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FULL-LENGTH REPORT

Deficits in spontaneous versus instructed emotion regulation in problematic pornography use

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ABSTRACT

Background and aims: Deficits in emotion regulation (ER) are considered a key factor in the development of addiction, highlighting ER as a potential target for treatment. However, ER in problematic pornography use (PPU) remains poorly understood. *Methods:* The current study investigated both spontaneous and instructed ER in male individuals at-risk for PPU (n = 35, average age = 20.40 ± 1.29) and in a control group (n = 33, average age = 20.06 ± 1.44). Initially, participants were evaluated with the Emotion Regulation Profile-Revised (ERP-R) to measure their spontaneous use of eight ER strategies across various negative emotion-eliciting scenarios. Subsequently, they completed an emotion reappraisal task, in which they were instructed to either observe or reappraise their reactions to negative images. Subjective emotional ratings (valence and arousal) and event-related potentials (ERPs) were recorded to examine the effects of deliberate ER on emotional processing. *Results:* The results indicated that individuals at-risk for PPU reported less frequent spontaneous use of reappraisal compared to those in the control group. Furthermore, in both groups, reappraisal led to a decrease in the late positive potential (LPP) and the self-reported intensity of emotions elicited by negative images. *Discussion and conclusions:* This indicates that both groups were able to effectively downregulate negative emotions through reappraisal when instructed. Our findings underscore the importance of incorporating ER skills, particularly reappraisal-based strategies, into the prevention and psychotherapy of PPU.

KEYWORDS

problematic pornography use, emotion regulation, reappraisal, late positive potential

INTRODUCTION

With advances in digital technology, the widespread availability of pornography has become a significant phenomenon (Kohut et al., 2020). While most individuals use it for entertainment purposes, a small subset develops problematic pornography use (PPU). PPU involves excessive consumption of pornography that results in adverse effects on interpersonal relationships, career, and mental health (Wéry & Billieux, 2017). At its most extreme, PPU can manifest as Compulsive Sexual Behavior Disorder (CSBD), recognized in the International Classification of Diseases, 11th Revision (ICD-11; WHO, 2020). CSBD is marked by persistent difficulties in managing intense and recurring sexual urges and behaviors. Individuals with CSBD may devote excessive time to sexual activities, neglecting their health, self-care, interests, and responsibilities; struggle to exert control with numerous unsuccessful attempts to curb their behavior; persist in sexual activities despite negative consequences; continue engaging in sexual behavior despite minimal satisfaction; and experience significant distress or impairment in various areas of life.

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Uncovering the factors contributing to the occurrence of PPU symptomatology is crucial for developing effective interventions and treatments. A recent systematic review identified hedonic motivations (e.g., sexual arousal) and coping with negative emotional states as primary factors driving pornography use (Grubbs et al., 2019). The latter motivation generally refers to using emotion regulation (ER) to distract from or suppress negative emotions, as well as to relieve stress (Böthe et al., 2021). Indeed, early conceptualizations and theoretical models of sexual addiction or hypersexual disorder have highlighted ER abnormalities as a critical component. For example, in Goodman's (1998) model, impaired ER, along with behavioral inhibition deficits and reward system abnormalities, constitute the three primary components of sexual addiction. Similarly, in Kafka's (2010) conceptualization of hypersexual disorder for DSM-5, two out of the five criteria specifically pertain to utilizing sexual behavior for ER or stress alleviation. More recently, the Interaction of Person-Affect-Cognition-Execution (I-PACE) model has delineated distinct phases in the progression of internet use disorders, emphasizing the pivotal role ER plays throughout (Brand, Young, Laier, Wölfling, & Potenza, 2016, 2019). Initially, pornography consumption provides gratification. Over time, individuals may increasingly turn to pornography for emotional regulation, establishing a reinforcing cycle of use. As consumption continues and possibly escalates, conditioning reinforces the link between external stimuli and emotional/cognitive responses. This reinforcement might later drive compensatory pornography use to manage negative emotions and cravings as addiction progresses.

Several lines of work have consistently provided empirical evidence linking emotion dysregulation and PPU (Gola et al., 2022; Testa, Villena-Moya, & Chiclana-Actis, 2024). Firstly, CSBD (including PPU) often co-occur with mood and anxiety disorders (Grant Weinandy, Lee, Hoagland, Grubbs, & Bőthe, 2023; Kuzma & Black, 2008; Raymond, Coleman, & Miner, 2003). ER difficulties are proposed to underlie the concurrent presence of CSBD with these disorders (Lew-Starowicz, Lewczuk, Nowakowska, Kraus, & Gola, 2020). Secondly, self-reported negative emotions have also been associated with PPU. For instance, prior research has identified emotional avoidance (Levin, Lee, & Twohig, 2019), boredom proneness (Coleman et al., 2023), and difficulties in ER, as well as feelings of loneliness (Cardoso, Ramos, Brito, & Almeida, 2022) as strong predictors of PPU. Men diagnosed with hypersexuality disorder were found to have higher rates of mood disorders and maladaptive ER strategies (Engel et al., 2019). In addition to cross-sectional data, a longitudinal study revealed that higher initial negative affect and impulsivity predicted PPU three years later (Rousseau, Bőthe, & Štulhofer, 2021). Thirdly, negative emotional states may enhance the salience of sexual stimuli, particularly in individuals with specific sexual motivations. In particular, inducing negative affect acutely increases motivated attention towards sexual stimuli among men exhibiting high levels of solitary sexual motivation (Markert, Baranowski, Koch, Stark, & Strahler, 2021).

Together, the mounting empirical evidence emphasizes the significant link between ER and PPU. It is worth noting that the current understanding of ER difficulties in PPU primarily stems from research utilizing trait questionnaires to assess dispositional ER strategies. Trait questionnaires, given their cross-situational scope, mainly offer insights into ER responses to general negative moods rather than to specific individual emotions. Nevertheless, each specific emotion leads to a unique physiological response pattern, which likely elicits different ER strategies (Ekman, 1992). Previous measures of ER in PPU provide an overall ER score but do not detail the specific strategies employed to attain this score. Another important aspect is determining whether people with PPU have a diminished ability to effectively apply ER strategies to mitigate negative emotions. Although investigations into trait ER have indicated that PPU is linked to reduced use of adaptive ER strategies and increased reliance on maladaptive ER strategies (e.g., Engel et al., 2019), there is still a paucity of knowledge regarding the ER abilities of those with PPU. No research has yet investigated the effectiveness of ER strategies in alleviating negative emotions when individuals with PPU are given explicit instructions.

