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Anhedonia and altered reward responsiveness: Relations to psychosocial functioning

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ABSTRACT

Background: Anhedonia—a core symptom of Major Depressive Disorder—is associated with poorer clinical outcomes, lower quality of life, and disrupted reward processing. However, putative relationships among self-reported anhedonia, well-being and anhedonic phenotypes (specifically, reward learning) remain largely unexplored. The main goal of the current study was to fill this gap in a large online adult community sample (N = 478).

Methods: To evaluate how different approaches to assessing anhedonia may capture these relationships, we administered the Probabilistic Reward Task (PRT) to probe reward learning and two clinical scales: the Snaith-Hamilton Pleasure Scale (SHAPS) and the Dimensional Anhedonia Rating Scale (DARS). In a first step, the SHAPS was administered to identify anhedonic vs. non-anhedonic individuals, who then performed an online PRT.

Results: Both scales were significantly associated with lower self-reported quality of life (QoL), as measured by the Quality of Life Enjoyment and Satisfaction Questionnaire Short Form (QLESQ-SF), with the SHAPS showing a stronger relationship to both QoL and reward learning. Follow-up computational modeling indicated the anhedonic group showed a significantly higher level of uncertainty while completing the PRT compared to the non-anhedonic group. Moreover, trial-by-trial analyses revealed group differences in PRT response patterns, such that anhedonic individuals were less likely to incorrectly indicate that they had seen the more frequently rewarded "rich" stimulus on trials that actually presented the less frequently rewarded "lean" stimulus.

Conclusions: Findings highlight the utility of combining subjective and behavioral measures to better understand the impact of anhedonia on daily functioning and reinforcement learning processes.

1. Introduction

Anhedonia, the reduced interest or pleasure in pleasurable activities, is a core symptom of Major Depressive Disorder (MDD), affecting up to 70 % of individuals with MDD [1–3]. Anhedonia is associated with worse clinical outcomes, including increased MDD risk, more severe symptoms, longer and more frequent depressive episodes, increased suicidality, and poorer treatment response to a variety of interventions including psychopharmacology, psychotherapy, and brain stimulation [2]. Notably, individuals with MDD find anhedonia particularly distressing and report it as a key contributor to impaired quality of life (QoL) [4,5]. As such, individuals with MDD consider the restoration of hedonic tone and positive affect to be critical markers of recovery [6,7]. Accordingly, anhedonia is an important symptom to target and understand more deeply in order to improve outcomes for individuals with MDD.

Anhedonia is complex and multidimensional, encompassing different processes that span various constructs within the Positive

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Valence Systems (PVS) domain of the Research Domain Criteria (RDoC) initiative (https://www.nimh.nih.gov/research/research-funded-by-nimh/rdoc/constructs/rdoc-matrix). Such constructs include *reward responsiveness*, *reward learning*, and *reward valuation*. This complexity poses both opportunities and challenges for accurate and meaningful measurement. Traditional self-report tools such as the Snaith-Hamilton Pleasure Scale (SHAPS; [8]) primarily assess consummatory pleasure, which can be defined as the hedonic experience that occurs during engagement in an enjoyable or rewarding activity, offering a relatively narrow view of anhedonia. Alternative scales aim at a more nuanced assessment of anhedonic behaviors. For example, the Dimensional Anhedonia Rating Scale (DARS; [9]) assesses interest, motivation, effort, and consummatory pleasure across various personalized domains, with factor analyses yielding a four-component structure (hobbies, food/-drink, social activities, and sensory experience). The Positive Valence Systems Scale-21 (PVSS-21; [10]) assesses responses to different stages, levels, and types of reward engagement and cognitions about reward by considering the RDoC PVS matrix. Finally, the Temporal Experience of Pleasure Scale (TEPS; [11]) assesses individual trait dispositions in both anticipatory and consummatory pleasure.

In addition to clinical scales, behavioral paradigms can capture objective and implicit aspects of anhedonia. The Probabilistic Reward Task (PRT) incorporates a differential reinforcement schedule to probe how participants learn from rewards ([2,12–15]. In the task, participants are instructed to distinguish between two difficult-to-discriminate stimuli that, unbeknownst to them, are linked to different reward probabilities. Participants cannot infer which stimulus is more advantageous based on the outcome of a single trial, and behavior on the task is optimized through gradual reward learning. Individuals without anhedonia develop a robust response bias, that is, a preference for the response associated with the more frequently rewarded (rich) stimulus. Individuals with depression, and specifically those reporting elevated anhedonia in daily life [16] or meeting the melancholic subtype of MDD [17], are characterized by a reduced response bias, and such blunting correlated with greater current and predicted future anhedonia symptoms as well as dysfunction within the brain reward pathway (see [2] for a review).

The overarching goal of this study was to examine how dimensions of anhedonia, measured through both self-report questionnaires and a behavioral task, relate to quality of life and to each other in a large online sample. Prior work in this area has often been limited to clinical populations or relied on a single measurement approach, leaving open questions about how elevated anhedonia relates to behavior and subjective wellbeing in more diverse, community-based samples. Specifically, we first investigated how different self-report measures of anhedonia–the SHAPS [8] and DARS [9]–related to QoL. We hypothesized that both scales would significantly relate to QoL. However, based on the DARS' focus on distinct reward-related processes with personally relevant rewards across multiple life domains, we hypothesized that DARS scores would show a stronger association with quality of life than SHAPS, which primarily assesses hedonic capacity in response to more generalized stimuli. The second goal was to examine how self-reported anhedonia related to behavioral measures of reward responsiveness, specifically response bias, and to compare reward learning between individuals with and without self-reported anhedonia and with and without MDD. Based on our prior work [12], we hypothesized that greater anhedonia (higher SHAPS and DARS scores) would be associated with a lower response bias and that individuals with anhedonia and individuals with a lifetime history of MDD would exhibit a reduced response bias. Lastly, we used computational modeling and trial-by-trial analyses to probe group differences in the emergence of response bias and mechanistic differences in response patterns in the PRT. Based on prior findings in independent MDD samples [14], we hypothesized that anhedonic individuals would show reduced reward sensitivity and impaired behavior adjustment on a trial-by-trial level based on the stimulus type and reward feedback of the immediately preceding trial [18].

2. Methods

2.1. Participants

Participants were recruited through Amazon's Mechanical Turk (MTurk; mturk.com) via CloudResearch (cloudresearch.com) [19]. Study-specific questionnaires were administered via REDCap [20,21] and the PRT was conducted on cognition.run. Meta-analyses of MTurk studies have found demographic characteristics of MTurk participants to closely align with the general U.S. population [22]. Participants provided electronic informed consent. All procedures followed the guidelines of the Mass General Brigham Human Research Committee. To ensure good data quality, we only enrolled participants who had at least 95 % of their previously completed MTurk tasks of acceptable quality with a minimum of 100 completed MTurk studies. Participants had to be over 18 years old and were geographically restricted to the U.S. in order to mirror previous online studies using similar parameters to yield good quality data [23]. Additionally, participants who had completed previous PRT versions [12] were excluded.

2006 participants completed questionnaires about demographic information, including sex assigned at birth and gender identity, current and past diagnoses of MDD, the presence of any lifetime psychiatric diagnoses, current psychotropic medication use and the SHAPS [8] (see Table 1). Six participants were excluded for failing an attention check in the SHAPS. SHAPS total scores were used to identify participants with anhedonia (defined by a categorical score of $\geq$3 on the SHAPS, [8]) and those without anhedonia (SHAPS score: 0–2). We invited 656 of these participants based on their SHAPS total scores to complete additional surveys on anhedonia, QoL, and depression, and the PRT. Seventy-two participants were excluded for incomplete questionnaire data and three for duplicate submissions identified using MTurk IDs (only the first submission was retained). An additional 97 were excluded for PRT performance (i.e., failing pre-specified quality control checks) and six more for unmatched behavioral and questionnaire data (for CONSORT diagram, see Supplemental Fig. 1). The final study sample consisted of 478 participants with complete PRT and questionnaire data (Anhedonic: N = 265, Non-Anhedonic: N = 213).

2.2. Task and procedures

2.2.1. Self-report questionnaires

Anhedonia was assessed using the SHAPS and DARS. The SHAPS is one of the most widely used self-report scales of hedonic capacity [8]. Categorical scoring was used to classify participants as anhedonic ($\geq$ 3) or non-anhedonic ($\leq$ 2; [8]). For all other analyses, continuous SHAPS total scores (possible range: 14–56) were used with individual items scored on a scale of 1 ("Strongly Agree") to 4 ("Strongly Disagree") [24]. The DARS is a personalized scale that assesses interest, motivation, effort, and consummatory pleasure across four domains: hobbies, food/drink, social activities, and sensory experiences. We reverse scored the DARS such that higher scores on both the SHAPS and DARS reflected higher levels of anhedonia. We assessed depression severity using a modified version of the Beck Depression Inventory-II (BDI-II; [25]), a widely used 21-item scale, which excluded the suicidality item; to account for this, we imputed the excluded item by adding the average of all other items to the total score [26]. QoL was assessed using the Quality of Life Enjoyment and Satisfaction Questionnaire-Short Form (QLESQ-SF; [27]), a self-report measure that evaluates overall enjoyment and

Table 1
Summary of demographics and clinical variables for anhedonic and non-anhedonic groups.

