

Interoception Moderates the Association Between Reward Sensitivity and Suicide Attempt History in Patients with Anorexia Nervosa

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Abstract

Background

Anorexia nervosa (AN) carries elevated suicide risk through poorly understood mechanisms. This study examined whether interoception and reward sensitivity, each separately implicated in suicide risk in AN, interact in relation to suicide attempt (SA) history.

Methods

160 patients with AN (Mage: 26 ± 10 years; 94% female) were assessed for interoceptive awareness (IA) deficits (EDI-2) and reward sensitivity (SPSRQ), alongside lifetime SA history and clinical covariates. Moderated logistic regression tested the IA $\times$ reward sensitivity interaction on SA history, adjusting for confounders and applying Lasso regularization.

Results

Lifetime SA history was reported by 22% ($N = 34$) of patients. SA history was positively associated with IA deficits ($OR = 1.71$, 95% CI $[1.25, 2.50]$, $p = 0.002$) and reward sensitivity ($OR = 1.22$, 95% CI $[1.09, 1.41]$, $p = 0.002$), with significant interaction between them ($OR = 0.99$, 95% CI $[0.98, 1.00]$, $p = 0.003$). Higher reward sensitivity predicted greater SA odds only among patients with relatively preserved IA; no association emerged among those with greater deficits. The interaction remained significant after adjusting for disorder duration and severity, alcohol/substance use disorder, and childhood trauma, and after regularization.

Conclusions

IA deficits moderated the reward sensitivity-SA relationship in AN. Reward-related mechanisms may contribute to suicidal behavior specifically among patients with preserved interoception, supporting individualized risk assessment integrating interoceptive and reward processes. Replication is needed.

Trial registration: ClinicalTrials.gov: NCT03160443

Highlights

- Interoceptive awareness (IA) deficits moderated the association between reward sensitivity and suicide attempt (SA) history in anorexia nervosa.
- Higher reward sensitivity predicted greater SA odds only in patients with relatively preserved IA, not in those with greater IA deficits.
- Findings held after adjustment for disorder duration and severity, alcohol/substance use, and childhood trauma, and Lasso regularization, supporting individualized risk assessment integrating interoceptive and reward processes.

Summary

Anorexia nervosa has been found linked to increased risk of suicide, but it is not fully understood why some people with the illness attempt suicide and others do not. This study looked at two things that may play a role: sensitivity towards bodily signals (e.g. hunger, emotional tension), and sensitivity towards rewarding experiences. We wanted to understand how these two dimensions interacted between one another in relation to suicide risk. Looking at 160 people with for anorexia nervosa, we found that for patients that were relatively sensitive to their bodily signals, the fact of being also strongly drawn to rewarding experiences was linked to having attempted suicide in the past. Among people who found it harder to notice their bodily signals, being drawn to reward was not linked to a history of suicide attempts. A longer illness and more difficult childhood experiences were also linked to suicide attempts. These findings suggest that body awareness and sensitivity to reward may combine to shape suicide risk in anorexia, and that clinicians may benefit from assessing both when evaluating risk. Because this study looked back in time rather than following people forward, more research is needed before firm conclusions can be drawn.

1. Introduction and aims

Anorexia nervosa (AN) is among the psychiatric disorders with the highest mortality rates, with suicide representing a leading cause of death. Beyond its severe physical consequences and psychiatric comorbidity, AN is characterized by markedly elevated rates of suicidal ideation (SI) and suicide attempts (SA) with particularly severe and highly lethal suicidal behaviors, compared to both healthy and psychiatric populations (1–3). Despite the clinical burden associated with suicidality in AN, the mechanisms underlying SA vulnerability in this population remain insufficiently understood.

Altered interoception, broadly defined as the ability to sense internal bodily states has increasingly been conceptualized as a transdiagnostic vulnerability factor for psychopathology (4). In AN, disturbances in bodily signal processing have been considered central to the disorder since its earliest conceptualizations and have been integrated into several contemporary models of AN pathophysiology (5–8). While interoception encompasses multiple dimensions, including objective accuracy, subjective sensibility, and metacognitive awareness, meta-analytic evidence suggests that abnormalities in AN predominantly concern subjective interoceptive sensibility rather than objective accuracy (9–11). However, since the publication of the Eating Disorder Inventory (EDI) by Garner (12), most authors studying eating disorders (ED) have been using the term ‘interoceptive awareness’, after the name of the relative EDI subscale, to alternatively refer to objective accuracy or subjective sensibility. In this study, when we will employ the term interoceptive awareness (IA), we will do so to adhere to the EDI nomenclature. Greater IA deficits, using the EDI, have consistently been associated with SI and SA among individuals with ED (13). Abnormal interoception has also been conceptualized as one core mechanism of suicide risk in ED (14). Within contemporary suicide models, including the Interpersonal Theory of Suicide (15, 16), interoceptive disturbance may contribute to the acquired capability for suicide by attenuating sensitivity to bodily distress and facilitating repeated exposure to painful experiences.