To address the aforementioned limitations, this study utilized the Emotion Regulation Profile-Revised (ERP-R; Nelis, Quoidbach, Hansenne, & Mikolajczak, 2011). The ERP-R is a vignette-based assessment that encompasses scenarios depicting various negative emotions. Each scenario highlights a distinct negative emotion (e.g., shame, guilt) and offers eight potential responses: four adaptive ER strategies and four maladaptive ER strategies. This instrument allows us to identify the specific ER strategies habitually employed by individuals at-risk for PPU in various emotional contexts. Additionally, to examine whether these individuals can reduce negative emotions through deliberate ER strategies, we utilized a controlled laboratory task to compare how individuals at-risk for PPU and controls employ reappraisal. Reappraisal refers to changing the trajectory of an emotional response by mentally altering or re-evaluating the significance of the emotion-eliciting situation (Gross, 2002). Compared to other regulation strategies, such as suppressing emotional expression, reappraisal is a particularly adaptable and effective method for mitigating the impact of negative emotional events (Gross, 2002; McRae, Ciesielski, & Gross, 2012). Participants were instructed to either passively observe negative and neutral images or to reappraise negative images to reduce negative emotions. To account for the complex elements of emotional processing, we measured both subjective (valence and arousal) and event-related potentials (ERPs) indicators elicited by affective images.

The application of electroencephalography (EEG) is crucial for exploring brain activity linked to the generation and regulation of emotions. Electrodes positioned on the scalp capture the rapidly changing EEG, which indicates ongoing electrical fluctuations in the brain. When EEG data are synchronized with specific events (such as stimulus presentation or response execution), the resulting voltage variations are termed ERPs, reflecting the synchronous activity of neuron groups related to those events. Since ER

entails variations in latency, onset, duration, offset, and response magnitude (Gross & Thompson, 2007), ERPs' high temporal precision is particularly beneficial for investigating the swift regulatory mechanisms involved in reappraisal. Numerous ERP studies on ER have focused on the late positive potential (LPP), a later ERP component detectable approximately 300 ms post-stimulus onset, persisting for several hundred milliseconds (Hajcak, MacNamara, & Olvet, 2010). The LPP reflects sustained attention and cognitive evaluation processes toward emotional or significant stimuli (Hajcak & Foti, 2020). It is particularly sensitive to the emotional salience of stimuli, displaying greater responses to both positive and negative stimuli in contrast to neutral stimuli (Hajcak, Weinberg, MacNamara, & Foti, 2012; Schupp et al., 2000). These results suggest that the LPP is linked to the strength and level of emotional reactivity. Because of its responsiveness to the emotional characteristics of stimuli, the LPP is ideal for investigating how ER strategies affect emotional responses (Littel & Franken, 2011). In a series of ERP investigations, reappraisal has consistently been found to effectively influence the LPP triggered by negative stimuli (Hajcak & Nieuwenhuis, 2006; Moser, Hajcak, Bukay, & Simons, 2006; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011). For example, when participants were instructed to reinterpret unpleasant images less negatively, there was a notable decrease in LPP amplitudes compared to those asked to maintain their initial emotional responses (Hajcak & Nieuwenhuis, 2006; Thiruchselvam et al., 2011). Moreover, the decrease in LPP amplitudes was positively associated with lower levels of self-reported emotional reactivity following reappraisal (Hajcak & Nieuwenhuis, 2006).

This study aims to examine both spontaneous and instructed use of ER strategies among individuals at-risk for PPU. Based on the theoretical foundations and existing research on ER and PPU, we hypothesized that, compared to controls, individuals at-risk for PPU would: (a) report lower use of adaptive ER strategies and higher reliance on maladaptive ER strategies, and (b) demonstrate impaired effectiveness in using reappraisal to down-regulate negative emotion.

METHODS

Participants

The sample size was calculated using G*Power 3.1.9 (Faul, Erdfelder, Lang, & Buchner, 2007). Given the limited previous research, an effect size of $f = 0.20$ was used in the power analysis to achieve 0.90 power at an α level of 0.05, resulting in a recommended sample size of 68. To prevent a decrease in statistical power due to potential dropouts, 72 participants were selected from a pool of 662 male college students at Chengdu Medical College, with 36 assigned to the at-risk PPU group and 36 to the control group. Only male individuals were chosen due to the higher incidence of PPU in men (Bőthe et al., 2020, 2024; Grubbs, Kraus, & Perry, 2019).

Several questionnaires are available for measuring PPU. Based on recent systematic reviews (Fernandez & Griffiths, 2021) and comparative assessments (Chen & Jiang, 2020), this study utilized the Problematic Pornography Consumption Scale (PPCS) for screening PPU (Bőthe et al., 2018). The PPCS employs a validated cutoff score of 76 (out of 126) to distinguish between problematic and non-problematic pornography use. In this study, participants scoring above 76 on the PPCS were included in the PPU group, while those scoring below 76 were assigned to the control group. We opted to select participants with scores as low as possible within the control group to ensure a clear distinction between problematic and non-problematic users. Participants were required to meet the following criteria: (1) age over 18 years; (2) self-identified heterosexual orientation; (3) right-handed; (4) no history of substance abuse or Axis-I psychiatric disorders, confirmed through the Mini International Neuropsychiatric Inventory (Sheehan et al., 1998); (5) no moderate or severe depression or anxiety disorders, as indicated by scores below 60 on the Self-Rating Depression Scale (SDS; Zung, Richards, & Short, 1965) and below 60 on the Self-Rating Anxiety Scale (SAS; Zung, 1971); and (6) no other behavioral addictions, including gaming and gambling disorders, as indicated by scores below 36 on the Internet Gaming Disorder Scale (IGDS; Pontes & Griffiths, 2015) and below 8 on the Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001). Due to excessive eye movement artifacts, one participant with PPU and three control participants were excluded.