	Anhedonic N (%)	Non-anhedonic N (%)	*p*-value
Total Number of Participants	265	213	
Age			0.13
18–24	15 (5.7 %)	4 (1.9 %)	
25–34	79 (29.8 %)	64 (30.0 %)	
35–44	90 (34.0 %)	75 (35.2 %)	
45–54	48 (18.1 %)	34 (16.0 %)	
55–64	25 (9.4 %)	21 (9.9 %)	
65 +	8 (3.0 %)	15 (7.0 %)	
Sex			0.57
Female	148 (55.8 %)	112 (52.6 %)	
Male	117 (44.2 %)	100 (46.9 %)	
Missing	0 (0 %)	1 (0.5 %)	
Gender			0.098
Cisgender Woman	134 (50.6 %)	108 (50.7 %)	
Cisgender Man	109 (41.1 %)	100 (46.9 %)	
Transgender	5 (1.9 %)	1 (0.5 %)	
Non-Binary/Genderqueer/Gender Fluid	6 (2.3 %)	1 (0.5 %)	
Other	3 (1.1 %)	1 (0.5 %)	
Prefer Not to Say	7 (2.6 %)	1 (0.5 %)	
Missing	1 (0.4 %)	1 (0.5 %)	
Race			0.52
American Indian or Alaska Native	0 (0 %)	1 (0.5 %)	
Asian	15 (5.7 %)	8 (3.8 %)	
Black or African American	21 (7.9 %)	22 (10.3 %)	
Multiracial	13 (4.9 %)	8 (3.8 %)	
White	206 (77.7 %)	169 (79.3 %)	
Other	7 (2.6 %)	2 (0.9 %)	
Missing	3 (1.1 %)	3 (1.4 %)	
Education			0.54
Junior High School	2 (0.8 %)	2 (0.9 %)	
High School	36 (13.6 %)	23 (10.8 %)	
Some College	61 (23.0 %)	42 (19.7 %)	
Technical School	12 (4.5 %)	7 (3.3 %)	
Junior College	16 (6.0 %)	9 (4.2 %)	
Four-Year College	104 (39.2 %)	93 (43.7 %)	
Graduate or Professional School	31 (11.7 %)	35 (16.4 %)	
Missing	3 (1.1 %)	2 (0.9 %)	
Income			< 0.001
Less than $10,000	21 (7.9 %)	6 (2.8 %)	
$10,000 - $25,000	49 (18.5 %)	19 (8.9 %)	
$25,000 - $50,000	71 (26.8 %)	52 (24.4 %)	
$50,000 - $75,000	56 (21.1 %)	58 (27.2 %)	
$75,000 - $100,00	29 (10.9 %)	42 (19.7 %)	
More than $100,000	39 (14.7 %)	36 (16.9 %)	
Lifetime MDD Diagnosis			< 0.001
Yes	114 (43.0 %)	40 (18.8 %)	
No	150 (56.6 %)	173 (81.2 %)	
Missing	1 (0.4 %)	0 (0 %)	
BDI-II			< 0.001
Mean (SD)	26.2 (13.7)	12.2 (12.4)	
Median [Min, Max]	26.3 [0, 62.0]	8.40 [0, 50.4]	
SHAPS			< 0.001
Mean (SD)	32.8 (5.15)	21.3 (4.29)	
Median [Min, Max]	32.0 [20.0, 56.0]	22.0 [13.0, 29.0]	
DARS			< 0.001
Mean (SD)	42.5 (13.7)	56.9 (9.93)	
Median [Min, Max]	42.0 [1.00, 68.0]	59.0 [16.0, 68.0]	
QLESQ-SF			< 0.001
Mean (SD)	40.0 (9.77)	54.7 (8.61)	
Median [Min, Max]	39.0 [15.0, 70.0]	55.0 [17.0, 70.0]	

Note. Numbers are n (%) of participants unless indicated otherwise; *p*-values reflect results from chi-squared tests. MDD, major depressive disorder; BDI-II, Beck Depression Inventory-II; SHAPS, Snaith-Hamilton Pleasure Scale; DARS, Dimensional Anhedonia Rating Scale; QLESQ-SF, Quality of Life Enjoyment and Satisfaction Questionnaire-Short Form. During a pre-screening, participants were categorized as anhedonic (SHAPS categorical score 0–2) or non-anhedonic (SHAPS score 3–14). The DARS scores shown in this table are not reverse scored. Lifetime MDD reflects self-reported diagnosis. Missing data reflect measures or items that were optional and therefore were not completed by all participants.

satisfaction pertaining to physical health, mood, work, household and leisure activities, social and family relationships, daily functioning, sexual desire/interest/performance, economic status, vision, ability to get around physically, overall well-being, medications, and contentment. For the current online sample, the internal reliability (Cronbach's alpha) was excellent for all scales (SHAPS: $\alpha = 0.91$; DARS: $\alpha = 0.95$; BDI-II: $\alpha = 0.95$; QLESQ-SF: $\alpha = 0.94$).

2.2.2. Probabilistic Reward Task

The online PRT was developed using jsPsych version 6 [28]; task code and stimuli are available upon request. Participants could only complete the task using a computer with a keyboard and were instructed

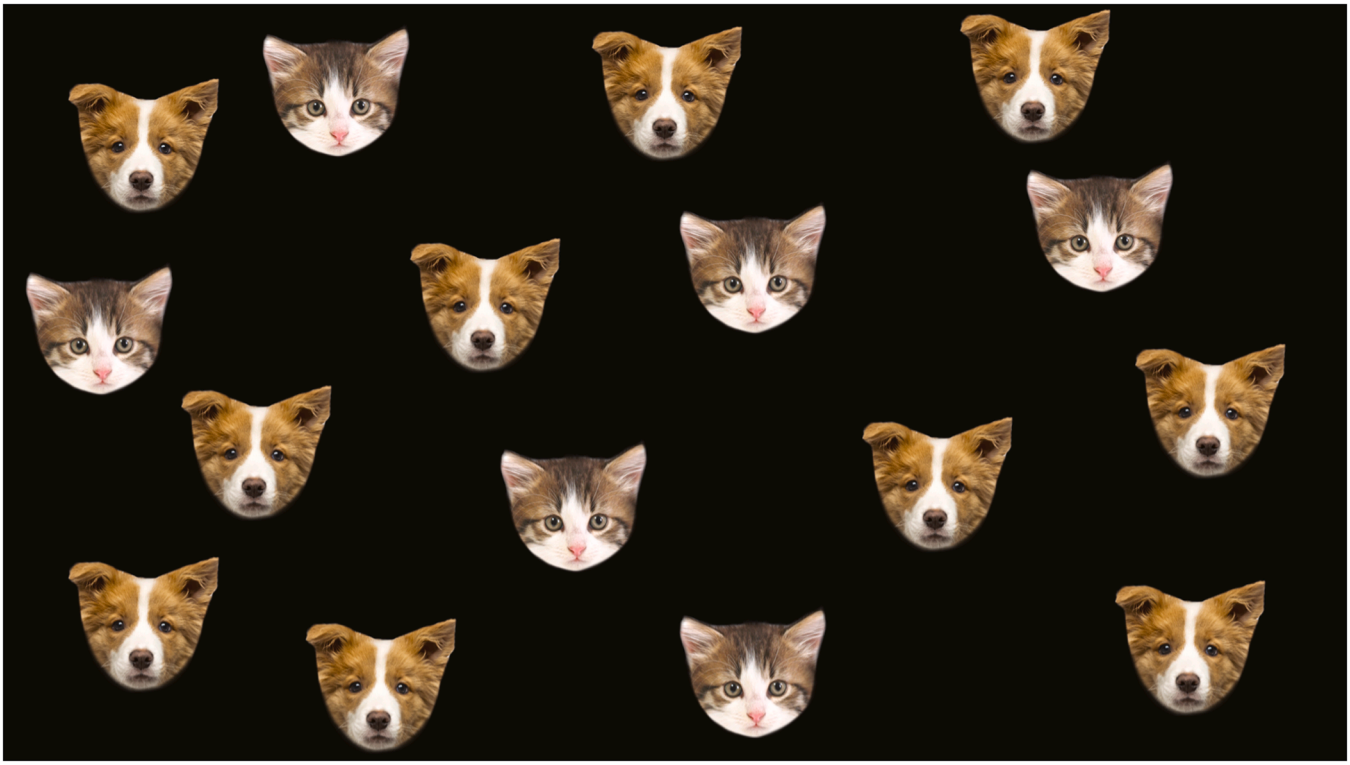

Fig. 1. Task Stimuli. Example of task stimuli. The example screen displays more dogs. Each participant was randomized such that the more rewarded ("rich") stimulus was either the screen with more cats or more dogs. Key assignments for responses were also counterbalanced across participants.