Reward-related alterations have also emerged as a core feature of AN. Neurobiological and behavioral findings suggest altered reward valuation, particularly in relation to food-related stimuli, whereby rewarding experiences may become aversive and aversive states acquire reinforcing properties (17). These alterations have been linked to dysfunction across fronto-insular and striatal circuitry and may contribute to the maintenance of restrictive behaviors (18, 19).

Reward processing and interoception are likely closely interconnected (20). Contemporary models propose that disrupted interoceptive signaling may distort the subjective representation of hunger, satiety, and affective bodily states, thereby altering reward valuation (7). In this framework, altered bodily signals may bias how rewarding/aversive experiences are perceived, potentially reinforcing maladaptive behaviors. (18). Alterations in reward learning and in positive valence systems have also been observed in relation to suicide-related outcomes. A systematic review has found blunted reward responsiveness is associated with SI, while non-suicidal self-injury appears associated with hyper-responsiveness to rewards. Additionally, alterations in reward learning were found associated with SA (21). Greater sensitivity to immediate rewards accompanied by poor consideration of long-term losses is also frequently observed in patients with SA history, especially with violent SA, as compared to psychiatric and healthy controls, across different decision-making tasks (22–24).

Taken together, available evidence suggests that both interoceptive dysfunction and reward-related alterations may contribute to suicide vulnerability in AN. However, these mechanisms have largely been investigated independently in relation to suicide risk. Little is known regarding whether abnormalities in reward sensitivity and interoception jointly characterize individuals with AN and a history of SA, or whether IA deficits may modulate the association between reward sensitivity and suicide risk. Therefore, the present study aimed to investigate the associations between IA deficits, reward sensitivity, and lifetime history of SA in a clinical sample of patients with AN.

2. Method

2.1. Participants

For this study, a sample of 160 AN patients were recruited from the Eating Disorder Unit of Lapeyronie University Hospital of Montpellier, France. The sample for this study was drawn from a larger cohort of a previous monocentric study which included 340 patients diagnosed with current ED. The original study was registered at *ClinicalTrials.gov* (Identifier: NCT03160443), the protocol was approved by the Local Ethics Committee (Sud Méditerranée IV – n° ID-RCB : 2017-A00269-44) and it was conducted in accordance with the Declaration of Helsinki. All patients met the following inclusion criteria: 1) aged 15 to 45 years, 2) native or fluent in French, 3) diagnosis of AN according to the Diagnostic and Statistical Manual of Mental Disorders-fifth edition (DSM-5) criteria, and 4) ability to provide informed consent. Patients were excluded if they possessed any of the following criteria: 1) inability to understand and complete the clinical evaluation, 2) pregnancy or breastfeeding, and 3) deprivation of liberty by judicial or

administrative decision. All participants, or both their official caregivers for patients younger than 18 years, signed an informed consent before participating in the study.

2.2. Measures

Sociodemographic variables, ED duration, lifetime history of SA, current medication, as well as general psychopathology according to DSM-5 criteria were assessed through structured interviews by senior psychiatrists.

2.2.1. Primary measures

The *Eating Disorder Inventory (EDI-2)* – *IA* subscale, French version, assessed interoceptive deficits, as conceptualized by Garner as a lack of confidence in recognizing emotional states and feelings of hunger/satiety. A higher score indicates greater interoceptive deficits. The EDI-2 is a 91-item scale investigating three ED-specific components and other subscales assessing psychological features associated with ED on a 6-point Likert scale (25). In this sample, the *IA* subscale showed excellent internal consistency ($\alpha = .90$), total score reliability was also excellent ($\alpha = .98$), while other subscales reliability ranged from acceptable to excellent ($\alpha = .79-.94$).

The *Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ)* – *Reward Sensitivity* subscale, French adaptation (26), measured the tendency to activate approaching behaviors in situations related to possible rewards or sensation-seeking. This 35-item instrument assesses functions dependent from two distinct behavioral systems, conceptualized by Gray's reinforcement sensitivity theory (27). While we focused on *reward sensitivity* for our main analyses, a second component, *punishment sensitivity*, assesses inhibition/avoidance tendencies in situations related to possible negative consequences or novelty. In our sample, subscale internal consistency was good for the reward component ($\alpha = .84$) and excellent for the punishment component ($\alpha = .90$).

