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Neural response to reward and pathological personality dimensions

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ABSTRACT

The neural response to reward has been implicated in internalizing psychopathology. The reward positivity (RewP), an event-related potential indicator of reinforcement learning and reward sensitivity, is blunted in individuals at risk for and currently experiencing depression. Recent evidence also suggests the RewP is enhanced in individuals with anxiety-based psychopathology. These findings suggest that the RewP may be associated with traits that underlie internalizing psychopathology, rather than solely reflecting current symptoms or diagnoses. The present study examined whether the RewP is associated with pathological personality dimensions relevant to internalizing psychopathology. A sample of 496 18–35-year-olds (70.9% female; 41% Caucasian) completed the doors task while we recorded electroencephalography to measure the RewP and a self-report measure of negative emotionality and detachment psychopathology dimensions and lower-order facet traits. Greater detachment was associated with a smaller RewP. In contrast, greater negative emotionality was associated with a larger RewP. The present study suggests that pathological personality dimensions involved in internalizing psychopathology demonstrate distinct and opposing relationships with the RewP.

1. Introduction

Depression is one of the most prevalent forms of mental illness in the United States (Kessler et al., 2005) and a growing global health concern (Kessler & Bromet, 2013; Proudman et al., 2021). Several theoretical models implicate emotional dysfunction as a core feature of depression. For example, the tripartite model proposes a general distress factor (high neuroticism/negative emotionality) common to depression and anxiety, and a unique factor (low extraversion/positive emotionality) associated with depression (Clark & Watson, 1991). The tripartite model has received strong empirical support (Kotov et al., 2010) and generalizes across the lifespan (Cook et al., 2004; Joiner et al., 1996; Watson et al., 1995). In addition, recent models focus on more specific aspects of extraversion/positive emotionality, such as impaired reward functions in depression (Admon & Pizzagalli, 2015). Together, these models are essential for guiding research on the neurobiological origins of depression that could aid in early identification, prevention, and treatment.

Several neuroscience techniques have been used to examine the neural response to reward in depression. Functional magnetic resonance imaging (fMRI) is one of the most often used imaging methods, and multiple meta-analyses have indicated decreased striatal activation to reward in depression (Keren et al., 2018; Zhang et al., 2013). However, fMRI studies have important limitations, including providing an indirect measure of brain activation, high scan costs, restrictions that contribute to small sample sizes and more limited statistical power, and poor reliability of both task-based activation (Elliott et al., 2020) and functional connectivity (Noble et al., 2019). Together, these factors impact the ability to use fMRI in individual differences research and clinical practice.

Electroencephalography (EEG) is another neuroscience technique that can be used to measure the neural response to reward. EEG contains several advantages, including excellent temporal precision, cost-effectiveness, and good reliability (Etkin & Mathalon, 2024). The reward positivity (RewP) is a positive deflection in the event-related potential signal to favorable feedback (e.g., winning money) relative to neutral or unfavorable feedback (e.g., breaking even or losing money). The RewP is hypothesized to index reinforcement learning and reward sensitivity as well as the initial neural response to reward (Proudfit, 2015). Collectively, most researchers conceptualize the RewP as a measure of the neural response to a rewarding outcome. The RewP has demonstrated good psychometric properties, including internal consistency and test-retest reliability (Amir et al., 2023; Levinson et al., 2017; Szenczy et al., 2021), and concurrent validity with behavioral, self-report (Bress & Hajcak, 2013), and fMRI measures of reward processing (Carlson et al., 2011; Foti et al., 2014).