to sit 50 cm from the screen. Various difficult-to-differentiate stimuli displayed images with faces of dogs and cats in ratios of 6:10 (Fig. 1). Participants were instructed to identify whether images presented a higher number of dogs or cats by pressing the appropriate key ('S' or 'L'). Participants were instructed to collect as much money as possible and informed that correct identification of some, but not all, trials would result in a monetary reward of 5 cents. Prior to the task, participants completed a series of practice trials. Unbeknownst to participants, rewards were administered in a ratio of 4:1 in which correct identification of one stimulus type (e.g., more cats) was rewarded 4 times more often (i.e., "rich stimulus") than the other (i.e., "lean stimulus"). This reward ratio differs from original versions of the PRT task which utilized a 3:1 reward ratio [13,14]. This more asymmetric reward ratio was used to replicate the online version of the PRT task conducted by [12], and is consistent with preclinical PRT data suggesting that response bias is linearly related to how asymmetrical the reinforcement schedule is, making a 4:1 ratio more efficient [29] and ensuring that a response bias would be elicited given the online administration of the task.

The online PRT task consisted of three blocks, each containing 100 trials, with a 30-second break between blocks. Each trial began with a fixation cross displayed for 500 ms, followed by the stimulus image presented for 325 ms. Four counterbalanced versions of the task were administered which varied based on which stimulus (more cats or more dogs) was designated as "rich" stimulus as well as which key ('S' or 'L') was used to select the rich responses.

Task performance was evaluated with respect to response bias and discriminability (which indexes task difficulty and was thus used as a control variable). The main variable of interest, response bias, serves as an index of participants' implicit preference for the rich stimulus, and was calculated as:

$$\text{Response Bias}: \log b = \frac{1}{2}\log\frac{(Rich_{correct} + 0.5) * (Lean_{incorrect} + 0.5)}{(Rich_{incorrect} + .05) * (Lean_{correct} + 0.5)}$$

Response bias is high when participants correctly classify the rich stimulus and tend to misclassify the lean stimulus for the rich. Participants who did not complete at least 80 valid trials per block – defined as RT of greater than 150 ms and less than 3250 ms as well as trials exceeding mean RT ± 3 SD, after log transformation – were excluded. To further dissect behavioral performance, we calculated response probabilities (probability of selecting "rich" or "lean" on the current trial) based on whether the immediately preceding trial was rich or lean and whether the preceding trial was rewarded or not [14]. Prior to statistical analyses, these probability values were arcsine-transformed to address non-Gaussian distributions.

Finally, we used computational modeling to test five reinforcement learning models and extracted two key parameters: learning rates and reward sensitivity (see below) [18]. The five models included: (1) Basic Stimulus-Action Model, where rewards are tied to specific stimulus-response pairs; (2) Stimulus-Action Model, where rewards are tied to specific stimulus-response pairs and non-rewards are treated as punishments; (3) Action Model, where learning is based only on actions, ignoring the stimulus; (4) Belief Model, where rewards are influenced by a mix of stimulus-action pairs, weighted by uncertainty; and (5) Counterfactual Belief Model in which rewards are still influenced by a mix of stimulus-action pairs and weighted by uncertainty, but also incorporates counterfactual updating. Computational models were fit using an empirical random-effects approach and were compared using group-level Bayesian Information Criterion (BIC) scores. Across three separate runs of the modeling, the Belief Model consistently provided the best fit for the data (Supplemental Fig. S2). The model generated a series of parameters including reward sensitivity (immediate behavioral impact of rewards) and learning rate (ability to accumulate and learn from rewards over time) as well as belief (reflecting uncertainty about the presented stimulus), instruction sensitivity (measuring how well participants followed task directions), and initial bias (tendency to favor one response over another). We constrained parameters with an empirical prior distribution without additional assumptions.

2.3. Data analyses

All statistical analyses were conducted in RStudio [30] (Version 2024.12.0 + 467). T-tests and chi-squared tests were conducted to test for group differences in demographic and clinical variables.

2.3.1. Relationships among anhedonia, quality of life and response bias

We ran Pearson's correlations to assess relationships among anhedonia, QoL, and response bias with the Hochberg correction for multiple comparisons. The Meng-Rosenthal test [31] was used to compare the strength of dependent correlations (i.e., QLESQ-SF with DARS vs. QLESQ-SF with SHAPS; response bias with DARS vs. response bias with SHAPS).

2.3.2. Group differences in PRT performance

Separate linear mixed effects models probed response bias and discriminability (which served as a control variable) as a function of *Group* (anhedonic vs. non-anhedonic; MDD vs. no MDD), *Block*, and the *Group* × *Block* interaction and accounting for person-level random effects. To assess how prior trial outcomes influenced response behavior (e.g., selecting rich on a lean trial or selecting lean on a rich trial), additional linear mixed effects models were conducted as a function of *Anhedonia Group* (anhedonic vs. non-anhedonic), *Preceding Trial Type* (rich vs. lean), and *Preceding Trial Feedback* (rewarded vs. not rewarded). Post-hoc *t*-tests were conducted to probe significant main effects and interactions with a Bonferroni correction. Finally, we conducted additional linear mixed effects models to assess anhedonia group differences on learning rate, belief, and reward sensitivity parameters from our computational modeling. Due to group differences in income, income was included as a covariate in all analyses.

3. Results

3.1. Participants

Participants in the anhedonic (n = 265) and non-anhedonic (n = 213) groups did not differ in age, sex, gender identity, race, and education level. However, the anhedonic group had a greater prevalence of lifetime MDD, greater depression severity, greater anhedonia (as measured by the DARS), lower QoL, and lower income compared to the non-anhedonic group (p's < .001; see Table 1). Of note, the mean continuous SHAPS scores for the anhedonic (M = 32.8) and non-anhedonic (M = 21.3) groups closely aligned with meta-analytic estimates ([32]; healthy: M = 20.2, 95 % CI [19.7, 20.8]; MDD: M = 33.1, 95 % CI.0, 34.1]), providing additional support for the validity of the categorical classification.

3.2. Online Probabilistic Reward Task

3.2.1. Relationships between anhedonia and quality of life

SHAPS and DARS were strongly correlated (r(476) = .67, p < .001, p_{adj} < .001, 95 % CI [.61,.71]), as expected. Higher QoL was significantly associated with lower levels of anhedonia as assessed by both the SHAPS (r(476) = -.69, p < .001, p_{adj} < .001, 95 % CI [-.73, −.64]) and DARS (r(476) = -.54, p < .001, p_{adj} < .001, 95 % CI [-.60, −.47]). The correlation between the QLESQ-SF and SHAPS was significantly