2.2.2. Secondary measures

The Childhood Trauma Questionnaire (CTQ) (28), French version (29), is a 28-item tool assessing maltreatment during childhood. Different forms of maltreatment are measured through five subscales: *emotional abuse*, *emotional neglect*, *sexual abuse*, *physical abuse*, and *physical neglect*. Respondents answer on a 5-point Likert scale ranging from 'never true' to 'very often true'. A total score is also calculated as a sum of all sub scores, which showed very good internal consistency ($\alpha = .89$) in our sample. Consistently with previous accounts, the physical neglect subscale showed very poor internal consistency ($\alpha = .51$), while all other subscales ranged from good to excellent reliability ($\alpha = .84-.95$).

The Eating Disorder Examination Questionnaire (EDE-Q), French version (30), is a measure composed of 28 items, rated on a 7-point Likert scale, assessing range, frequency, and severity of disordered eating over the previous 28 days (31). While originally composed of multiple subscales, in this study we considered the Global Average Score as an index of overall ED symptoms severity. Additionally, we

extracted items 16 and 17 from the original scale to calculate purging behaviors frequency (i.e. vomiting, laxatives use). In our sample, total internal consistency was excellent ($\alpha = .94$).

The Body Appreciation Scale (BAS-2), French adaptation (32), is a 10-item self-report questionnaire meant to assess the degree of acceptance of, favorable opinion toward, and respect for their bodies, as a unidimensional construct (33). A total score is calculated based the average across all items, rated on a 5-point Likert scale from 'never' to 'always', which showed excellent reliability ($\alpha = .95$) in our sample.

The Yale Food Addiction Scale (YFAS), French version (34), is a 35-item instrument measuring addictive-like eating in the previous year, as defined by the diagnostic criteria for substance dependence by DSM-IV-TR (35) and applied in relation to calorie-dense foods (36). A dimensional symptom count score, ranging from 0 to 7 and resulting from the summation of all satisfied criteria, showed excellent internal consistency in the present sample ($\alpha = .95$).

The Detail and Flexibility Questionnaire (DFLEX) is a 24-item measure designed to assess two aspects of neurocognitive functioning strongly associated with EDs and obsessive-compulsive traits (37). It is originally composed of two subscales: *cognitive rigidity* and *attention to detail*. In our sample, subscale reliability was good for both subscales (cognitive rigidity: $\alpha = .82$; attention to detail: $\alpha = .85$).

2.3. Statistical analyses

Descriptive statistics were used to summarize sociodemographic and clinical characteristics for the total sample and stratified by lifetime SA history. Between-group differences were examined using Wilcoxon rank-sum tests for continuous variables, chi-square tests for categorical variables, and standardized mean difference was calculated to measure effect size. A logistic regression model was fitted to examine the interaction between EDI IA deficits and SPSRQ reward sensitivity in relation to lifetime history of SA. The model was subsequently adjusted for covariates identified in univariate analyses using a liberal inclusion threshold ($p \leq .15$). Remaining EDI subscales were excluded from adjustment, even when satisfying this criterion, to limit the number of predictors and favor parsimony; sensitivity analyses confirmed that their inclusion did not affect the significance of the interaction effect (see Supplementary Table 1). Psychiatric diagnoses were preferred over psychopharmacological treatments as covariates, as they represent a more stable index of underlying psychopathology; medication use may vary due to factors unrelated to illness severity, such as treatment access, adherence, or prescribing practices, and its inclusion alongside diagnoses would introduce redundancy and reduce model interpretability. Sensitivity analyses assessing potential confounding effects of pharmacological treatment are reported in Supplementary Table 2. The CTQ total score was preferred over individual subscale scores to capture overall childhood trauma burden while limiting the number of predictors. Given the substantial intercorrelations among subscales, the total score also reduced multicollinearity and improved parsimony. Finally, Lasso regularization was applied to the adjusted model to further improve stability and avoid overfitting. All analyses were performed in R software (version 4.4.2; R Core Team, 2024).

3. Results

3.1. Description of the sample by SA history

Descriptive statistics are displayed in Table 1. Our sample comprised 160 AN patients with mean age of 26 ± 10 years, the majority of which were females ($N = 150$, 94%). Overall, 35 (22%) patients had a lifetime history of SA. Patients in the SA group were significantly older ($SMD = 0.348$; $p = 0.044$) than the non-SA group, had a longer disorder duration ($SMD = 0.487$; $p = 0.012$), and more frequently comorbid alcohol use/substance use disorder (AUD/SUD) ($SMD = 0.557$; $p = 0.003$).

