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Emotional impulsivity and emotion regulation deficits as important factors in clinically challenging behaviors in psychiatric disorders

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Emotional impulsivity and emotion regulation deficits as important factors in clinically challenging behaviors in psychiatric disorders

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Editorial: Emotional impulsivity and emotion regulation deficits as important factors in clinically challenging behaviors in psychiatric disorders

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Editorial on the Research Topic

Emotional impulsivity and emotion regulation deficits as important factors in clinically challenging behaviors in psychiatric disorders

In the Research Topic "*Emotional Impulsivity and Emotion Regulation Deficits as Important Factors in Clinically Challenging Behaviors in Psychiatric Disorders*", we examine the role of emotion-related impulsivity (also known as "urgency") and emotion regulation deficits in behaviors such as suicidality, nonsuicidal self-injury, pathological eating, and mood disorders. The articles in this Research Topic use a range of methodologies, including ecological momentary assessment, experimental paradigms, self-report methods, and neuroimaging to study urgency and its correlates. In addition, the articles provide accounts of how urgency may play out in the context of broader theories of emotion and nonemotion-based models. This Research Topic thus represents a comprehensive examination of urgency and emotion dysregulation and how they interact with each other and relate to psychopathology. We are fortunate to have received contributions of more than 10 articles from leaders in the field.

Prior work had established urgency and emotion dysregulation as important factors in psychopathology and challenging clinical behaviors (1). The studies in this Research Topic support and extend this prior work. For example, in a preliminary study, Hoptman et al. used an fMRI emotion regulation task to show that people with schizophrenia who have high levels of suicidal ideation and behavior (SIB) have reduced activation in emotion regulation-relevant circuitry compared to those with lower levels of SIB in multiple regions, including medial prefrontal cortex, rostral anterior cingulate, superior frontal gyrus, dorsolateral prefrontal cortex, right middle cingulate, and right superior temporal gyrus. Moreover, across groups, higher activation in right middle cingulate gyrus, right superior temporal gyrus, and right DLPFC correlated with lower levels of negative urgency. This

finding suggests that deficient activation in these regions might be associated with the kinds of emotion dysregulation seen in suicidal ideation and behavior. Prior work with this sample showed that people in the high SIB group had highly elevated negative urgency compared to those in the low SIB group (2). Consistent with this finding, Ortin-Peralta et al. identified pathways between negative and positive urgency and intergenerational transmission of suicide risk in children. In an in-depth examination of the interpersonal theory of suicide, Ranjbar et al. showed that emotion dysregulation mediated the pathways between suicidal ideation constructs, such as perceived burdensomeness and thwarted belongingness on one hand and suicidal behavior on the other. In healthy adolescents, Fisher-Fox et al. found that baseline urgency predicted increased emotion dysregulation over time, providing support for a temporal relationship between the two constructs.

Two articles in those exhibiting non-suicidal self-injury (NSSI) highlighted the importance of emotion dysregulation in this phenomenon. Thus, Liu et al. showed that lower levels of self-compassion and lower usage of cognitive reassessment emotion regulation strategies were associated with higher levels of NSSI in adolescents with mood disorders. Along similar lines, Ge et al. showed that relationships between a profile of neuroticism, childhood victimization, poor resilience, and family dysfunction on one hand and NSSI on the other was mediated by emotion dysregulation, which was in turn moderated by maladaptive cognitive emotion regulation. Finally, Belloli et al. identified links between emotional dysregulation and psychopathological traits such as anxiety and depression in candidates for bariatric surgery. In each of these cases, the work described the critical role of urgency and/or emotion dysregulation in these clinically challenging behaviors.

Two articles examine the role of urgency in broader theories of emotion Fisher-Fox et al.) and in contexts beyond emotion. Elliott et al. Fisher-Fox et al. consider ways in which to integrate urgency into broader existing emotion theories that highlight adaptive, in addition to maladaptive, impacts of emotions on behavior, as a means to catalyze future research in this area. Elliott et al. tested whether emotions uniquely lead to urgency, finding that while emotions are key in driving risk-taking, people high in urgency may demonstrate risk-taking in other physiologically charged contexts as well (e.g., tiredness and hunger).