Procedure

Participants were recruited via campus advertisements promoting the study as "Research on pornography consumption and cognitive response." A total of 662 interested participants accessed the online survey by scanning a QR code. According to the PPU screening protocol (cutoff score of 76), 75 candidates underwent a structured psychiatric assessment by a psychiatrist to rule out any Axis I psychiatric disorders and substance abuse. Additionally, they completed a set of questionnaires to exclude mood disorders and other behavioral addictions. Three participants were excluded for not meeting the inclusion criteria. Ultimately, 72 participants (36 in each group) who met the screening criteria and were free from the specified disorders were invited to participate in the ERPs study. In the laboratory, participants first completed the ERP-R, followed by an ER task and an incentive delay task (reported elsewhere, Wang, Li, Tang, & Li, 2024), while their ERPs were recorded.

Questionnaire assessment

Participants completed six self-reported questionnaires. PPCS (Bőthe et al., 2018): This instrument assesses symptoms of problematic pornography use with 18 items across six dimensions (salience, mood modification, conflict, tolerance, relapse, and withdrawal) on a 7-point scale (1 = never, 7 = always). Total scores range from 18 to 126, with scores exceeding 76 indicating the presence of PPU. In this study, Cronbach's α was 0.99.

ERP-R (Nelis et al., 2011): This scale evaluates the down-regulation of negative emotions through nine scenarios, each targeting a specific emotion (e.g., anger, sadness, fear, jealousy, shame, guilt) with eight potential responses. Responses are classified as adaptive (e.g., situation modification, attention reorientation, positive reappraisal, emotional expression) or maladaptive (e.g., learned helplessness, substance abuse, rumination, acting out). Participants selected the strategies that best reflected their reactions, earning 1 point for each selected strategy, with no limit on the number of responses. In this study, Cronbach's α was 0.72.

SDS (Zung et al., 1965): This scale assesses depression with 20 items on a 4-point scale (scores ranging from 20 to 80), where higher scores indicate greater levels of depression. The classification of scores is as follows: 20–44 indicates a normal range, 45–59 suggests mildly depressed, 60–69 reflects moderately depressed, and 70 and above signifies severely depressed. In this study, Cronbach's α was 0.83.

SAS (Zung, 1971): This questionnaire evaluates anxiety with 20 items on a 4-point scale (raw scores ranging from 20 to 80), where higher scores indicate increased anxiety. The "Anxiety Index" score is derived by multiplying the raw score by 1.25 and then truncating to the nearest integer. The classification of scores is as follows: 20–44 indicates a normal range, 45–59 reflects mild anxiety levels, 60–74 denotes moderate anxiety levels, and 75 and above signifies severe anxiety levels. In this study, Cronbach's α was 0.85.

Internet Gaming Disorder Scale (IGDS) (Pontes & Griffiths, 2015): This scale assesses gaming disorder with 9 items scored on a 5-point scale (scores ranging from 9 to 45), with scores above 36 indicating a disorder. In this study, Cronbach's α was 0.91.

Problem Gambling Severity Index (PGSI) (Ferris & Wynne, 2001): This index evaluates gambling disorder using 9 items on a 4-point scale (scores ranging from 0 to 27), with scores exceeding 8 indicating a disorder. In this study, Cronbach's α was 0.65.

Stimuli

A set of 120 images was chosen from the Chinese Affective Picture System (CAPS; Lu, Hui, & Yu-Xia, 2005), including 80 negative images (40 for passive viewing and 40 for ER) and 40 neutral images. Negative images (2.65 ± 0.87) had significantly lower normative valence scores than neutral images (5.44 ± 0.82), t (118) = 16.79, $p < 0.001$. They also had significantly higher arousal scores (6.22 ± 0.59) compared to neutral images (4.15 ± 1.13), t (118) = −10.88, $p < 0.001$. No significant differences were found in valence (2.54 ± 0.85 vs. 2.76 ± 0.89) or arousal (6.23 ± 0.56 vs. 6.22 ± 0.61) between negative images used in the passive viewing and reappraisal conditions, $ps > 0.25$.

ER task

In the ER task, participants either passively observe negative or neutral images (attend condition) or reinterpret negative images to reduce negative emotions (reappraisal condition). The task consisted of 6 blocks, each with 20 trials, two blocks for each condition. To avoid inducing sustained mood states, the sequence of the attend (neutral, negative) and reappraisal (negative) blocks was pseudo-randomized.

In the attend block, participants viewed the images and experienced any arising emotions. In the reappraisal block, they reinterpreted the images to lessen negative emotions, such as by imagining the scenes as movie stills or anticipating a positive outcome. In line with earlier ER research (Hajcak & Nieuwenhuis, 2006; Moser et al., 2006), the experimenter provided examples of reappraisal techniques (see Appendix for details), then participants applied these techniques to additional images. After confirming effective use of reappraisal, participants proceeded to the main experiment.

Figure 1 illustrates the experimental procedure for the ER task. Each trial began with a fixation cross displayed for 500 ms, followed by a 1,000 ms instruction cue of either "Attend" or "Reappraisal" to guide the participants on their task. After the instruction cue, a blank screen was shown for 500 ms, followed by the presentation of a negative or neutral image for 3,000 ms. Following the image presentation, participants were asked to rate the valence (1 = very negative to 9 = very positive) and arousal (1 = very calm to 9 = very excited) of each image using a 9-point Likert scale.

Electrophysiological recording and analysis

The EEG data were recorded using an elastic cap with 64 scalp electrodes and amplified with a BrainAmp system (Brain Products GmbH, Munich, Germany). Reference electrodes were placed on the left and right mastoids, and the ground electrode at the medial frontal area. Vertical electrooculograms (EOGs) were recorded from the right eye. Electrode impedance was maintained below 5 kΩ. Offline data analysis was conducted with Brain Vision Analyzer 2.0, applying a bandpass filter between 0.01 and 30 Hz (24 dB/oct). Ocular artifacts were corrected using independent component analysis with the Meaned Slope Algorithm, and ocular interference was identified through topographic visual inspection. Artifacts from muscle or movement were removed based on criteria: a maximum voltage step exceeding 50 μV/ms or an absolute difference greater than 100 μV within 200 ms. Grand averages were computed for each condition: Attend-neutral, Attend-negative, and Reappraisal-negative. The mean number of artifact-free epochs were 27.62 (SD = 6.87), 28.21 (SD = 6.63), and 27.29 (SD = 7.54), respectively, with no significant differences between ER conditions, F (2, 134) = 1.55, $p > 0.21$.