Table 1
Description of the population by SA history

Characteristic	Total sample		Without SA history	With SA history	p- value ²	SMD test
	N	N = 160 ¹	N = 125 ¹	N = 35 ¹		
Age	160	26 (10)	25 (10)	29 (12)	0.044	0.348
Gender	160				> 0.9	0.029
Female		150 (94%)	117 (94%)	33 (94%)		
Male		10 (6.3%)	8 (6.4%)	2 (5.7%)		
Professional Status	160				0.063	0.332
Active		135 (84%)	109 (87%)	26 (74%)		
Inactive		25 (16%)	16 (13%)	9 (26%)		
Educational level (years)	149	13.38 (2.35)	13.27 (2.38)	13.76 (2.24)	0.3	0.213
Duration of disorder	155	9 (9)	8 (8)	13 (12)	0.012	0.487
Frequency of purging behavior (last 28 days)	158	9 (19)	9 (20)	9 (15)	0.2	0.034
Current MDE	146				0.12	0.298
No		100 (68%)	81 (72%)	19 (58%)		
Yes		46 (32%)	32 (28%)	14 (42%)		
Lifetime BD	146				0.12	0.329
No		135 (92%)	107 (95%)	28 (85%)		
Yes		11 (7.5%)	6 (5.3%)	5 (15%)		
Current AD	145				0.4	0.170
No		71 (49%)	57 (51%)	14 (42%)		
Yes		74 (51%)	55 (49%)	19 (58%)		
Current OCD	146				> 0.9	0.075

Characteristic	Total sample		Without SA history	With SA history	p- value ²	SMD test
	N	N = 160 ¹	N = 125 ¹	N = 35 ¹		
No		135 (92%)	104 (92%)	31 (94%)		
Yes		11 (7.5%)	9 (8.0%)	2 (6.1%)		
Current PTSD	146				0.078	0.324
No		138 (95%)	109 (96%)	29 (88%)		
Yes		8 (5.5%)	4 (3.5%)	4 (12%)		
Current AUD/SUD	146				0.003	0.557
No		135 (92%)	109 (96%)	26 (79%)		
Yes		11 (7.5%)	4 (3.5%)	7 (21%)		
Anxiolytics/hypnotics Intake	160				0.2	0.264
No		124 (78%)	100 (80%)	24 (69%)		
Yes		36 (23%)	25 (20%)	11 (31%)		
Antidepressive Intake	160				0.021	0.438
No		104 (65%)	87 (70%)	17 (49%)		
Yes		56 (35%)	38 (30%)	18 (51%)		
Antipsychotic Intake	160				0.008	0.479
No		144 (90%)	117 (94%)	27 (77%)		
Yes		16 (10%)	8 (6.4%)	8 (23%)		
EDI - Drive for Thinness	157	11.9 (5.7)	11.4 (5.8)	14.0 (5.1)	0.011	0.477
EDI - Bulimia	158	4.4 (5.2)	3.8 (4.8)	6.6 (5.9)	0.005	0.513
EDI - Body Dissatisfaction	158	13 (7)	12 (6)	16 (7)	0.017	0.465

Characteristic	Total sample		Without SA history	With SA history	p- value ²	SMD test
	N	N = 160 ¹	N = 125 ¹	N = 35 ¹		
EDI - Ineffectiveness	159	11 (7)	10 (7)	13 (6)	0.030	0.380
EDI - Perfectionism	160	7.9 (5.0)	7.4 (4.8)	9.8 (5.3)	0.014	0.484
EDI - Interpersonal Distrust	160	6.4 (4.5)	6.5 (4.4)	6.1 (5.1)	0.5	0.072
EDI - IA deficits	160	12 (7)	11 (8)	13 (7)	0.093	0.291
EDI - Maturity Fears	159	6.4 (5.7)	6.8 (5.7)	4.8 (5.3)	0.034	0.357
EDI - Asceticism	158	7.7 (4.2)	7.3 (4.3)	9.0 (3.9)	0.017	0.432
EDI - Impulse Regulation	158	6.9 (6.5)	6.3 (6.2)	9.0 (6.9)	0.030	0.399
EDI - Social Insecurity	158	7.9 (5.1)	7.4 (5.0)	9.5 (5.0)	0.024	0.427
SPSRQ - Punishment	150	51 (10)	49 (10)	55 (9)	0.008	0.547
SPSRQ - Reward	149	38 (9)	37 (9)	40 (9)	0.035	0.366
EDE-Q - Global Score	156	3.40 (1.52)	3.26 (1.54)	3.90 (1.33)	0.021	0.448
BAS2 - Total Score	158	2.26 (0.95)	2.35 (0.95)	1.96 (0.90)	0.013	0.420
CTQ - Emotional Abuse	155	10.2 (5.0)	9.0 (4.1)	14.3 (5.9)	< 0.001	1.029
CTQ - Physical Abuse	157	6.70 (3.68)	6.19 (3.09)	8.49 (4.90)	< 0.001	0.561
CTQ - Sexual Abuse	154	7.5 (4.8)	6.9 (4.0)	9.8 (6.5)	0.002	0.553
CTQ - Emotional Neglect	157	11.9 (5.0)	11.1 (4.5)	14.9 (5.5)	< 0.001	0.753
CTQ - Physical Neglect	155	7.49 (2.71)	7.13 (2.47)	8.82 (3.16)	0.002	0.596
CTQ - score	147	44 (17)	40 (14)	57 (20)	< 0.001	0.990
DFLEX - Cognitive rigidity	156	49 (11)	49 (11)	51 (10)	0.3	0.189
DFLEX - Attention to detail	155	42 (12)	41 (12)	44 (11)	0.2	0.243
YFAS - Total score	159	4.8 (3.3)	4.4 (3.3)	6.1 (3.2)	0.007	0.531
¹ Mean (SD); n (%)						