Finally, two articles represented methodological advances. Ajilore et al. examined entropy of passive phone keystrokes and found that it was associated with performance on tasks of executive function and correlated with both depressive symptoms and the variability of phone app-derived impulsive feelings in people with bipolar disorder. Finally, Allen et al. used an innovative task that examined emotional and nonemotional working memory, as well as affective flexibility. They found that neutral, but not emotional, working memory performance correlated with emotion-related impulsivity and internalizing psychopathology. By linking cognitive performance with emotion and impulsivity, the results of both articles imply shared or overlapping mechanisms of cognitive performance and the regulation of emotion and action, as well as the likely centrality of cognitive control.

The articles in this Research Topic highlight and extend the importance of urgency in psychopathology. Further work will help identify the distinctions between urgency and emotion dysregulation and will provide important clues to how emotion-related impulsivity influences emotion dysregulation and thereby may lead to dysregulated behavior. Future directions likely will include using neuroimaging to examine the neural correlates of these constructs, experimental paradigms to better establish causality and mechanisms, and ecological momentary assessment to better understand the complex and reciprocal interactions between urgency and emotion dysregulation over time. A better understanding of the phenomenology, neural circuitry, and temporal nature of urgency and emotional dysregulation is likely to have treatment implications, whether by psychological, neuromodulatory, pharmacological, or neurofeedback mechanisms. This knowledge will likely lead to improved treatment approaches to address challenging behaviors in numerous clinical populations.

Author contributions

MH: Writing – review & editing, Writing – original draft. MC: Writing – original draft, Writing – review & editing. AA: Writing – original draft, Writing – review & editing.

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Maladaptive cognitive regulation moderates the mediating role of emotion dysregulation on the association between psychosocial factors and non-suicidal self-injury in depression

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Introduction: Non-suicidal self-injury (NSSI) is highly prevalent in depression, and is associated with psychosocial factors, emotion dysregulation, and strategies of cognitive emotion regulation. However, the internal combination and interactions of these risk factors in depression remain unclear.

Methods: Data from 122 patients with depression, including 56 with NSSI and 66 without NSSI, were analyzed. Self-rating scales were used to assess psychosocial factors, emotion dysregulation, and cognitive regulation strategies. Sparse partial least squares discriminant analysis (sPLS-DA) was employed to explore internal combinations in each profile. A moderated mediation model was applied to examine their interactional relationship.

Results: The results identified an NSSI-related psychosocial profile characterized by high neuroticism, childhood trauma, poor family functioning, and low psychological resilience. Emotion dysregulation, including high levels of alexithymia, anhedonia, and emotion regulation difficulties, mediated the association between this psychosocial profile and NSSI. The mediated effect was further moderated by maladaptive cognitive regulation strategies.

Limitations: Lack of sufficient information on NSSI frequency and severity. Relatively small sample size for discussing the impact of gender and age of depressive patients with NSSI.

Conclusion: These findings hold important implications for the prevention, treatment, and rehabilitation of NSSI.

KEYWORDS

non-suicidal self-injury (NSSI), depression, emotional dysregulation, psychosocial factors, maladaptive cognitive regulation strategies

1 Introduction

Non-suicidal self-injury (NSSI) refers to the deliberate, direct injuring bodily tissues without suicidal intent and is socially unacceptable (1). NSSI is highly prevalent among adolescents and clinical samples with mental disorders (2). Its prevalence has been increasing, particularly in patients with depression (3). NSSI represents a significant challenge for mental health professionals and has been linked to various adverse outcomes, including increased risk of suicidal behaviors and a considerable impact on overall well-being.