The RewP has been examined in relation to multiple forms of

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internalizing psychopathology. A meta-analysis indicated a more blunted RewP in depression (Keren et al., 2018). A blunted RewP has also been associated with family history (i.e., risk) for depression (Allison et al., 2023; Beatty et al., 2024) and predicts the development of depressive episodes and symptoms (Burani et al., 2021; Mackin et al., 2023; Nelson et al., 2016). Together, these results suggest that the RewP also indexes risk for depression, and it might be better to examine the RewP in relation to trait-like indicators of depression. The RewP has also been examined in anxiety – a larger RewP has been associated with greater social anxiety (Kessel et al., 2015; Nelson & Jarcho, 2021) and both concurrent and family history of fear psychopathology (Beatty et al., 2024); on the other hand, a more blunted RewP has been associated with greater generalized anxiety symptoms, which are characterized by greater distress psychopathology (Kessel et al., 2015). Altogether, the RewP has been related to several internalizing disorders and symptoms across the course of psychopathology, and the RewP might have dissociable relationships with trait-like representation of internalizing psychopathology. However, these relationships are difficult to disentangle with a continued focus on categorical disorders, particularly given the high comorbidity between depression and anxiety disorders, and it might be better to examine dimensional, trait representations of psychopathology.

The Hierarchical Taxonomy of Psychopathology (HiTOP) is an empirical classification system that emphasizes a dimensional and hierarchical structure of psychopathology (Kotov et al., 2021). In the HiTOP model, depression and anxiety disorders have been linked to multiple dimensions (Watson et al., 2022). For example, symptom components such as dysphoria, lassitude, anhedonia, social anxiety, and phobia are organized under the internalizing spectrum, while symptom components such as anhedonia, intimacy avoidance, and withdrawal are organized under the detachment spectrum. From this dimensional perspective, comorbidity may reflect simultaneous dysfunction in multiple domains, and specific variation in each domain may be responsible for the unique characteristics of an individual categorical disorder. Therefore, it is possible that the different associations between the RewP and anxiety and depressive disorders, despite them being highly comorbid, are due to the RewP's unique relationships directly with higher-order dimensions. The internalizing and detachment dimensions in the HiTOP model are analogous to high negative emotionality/-neuroticism and low positive emotionality/extraversion, respectively (Widiger et al., 2019). To this end, the empirically derived classification system, HiTOP, and the theoretical model of internalizing psychopathology, the tripartite model, converge on the higher-order dimensions most relevant to depression and anxiety – namely, negative emotionality/neuroticism, and low positive emotionality/detachment. Therefore, the present study focuses on these two higher-order pathological dimensions and seeks to clarify their relationships with the RewP.

Previous literature studying the RewP in relation to normative negative and positive emotionality has begun to identify differences in their relationships with the RewP. Research on normative personality traits found that lower positive emotionality at age three predicted a more blunted RewP at age nine (Kujawa et al., 2015). Similarly, a separate investigation of adolescent girls indicated that lower extraversion was associated with a more blunted RewP, but only in the context of low neuroticism (Speed et al., 2018). A few studies have begun to examine the relationship between pathological negative and positive emotionality dimensions and the RewP. Utilizing the Comprehensive Assessment of Traits relevant to Personality Disorder (CAT-PD; Simms et al., 2011), a self-report measure of facet traits of personality pathology that are consistent with the Alternative Model of Personality Disorder (American Psychiatric Association, 2013), two studies identified a similar pattern. In a sample of young adults with various levels of autistic traits, Barkley et al. (2025) found that greater negative emotionality was associated with a greater RewP, and greater detachment was associated with a more blunted RewP. In a community sample of adolescent females, Li and Nelson (2026) found that greater negative emotionality was associated with a greater RewP, while a facet trait within the detachment dimension, emotional detachment, was associated with a more blunted RewP. These results suggested broadly that negative and positive emotionality dimensions are distinctly associated with the RewP, yet the studies were focused on more specific populations, and the latter study found the detachment association at the lower-order level instead. Other studies also found support for the RewP's association with these dimensions at lower-order pathological traits. Two studies found that a blunted RewP was associated with greater anhedonia (Banica et al., 2022; Liu et al., 2022). In a recent investigation, the RewP was found to be associated with trait anhedonia and threat sensitivity in opposing directions, such that the RewP was negatively associated with anhedonia but positively associated with threat sensitivity (Bowyer et al., 2025).