Characteristic	Total sample		Without SA history	With SA history	p-value ²	SMD test
	N	N = 160 ¹	N = 125 ¹	N = 35 ¹		
² Wilcoxon rank sum test; Fisher’s exact test; Pearson’s Chi-squared test						
SMD: Standardized Mean Difference; MDE: major depressive episode; BD: bipolar disorder; AD: Anxiety disorder; OCD: obsessive-compulsive disorder; PTSD: post-traumatic stress disorder; AUD/SUD: alcohol use disorder/substance use disorder; EDI: Eating Disorder Inventory; IA: Interoceptive Deficits; SPSRQ: Sensitivity to Punishment and Sensitivity to Reward Questionnaire; EDE-Q: Eating Disorder Examination Questionnaire; BAS2: Body Appreciation Scale; CTQ: Childhood Trauma Questionnaire; DFLEX: Detail and Flexibility Questionnaire; YFAS: Yale Food Addiction Scale.						

Regarding ED psychopathology, patients with SA history showed greater ED severity (EDE-Q; SMD = 0.448; $p = 0.021$), increased food addiction (YFAS; SMD = 0.531; $p = 0.007$) and significantly lower body appreciation (BAS-2; SMD = 0.420; $p = 0.013$). Across EDI domains, the SA group scored significantly higher on drive for thinness, bulimia, body dissatisfaction, ineffectiveness, perfectionism, asceticism, impulse regulation, and social insecurity (SMD range = 0.357–0.513; p range = 0.005–0.030).

Importantly, IA deficits were not significantly associated with SA history in univariate analysis, while *reward sensitivity* (SPSRQ; SMD = 0.366; $p = 0.035$) and *punishment sensitivity* (SPSRQ; SMD = 0.547; $p = 0.008$) were both individually associated with SA history.

Finally, the SA group reported significantly more traumatic experiences across all kinds of childhood maltreatment (SMD range = 0.553–1.029; p range < 0.001–0.002).

3.2. Interaction between interoceptive deficits and reward sensitivity in relation to suicide attempt

3.2.1. Moderated logistic regression of SA history

As shown in Table 2, the moderated logistic regression model indicated that greater IA deficits (EDI) were significantly associated with greater odds of SA history (OR = 1.71, 95% CI [1.25, 2.50], $p = 0.002$). Higher reward sensitivity (SPSRQ) was also significantly associated with increased odds of SA history (OR = 1.22, 95% CI [1.09, 1.41], $p = 0.002$). Importantly, the interaction between IA deficits and reward sensitivity was significant (OR = 0.99, 95% CI [0.98, 1.00], $p = 0.003$), indicating that the association between reward sensitivity and SA history varied as a function of interoceptive deficits. Figure 1 illustrates higher reward sensitivity was linked with higher odds of SA history only among individuals with better IA. No such association was observed among individuals with poorer IA.

Table 2
Moderated logistic regression model of SA history

Characteristic	OR	95% CI	p-value
EDI - IA deficits	1.71	1.25, 2.50	0.035
SPSRQ - Reward	1.22	1.09, 1.41	0.052
EDI - IA deficits * SPSRQ - Reward	0.99	0.98, 1.00	0.003
Abbreviations: OR = Odds Ratio, CI = Confidence Intervals			
EDI-IA: Eating Disorder Inventory-Interceptive Awareness Deficits; SPSRQ: Sensitivity to Punishment and Sensitivity to Reward Questionnaire.			