The ERP epoch spanned 1,200 ms, from 200 ms before stimulus presentation to 1,000 ms after. LPP amplitude was assessed in the 300–700 ms window, using the average across central-parietal and parietal electrodes (CPz, CP3, CP4, Pz, P3, and P4), following visual inspection of the grand average ERP and established protocols from previous studies (Hajcak & Nieuwenhuis, 2006; Moser et al., 2006).

Data analysis

Group differences in clinical assessment (PPU, depression, anxiety, gaming, and gambling) were analyzed using

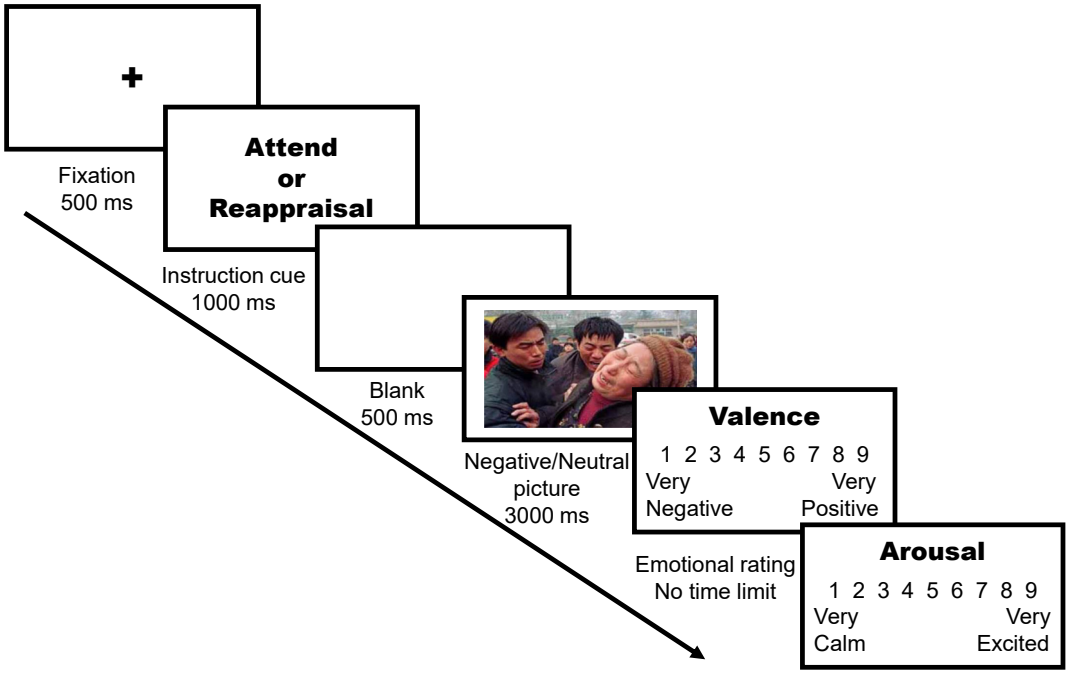

Fig. 1. Schematic representation of the Emotion Regulation (ER) tasks. Each trial began with the display of a fixation cross for 500 ms. This was followed by an instruction cue, either "Attend" or "Reappraisal," presented for 1,000 ms to guide participants on their assigned task. Subsequently, a blank screen appeared for 500 ms before the presentation of either a negative or neutral image for 3,000 ms. After viewing the image, participants were instructed to rate its valence and arousal using a 9-point Likert scale

independent sample *t*-tests. Differences in spontaneous ER strategies between individuals at-risk for PPU and controls were examined using multivariate analysis of variance (MANOVA), with eight ER strategies from the ERP-R as dependent variables and group as the fixed factor. For subjective measures (valence and arousal ratings) and LPP measures, a 2 × 3 repeated-measures analysis of variance (ANOVA) was conducted. The group was the between-subjects factor, and ER type (Attend-neutral, Attend-negative, Reappraisal-negative) was the within-subjects factor. Post-hoc pairwise comparisons were performed with Bonferroni adjustments. When sphericity was not met, the Greenhouse-Geisser correction was applied. Effect sizes were computed using Cohen's d (small, medium, and large corresponding to 0.2, 0.5, and 0.8, respectively) and partial eta squared (η; small, medium, and large corresponding to 0.01, 0.06, and 0.14, respectively).

Ethics

The research protocol was reviewed and approved by the local Ethical Review Board, and informed consent was obtained from all participants. Participants received compensation at an hourly rate of 50¥ (approximately $7) for their involvement.

RESULTS

Group characteristics

Individuals at-risk for PPU had higher PPCS scores and showed greater anxiety and depression than the control group (Table 1). This is consistent with the clinical profile of PPU, which often co-occurs with emotional disorders (Grant Weinandy et al., 2023; Raymond et al., 2003). However, no significant differences were observed between the groups in other measured variables.

Spontaneous ER strategies

A MANOVA was conducted with eight ER strategies from the ERP-R as the dependent variable and group as the fixed factor. The results revealed a significant multivariate effect of the group on ER strategies (Wilks' $\Lambda = 0.77$, $F_{(8, 59)} = 2.24$, $p = 0.037$, $\eta_p^2 = 0.23$). This effect was primarily due to the reduced use of the reappraisal strategy in individuals at-risk for PPU compared to controls ($F_{(1, 66)} = 8.27$, $p = 0.005$, $\eta_p^2 = 0.11$, indicating a medium to large effect size; see Table 2 and Fig. 2). Although the *p*-value for the situation modification strategy was below $\alpha = 0.05$ ($F_{(1, 66)} = 5.05$, $p = 0.028$, $\eta_p^2 = 0.07$), it did not reach the threshold for statistical significance after applying the Bonferroni correction (0.05/8 = 0.00625). No significant differences were found between groups in other ER strategies ($ps > 0.16$).

