seeking than those with AN-BP or BN, among which there were no significant difference.
Jiang et al. [74]	2010	CPAS	17 subjects with AN-R 29 healthy controls	Although the AN-R patients had a higher score on the CPAS than healthy controls, the difference failed to reach significance.
Harrison et al. [81]	2011	BIS-BAS	29 subjects with AN-R 55 subjects with AN-BP 34 subjects with BN 74 subjects recovered from EDs 91 healthy controls	The only measure on which the subgroups (AN-R, AN-BP, BN) differed significantly was BAS-FS. AN-R individuals scored significantly lower on the BAS-FS than recovered patients.
Tchanturia et al. [65]	2012	RSAS	72 subjects with AN 14 subjects with recAN 19 subjects with BN 43 healthy controls	Participants with AN and BN both reported significantly higher levels of social anhedonia than healthy controls, with large effect sizes.
Harrison et al. [66]	2014	RSAS	105 subjects with AN 30 subjects with recAN 46 subjects with BN 136 healthy controls	Individuals with AN and BN scored significantly higher than healthy controls for the RSAS and the recovered AN group showed an intermediate profile, scoring significantly lower than acute participants and significantly higher than healthy controls.
Tchanturia et al. [68]	2014	RSAS	71 subjects with AN: 36 subjects completed CREST	A significant decrease in total score on the RSAS between pre and post-intervention was observed.
Tchanturia et al. [69]	2015	RSAS	37 subjects with AN: 33 subjects completed CREST	A significant decrease in total score on the RSAS between pre and post-intervention was observed.
Lang et al. [67]	2016	CSAS	66 subjects with AN 75 healthy controls	CSAS sores were significantly higher in AN individuals compared to healthy controls. Reduced expression of positive emotions was associated with some clinical variables including elevated social anhedonia.

continues

TABLE I. *Follows.*

Boehm et al. [76]	2018	SHAPS-D	35 subjects with acute AN who underwent an inpatient treatment program 33 subjects with recAN who completed the inpatient treatment program healthy controls	A significantly higher SHAPS-D score was found for acAN and recAN than HC, while no significant difference was found between acAN and recAN. groups Longitudinally, the SHAPS-D score did not differ significantly before and after weight restoration.
Adamson et al. [70]	2018	RSAS	66 subjects with AN who underwent CREST individually 62 subjects with AN who underwent a group CREST	In both the individual and group format intervention, subjects did not report a significant difference in social anhedonia before and after CREST.
Monteleone A.M. et al. [82]	2018	BIS-BAS	48 subjects with AN (38 AN-R;10 AN-BP) 30 subjects with BN 45 healthy controls	Compared to healthy controls, AN and BN individuals reported significant higher scores on sensitivity to punishment (BIS score) but not on reward sensitivity (BAS score). Increased reward sensitivity (BAS-Fun Seeking score) was found in BN individuals compared to AN-R.
Jiang et al. [75]	2019	CPAS	14 subjects with AN-R 13 subjects with BN 12 healthy controls	BN patients presented more anhedonia than healthy controls. AN group did not show significant difference from healthy controls.
Harrison et al. [71]	2020	RSAS	12 subjects with AN underwent CREST individual format 27 subjects with AN underwent CREST group format	Significant decrease in social anhedonia at post treatment for both the individual and group format of treatment.
Dolan et al. [77]	2021	Anhedonia Subscale of the BDI The trait subscale of the STAI	499 adults and adolescents in a partial hospitalization program for EDs: 196 AN-R, 69 AN-BP, 103 BN, 15 BED, 26 ARFID, 92 OSFED	Anhedonia scores significantly decreased from admission to discharge in all the groups The AN-BP group endorsed the highest levels of anhedonia. The ARFID group reported the lowest level of anhedonia and had significantly lower anhedonia than the other diagnostic groups. The OSFED group had significantly higher scores than the AN-R group but did not differ significantly from any other group.
Dolan et al. [78]	2022	TEPS	51 subjects with AN 40 subjects with BN 33 subjects with OSFED 83 healthy controls	There were no significant difference in the TEPS consummatory scores across individuals with AN, BN, OSFED, and HC. Anticipatory pleasure was found to be significantly higher in healthy controls than in patients with AN and OSFED. There were no significant difference among patients with AN, BN and OSFED.