Prior research has suggested that self-harm behaviors may be influenced by a combination of genetic traits, mental disorders, and various psychosocial and familial factors (4, 5). Despite the lack of fully elucidated risk factors and their specific mechanisms, NSSI is commonly motivated by the need to cope with emotional distress and may serve as a strategy for regulating negative emotions (6). Nock proposed an integrated theoretical model of the development and maintenance of NSSI (7). This model identifies two primary categories of factors contributing to the risk of NSSI, distal psychosocial risk factors, including personality traits, childhood trauma, and poor family functioning, lead to intrapersonal and interpersonal vulnerability in emotion dysregulation. A growing body of evidence suggest that emotion dysregulation plays a pivotal role in the association between depression and NSSI (8). Depression, characterized by significant and persistent depressed mood, lack of pleasure and loss of interest, accompanied by cognitive and behavioral changes of varying degrees, is a widely prevalent psychiatric disorder. Beyond its core symptoms, depression is also associated with a complex web of psychosocial factors (9). Previous studies on risk factors for NSSI in depression have mainly focused on psychosocial factors and emotion dysregulation, with some indicating the mediating role of emotion dysregulation. In a study of adolescents, the association between childhood maltreatment and NSSI-related clinical outcomes was partially explained by impulsivity (10). Another study presented the association of poor family functioning and adolescent NSSI, which was mediated by depression (11). There was also a study summarizing that neuroticism positively predicts depression and NSSI behaviors, and affects NSSI through the mediating effect of emotion regulation and depression (12). However, most studies have examined individual risk factors in isolation, limiting our understanding of the internal combinations of psychosocial factors and emotion dysregulation associated with NSSI.

Additionally, the affect regulation hypothesis (13) has been developed to explain the impact of emotion regulation strategies on NSSI. Emotional dysregulation encompasses internal vulnerabilities related to various emotional aspects, including emotional perception, experience, and expression. Recent work suggested that the effects of emotion regulation strategies may emphasize the role of cognitive factors in modifying NSSI-related emotion dysregulation, indicating that these regulations are implemented at the cognitive level. One study reported that the experience of childhood maltreatment and stressful life events showed a significant indirect effect on NSSI through adaptive cognitive emotion regulation strategies (14). It was revealed that in the repetitive NSSI group, the effect of stress on NSSI frequency was mediated by emotion dysregulation, and the effect of stress on NSSI addictive features was mediated by both emotion dysregulation and maladaptive cognitive schemas in another research (15). However, it remains unclear whether these cognitive strategies moderate the mediating role of emotion dysregulation in the relationship between psychosocial factors and NSSI.

In the current study, we aimed to examine the correlation between psychosocial factors (individual and environmental), emotion dysregulation (intrapersonal and interpersonal), and cognitive regulation strategies (adaptive and maladaptive) in relation to NSSI using sparse partial least squares discriminant analysis (sPLS-DA). We then performed a moderated mediation analysis to explore how psychosocial factors and NSSI interact through emotion dysregulation, which is in turn moderated by cognitive regulation strategies (Figure 1).

2 Materials and methods

2.1 Participants

From October 2022 to June 2023, we recruited 122 outpatients or inpatients from Peking University Sixth Hospital diagnosed with depression, comprising 56 cases with NSSI (NSSI+) and 66 cases without NSSI (NSSI−). Depressive patients in partial remission could be included. They do not need to be higher than a cut-off. To meet the diagnostic criteria for NSSI behavior as recommended in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), NSSI+ participants had to have engaged in NSSI behaviors on more than 5 days within the past 12 months, whereas NSSI- participants had no history of self-injury. Additional inclusion criteria were: (a) aged 16–60 years; and (b) ICD-10 diagnosed with depressive episode or major depressive disorder according to the International Classification of Diseases, Tenth Edition (ICD-10). Exclusion criteria included: (a) patients who injure themselves in order to commit suicide; (b) accidental injuries that do not meet NSSI diagnostic criteria; (c) diagnosis of other current mental disorders, such as pervasive developmental disorders, psychotic disorders, manic episodes, substance dependence, or obsessive-compulsive disorders; and (d) presence of severe unstable physical illness. All participants provided written informed consent, and the study was approved by the Peking University Sixth Hospital Medical Ethics Committee.