Instructed ER strategies

Subjective emotional ratings. A repeated measures ANOVA compared the average scores of the at-risk PPU and control groups on subjective ratings of emotional valence and arousal across different ER types (see Fig. 3). The analysis revealed a significant main effect of ER type on valence ($F_{(2, 132)} = 265.69$, $p < 0.001$, $\eta_p^2 = 0.80$). Post hoc

Table 1. Demographic details and self-report scores across participant groups

Variables	Min–Max	PPU (n = 35)	Control (n = 33)	t/χ^2	p	Cohen's d
Demographic characteristic						
Age, *M* (*SD*)	18–23	20.40 (1.29)	20.06 (1.44)	1.03	0.31	0.25
Grade, *n* (%)				5.48	0.14	
Freshman		4 (11.4)	11 (33.3)			
Sophomore		12 (34.3)	8 (24.2)			
Junior		8 (22.9)	8 (24.2)			
Senior		11 (31.4)	6 (18.2)			
Emotional characteristic						
SDS, *M* (*SD*)	20–51	38.20 (7.26)	33.24 (7.06)	2.85	**0.006**	0.69
SAS, *M* (*SD*)	25–56	39.89 (9.59)	33.70 (5.07)	3.30	**0.002**	0.80
Addiction-related characteristic						
PPCS, *M* (*SD*)	18–105	89.63 (8.62)	18.55 (1.00)	47.05	**<0.001**	11.42
IGDS, *M* (*SD*)	9–29	14.20 (6.01)	14.58 (5.46)	−0.27	0.79	0.07
PGSI, *M* (*SD*)	0–4	0.29 (0.79)	0.24 (0.71)	0.24	0.81	0.06

Note. IGDS, Internet Gaming Disorder Scale; PGSI, Problem Gambling Severity Index; PPU, Problematic Pornography Use; PPCS, Problematic Pornography Consumption Scale; SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale.
Bold values indicate statistical significance at the $p < 0.05$ level.

Table 2. Means and standard deviations for spontaneous and instructed emotion regulation across emotion regulation conditions and participant groups

	PPU (n = 35)	Control (n = 33)
Spontaneous emotion regulation		
Emotion expression	3.40 ± 1.33	3.55 ± 2.27
Attention Reorientation	2.57 ± 1.33	2.36 ± 1.50
Situation Modification	3.89 ± 1.60	4.88 ± 2.03
Reappraisal	3.66 ± 2.07	5.09 ± 2.04
Substance abuse	1.17 ± 1.56	0.79 ± 1.17
Learned helpless	2.14 ± 2.02	1.91 ± 1.83
Acting out	2.17 ± 1.76	2.06 ± 1.34
Rumination	2.89 ± 2.11	3.64 ± 2.34
Instructed emotion regulation		
Valence		
Attend-Neutral	5.40 ± 0.60	5.40 ± 0.47
Attend-Negative	2.71 ± 0.88	2.45 ± 0.76
Reappraisal-Negative	3.38 ± 0.94	3.53 ± 0.77
Arousal		
Attend-Neutral	4.19 ± 1.28	4.02 ± 1.31
Attend-Negative	6.55 ± 1.05	6.45 ± 0.81
Reappraisal-Negative	5.88 ± 1.18	6.03 ± 1.13
LPP		
Attend-Neutral	3.04 ± 4.02	3.62 ± 2.75
Attend-Negative	6.37 ± 3.33	6.20 ± 3.57
Reappraisal-Negative	5.28 ± 4.20	5.16 ± 3.53

Note. LPP, Late Positive Potential; PPU, Problematic Pornography Use.

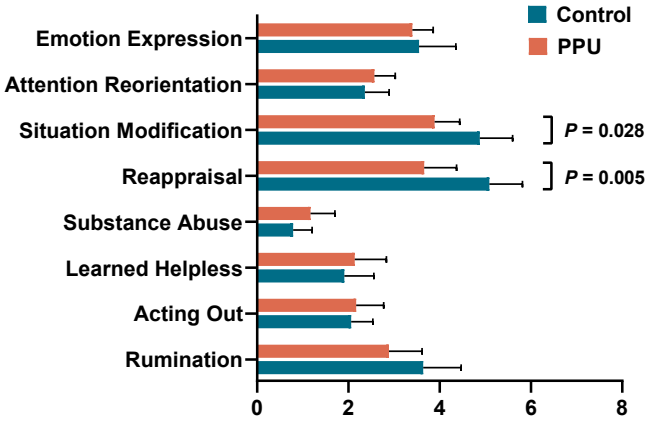

Fig. 2. Scores of PPU and Control groups on eight spontaneous emotion regulation strategies. Error bar indicates 95% confidence interval (CI)

comparisons showed that valence scores were significantly lower in the Attend-negative condition (2.58 ± 0.83) compared to the Reappraisal-negative condition (3.45 ± 0.86; $t_{(66)} = 6.15$, $p < 0.001$, Cohen's d = 1.15), which were lower than the Attend-neutral condition (5.40 ± 0.54; $t_{(66)} = 17.12$, $p < 0.001$, Cohen's d = 2.58). The main effect of group ($F_{(1, 66)} = 0.12$, $p > 0.73$) and the group × ER type interaction ($F_{(2, 132)} = 1.42$, $p > 0.24$) were not significant. For arousal scores, there was a significant main effect of ER type ($F_{(2, 132)} = 141.56$, $p < 0.001$, $\eta_p^2 = 0.68$), with higher scores in the Attend-negative condition (6.50 ± 0.93) compared to the Reappraisal-negative condition (5.95 ± 1.15; $t_{(66)} = 4.76$, $p < 0.001$, Cohen's d = 0.48), and higher in the Reappraisal-negative condition than the Attend-neutral condition (4.11 ± 1.29; $t_{(66)} = 11.33$, $p < 0.001$, Cohen's d = 1.62). The main effect of group ($F_{(1, 66)} = 0.16$, $p > 0.69$) and the group × ER type interaction ($F_{(2, 132)} = 1.12$, $p > 0.32$) were not significant.