AN = Anorexia Nervosa; AN-BP = Anorexia Nervosa- Bulimic Purgative subtype; AN-R = Anorexia Nervosa Restricting subtype; rec-AN = Anorexia Nervosa recovered ARFID = Avoidant Restrictive Food Intake Disorder; BED = Binge Eating Disorder; BN = Bulimia Nervosa; BDI = Beck Depression Inventory II; BIS-BAS = Behavioral Inhibition System- Behavioral Activation System; CPAS = Chapman Physical Anhedonia Scale; CREST = Cognitive Remediation and Emotion Skill Training; CSAS = Chapman Social Anhedonia Scale; EDNOS = Eating Disorders not Otherwise Specified; OSFED = Other Specified Eating or Feeding Disorder; RSAS = Revised Chapman Social Anhedonia Scale; SHAPS = Snaith Hamilton Pleasure Scale; STAI = Stait Trait Anxiety Inventory; TEPS = Temporal Experience of Pleasure Scale.

Social anhedonia in anorexia nervosa

Eiber et al. [64] tested the hedonic response and the fear of weight gain after ingestion of a sucrose solution in a sample of patients with AN-R, AN-BP and BN measuring also the social and physical anhedonia. They found that social anhedonia scores did not significantly differ among the diagnostic groups but in all the ED group they significantly correlated positively with low mood (measured by Montgomery-Asberg Depression Rating Scale), drive for thinness and fear of swallowing sucrose solution and negatively with maximal hedonic response to sucrose solution ingestion. The authors suggested that social factors may be implicated in motivating the patients' fear of gaining weight and in triggering a decrease of pleasantness rating.

Some studies evaluated social anhedonia in AN individuals compared with healthy controls. Tchanturia et al. [65] and Harrison et al. [66] assessed self-reported social anhedonia through the RSAS in individuals with AN, recovered AN, BN, and healthy controls, showing that patients with AN and BN had higher levels of social anhedonia than healthy controls; recovered AN did not report significant differences with healthy controls. However, social anhedonia was associated with longer illness duration and, together with severity of body weight loss, significantly predicted work/social difficulties [66]. According to previous findings [64], patients with AN did not show higher levels of social anhedonia than individuals with BN.

Lang et al. [67], exploring the correlation between facial expressions and some clinical variables including social anhedonia, obtained results similar to previous studies with greater social anhedonia in AN individuals compared to healthy controls.

Other studies have assessed social anhedonia using RSAS in AN individuals before and after Cognitive Remediation and Emotion Skill Training (CREST) [68-71]. While Tchanturia et al. [68,69] and Harrison et al. [71] reported significant decrease in RSAS scores following CREST, Adamson et al. [70] did not find any significant change in social anhedonia in AN people undergoing CREST in both the individual and group formats.

Physical anhedonia in anorexia nervosa

Davis and Scott-Robertson [72] compared anhedonia through the CPAS in patients with AN-R and in a group of bodybuilders, revealing that both groups had very high levels of physical anhedonia. Similar results were obtained by Eiber et al. [64], who showed that physical anhedonia levels did not significantly differ among subjects with AN-R, AN-BP or BN, although scores on CPAS were approximately 20 points higher in EDs patients than HC assessed in a previous study [73]. In a subsequent study Davis and Woodside [61] compared patients with AN, BN and ED not otherwise specified (EDNOS), dichotomized according to their exercise status in exercising patients (who exercised more than 1 hour per day, for at least 6 days per week, for a period of 1 month or more) and non-exercising patients, to test the idea that anhedonia might be related to high levels of physical activity, the latter as a compensatory mechanism. Results demonstrated that, among patients without excessive exercise, levels of physical anhedonia were higher in AN patients than individuals with BN or EDNOS, whereas among participants with excessive exercise, there were no significant differences in anhedonia scores among all the diagnostic groups.

Jiang et al. [74] in a first study compared patients with AN-R to HC and in a subsequent study [75] included also patients with BN. Although in both studies, AN-R patients had a higher score on CPAS than healthy controls, the difference failed to reach significance. Patients with BN, instead presented higher levels of physical anhedonia than healthy controls.