2.2 Measures

Depression and anxiety levels were assessed using the Zung self-rating anxiety scale (SAS) and the Zung self-rating depression scale (SDS) (16) and raw scores were employed in this study. The SAS has been shown to have good internal consistency with a Cronbach's α of 0.82. The SDS scale was tested to show good reliability and validity, with a Cronbach's α coefficient of 0.842 and a retest reliability correlation coefficient of 0.809 in the Chinese sample (17, 18). Psychosocial factors, emotion dysregulation, and cognitive regulation strategies were measured using nine self-assessment scales (Figure 2A).

2.2.1 Psychosocial factors

Nineteen features from four questionnaires were integrated to assess psychosocial factors: (a) NEO Five Factor Inventory (NEOFFI) (19), assessing the five dimensions of personalities, including neuroticism, extraversion, openness, conscientiousness, and agreeableness. The NEOFFI is valid and reliable with excellent internal

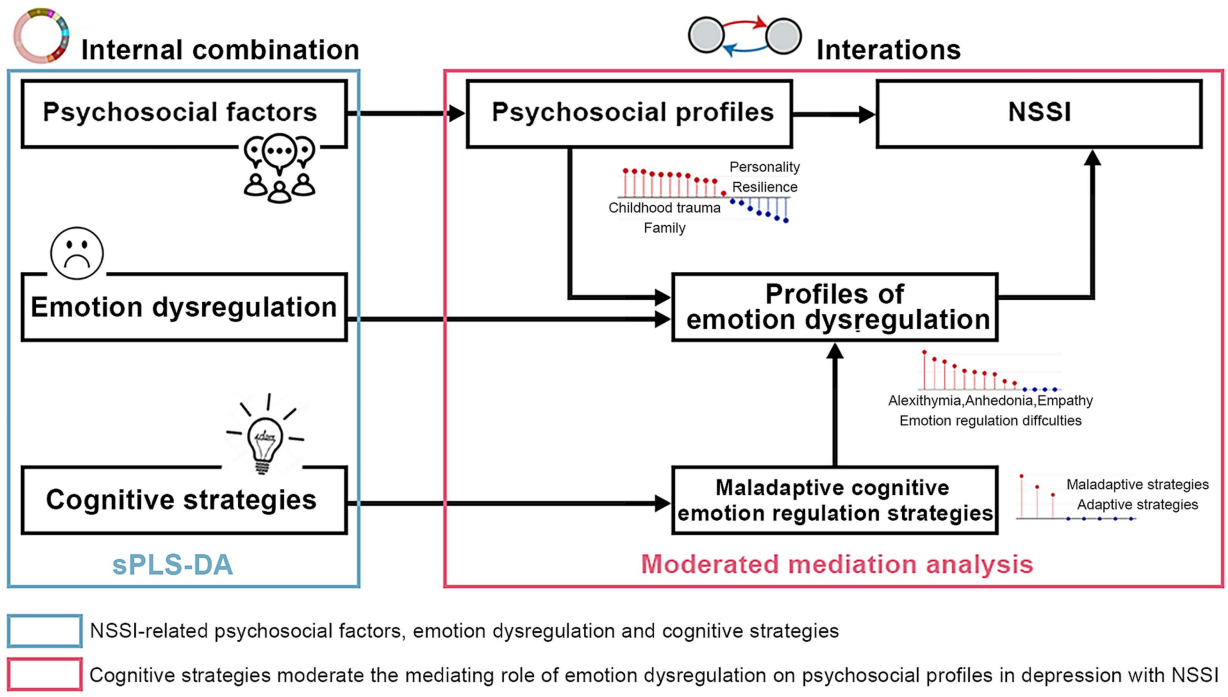

FIGURE 1
Pipeline for the study design. NSSI-related psychosocial factors, emotional impairments, and cognitive strategies were identified using sPLS-DA. A moderated mediation analysis was performed to investigate the interaction effect among psychosocial profiles, emotion dysregulation and cognitive strategies that are associated with NSSI. sPLS-DA, spare partial least squares discriminant analysis; NSSI, non-suicidal self-injury.