ERPs data. The ANOVA revealed a significant main effect of ER type ($F_{(2, 132)} = 31.92$, $p < 0.001$, $\eta_p^2 = 0.33$). Post hoc comparisons showed that all participants, both the at-risk PPU group and the control group, exhibited larger LPP amplitudes in the Attend-negative (6.29 ± 3.42; $t_{(66)} = 7.78$, $p < 0.001$, Cohen's d = 0.82) and Reappraisal-negative (5.22 ± 3.86; $t_{(66)} = 4.65$, $p < 0.001$, Cohen's d = 0.52) conditions compared to the Attend-neutral condition (3.32 ± 3.45). The difference between the Reappraisal-negative and Attend-negative conditions was significant

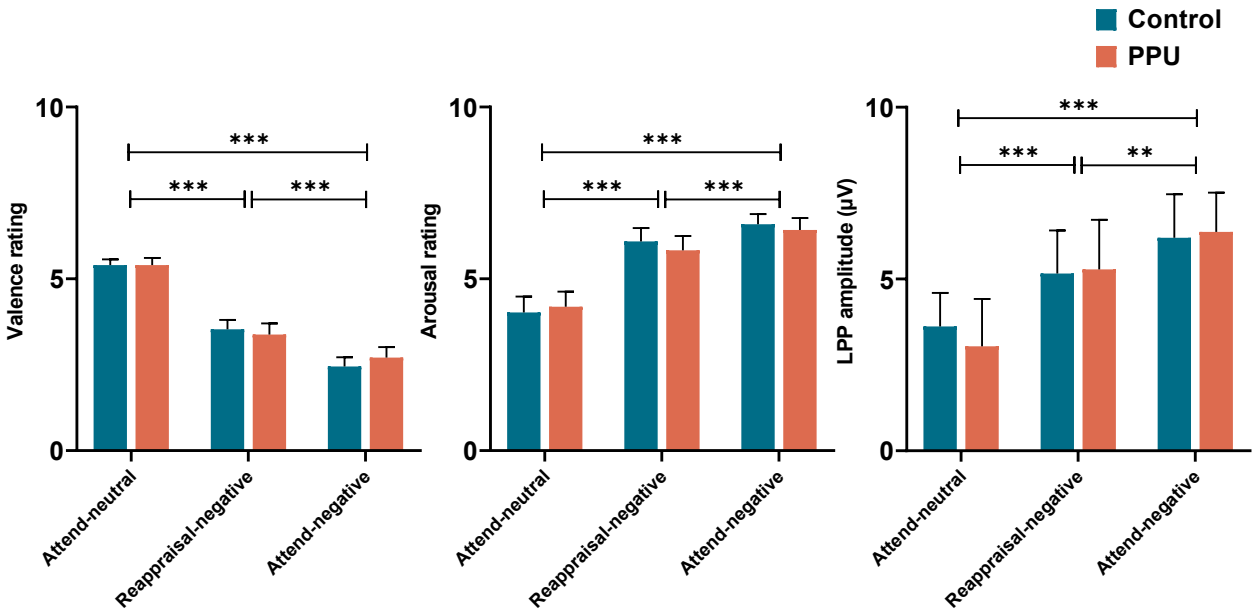

Fig. 3. Mean emotion ratings and LPP amplitudes as a function of emotion regulation condition and participant group. Significance is noted: $^{**}p < 0.01$, and $^{***}p < 0.001$. Error bar indicates 95% confidence interval (CI)

($t_{(66)} = 3.20$, $p = 0.006$, Cohen's d = 0.30); all participants showed reduced LPP amplitudes in response to negative images that were reappraised compared to those that were passively viewed (see Figs 3 and 4). Furthermore, neither the main effect of Group ($F_{(1, 66)} = 0.02$, $p > 0.90$) nor the interaction between Group and ER type ($F_{(2, 132)} = 0.63$, $p > 0.53$) was significant.

DISCUSSION

The objective of this study was to explore both spontaneous and instructed ER efforts among individuals at-risk for PPU. To achieve this, individuals at-risk for PPU and a control group completed the ERP-R to assess their spontaneous use of adaptive and maladaptive ER strategies in response to various emotion-eliciting situations. Additionally, participants engaged in an ER task where they were instructed to employ reappraisal strategies to mitigate negative emotions triggered by negative stimuli.

Our primary hypotheses were partially confirmed. As anticipated, the findings on adaptive ER strategies revealed that individuals at-risk for PPU used reappraisal less frequently than controls in response to negative emotion-eliciting situations. This aligns with empirical evidence on trait ER, demonstrating that participants with PPU score lower on reappraisal measures, as assessed by the Emotion Regulation Questionnaire (Engel et al., 2019). These results reinforce the idea that individuals with PPU are less inclined to use adaptive ER strategies, particularly reappraisal, in response to negative situations. Contrary to our hypothesis, there were no observed differences between groups in the use of maladaptive ER strategies. Therefore, it appears that the pathology of PPU is more closely linked to a deficiency in adaptive ER strategies rather than an overreliance on maladaptive strategies. The way individuals regulate their emotions can impact their decision to use pornography. For instance, if someone struggles to manage negative emotions effectively (e.g., unable to spontaneously use reappraisal strategies), they might turn to pornography as a coping mechanism. Pornography can provide immediate rewarding (Laier & Brand, 2017), helping to alleviate negative emotions and stress in the short term. This reduction in negative emotions and stress reinforces the cognitions linked to pornography use (Brand et al., 2016, 2019). In other words, people may come to view pornography as an effective way to handle stress and negative feelings. Over time, this reinforcement increases the likelihood that individuals will continue using pornography as a coping strategy, becoming more reliant on it whenever they experience negative emotions or stress. This leads to a cycle where pornography use becomes their primary method for managing emotions. Consequently, motivations related to ER and stress coping are expected to be linked with PPU (Testa et al., 2024). For instance, studies have found positive correlations between PPU and emotional subscales of the Pornography Use Motivations Scale (Baranowski, Vogl, & Stark, 2019). Additionally, recent research suggests a connection between stress-reduction motivations and the risk of PPU before and after the COVID-19 pandemic (Jiang, Lu, Hong, Zhang, & Chen, 2022).