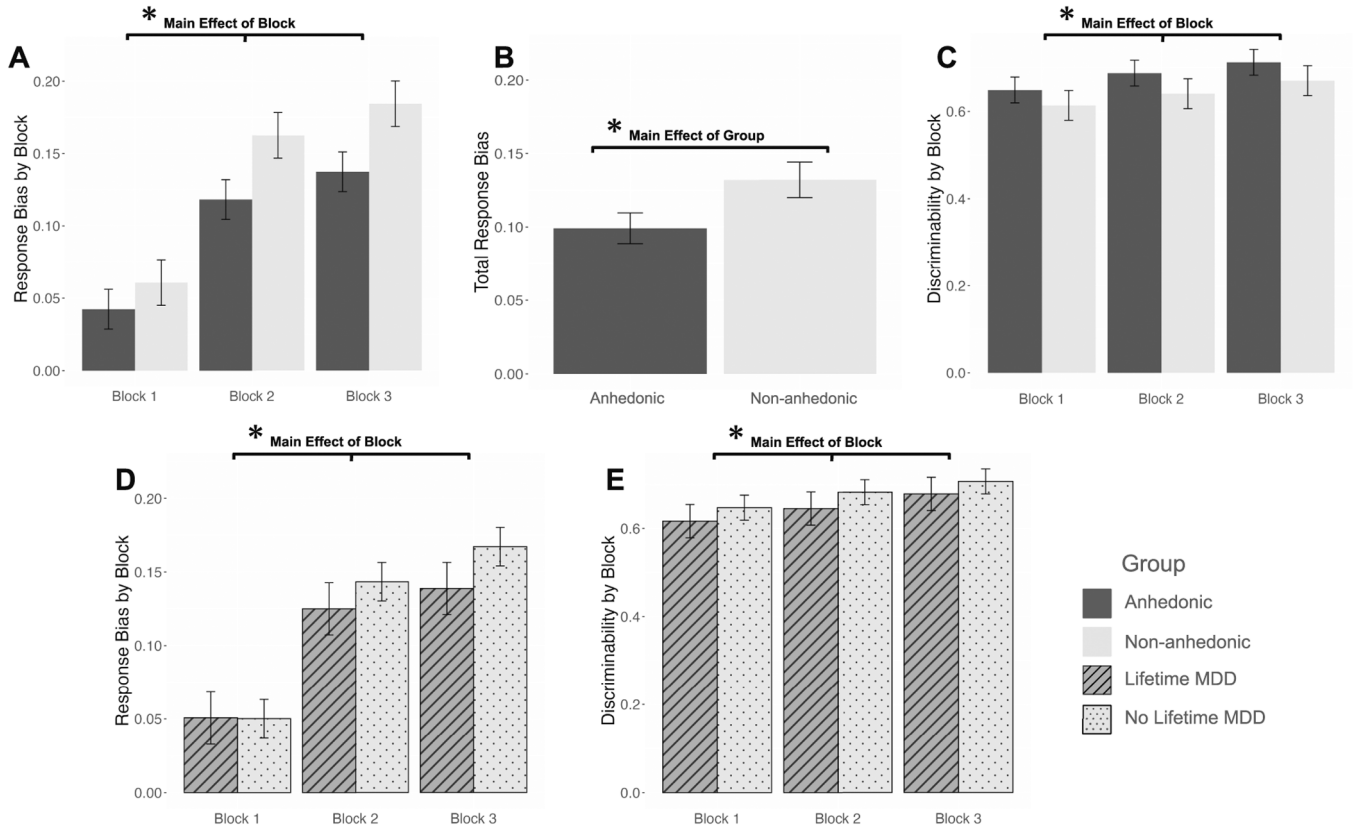

Fig. 2. Results from linear models examining the effects of anhedonia, lifetime MDD, and block on PRT. Key findings are indicated. Error bars reflect standard errors of the mean. **(A)** Response bias across blocks by Anhedonia Group. Response bias significantly increased across blocks for all participants and **(B)** there was a significant main effect of Anhedonia Group. **(C)** Discriminability across blocks by Anhedonia Group. Across all participants discriminability increased significantly across blocks and did not differ significantly by Anhedonia Group. **(D)** Response bias across blocks by Lifetime MDD Group. Across all participants response bias increased significantly across blocks but did not differ significantly by MDD status. **(E)** Discriminability across blocks by lifetime MDD status. Across all participants discriminability increased significantly across blocks and did not differ significantly by MDD status. Horizontal bars with asterisks (*) represent significant differences.

Table 2
Linear mixed effects models results.

Test	Comparison	Statistic	df	*p*-value	Effect Size
Anhedonia Grouping					
Response Bias	Income	$F = 0.71$	5, 469	.62	$\eta_p^2 = .00$
	Lifetime MDD	$F = 0.13$	1, 469	.72	$\eta_p^2 = .00$
	Anhedonia Group	$F = 4.47$	1, 469	.04*	$\eta_p^2 = .01$
	Block	$F = 60.44$	2, 950	< .001*	$\eta_p^2 = .11$
	Anhedonia Group × Block	$F = 1.17$	2, 950	.31	$\eta_p^2 = .00$
Discriminability	Income	$F = 1.89$	5, 469	.09	$\eta_p^2 = .02$
	Lifetime MDD	$F = 1.09$	1, 469	.30	$\eta_p^2 = .00$
	Anhedonia Group	$F = 1.74$	1, 469	.19	$\eta_p^2 = .00$
	Block	$F = 10.40$	2, 950	< .001*	$\eta_p^2 = .02$
	Anhedonia Group × Block	$F = 0.09$	2, 950	.91	$\eta_p^2 = .00$
Belief	Income	$F = 3.48$	5, 470	< .005*	$\eta_p^2 = .04$
	Lifetime MDD	$F = 0.15$	1, 470	.70	$\eta_p^2 = .00$
	Anhedonia Group	$F = 8.41$	1, 470	< .005*	$\eta_p^2 = .02$
Lifetime MDD Grouping					
Response Bias	Income	$F = 1.29$	1, 474	.26	$\eta_p^2 = .00$
	Lifetime MDD Group	$F = 0.73$	1, 474	.39	$\eta_p^2 = .00$
	Block	$F = 47.30$	2, 950	< .001*	$\eta_p^2 = .09$
	Lifetime MDD Group × Block	$F = 0.86$	2, 950	.42	$\eta_p^2 = .00$
Discriminability *Lifetime MDD Group*	Income	$F = 0.50$	1, 474	.48	$\eta_p^2 = .00$
	Lifetime MDD Group	$F = 0.12$	1, 474	.73	$\eta_p^2 = .00$
	Block	$F = 9.41$	2, 950	< .001*	$\eta_p^2 = .02$
	Lifetime MDD Group × Block	$F = 0.05$	2, 950	.95	$\eta_p^2 = .00$
Probability of selecting Lean on Rich Trial (Rich Miss) *Anhedonia Group*	Income	$F = 1.78$	5, 463.66	.12	$\eta_p^2 = .02$
	Lifetime MDD	$F = 0.47$	1, 463.12	.49	$\eta_p^2 = .00$
	Anhedonia Group	$F = 0.06$	1, 463.80	.81	$\eta_p^2 = .00$
	Preceding Trial Type	$F = 44.19$	1, 1408.83	< .001*	$\eta_p^2 = .03$
	Preceding Trial Feedback	$F = 0.40$	1, 1408.83	.53	$\eta_p^2 = .00$
	Anhedonia Group × Preceding Trial Type	$F = 0.57$	1, 1408.84	.45	$\eta_p^2 = .00$
	Anhedonia Group × Preceding Trial Feedback	$F = 0.36$	1, 1408.84	.54	$\eta_p^2 = .00$
	Trial Type × Trial Feedback	$F = 65.88$	1, 1408.83	< .001*	$\eta_p^2 = .04$
	Anhedonia Group × Trial Type × Trial Feedback	$F = 0.21$	1, 1408.84	.65	$\eta_p^2 = .00$
Post-hoc *t*-tests: Lean on Rich Trial					
Preceding Trial Rewarded	Preceding Trial Rich vs. Preceding Trial Lean	$t = 1.02$	455	.31	$d = -.044$
Preceding Trial Not Rewarded	Preceding Trial Rich vs. Preceding Trial Lean	$t = -8.82$	455	< .001*	$d = .424$
Preceding Trial Rich	Preceding Trial Rewarded vs. Preceding Trial Not Rewarded	$t = 6.03$	1419	< .001*	$d = -.396$
Preceding Trial Lean	Preceding Trial Rewarded vs. Preceding Trial Not Rewarded	$t = -5.32$	1415	< .001*	$d = .346$
Probability of selecting Rich on Lean Trial (Lean Miss) *Anhedonia Group*	Income	$F = 1.79$	5, 468.32	.11	$\eta_p^2 = .02$
	Lifetime MDD	$F = 0.02$	1, 468.52	.89	$\eta_p^2 = .00$
	Anhedonia Group	$F = 4.72$	1, 468.69	.03*	$\eta_p^2 = .01$
	Preceding Trial Type	$F = 7.49$	1, 1412.15	.01*	$\eta_p^2 = .01$
	Preceding Trial Feedback	$F = 2.75$	1, 1412.15	.10	$\eta_p^2 = .00$
	Anhedonia Group × Preceding Trial Type	$F = 0.99$	1, 1412.15	.32	$\eta_p^2 = .00$
	Anhedonia Group × Preceding Trial Feedback	$F = 0.50$	1, 1412.15	.47	$\eta_p^2 = .00$
	Trial Type × Trial Feedback	$F = 26.72$	1, 1412.15	< .001*	$\eta_p^2 = .02$
	Anhedonia Group × Trial Type × Trial Feedback	$F = 0.08$	1, 1412.15	.67	$\eta_p^2 = .00$
Post-hoc *t*-tests: Rich on Lean Trial					
Preceding Trial Rewarded	Preceding Trial Rich vs. Preceding Trial Lean	$t = -1.46$	455	< .001*	$d = .115$
Preceding Trial Not Rewarded	Preceding Trial Rich vs. Preceding Trial Lean	$t = 5.14$	455	< .001*	$d = -.371$
Preceding Trial Rich	Preceding Trial Rewarded vs. Preceding Trial Not Rewarded	$t = -2.64$	455	< .001*	$d = .171$
Preceding Trial Lean	Preceding Trial Rewarded vs. Preceding Trial Not Rewarded	$t = 5.15$	455	< .001*	$d = -.315$

Note. Linear model results for behavioral performance and response probabilities from the Probabilistic Reward Task (PRT). For anhedonia and lifetime MDD groupings, a significant difference in income was found, so income was added as a covariate. Analyses were conducted for response bias and discriminability across task *Block* and clinical groupings: *Group* is separated into "Anhedonic" and "Non-Anhedonic"–based on SHAPS scores–and Lifetime MDD is based on self-reported history of Major Depressive Disorder. The belief parameter from our Belief Model is included as the only computational modeling variable with significant findings. Probability linear models assessed the likelihood of selecting the rich or lean stimulus on a given trial as a function of *Preceding Trial Type* (Rich vs. Lean) and *Preceding Trial Feedback* (Rewarded vs. Not Rewarded), including relevant interactions with anhedonia group; post hoc paired *t*-tests were conducted to compare the effect of *Preceding Trial Type* separately for rewarded and non-rewarded trials, and the effect of *Preceding Trial Reward* separately for rich and lean trials. Significant effects are denoted with an asterisk. ηp^2 = partial eta squared.

stronger than the correlation between the QLESQ-SF and DARS (z = 6.00, 95 % CI [.18,.36]).