Some evidence, regarding changes in physical anhedonia after treatments, was provided by a study [76] that assessed anhedonia and depressive symptoms, by means of the SHAPS-D and BDI, respectively, before and after weight restoration in AN individuals. Results indicated there was a significant decrease in depression after weight recovery, but no significant change in anhedonia.

In this study, a significant positive correlation also emerged between ED psychopathology as measured by the Eating Disorder Inventory II and anhedonia as measured by the SHAPS-D in individuals with acute AN.

Dolan et al. [77] measured anhedonia in AN individuals and other EDs on admission and at discharge from a partial hospitalization program. Results indicated that the AN-BP group showed the highest levels of anhedonia, and the Avoidant Restrictive Food Intake Disorder group reported the lowest levels of anhedonia and had a significantly lower anhedonia than the other diagnostic groups. Furthermore, differently from Boehm et al's study [76], anhedonia scores significantly decreased from admission to discharge. Therefore, while results of Boehm et al. [76] suggest that in AN anhedonia might be not related to malnutrition, the findings of Dolan et al. [77] support the opposite. Thus, the stait or trait nature of anhedonia in AN remains to be elucidated.

Dolan et al. [78] used the TEPS, which exclusively assesses physical anhedonia and distinguishes between anticipatory and consummatory pleasure, to compare patients with AN, BN, other EDs and healthy controls. No significant differences in TEPS consummatory scores emerged between individuals with AN, BN, Other Specified Feeding or Eating Disorder (OSFED) and healthy controls, suggesting that individuals with EDs

experience similar levels of consummatory pleasure of individuals with no history of disease. In contrast, anticipatory pleasure was found to be significantly higher in healthy controls than in patients with AN and OSFED. Finally, comparison between diagnostic groups revealed no significant differences among patients with AN, BN and OSFED.

The behavioral inhibition - Behavioral activation system in anorexia nervosa

Four studies have evaluated the Behavioral- Inhibition Behavioral Activation System in patients with AN and with other EDs.

All the studies [79-82] consistently demonstrated that AN-R patients have significantly lower scores on the BAS- Fun Seeking than people with AN-BP, BN and healthy controls [79,82].

Moreover, Claes et al. [79] showed that individuals with AN-R exhibited higher scores on the BIS scale than those with AN-BP or BN or HC. Similarly, Monteleone et al al. [82] reported higher scores on punishment sensitivity (BIS score) of AN and BN patients compared to HC.

In summary, these findings seem to suggest that patients with AN-R are more likely to engage behaviors that can lead to negative outcome, whereas they are less prone to look for rewarding stimuli.

Conclusions

Our review of the literature supports anhedonia as an explanatory model of the reward-related abnormalities reported in AN. Indeed, people with AN have been found to report, although not unanimously, greater levels of both social and physical anhedonia than healthy controls.

In addition, it was found that greater anhedonia was correlated with a number of variables indicating greater ED severity, including general measures of ED psychopathology [76], longer disease duration[66], and excessive physical exercise [61].

Studies comparing anhedonia and depressive symptomatology in the AN before and after weight recovery showed improvement in depressive symptoms but were not consistent in anhedonia outcome[76]. Indeed, some studies reported amelioration of anhedonia after treatment, whereas some others did not. If the last case will be confirmed by future larger studies, anhedonia could be framed as a trait symptom and not a state symptom and would contribute to make anhedonia a separate treatment target and not a symptom included in the treatment of depressive symptomatology.

Anyway, despite current discrepancies in results, there is agreement on implementing targeted treatment for anhedonia. Indeed, delineating an anhedonic phenotype, and thus targeted treatment, would improve the prognosis of AN, considering that patients with high levels of anhedonia are also those with greater work/social difficulties [66].

Finally, future research should focus on how anhedonia correlates with components of reward processing in EDs, improving theoretical models and consequently therapeutic strategies.

Conflict of interest statement

The Authors declare no conflict of interest.

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Authors' contributions

RC and GC contributed in conception, proposal, data collection and analysis, and manuscript preparation

Ethical consideration

Not applicable.

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