However, it is crucial to highlight that the cross-sectional nature of this study does not permit the establishment of causal relationships. We cannot determine whether a lack of reappraisal leads to more severe PPU or if PPU symptoms are associated with a reduced tendency to use reappraisal. Although some scholars suggest that individuals with PPU may use pornography to manage stress or discomfort

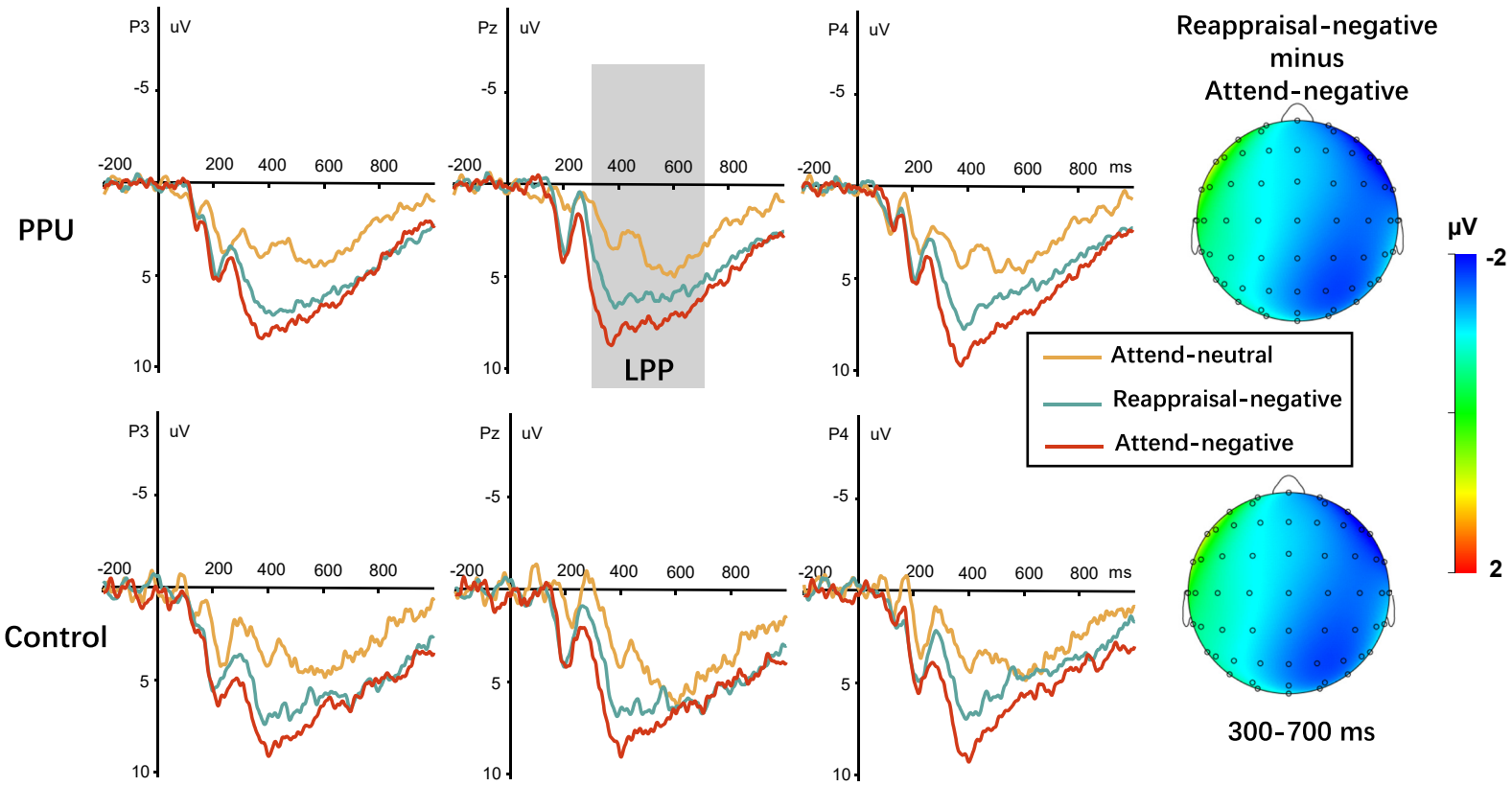

Fig. 4. ERP waveforms illustrating responses in the Attend-neutral, Attend-negative, and Reappraisal-negative conditions for the PPU group (top) and control group (bottom). Scalp distributions show the difference between Reappraisal-negative and Attend-negative conditions in the late time window (300–700 ms) for each group

(e.g., Lew-Starowicz et al., 2020), research also indicates that these individuals experience significant distress due to their symptoms. For instance, in a 10-week diary assessment of CSBD patients (Wordecha et al., 2018), all participants reported using pornography and masturbation to regulate emotions and stress. However, after their pornography use, negative emotions such as anxiety, shame, sadness, and loneliness resurfaced. Thus, current understanding suggests that PPU may both result from and contribute to difficulties in ER and related negative emotions. Longitudinal studies are required to investigate the temporal relationships between emotion dysregulation, stress coping mechanisms, and the development and progression of PPU. Such studies could provide valuable insights into the factors that may predict PPU.

The hypothesis that individuals at-risk for PPU would be less effective at using reappraisal compared to controls was not supported. Instead, our findings indicate that both individuals at-risk for PPU and the control group can utilize reappraisal when guided and experience comparable benefits from its application. These benefits are evident in both the subjective assessment of negative emotional stimuli and the electrophysiological indicator, LPP amplitude. Specifically, compared to passive viewing of negative stimuli, all participants showed increased valence ratings and decreased arousal levels, along with a reduction in LPP amplitude under the reappraisal condition. Taken together, our findings indicate that individuals at-risk for PPU can effectively utilize reappraisal strategies to manage negative emotions in a controlled laboratory setting, though they may not apply these strategies spontaneously in their daily lives. Similar results have been observed in other psychopathological disorders. For instance, studies have shown that individuals with depression or alcohol use disorder can effectively use reappraisal to downregulate negative emotions when instructed in a laboratory but are less likely to do so spontaneously (Joormann & Stanton, 2016; Quigley & Dobson, 2014; Suzuki et al., 2020). This implies that the issue may not lie in the inability of individuals with PPU to regulate emotions but rather difficulties in implementing these strategies due to factors such as motivation, environmental influences, or executive function. It is also possible that individuals with PPU find ER more challenging in daily life compared to a laboratory setting, possibly due to increased uncertainties, higher stress levels, or reduced support. Therefore, targeted ER training could be significantly beneficial, helping these individuals manage emotions more effectively during difficult times and making these strategies more accessible and practical in everyday life (Cohen & Ochsner, 2018).