3.2.2. Relationships between response bias and depressive symptoms/QoL

Higher response bias was associated with higher QoL (QLESQ-SF; (r (476) = .12, p = .009, p_{adj} = .037, 95 % CI [.03,.021]). Higher response bias was associated with lower anhedonia as measured by the SHAPS (r (476) = -.10, p = .028, p_{adj} = .085, 95 % CI [-.19, −.01]), but not the DARS (r(476) = -.03, p = .450, p_{adj} = .450, 95 % CI [-.12,.06]). Highlighting specificity, response bias was not associated with overall depressive symptoms as assessed by the BDI (r(476) = -.06, p = .202, p_{adj} = .403, 95 % CI [-.15,.03]).

3.2.3. Group differences in PRT performance

An *Anhedonia Group* (anhedonic vs. non-anhedonic) × *Block* omnibus test controlling for income and lifetime MDD diagnosis predicting response bias revealed significant main effects of *Block* and *Anhedonia Group*. Follow-up tests indicated greater response bias in Blocks 2 (M =.14, SD =.23) and 3 (M =.16, SD =.22) compared to Block 1 (M =.05, SD =.21), but no significant difference between Blocks 2 and 3 (Fig. 2A). The anhedonic group (M =.10, SD =.21) had an overall lower response bias (Fig. 2B, Table 2) than the non-anhedonic group (M =.14, SD =.23). There was no *Anhedonia Group* × *Block* interaction (see Table 2 and Fig. 2). An *Anhedonia Group* × *Block* omnibus test predicting discriminability scores and controlling for income revealed a significant main effect of *Block* such that discriminability increased across blocks (Block 1: M =.610, SD =.434; Block 2: M =.643, SD =.472; Block 3: M =.670, SD =.473). Importantly, for discriminability, there was no main effect of *Anhedonia Group* or interaction (Fig. 2C, Table 2), suggesting that response bias effects were not influenced by task difficulty.

Additional *Lifetime MDD Group* × *Block* omnibus tests controlling for income predicting response bias and discriminability both revealed significant main effects of *Block,* with an increase across blocks (Figs. 2D, 2E). There were no significant main effects of *MDD Group* or *MDD Group x Block* interactions (Table 2), so for all other analyses, we focused on the *Anhedonia Group* factor. An omnibus test predicting our Belief Model's belief parameter by *Anhedonia Group* and controlling for *Income* revealed significant main effects of *Income* and *Anhedonia Group*. Those with anhedonia had greater belief (M = 3.67; SD = 1.76), implying greater uncertainty, compared to those without anhedonia (M = 3.29; SD = 1.75). However, there were no significant results with initial bias, instruction sensitivity, learning rate, or reward sensitivity (p≥.41) (Supplemental Table S1). See Supplemental Material for full clinical scale correlations to the belief parameter.

3.2.4. Probability analyses

Two *Anhedonia Group x Preceding Trial Type x Preceding Trial Reward* omnibus tests examining the probability of selecting lean on a rich trial and selecting rich on a lean trial showed similar patterns in response behavior. Critically, a main effect of *Anhedonia Group* emerged only for the probability for selecting rich on a lean trial, such that the anhedonic group (M = 25.5 %, SD = 20.7 %, Fig. 3C) was less likely to select rich on a lean trial compared to the non-anhedonic group (M = 29.4 %, SD = 22.8 %; Fig. 3C). We also found significant main effects of *Preceding Trial Type*, which were qualified by *Preceding Trial Type* × *Preceding Trial Reward* interactions for both response probabilities (Table 2). These interactions, however, did not vary by *Anhedonic Group*, and their follow up tests are reported in the Supplemental Material (see also Supplemental Table S2 and Supplemental Fig. S3).

4. Discussion

This study aimed to examine associations among self-reported anhedonia, quality of life, and a behavioral measure of reward learning in a large online sample. Consistent with our hypotheses, significant associations emerged among self-reported anhedonia, quality of life, and reward learning, consistent with models linking anhedonia to disruptions in reward-related learning processes. Group differences in response bias were specific to anhedonia and not lifetime MDD diagnosis, replicating prior findings [16]. While both depression and anhedonia were strongly correlated with quality of life, findings highlight the relevance of anhedonia for psychosocial functioning [33].

To address the first two goals of our study, we examined how self-reported anhedonia related to QoL and a behavioral measure of reward learning. Consistent with our first hypothesis, both the SHAPS and DARS were significantly correlated with the QLESQ-SF. However, the SHAPS showed significantly stronger associations with QoL than the DARS – contrary to our hypothesis suggesting that global hedonic capacity may be more closely linked to perceived quality of life than domain-specific reward engagement. While the SHAPS and DARS were strongly correlated, approximately 55 % of their variance did not overlap, suggesting that they capture overlapping but distinct facets of anhedonia [9]. This distinction may help explain the differential patterns we observed: consistent with prior work, the SHAPS, which focuses on consummatory pleasure [34], aligns more closely with the QLESQ-SF's emphasis on recent satisfaction with mood, health, and relationships, as well as with the PRT, which is particularly sensitive to deficits in consummatory reward processing [35]. Alternatively, the broader, multidimensional structure of the DARS, which includes four domains (hobbies, food/drink, social activities, sensory experience) that may be less directly captured by either the QLESQ-SF or reward learning processes engaged in the PRT, might have led to weaker associations. Similarly, and consistent with prior studies in independent samples (e.g. [13]), response bias did not correlate with BDI scores, likely because the BDI assesses a broad range of depressive symptoms beyond anhedonia. Overall, these findings highlight the central role of consummatory pleasure for quality of life and behaviorally relevant features of anhedonia.

Finally, our third goal was to examine possible sources of group differences in response bias. Based on prior research, we confirmed our hypothesis that the anhedonic group would show a diminished overall response bias relative to the non-anhedonic group [16,17]. Probability analyses further clarified that the anhedonic group was less likely to select the rich stimulus on a lean trial – consistent with prior findings in unmedicated individuals with MDD [14]. These findings suggest that response bias may develop differently in anhedonic and non-anhedonic individuals based on how recent information shapes choices: non-anhedonic individuals favor the rich stimulus, while the diminished bias in the anhedonic group was due to a lower propensity to misclassify the lean stimulus as rich, indicative that their behavior was less shaped by the asymmetric reinforcement schedule. Notably, this effect was not further modulated by the outcome in the preceding trial, highlighting a generally reduced ability to modulate behavior as a function of rewards among anhedonic individuals.

Interestingly, an additional group difference emerged in the belief parameter from the Belief model, with the anhedonic group showing greater uncertainty than the non-anhedonic group. This elevated uncertainty may reflect reduced decision confidence and less consistent application of learned reward information across the task, aligning with the decreased tendency to select the rich stimulus on lean trials. These findings highlight a putative cognitive mechanism underlying altered reward-based behavior [18]. Future studies evaluating this interpretation are warranted. Here too, group differences were specific to anhedonia rather than lifetime MDD, further emphasizing that altered reward processing may be more tightly linked to anhedonic symptoms rather than depression more broadly [36].