Altogether, these results suggest that a blunted RewP might best relate to the detachment dimension, while a larger RewP might be due to relationships with the negative emotionality dimension. Importantly, high negative emotionality and low positive emotionality are often correlated, especially in depressive psychopathology. Prior work has demonstrated that correlated constructs that exhibit opposite relationships with an outcome can produce reciprocal suppressor effects, whereby accounting for shared variance strengthens the associations of each construct with the outcome variable (Watson et al., 2013). Recent studies supported that internalizing-related traits or symptoms may exhibit opposite relationships with the RewP and that these associations often become stronger after accounting for their shared variance (Beatty et al., 2024; Nelson & Jarcho, 2021; Bowyer et al., 2025). These findings raise the possibility that analogous suppressor effects may also emerge among higher-order personality pathological dimensions. Therefore, the distinct and opposing relationships expected between detachment and negative emotionality dimensions and the RewP may be most evident after controlling for the shared variance between the two dimensions.

The present study examined the association between the RewP and pathological personality dimensions central to internalizing psychopathology, negative emotionality and detachment. Participants completed a monetary reward task with an EEG recording to elicit the RewP and the CAT-PD to measure detachment and negative emotionality dimensions. The CAT-PD assesses relatively stable, trait-like dimensions of psychopathology rather than symptoms occurring within a specific time frame, allowing for the examination of enduring vulnerabilities that are also relevant to non-personality disorder psychopathology. Based on previous literature on the RewP with normative and pathological negative and positive emotionality, we hypothesized that, after accounting for the shared variance between the two dimensions, a more blunted RewP would be associated with greater detachment, while a larger RewP would be associated with greater negative emotionality. We also conducted exploratory analyses testing whether the associations between the RewP and both detachment and negative emotionality were due to specific lower-order traits.

2. Methods

2.1. Participants

The sample included 549 18–35-year-old adults ($M_{age} = 21.59$, $SD_{age} = 3.66$; 70.9% assigned sex female; 96.5% at least partial college education or more; race/ethnicity: 33.0% Asian, 7.1% Black or African American, 41.1% Caucasian, 12.2% Hispanic or Latino, 0.2% Native Hawaiian or Other Pacific Islander, 4.8% more than one race; immigration history and socioeconomic status were not collected) recruited between 2019 and 2022 from two sources (see Supplemental Materials for separate demographics of each source and differences in study variables). Participants were excluded from data analyses due to not completing the laboratory session due to COVID−19 restrictions ($n = 25$), not completing the CAT-PD ($n = 2$), or having poor EEG signal that resulted in the loss of 50% or more of trials ($n = 26$) in the doors task, resulting in a final sample of 496. We conducted an a priori power analysis for multiple regression with eleven predictors that included all lower-order traits of detachment and negative emotionality dimensions. Assuming a small effect size ($f^2 = 0.05$) and an alpha level of.05, the analysis indicated that approximately 422 participants would be needed to achieve 90% statistical power; thus, our final sample exceeds the minimum required sample size and provides sufficient power to detect the anticipated effects.