3.2.2. Adjusted moderation model

Covariates eligible for inclusion in the adjusted model were selected based on univariate analyses ($p \leq .15$) and included age, professional status, duration of the disorder, current major depressive episode (MDE), bipolar disorder (BD) diagnosis, current post-traumatic stress disorder (PTSD), current AUD/SUD disorder, SPSRQ punishment subscale, EDE-Q global score BAS-2 score, CTQ total score, YFAS score. Following LASSO regularization, disorder duration, current AUD/SUD, EDE-Q global score, and CTQ total score were retained as covariates. As displayed in Table 3, greater odds of SA history were significantly associated with longer disorder duration (OR = 1.77, 95% CI [1.04, 3.19], $p = 0.041$) and with more severe childhood trauma (CTQ; OR = 2.38, 95% CI [1.33, 4.59], $p = 0.005$). Importantly, the interaction between reward sensitivity (SPSRQ) and IA deficits (EDI) remained significant (OR = 0.27, 95% CI [0.10, 0.60], $p = 0.004$). Conversely, main effects of reward sensitivity and IA deficits were not significant in the adjusted regularized model. Other retained covariates (disorder duration, current AUD/SUD diagnosis, and ED symptom severity) were not significantly associated with SA history in the final model.

Table 3
Regularized adjusted moderation model of SA history

Characteristic	OR	95% CI	p-value
Duration of disorder	1.77	1.04, 3.19	0.041
Current AUD/SUD	6.93	0.84, 84.5	0.091
EDE-Q - global score	1.41	0.71, 2.89	0.3
CTQ - score	2.38	1.33, 4.59	0.005
SPSRQ - Reward	1.37	0.71, 2.76	0.3
EDI - IA deficits	1.23	0.61, 2.53	0.6
SPSRQ - Reward * EDI - IA deficits	0.27	0.10, 0.60	0.004
Abbreviations: OR = Odds Ratio, CI = Confidence Intervals			
AUD/SUD: alcohol use disorder/substance use disorder; EDE-Q: Eating Disorder Examination Questionnaire; CTQ: Childhood Trauma Questionnaire; EDI: Eating Disorder Inventory; SPSRQ: Sensitivity to Punishment and Sensitivity to Reward Questionnaire.			

4. Discussion

In the present sample, we investigated and found a moderating effect of IA in the association between reward sensitivity and SA history in AN patients. Specifically, greater reward sensitivity was associated with increased odds of SA history only among individuals with relatively preserved IA, whereas no such association emerged among those with poorer interoception. This suggests that reward sensitivity may be more relevant to suicide vulnerability when bodily signal processing remains sufficiently intact. Importantly, this interaction remained significant after regularization and adjustment for relevant clinical covariates, including disorder duration, ED severity, current AUD/SUD, and childhood trauma, underscoring its robustness. These findings extend and specify neurobiological models of AN by indicating that interoceptive processing may influence how reward sensitivity relates to SA. Previous theoretical accounts conceptualize AN as involving altered integration between interoceptive signals and reward processing, driven by abnormal functioning in front striatal and insular circuits (5, 7). Our results suggest these alterations may map onto distinct suicide risk profiles in AN, marked by specific patterns of interoceptive and reward-related processes.

Sample characteristics were broadly consistent with existing literature, with some notable divergences: disorder duration was comparable to, or slightly higher than, previous reports (19, 39). SA history prevalences in the present sample (22%) were lower than those reported by an earlier review, but they exceeded those of more recent meta-analysis (40, 41). IA deficits in our sample (mean = 12, *SD* = 7) were comparable with previous meta-analytical findings (10). However, unlike Hielscher & Zopf's mixed ED/non-ED samples (13), the univariate IA-SA association was not significant here, while the reward sensitivity-SA association was positive and significant, diverging from other accounts (42).

As to our main findings, reward sensitivity was associated with a history only in individuals with relatively intact IA, partially contradicting the idea that interoceptive deficits drive reward contamination by distorting bodily states representation underlying reward valuation (18). Although causal claims are precluded by the cross-sectional design, greater IA may facilitate dysfunctional reinforcement learning by heightening the affective and motivational salience of internal and external stimuli. When maladaptive behaviors (e.g. self-starvation, self-injury, suicidal behavior) provide temporary relief, increased IA may strengthen their reinforcing value, consolidating reward contamination, consistent with prior findings that reward sensitivity predicts SA in AN specifically when self-starvation is experienced as rewarding (43). The combination of elevated IA and high reward sensitivity may thus create conditions for reward contamination to crystallize, increasing SA vulnerability. Additionally, elevated IA is not inherently adaptive; a distinction should be made between regulated, mindful attention to the body versus anxiety-driven hypervigilance (44), the latter linked to greater emotional susceptibility (45). Elevated shame and guilt around disordered eating in AN (46), may heighten emotional reactivity via frustration intolerance and emotion dysregulation (47, 48), prompting rapid-relief-seeking behavior in highly reward-sensitive individuals. A subgroup combining elevated interoceptive and reward sensitivity may therefore face greater SA risk through heightened behavioral reactivity consistent with a *disorder-driven* suicidality profile marked by responsiveness to disorder-related cues (43), with negative-reinforcement models of self-injury (49, 50), and with stress-responsive/pain-hypersensitive suicide risk subtypes from clustering models (51, 52). Future research should aim to replicate these findings on larger samples, and consider IA and reward sensitivity as candidate indicators for clustering analyses of suicide risk in AN.