4.1. Limitations and future directions

Findings should be considered within the context of several limitations. First, all study procedures were conducted entirely online, which, while allowing for the recruitment of a large and diverse sample, likely

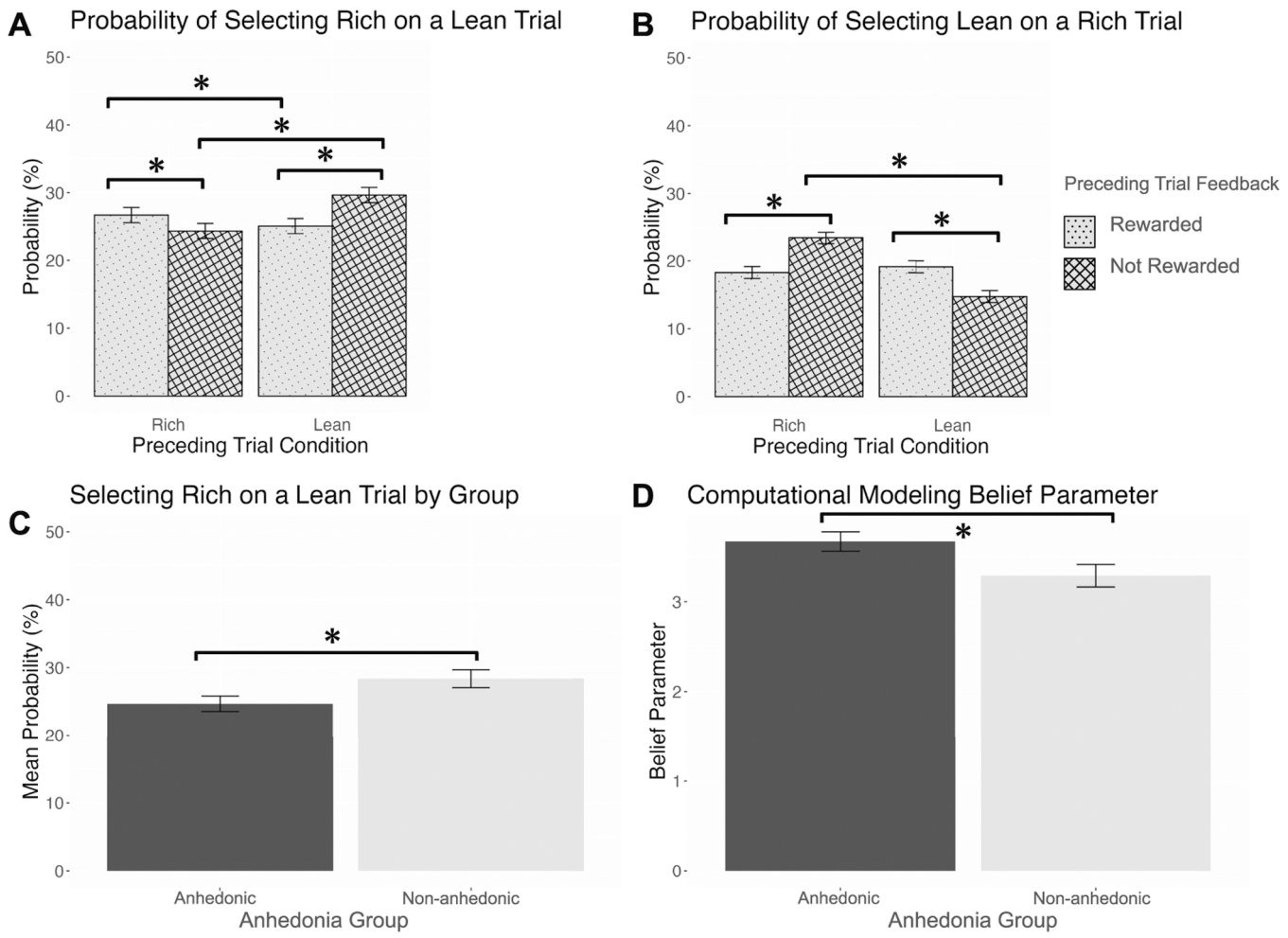

Fig. 3. Results from PRT probability analysis linear models and computational modeling parameters **(A-B)** Bar plots visualizing differences in trial-by-trial response probabilities across preceding trial types and preceding trial feedback. Each graph displays the estimated marginal mean probability adjusting for income and self-reported lifetime MDD diagnosis (± standard error) for a specific response type: **(A)** Probability of selecting rich on a lean trial, **(B)** Probability of selecting lean on a rich trial. Within each plot, data are separated by preceding trial type (Rich vs. Lean), and bars are coded by preceding trial feedback (Rewarded vs. Not Rewarded). **(C)** Bar plot visualizing main effect of group on selecting rich on a lean trial. **(D)** Bar plot visualizing the main effect of group for the belief parameter. Horizontal bars with asterisks (*) represent significant differences (see Table 2).

introduced variability in data quality, resulting in substantial exclusions due to incomplete or low-quality questionnaire and task data. Second, although the use of a non-clinical, community-based sample represents a strength, it also introduces several important limitations. Specifically, the restricted range of symptom severity in the present sample may limit the generalizability of findings to clinical populations. However, the mean SHAPS scores observed across groups were consistent with the range of scores reported for clinical populations in the meta-analysis by Trøstheim et al. [32]. Nevertheless, the absence of clinician-administered diagnostic assessments and verification of treatment status further constrains the interpretation of results. Third, although detailed instructions were provided and participants who failed data quality checks were excluded, the absence of an experimenter may limit task compliance. Despite these constraints, data showed the expected effects, including an increase in response bias from the first to the other blocks, replicating prior online findings in independent samples assessed with the same version of the PRT [12]. Future research should replicate the current findings using lab administration of the PRT.

Fourth, all clinical measures relied exclusively on self-report, which may introduce biases related to participants' insight, recall, or willingness to disclose symptoms. In particular, diagnostic status was determined based on participants' responses to a self-report item assessing whether they had ever been diagnosed with major depressive disorder, rather than through clinician-administered diagnostic interviews. As a result, diagnostic groupings may not fully align with objective clinical diagnoses and may be influenced by inaccuracies in self-reported diagnostic history. Nonetheless, reliance on self-report measures my limit the precision of diagnostic characterization and may not fully capture the underlying mechanisms contributing to reward processing deficits. Future studies may benefit from incorporating clinician-administered diagnostic assessments, treatment verification, and multi-method behavioral measures of anhedonia and depression. Examining how specific facets of anhedonia align with distinct task features or phases could offer a more nuanced understanding of reward processing and dysfunction. Finally, incorporating neural or physiological data could provide a more comprehensive picture of the mechanisms underlying anhedonia and the reward-related learning processes that may contribute to it.

4.2. *Clinical implications*

These findings yield important clinical implications for individuals with anhedonia. Despite the SHAPS's sole focus on consummatory pleasure, this widely used scale may be more sensitive than other measures of anhedonia like the DARS in detecting clinically relevant

anhedonia linked to behavioral deficits and functional impairment. Most notably, the SHAPS emerged as a stronger predictor of both subjective quality of life and reward learning. These results suggest that targeting specific aspects of anhedonia—particularly consummatory deficits—may enhance the identification of individuals most at risk for poor functioning and inform more tailored treatment approaches. For example, patients with consummatory deficits may benefit from strategies geared toward increasing the salience of positive experiences, like practicing mindfulness while engaging in a pleasant activity. On the other hand, patients who struggle to anticipate treatment benefits may benefit from motivational interviewing and from providers who emphasize the concrete rewards of treatment [10], while those who underestimate their likelihood of treatment response may benefit from cognitive interventions and psychoeducation to address distorted reward expectancies.

4.3. Conclusions

The present study provides novel insights linking self-reported and behavioral indicators of anhedonia to quality of life and reward responsiveness in a large and diverse online sample. We found differences in the development of response bias between individuals with and without elevated anhedonia, replicating prior findings [13,16,17]. Together, these findings underscore the multidimensional nature of anhedonia and support the integration of both subjective and objective approaches to its measurement. They also highlight the potential utility of behavioral tasks like the PRT in refining clinical assessment and guiding treatment strategies for this critical symptom of depression.

Declaration of Competing Interest

Over the past 3 years, Dr. Pizzagalli has received consulting fees from Abbvie, Arrowhead Pharmaceuticals, Boehringer Ingelheim, Circular Genomics, Compass Pathways, Engrail Therapeutics, Neumora Therapeutics, Neurocrine Biosciences, Neuroscience Software, Takeda, Tap Sciences, and Xenon Pharmaceuticals; he has received honoraria from the American Psychological Association, Psychonomic Society and Springer (for editorial work) and Alkermes; he has received research funding from the BIRD Foundation, Brain and Behavior Research Foundation, Circular Genomics, Millennium Pharmaceuticals, National Institute of Mental Health, and Wellcome Leap; he has received stock options from Ceretype Neuromedicine, Compass Pathways, Engrail Therapeutics, Neumora Therapeutics, and Neuroscience Software. No funding or any involvement from these entities was used to support the current work, and all views expressed are solely those of the author. Harvard University retains the copyright for the Probabilistic Reward Task.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.xjmad.2026.100169.