A total of 249 18–35-year-old adults were oversampled for psychopathology and recruited from Long Island, NY, via online advertisements that targeted the cardinal symptoms of 12 different psychiatric disorders (attention-deficit/hyperactivity disorder, alcohol use disorder, bipolar disorders, depressive disorders, eating disorders, generalized anxiety disorder, obsessive-compulsive disorder, panic disorder, posttraumatic stress disorder, schizophrenia spectrum and other psychotic disorders, social anxiety disorder, and substance use disorder). These participants were screened for inclusion using a two-step approach. First, individuals who responded to the advertisement were contacted on the phone and were administered the Structured Clinical Interview for the DSM−5 (SCID−5; First et al., 2015) screening questions for all assessed disorders. For disorders without SCID−5 screening questions, individuals were asked the cardinal symptom question(s) from the respective module. Second, if participants verbally endorsed at least one SCID−5 cardinal symptom, they were then asked to complete an online survey that contained self-report symptom component measures that corresponded to each assessed disorder, including the Inventory of Depression and Anxiety Symptoms – Expanded Version (IDAS-II; Watson et al., 2012) dysphoria, ill temper, mania, panic, social anxiety, claustrophobia, traumatic intrusions, checking, ordering, and cleaning subscales; the CAT-PD unusual beliefs and unusual experiences subscales; and the Externalizing Spectrum Inventory – Brief Form (ESI-BF; Patrick et al., 2013) alcohol problems and drug problems subscales. If the individual's self-report subscale score that corresponded to the endorsed SCID−5 cardinal symptom produced a normed score of $T \geq 65$, then the individual was enrolled in the study. Exclusion criteria were active auditory or visual hallucinations, autism spectrum disorder, Down syndrome, history of select neurological conditions (cerebral palsy, epilepsy, multiple sclerosis, Parkinson's disease, stroke, traumatic brain injury), head injury associated with a loss of consciousness of 60 s or more, or an inability to read or write English. Participants were compensated $25 per hour. A total of 300 college students were also recruited from the Stony Brook University Department of Psychology Undergraduate Subject Pool. Exclusion criteria were an inability to speak or read English. Participants were compensated with course credit. Across both samples, all participants completed the identical behavioral tasks, electroencephalography (EEG) recording, and self-report measures of pathological personality domains and traits. Informed consent was obtained prior to participation and all procedures were approved by the Stony Brook University Institutional Review Board (#1106252).

3. Measures

3.1. Negative emotionality and detachment dimensions

Participants completed the Comprehensive Assessment of Traits relevant to Personality Disorder (CAT-PD; Simms et al., 2011), which is a 216-item self-report measure of traits relevant to personality disorder. The CAT-PD consists of 33 facet traits of personality pathology that are consistent with the PSY−5 structure of personality traits (Wright & Simms, 2014) and the Alternative Model of Personality Disorder (American Psychiatric Association, 2013). Negative emotionality and detachment were two factor-analytically derived domains (Ringwald et al., 2023) that were calculated by applying factor loadings to each facet trait and summing all values. The negative emotionality dimension consisted of 7 facet traits: affective lability, anger, anxiousness, depressiveness, relationship insecurity, mistrust, and health anxiety. The detachment dimension consisted of 4 facet traits: anhedonia, social withdrawal, romantic disinterest, and emotional detachment. Cronbach's α for the domains were calculated by including items from traits that loaded highest on that domain and were as follows: negative emotionality $\alpha = .90$ and detachment $\alpha = .76$.

4. Procedure

4.1. Doors task

Participants completed a modified version of the doors task that was administered using Presentation (Neurobehavioral Systems, Inc., Albany, CA, USA). Participants were instructed that they would complete a task where they would be shown four doors on a computer monitor and asked to guess which door contained a prize. At the beginning of each trial, a number (1, 2, or 3) appeared on the screen that informed the participant of how many points that trial was worth or how many doors contained the prize. Next, the four doors appeared on the screen until the participant chose a door using the keyboard. After selecting a door, participants viewed a white fixation cross for 1000 ms and then viewed feedback for 1500 ms, indicating that they were either correct and won the prize (green circle) or they were incorrect and did not win the prize (white circle). The feedback stimulus was followed by a fixation cross presented for 1500 ms, immediately followed by the message "Click for next round". This prompt remained on the screen until the participant responded with a button press to initiate the next trial. Participants completed 360 trials that involved an equal number of win (180) and break even (180) outcomes. All participants were given $5 in winnings for the task.

The doors task involved a probability and a magnitude manipulation. In the probability blocked task, participants completed three blocks of trials: 1 door contained the prize (low probability trials), 2 doors contained the prize (medium probability trials), or 3 doors contained the prize (high probability trials). Trials varied in the number of doors that contained the prize (1, 2, or 3 doors, i.e., probability manipulation) and the number of points that would be earned if they chose the correct door (1, 2, or 3 points, i.e., magnitude manipulation). Participants completed one of two versions of the task (counterbalanced) that either blocked trials by probability or magnitude. At the beginning of each block, participants were told how many doors contained the prize (1, 2, or 3) for all trials during that block. Participants completed 120 trials per block that contained an equal number of 1, 2, and 3-point trials (40 each), and each of those trials resulted in the same proportion of win and break-even results as a function of the probability type (i.e., low probability: 10 wins and 30 break-even outcomes; medium probability: 20 win and 20 break-even outcomes; high probability: 30 win and 10 break-even outcomes). The probability block order was counterbalanced across participants, and the magnitude trial order was randomized within participants. In the magnitude blocked task, trials were blocked by the magnitude, and the number (1, 2, or 3) that appeared on the screen informed that participant of how many doors contained the prize. The trial structure, counterbalanced across participants and randomized within participants, was identical to the probability blocked task. Importantly, both the probability and magnitude blocked tasks contained an identical number of win (180) and break even (180) outcomes and total trials (360).