consistency scores of 0.82 to 0.89 in Chinese sample (20). (b) Connor-Davidson Resilience Scale (CD-RISC) (21) measuring the psychological resilience, including tenacity, strength, and optimism. The reliability coefficient of the Chinese version of CD-RISC was 0.91. The validity of CD-RISC was also satisfying in terms of the actual data. (c) Childhood Trauma Questionnaire (CTQ) (22), retrospectively assessing the childhood maltreatment, including emotional abuse, physical abuse, sexual abuse, emotional neglect, and physical neglect. The CTQ is valid and reliable with internal consistency scores of 0.64 in Chinese sample. (d) Family Assessment Device (FAD) (23), measuring the individual perceptions of his/her family functioning, comprising problem solving, communication, roles, affective responsiveness, affective involvement, behavioral control. The FAD has been shown to be valid and reliable.

2.2.2 Emotion dysregulation

Emotion dysregulation was evaluated through four scales, including 14 features: (a) Toronto Alexithymia Scale (TAS) (24), assessing an individual's ability to express and recognize internal and external emotions, including difficulty identifying feelings, difficulty describing feelings and externally-oriented thinking. The TAS attained good psychometric properties in the Chinese sample. (b) Interpersonal Reactivity Index-C (IRI-C) (25), evaluating the ability to empathize in four dimensions of perspective taking, fantasy, empathetic concern, and personal distress. The scale demonstrated satisfactory internal consistencies (ranging from 0.61 to 0.85). (c) Snaith-Hamilton Pleasure Scale (SHAPS) (26), measuring anhedonia, the inability to feel pleasure, categorized into, contact/sense and dietary/interest. The SHAPS also showed valid and reliable with an excellent internal consistency of 0.93. (d) The Difficulties in Emotion Regulation Scale (DERS-16) (27), covering lack of emotional clarity, difficulty in goal-directed behaviors, impulse control difficulties, limited strategies, and nonacceptance of negative emotions. The DERS-16 has retained excellent internal consistency, good test–retest reliability, and good convergent and discriminant validity in Chinese.

2.2.3 Cognitive regulation strategies

Cognitive Emotion Regulation Questionnaire (CERQ) (28, 29) was used to assess eight strategies, including acceptance, positive refocusing, positive reappraisal, putting into perspective (adaptive), and rumination, self-blame, blaming others, catastrophizing (maladaptive). Higher scores indicated a higher likelihood of using a particular cognitive strategy to cope with negative events. The CERQ has been shown to be valid and reliable in both total scale and subscales.

2.3 Statistical analysis

SPSS 26.0 was used for descriptive statistics of participants' demographic and all measures, presenting frequencies and proportions for categorical variables and means and standard deviations for normally distributed numerical variables. Independent samples *t*-test and chi-square test were employed to compare differences between NSSI+ and NSSI− groups in demographic and all scales.

Sparse partial least squares discriminant analysis (sPLS-DA) was conducted using the R package mixOmics to identify NSSI-related