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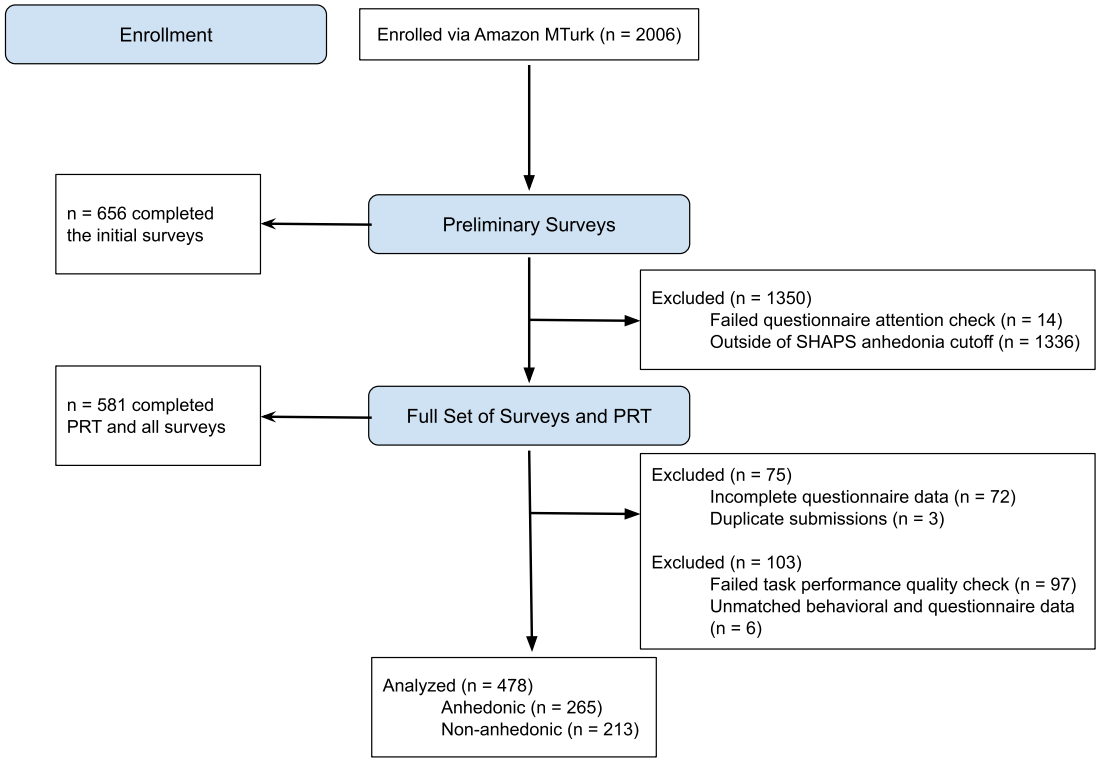
Anhedonia and Altered Reward Responsiveness: Relations to Psychosocial Functioning

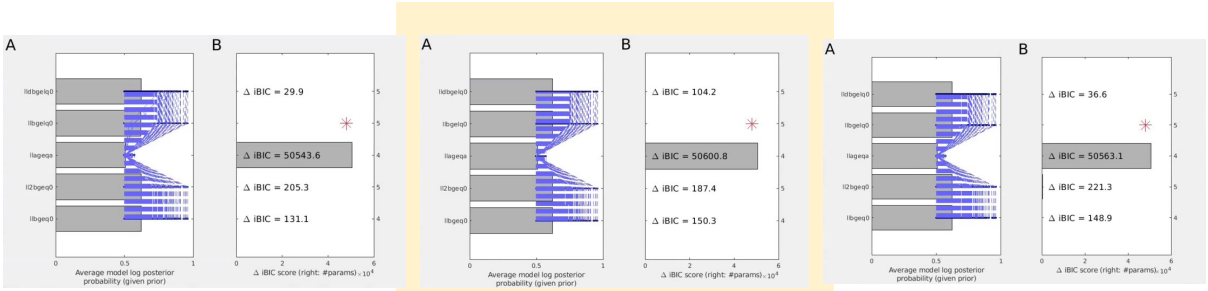
Supplemental Material

Supplemental Methods



Supplemental Fig. S1. Consort flow diagram
Flow diagram of the progress through the phases of the present online study; this includes enrollment, allocation, task performance quality check, and data analysis. SHAPS, Snaith-Hamilton Pleasure Scale. Participants were categorized as anhedonic based on a categorical SHAPS of 0–2 or non-anhedonic with a categorical SHAPS score of 3–14.

Supplemental Results



Supplemental Fig. S2. PRT computational modeling

Model comparison results across three simulation runs for five candidate models: Counterfactual Belief Model, Belief Model, Action-Only Model, Stimulus-Action Model, and Basic Stimulus-Action Model. Each panel displays the Integrated Bayesian Information Criterion (IBIC) values for each of the five models, accounting for complexity, and assessing model fit; lower IBIC values indicate better fit. Red asterisks indicate the best-fitting model in each run. Across all three simulations, the Belief Model consistently provided the best fit to the data. The middle panel (Run 2) showed the lowest overall IBIC and was therefore selected for all subsequent analyses.

Relationships between PRT Computational Parameters and Symptoms

Several self-report questionnaires demonstrated statistically significant associations, though group-level differences were generally absent. Notably, belief was significantly higher among individuals with elevated anhedonia (M = 3.67; SD = 1.76), indicating greater uncertainty, compared to those without anhedonia (M = 3.29; SD = 1.75), but did not differ by MDD status. Higher belief, or task uncertainty, was associated with higher anhedonia as measured by the SHAPS (r(476) = .14, p = .003, p_adj = .012, 95% CI [.05, .22]) and lower quality of life as measured by the QLESQ-SF (r(476) = -.12, p = .011, p_adj = .034, 95% CI [-.20, -.03]). However, belief showed no significant correlations to anhedonia as measured by the DARS (r(476) = .04, p = .333, p_adj = .666, 95% CI [-.05, .13]) nor depression as measured by the BDI (r(476) = .02, p = .729, p_adj = .729, 95% CI [-.07, .11]). Instruction sensitivity, baseline bias, reward sensitivity, and learning rate did not differ between anhedonia or MDD groups, so no further analyses were conducted.

Positive Valence Systems Scale Scores, PRT Performance, and Quality of Life

In exploratory analyses, and in response to an anonymous reviewer, we examined correlations between six PVSS subscales (reward valuation, reward expectancy/anticipation, effort valuation, reward anticipation, initial responsiveness, and reward satiation) and quality of life (QoL) and PRT response bias. All subscales were significantly correlated with QoL (r range = .62-.71, $p \leq .001$, $p\_adj \leq .001$). For response bias, all subscales except reward valuation (r =

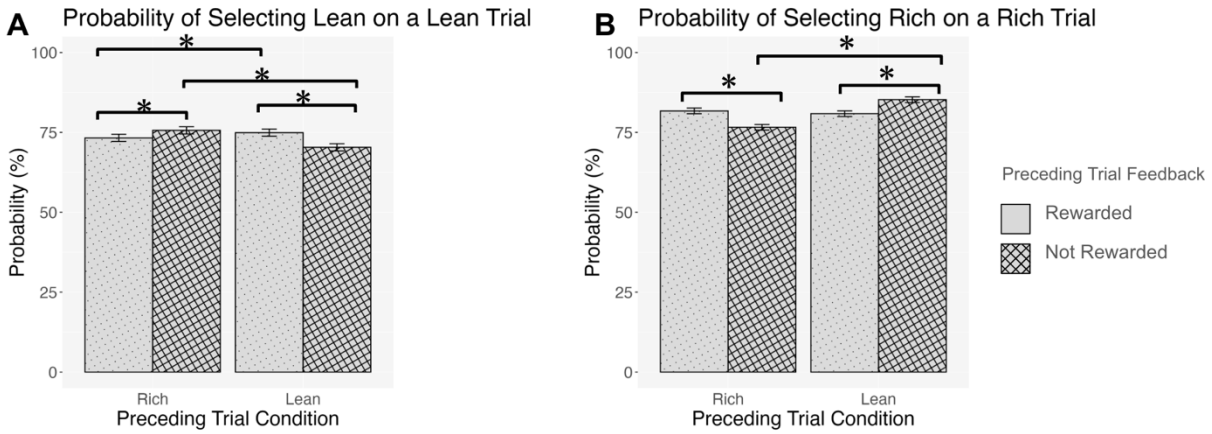
.04, p = .39, p_adj = .39) and reward expectancy (r = .08, p = .07, p_adj = .09) showed significant correlations (r range = .10–.14, p range = .002-.005, p_adj range = .02-.05). Overall, these findings indicate that while PVSS subscales broadly relate to reward processing and QoL, no single subscale uniquely accounted for associations with behavioral response bias, supporting the robustness of the primary SHAPS findings.

Probabilistic Reward Task Trial Analyses

Post-hoc pair t-tests revealed that the probability of selecting rich on a lean trial was higher when the preceding trial type was rich and rewarded ($Lean_{current\ trial}$-$Rich_{response}$: M = .268, SE = .011), compared to when the preceding trial type was lean and rewarded ($Lean_{current\ trial}$-$Lean_{response}$: M = .252; SE = .011). Conversely, the probability of selecting lean on a rich trial was not significantly different following a rewarded trial based on whether the preceding trial was rich or lean.