4.2. EEG recording and processing

Continuous EEG was recorded via ActiveTwo system (BioSemi, Amsterdam, Netherlands) using an elastic cap with 34 electrode sites (32 standard channels plus FCz and Iz) placed according to the 10/20 system. Electrooculogram (EOG) was recorded using four additional facial electrodes: two placed approximately 1 cm outside of the right and left eyes and two placed approximately 1 cm above and below the right eye.

All electrodes were sintered Ag/AgCl electrodes. The EEG was digitized with a sampling rate of 1024 Hz using a low-pass fifth-order sinc filter with a half-power cutoff of 204.8 Hz. A common mode sense active electrode producing a monopolar (non-differential) channel was used as the recording reference.

EEG data were analyzed using BrainVision Analyzer 2.2 (Brain Products, Gilching, Germany). Data were referenced offline to the average of left and right mastoids, band-pass filtered (0.1–30 Hz), and corrected for eye movement artifacts (Gratton et al., 1983). Epochs containing a voltage greater than 50 μV between sample points, a voltage difference of 300 μV within a segment, or a maximum voltage difference of less than 0.50 μV within 100 ms intervals were automatically rejected. Additional artifacts were identified and removed based on visual inspection. Feedback-locked epochs were extracted with a duration of 1000 ms, including a 200 ms pre-stimulus and 800 ms post-stimulus interval. The 200 ms pre-stimulus interval was used as the baseline. The feedback-locked RewP was quantified as the mean activity from 200 to 300 ms at FCz after the onset of feedback, where the difference between win and break-even conditions was maximal. The ΔRewP was calculated as the difference in the feedback-locked RewP between the win and the break-even feedback. The average number of trials available to calculate the RewP was 174.78 for win ($SD = 11.65$) and 175.58 for break-even ($SD = 11.53$). The split-half reliability, corrected using the Spearman-Brown prophecy formula (Nunnally et al., 1967), was.95 for win and.92 for break-even. The reliability of the ΔRewP difference score, calculated using the Furr and Bacharach (2013) adjusted formula, was.67.

4.3. Data analysis

To examine task effects and confirm the overall presence of the RewP, we conducted a paired samples *t*-test between the neural response to win and break-even feedback. The present study collapsed across both magnitude and probability manipulations in the measurement of the RewP. See Supplemental Materials for the effects of the probability and magnitude manipulations on the ΔRewP.

To examine the association between the pathological personality domains, we conducted both Pearson correlations and a multiple regression, which allowed us to examine independent relationships, with pathological personality domains as the independent variables and the ΔRewP as the dependent variable. To examine whether lower-order traits or higher-order domains contributed to their association with the RewP, we conducted exploratory follow-up analyses in two multiple regressions, one with all negative emotionality facet traits as independent variables and the ΔRewP as the dependent variable, and one with all detachment facet traits as independent variables and the ΔRewP as the dependent variable. False discovery rate (FDR) correction was performed using the Benjamini-Hochberg (1995) procedure separately within each multiple regression. All analyses were conducted in RStudio 2022.07.2.

Data, code, and materials to reproduce the main findings of the present study are available on OSF at https://osf.io/hs2kg/.

5. Results

5.1. Task effect

See Fig. 1 for grand average waveforms and scalp distributions. Across all participants, results indicated a greater neural response to win compared to break-even feedback, $M_{difference} = 2.97$, 95% CI: 2.72, 3.23, $t = 23.10$, $p < .001$, Cohen's $d = 1.04$.