This study has significant theoretical and clinical implications. The ICD-11 classifies CSBD as an impulse control disorder, with diagnostic criteria that do not include ER-related symptoms (WHO, 2020). However, our study highlights the importance of the connection between ER and PPU. ER also plays a significant role in gambling disorder, which was previously considered an impulse control disorder but is now reclassified as a behavioral addiction (Rogier & Velotti, 2018). According to the self-medication hypothesis (Khantzian, 1997), addictive behaviors may function through negative reinforcement mechanisms to regulate negative emotions or reduce stress. Many scholars now argue that CSBD, including PPU, is more appropriately classified as a behavioral addiction (e.g., Brand et al., 2020; Stark, Klucken, Potenza, Brand, & Strahler, 2018). Investigating the role of ER in CSBD and PPU could further clarify this classification. Additionally, comprehensive research on ER in these disorders may contribute to the reconceptualization of the core components of CSBD (Gola et al., 2022). From a transdiagnostic perspective, impairments in ER are crucial to the development of various psychiatric conditions (Aldao, Nolen-Hoeksema, & Schweizer, 2010). Nolen-Hoeksema and Watkins (2011) suggest that ER issues lead to specific symptom patterns only when combined with certain moderating factors. For example, depression symptoms may emerge following failure events, and eating disorder symptoms may develop due to heightened sensitivity to food reward. Future research should test the assumptions of transdiagnostic ER models to understand why individuals with similar ER issues exhibit different symptom profiles.

Our findings offer experimental validation for the therapeutic benefit of incorporating reappraisal techniques in psychotherapies, such as cognitive-behavioral therapy (CBT), for treating PPU. Recent evidence demonstrates the effectiveness of CBT in the treatment and intervention of CSBD and PPU (Antons et al., 2022). Studies have demonstrated that participants receiving CBT, compared to those on a waitlist, experienced reductions in PPU and CSBD symptoms, decreased depression levels, and improved quality of life (Böthe, Baumgartner, Schaub, Demetrovics, & Orosz, 2021; Hallberg et al., 2019, 2020). CBT utilizes diverse methods, including cognitive restructuring, managing adverse thoughts, and stress reduction techniques. These approaches are crucial for developing effective coping mechanisms and enhancing ER. Therapists guide patients in CBT to analyze cognitive, emotional, and behavioral responses related to their sexual impulses, addressing impulse control and negative thought patterns (Hallberg et al., 2019, 2020). Additionally, CBT's relapse prevention strategies help patients recognize and manage high-risk situations, handle stress, and find positive rewards from other enjoyable activities (Hallberg et al., 2020). Therefore, while the effectiveness of treatments for PPU is still under investigation, future interventions should place greater emphasis on teaching adaptive ER strategies, such as reappraisal, in addition to reducing maladaptive ER strategies.

This study has several limitations. First, it involved a non-clinical sample of university students, owing to the growing prevalence of PPU among this group (Chen, 2022). Replicating this research with a clinically diagnosed sample could help determine if individuals with more severe PPU show deficits in instructed ER. Additionally, including more diverse populations (e.g., women) would improve the generalizability of the results. Second, some participants may have struggled to assess their ER efforts in a laboratory environment. Conducting this research in a more

ecologically valid setting, such as through ecological momentary assessment or diary studies, would allow participants greater freedom to describe their ER strategies. Third, it should be noted that the conclusions derived from the present findings are restricted to instructed reappraisal strategies. Consequently, there is limited information regarding other methods participants may employ to down-regulate their negative emotions. Future research should explore a broader range of instructed ER strategies, encompassing approaches such as suppression, emotional expression, and others. Finally, this study did not consider the potential impact of moral disapproval or religiosity in the assessment of PPU. Many individuals, especially in culturally conservative countries like China (Chen, 2022), experience distress due to moral judgments and disapproval regarding sexual behavior or pornography viewing. While this may affect their emotional states or regulation abilities, experiencing distress solely from moral conflict is insufficient for a classification of CSBD (WHO, 2020). Therefore, future research should aim to assess moral disapproval and religiosity to gain a more comprehensive understanding of the relationship between CSBD (including PPU) and ER.

CONCLUSION

This study is the first to examine both spontaneous and instructed ER in individuals at-risk for PPU. The findings indicate that these individuals use adaptive appraisal strategies less frequently than controls without guidance. However, when instructed, they can effectively employ these strategies. Since individuals at-risk for PPU can manage negative emotions when guided, the next crucial step is to develop methods to train them to use these strategies more consistently in everyday life.

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Appendix: Reappraisal Tactic Training

The participants practiced two reappraisal strategies: distancing and situational reinterpretation.

Distancing

The reappraisal creates a feeling of physical or psychological separation from the depicted events. Examples are: "I'm not familiar with them," "this situation doesn't impact me," "this doesn't concern me," "I'm indifferent," and "I'm distanced from them."

For instance, when seeing a poisonous snake, the distancing reappraisal might be expressed as:
"The snake is not near me; it's just a part of a photo or video."
"I don't need to worry because I'm in a safe environment, far from danger."
"This is a natural phenomenon; the snake is in its habitat while I am in my own space, unaffected."

Situational reinterpretation

The following strategies involve reinterpreting the current situation depicted in a photograph. These approaches collectively help to reframe the emotional impact of distressing images by altering the interpretation of the circumstances.

Change Current Circumstances: This involves viewing the situation in a less negative light, for instance, recognizing that an injury may not be as serious as it seems or that someone appearing in pain is not suffering as much as it looks.
Reality Challenge: This strategy questions the authenticity of the scene, suggesting it might not be real or could be part of a staged event, like a movie or a Halloween costume.
Change Future Consequences: Here, the focus is on the potential for improvement over time, emphasizing that suffering is temporary and that future outcomes may differ from initial perceptions.

For example, when viewing a picture of a car accident, situational reappraisal can be expressed as:
"The damage looks serious, but the people involved might have just minor injuries and are receiving help."
"This could be a staged photo or part of a safety demonstration; it doesn't represent a real accident."
"Although it looks bad now, the situation will improve; insurance will cover the damages, and everyone will recover."