More broadly, the reward–SA relationship may depend on the integrity of interoceptive processing systems, given IA's role in value-based decision-making via internal affective signals (53, 54) pointing to interoceptive-reward integration as a key neurocognitive mechanism underlying differential suicide risk profiles in AN.

After adjustment, alongside the interaction effect, longer disorder duration and greater childhood trauma severity were significantly associated with SA, consistent with prior evidence linking earlier onset/longer duration (55) and adverse childhood experiences (56) to SA, and with meta-analytic evidence of two-to-threefold higher SA rates following childhood maltreatment (57).

These findings may help reconcile mixed evidence on interoception's role in suicidality: while interoceptive deficits have been linked to suicide risk (13), this relationship has not consistently held when controlling for broader clinical severity. Rather than acting as an independent risk factor, interoception may shape how reward sensitivity translates into behavior, its clinical relevance depending on whether internal bodily and affective signals remain sufficiently represented to guide motivation and reinforcement. This supports a disorder-driven profile of suicide risk in AN patients proposed by Lee(43) and existing neurobiological models emphasizing interoceptive and reward-related processes in AN pathophysiology (5, 7), underscoring that suicide vulnerability in AN arises from interacting neurocognitive systems rather than isolated symptom dimensions.

4.1. Clinical implications

These findings may carry implications for clinical practice. First, they underscore the importance of assessing both reward sensitivity and interoception when evaluating suicide risk in patients with AN. Rather than acting as isolated vulnerability factors, our findings suggest that these dimensions may interact in shaping susceptibility to suicidal behavior. The observed moderation raises the possibility that distinct interoceptive–reward profiles may characterize suicide vulnerability in AN. Individuals combining relatively preserved IA with elevated reward sensitivity may represent a subgroup in whom maladaptive behaviors, including SA, acquire greater motivational salience through reinforcement-related processes. Conversely, individuals with more severe interoceptive deficits may be characterized by alternative pathways to suicide vulnerability that are less dependent on reward sensitivity.

This may inform individualized clinical monitoring and intervention planning. However, given the exploratory and cross-sectional nature of the present findings, such distinctions should be considered preliminary. Future research is needed to determine whether specific interoceptive–reward profiles may differ in treatment response or benefit from tailored intervention strategies targeting emotion regulation, motivational processes, or interoceptive functioning.

Finally, despite calling for caution when interpreting multivariable analyses given the limited number of SA events, the association between childhood trauma and SA history was robust. Our findings may emphasize the importance of trauma-informed psychological interventions to care in AN, possibly targeting bodily mentalization and interoceptive dysregulation, such as trauma-focused mentalization-based treatment (58).

4.2. Limitations and future directions

Several limitations should be acknowledged. First, given the limited number of SA events, multivariable analyses should be interpreted with great caution. Nevertheless, the interaction term remained statistically significant across multiple adjusted models and was selected by the Lasso procedure despite substantial penalization. Second, the cross-sectional design precludes causal inferences regarding the relationships observed. Longitudinal studies are needed to determine whether and how these dimensions prospectively influence SA vulnerability. Moreover, interoception is increasingly conceptualized as a multidimensional construct. Interoceptive functioning was assessed using the EDI-IA subscale, primarily capturing subjective sensibility and difficulties identifying internal emotional and bodily states. Beyond these dimensions, IA may encompass both adaptive, mindful attention to bodily sensations, which can facilitate emotion regulation, and maladaptive forms of anxiety-driven hypervigilance toward bodily signals. Future research would benefit from employing assessment tools capable of capturing these distinct IA dimensions. Finally, our findings derive from secondary analyses conducted on pre-existing data, rather than from a study specifically designed to test the present research question. Thus, they should be considered exploratory and be interpreted cautiously until replicated.