5.2. Bivariate correlations

Detachment and negative emotionality were moderately and positively correlated ($r = .57$, $p < .001$, 95% CI:.50,.62). See Supplemental Materials Table S1 for descriptive statistics and correlations between the pathological personality traits within each domain. Greater negative emotionality was associated with a larger ΔRewP, $r = .10$, $p = .020$, 95% CI:.02,.19. Detachment was not associated with the ΔRewP, $r = -.02$, $p = .632$, 95% CI: −.11,.07.

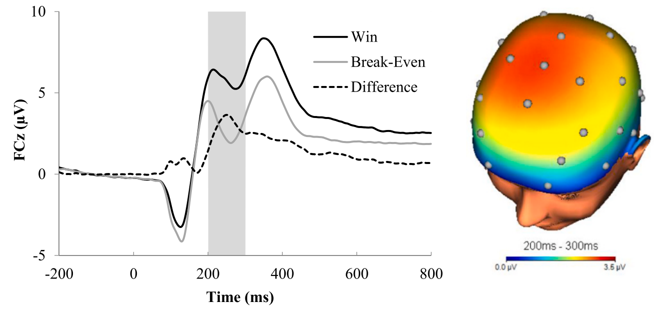

Fig. 1. *Event-Related Potential Waveforms and Scalp Distribution, Note.* The waveform (left) shaded region indicates the time segment (200–300 ms) where the event-related potential response to win and break-even feedback was quantified. The scalp distribution (right) depicts the mean activity from 200 to 300 ms. ms = milliseconds.

5.3. Linear regressions

The overall model was significant, $F(2, 493) = 5.19$, $p = .006$, $R^2 = .02$. As shown in Fig. 2, results indicated that greater detachment was associated with a more blunted ΔRewP, $\beta = -.12$, $p = .028$ ($p_{FDR} = .028$), 95% CI: −.23, −.01, VIF = 1.47. Conversely, greater negative emotionality was associated with a larger ΔRewP, $\beta = .17$, $p = .002$ ($p_{FDR} = .003$), 95% CI:.07,.28, VIF = 1.47.

Follow-up analyses indicated that no detachment trait was independently associated with the ΔRewP. For negative emotionality traits, results indicated that greater affective lability was independently associated with a larger ΔRewP, $\beta = .14$, $p = .031$, 95% CI:.01,.27, VIF = 2.11. However, this association did not survive FDR correction across the seven negative emotionality traits and should therefore be interpreted cautiously. See Supplemental Materials for complete results of trait-level regressions.

6. Discussion

The present study examined pathological personality dimensions and the neural response to reward via the RewP. Greater detachment was associated with a smaller RewP. In contrast, greater negative emotionality and the trait affective lability were associated with a larger RewP. Overall, the present study indicates that pathological personality dimensions implicated in internalizing psychopathology demonstrate distinct and opposing relationships with the RewP.

The present study provides important considerations for understanding the relationship between the neural response to reward and higher-order dimensions of psychopathology relevant to internalizing disorders. Although detachment and negative emotionality are positively correlated and are both implicated in internalizing psychopathology across the tripartite model and the HiTOP model (Clark & Watson, 1991; Watson et al., 2022), they demonstrated opposite relationships with the RewP. These findings suggest that meaningful heterogeneity may exist in neural responses to reward across transdiagnostic dimensions of internalizing psychopathology, beyond what is captured by commonly co-occurring symptoms. In addition, the association between the RewP and detachment was only present after controlling for the common variance with negative emotionality. These results are consistent with a reciprocal suppressor effect (Watson et al., 2013), suggesting that the neural response to reward may be differentially associated with distinct dimensions of psychopathology that are