Otherwise, the response patterns for both response probabilities were the same. When the preceding trial and current trial type were the same, the probability of misclassifying the current trial was significantly lower if the preceding trial was rewarded ($Rich_{current\ trial}$-$Rich_{response}$: M = .182, SE = .009; $Lean_{current\ trial}$-$Lean_{response}$: M = .252; SE = .011) compared to not rewarded (Rich-$Rich_{response}$: M = .232, SE = .009; $Lean_{current\ trial}$-$Lean_{response}$: M = .297; SE = .011). The opposite was true if the preceding and current trial type were not the same such that the probability of misclassifying the current trial was significantly greater if the preceding trial was rewarded ($Rich_{current\ trial}$-$Lean_{response}$: M = .190, SE = .009; $Lean_{current\ trial}$-$Rich_{response}$: M = .268, SE = .011) compared to not rewarded ($Rich_{current\ trial}$-$Lean_{response}$: M = .147, SE = .009; $Lean_{current\ trial}$-$Rich_{response}$: M = .297; SE = .011).

Finally, the probability of correctly classifying the current stimulus was significantly greater for both rich and lean trials when the preceding and current trial type were the same and the preceding trial was rewarded ($Lean_{current\ trial}$-$Lean_{response}$: M = .748, SE = .011; $Rich_{current\ trial}$-$Rich_{response}$: M = .818, SE = .009) compared to when the preceding trial stimulus was the same and not rewarded ($Lean_{current\ trial}$-$Lean_{response}$: M = .703, SE = .011; $Rich_{current\ trial}$-$Rich_{response}$: M = .768, SE = .009) (see Supplemental Fig. 3A and 3B).



Supplemental Fig. S3. Additional PRT probability analysis graphs

Graphs from PRT probability analysis linear models. **(A-B)** Bar plots visualizing differences in trial-by-trial response probabilities across preceding trial types and preceding trial feedback. Each graph displays the estimated marginal mean probability adjusting for income and self-reported lifetime MDD diagnosis (± standard error) for a specific response type: **(A)** Probability of selecting lean on a lean trial, and **(B)** Probability of selecting rich on a rich trial. Within each plot, data are faceted by preceding trial type (Rich vs. Lean), and bars are coded by preceding trial feedback (Rewarded vs. Not Rewarded).

Supplemental Table S1. T-tests for computational modeling parameters. Linear model results for behavioral performance. Post-hoc t-tests from linear modeling assessed computational modeling constructs. Significant effects are denoted with an asterisk.

Computational Model Parameter	Comparison	Statistic	df	*p*-value	Effect Size
Belief	Anhedonia vs. No Anhedonia	$t = 2.74$	427.74	. 01*	$d = .26$
Belief	Lifetime MDD vs. No Lifetime MDD	$t = 1.55$	320.87	.12	$d = .15$
Reward Sensitivity	Anhedonia vs. No Anhedonia	$t = .06$	449.77	.95	$d = .005$
Reward Sensitivity	Lifetime MDD vs. No Lifetime MDD	$t = -.41$	310.66	.68	$d = -.04$
Learning Rate	Anhedonia vs. No Anhedonia	$t = .10$	457.14	.92	$d = .009$
Learning Rate	Lifetime MDD vs. No Lifetime MDD	$t = -.068$	286.14	.50	$d = -.07$
Instruction Sensitivity	Anhedonia vs. No Anhedonia	$t = -1.93$	460.73	.05	$d = -.18$
Instruction Sensitivity	Lifetime MDD vs. No Lifetime MDD	$t = -1.57$	283.28	.12	$d = -.14$
Baseline Bias	Anhedonia vs. No Anhedonia	$t = -1.83$	458.21	.07	$d = -.17$
Baseline Bias	Lifetime MDD vs. No Lifetime MDD	$t = -.08$	308.11	.93	$d = -.008$
Reward Learning	Anhedonia vs. No Anhedonia	$t = -1.30$	436.73	.20	$d = -.12$
Reward Learning	Lifetime MDD vs. No Lifetime MDD	$t = -1.22$	288.37	.22	$d = -.12$

Abbreviations: ηp^2 = partial eta squared. *d* = Cohen's d. *df* = degrees of freedom. MDD = Major Depressive Disorder.

Supplemental Table S2. Full linear mixed effects modeling results. Response probabilities from the Probabilistic Reward Task (PRT). A significant group difference in income was found, so income was added as a covariate. Probability linear models assessed the likelihood of selecting the rich or lean stimulus on a given trial as a function of *Preceding Trial Type* (Rich vs. Lean) and *Preceding Trial Feedback* (Rewarded vs. Not Rewarded), including relevant interactions with anhedonia group; post hoc paired t-tests were conducted to compare the effect of *Preceding Trial Type* separately for rewarded and non-rewarded trials, and the effect of *Preceding Trial Reward* separately for rich and lean trials. *Group* is separated into "Anhedonic" and "Non-Anhedonic" – based on categorical SHAPS scores – and Lifetime MDD is based on self-reported history of Major Depressive Disorder. Significant effects are denoted with an asterisk.

Test	**Comparison**	**Statistic**	**df**	***p*-value**	**Effect Size**
Dependent Variable *Grouping Variable*					
Probability of selecting Lean on Lean Trial (Lean Hit) *Anhedonia Group*	Income	$F = 1.79$	5, 468.23	.11	$\eta_p^2 = .02$
	Lifetime MDD	$F = 0.02$	1, 468.52	.98	$\eta_p^2 = .00$
	Anhedonia Group	$F = 4.72$	1, 468.69	.03 *	$\eta_p^2 = .01$
	Preceding Trial Type	$F = 7.49$	1, 1412.15	.01 *	$\eta_p^2 = .01$
	Preceding Trial Feedback	$F = 2.74$	1, 1412.15	.09	$\eta_p^2 = .00$
	Anhedonia Group × Preceding Trial Type	$F = 1.00$	1, 1412.15	.32	$\eta_p^2 = .00$
	Anhedonia Group × Preceding Trial Feedback	$F = 0.50$	1, 1412.15	.48	$\eta_p^2 = .00$
	Trial Type × Trial Feedback	$F = 26.72$	1, 1412.15	<.001 *	$\eta_p^2 = .02$
	Anhedonia Group × Trial Type × Trial Feedback	$F = 0.18$	1, 1412.15	.67	$\eta_p^2 = .00$
Post-hoc t-tests: Lean on Lean Trial					
Preceding Trial Rewarded	Preceding Trial Rich vs. Preceding Trial Lean	$t = 1.02$	455	.31	$d = -.044$
Preceding Trial Not Rewarded	Preceding Trial Rich vs. Preceding Trial Lean	$t = -8.82$	455	<.001*	$d = .424$

Preceding Trial Rich	Preceding Trial Rewarded vs. Preceding Trial Not Rewarded	t = 6.03	1419	<.001*	d = -.396
Preceding Trial Lean	Preceding Trial Rewarded vs. Preceding Trial Not Rewarded	t = -5.32	1415	<.001*	d = .346
Probability of selecting Rich on Rich Trial **(Rich Hit)** *Anhedonia Group*	Income	F = 1.78	5, 463.66	.12	η_p^2 = .02
	Lifetime MDD	F = 0.47	1, 463.12	.49	η_p^2 = .00
	Anhedonia Group	F = 0.06	1, 463.80	.81	η_p^2 = .00
	Preceding Trial Type	F = 44.18	1, 1408.83	<.001 *	η_p^2 = .03
	Preceding Trial Feedback	F = 0.40	1, 1408.83	.55	η_p^2 = .00
	Anhedonia Group × Preceding Trial Type	F = 0.57	1, 1408.84	.45	η_p^2 = .00
	Anhedonia Group × Preceding Trial Feedback	F = 0.36	1, 1408.84	.55	η_p^2 = .00
	Trial Type × Trial Feedback	F = 65.88	1, 1408.83	<.001 *	η_p^2 = .04
	Anhedonia Group × Trial Type × Trial Feedback	F = 0.21	1, 1408.84	.65	η_p^2 = .00
Post-hoc t-tests: Rich on Rich Trial					
Preceding Trial Rewarded	Preceding Trial Rich vs. Preceding Trial Lean	t = -1.46	455	<.001*	d = .115
Preceding Trial Not Rewarded	Preceding Trial Rich vs. Preceding Trial Lean	t = 5.14	455	<.001*	d = -.371
Preceding Trial Rich	Preceding Trial Rewarded vs. Preceding Trial Not Rewarded	t = -2.64	455	<.001*	d = .171
Preceding Trial Lean	Preceding Trial Rewarded vs. Preceding Trial Not Rewarded	t = 5.15	455	<.001*	d = -.315

Abbreviations: ηp^2 = partial eta squared. d = Cohen's d. df = degrees of freedom. MDD = Major Depressive Disorder.