Conclusions

The present study provides novel evidence that IA moderates the relationship between reward sensitivity and SA history in individuals with AN. These findings highlight the importance of interoceptive–reward integration as a potential neurocognitive mechanism underlying suicide risk in AN. Additionally, they provide preliminary support for the existence of disorder-driven and anhedonic profiles of suicide risk in AN (43). Interoception may represent a key factor shaping how reward-related vulnerabilities translate into suicidal behavior, underscoring its relevance as both a mechanistic target and a potential focus for clinical intervention.

Declarations

Ethics approval and consent to participate

The protocol for this study was approved by the Local Ethics Committee (Sud Méditerranée IV – n° ID-RCB : 2017-A00269-44) and the study was conducted in accordance with the Declaration of Helsinki. All participants, or both their official caregivers for patients younger than 18 years, signed an informed consent before participating in the study.

Consent for publication

All the authors have given their consent for the publication of this manuscript.

Competing interests

The authors declare that the research was conducted in the absence of any potential conflict of interest.

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Author Contribution

F.B. contributed to conceptualization, data curation, formal analysis, visualization and writing – original draft; M.M. contributed to data curation, formal analysis, methodology, validation and visualization; P.C. contributed to conceptualization, project administration, supervision, validation and writing – review & editing; S.G. contributed to conceptualization, investigation, resources, project administration, supervision, validation and writing – review & editing.

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Data Availability

The data that support the findings of this study are available from the corresponding authors upon reasonable request.

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Figures

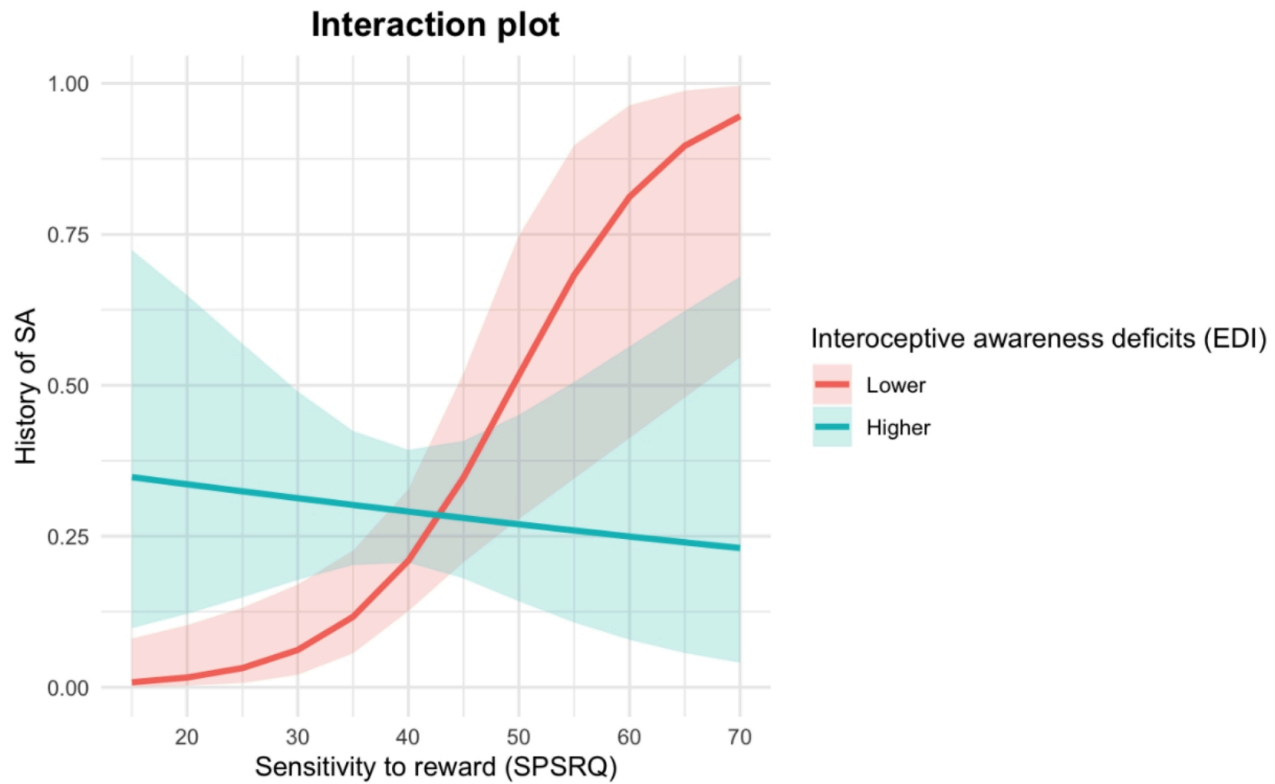


Figure 1

Interaction between sensitivity to reward (SPSRQ) and IA deficits (EDI) in relation to SA history

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