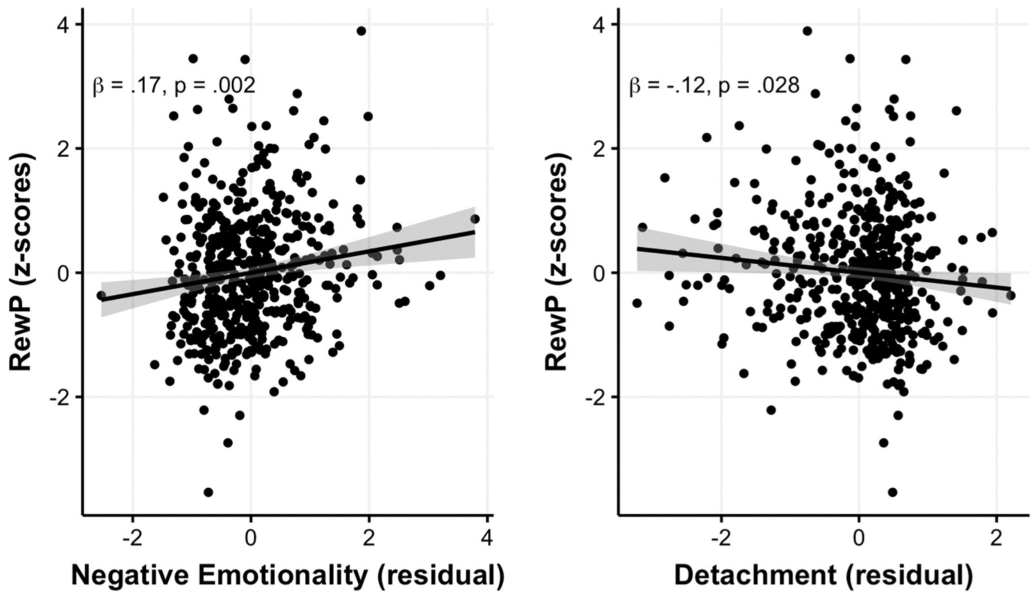

Fig. 2. *Scatterplots of Pathological Personality Dimensions and the RewP, Note.* After regressing on detachment, the residual of negative emotionality was positively associated with the RewP (left). After regressing on negative emotionality, the residual of detachment was negatively associated with the RewP (right).

frequently obscured by their substantial overlap. More broadly, the results highlight the importance of examining the unique variance of hierarchical dimensions of psychopathology, rather than relying solely on highly comorbid internalizing constructs when studying the neural correlates of psychopathology. Furthermore, results also emphasize the importance of examining the neural response to reward in relation to higher-order trait-like dimensions. Indeed, the RewP has been associated with both current depression (Keren et al., 2018) and risk for depression (Burani et al., 2021; Mackin et al., 2023; Nelson et al., 2016). The focus on just one manifestation of illness or current symptoms might overlook the importance of variance in comorbid or past psychopathology that is also related to the neural response to reward.

The present study also provides further clarity on the relationship between the RewP and internalizing psychopathology. Greater detachment, a pathological dimension analogous to low positive emotionality, was associated with a more blunted RewP. In addition, the results were specific to the detachment spectrum, and the RewP was not related to unique variance in any specific detachment trait. These results are consistent with previous investigations that found a more blunted RewP associated with greater anhedonia (Liu et al., 2022). Recent studies have also found that greater anhedonia in childhood predicted blunted development of the RewP across adolescence (Szenczy et al., 2024), and a more blunted RewP in early adolescence predicted the onset of depression and not anxiety disorders (Hoang et al., 2024). Together, results of the present study add to the evidence suggesting that the blunted neural response to reward often observed in depression is at least partially due to relationships with the detachment spectrum.

In contrast, a larger RewP was associated with greater negative emotionality. These results are consistent with previous research demonstrating that the RewP is associated with greater social anxiety (Kessel et al., 2015; Nelson & Jarcho, 2021) and fear psychopathology (Beatty et al., 2024). Neuroticism and negative emotionality are often examined in relation to emotional reactivity to aversive or unpleasant stimuli. High neuroticism has been associated with greater startle and skin conductance response to aversive stimuli, heightened amygdala and anterior cingulate cortex activation in response to emotional stimuli, heightened attention toward threatening stimuli, and greater late positive potential response to arousing unpleasant images (for a review, see Ormel et al., 2013). Nevertheless, these findings do not preclude the possibility that certain aspects of negative emotionality are also associated with heightened responsiveness to appetitive or rewarding outcomes. The reinforcement sensitivity theory (RST) provides a justification for the presence of the distinct relationships between pathological dimensions and the neural response to reward. The RST proposes that there is a dimension on the neuroticism-extraversion quadrant representing the neurobiological behavioral activation system (Gray, 1970). People who are high on the behavioral activation dimension will be hypersensitive to rewarding stimuli. Thus, heightened sensitivity to reward will be associated with both high extraversion and high neuroticism. This relationship has been confirmed with empirical evidence, which found a positive correlation between sensitivity to reward and neuroticism and a positive correlation between sensitivity to reward and extraversion (Mitchell et al., 2007). After accounting for the substantial overlap in detachment and negative emotionality, the unique variance in detachment may primarily reflect diminished positive affect and reduced approach motivation, which is consistent with lower behavioral activation system activity and thus, a more blunted RewP. In contrast, the unique variance in negative emotionality may reflect heightened emotional and motivational reactivity, including greater sensitivity to salient, uncertain, or emotionally evocative outcomes. Such characteristics may be associated with increased responsiveness to reward-related stimuli and, therefore, a larger RewP. In addition, among the negative emotionality traits, the RewP was independently associated with greater affective lability, a trait characterized by the tendency to experience strong, rapid, and unpredictable shifts in emotion and mood. Although this association did not survive correction for multiple comparisons and should be interpreted cautiously, it may tentatively suggest that the RewP might also relate to more narrow aspects of negative emotionality, such as hyperreactivity to uncertain outcomes, that are also present in the context of other anxiety- and fear-based psychopathology. Altogether, although the unique variance in negative emotionality and detachment should not be interpreted as direct proxies for specific RST constructs, RST provides a useful framework for conceptualizing the heterogeneity within correlated dimensions of psychopathology and understanding why there may exhibit distinct and even opposing relationships with the neural response to reward.

The present study had several limitations that need to be taken into consideration. First, the sample included more assigned sex females than males, which limited the ability to examine whether the results differed between males and females. The sample was also predominantly White and consisted of primarily individuals with at least a partial college education and from households in relatively affluent geographic regions, therefore limiting the generalizability to other populations with different demographic characteristics. Second, the assessment of pathological personality dimensions was limited to a self-report measure, and it is possible that an interview-based measure might provide a more accurate and nuanced representation of the traits. Furthermore, the present study used a cross-sectional design, which limits the ability to better understand the causal relationship between the neural response to reward and psychopathology. Lastly, the present study used a modified doors task that manipulated reward probability and magnitude and contrasted the win condition with break-even, rather than loss, outcomes. Consequently, the RewP observed in this study may reflect a neural response not only to reward but also to uncertainty and the reward valuation processes, which may be particularly relevant to the hyperreactivity to uncertain outcomes aspect of negative emotionality. Although supplemental analyses indicated that the observed associations were not moderated by reward probability and magnitude conditions, caution is warranted when comparing the present findings directly with studies employing more traditional doors paradigms.

In conclusion, the present study indicated that detachment and negative emotionality—pathological personality dimensions central to internalizing psychopathology—demonstrated distinct and opposing relationships with the neural response to reward. Future studies should continue to examine the role of the neural response to reward in relation to transdiagnostic dimensions of psychopathology to help refine the literature on the neurobiological bases of mental illness.

CRediT authorship contribution statement

Brady D. Nelson: Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Mohan Li:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Conceptualization.

Ethics approval

All procedures were approved by the Stony Brook University Institutional Review Board (#1106252).

Declaration of Generative AI and AI-assisted technologies in the writing process

The authors did not use generative AI technologies for the preparation of this work. Generative AI was not used in the preparation of this manuscript.

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Declaration of Competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.biopsycho.2026.109339.

Data Availability

Data, code, and materials to reproduce the main findings are available at: at https://osf.io/hs2kg/.

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