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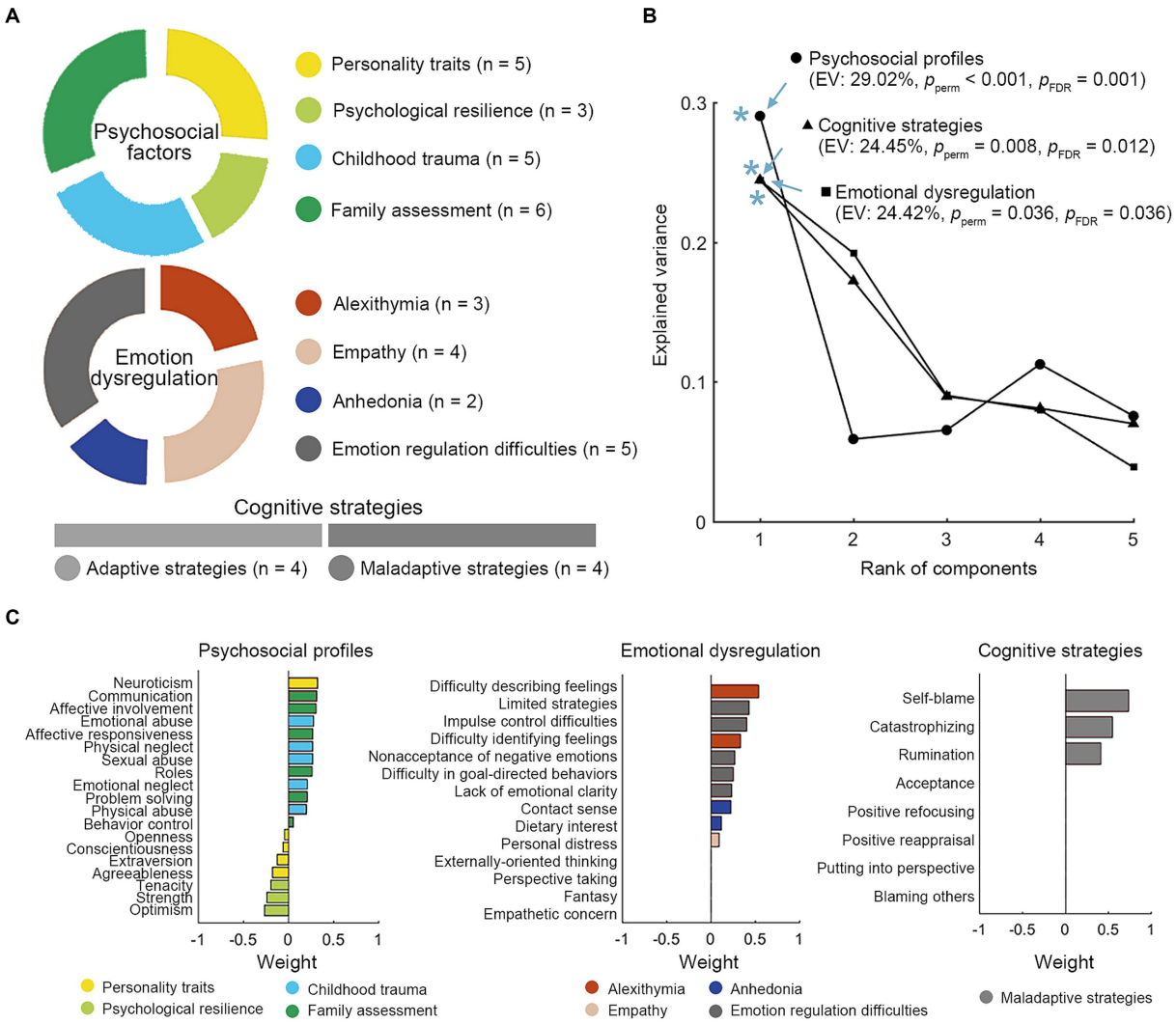

FIGURE 2
NSSI-related profiles of psychosocial factors, emotion dysregulation, and cognitive strategies. **(A)** Nineteen psychological factors belonging to 4 modules, fourteen items of emotional impairments from 4 categories and two kinds of cognitive regulations (each of which has 4 strategies) are included. **(B)** The sPLS-DA model identified a NSSI-related psychosocial profile (EV: 29.02%, *P*perm < 0.001, P_{FDR} = 0.001), profiles of emotional impairments (EV: 24.45%, *P*perm = 0.008, P_{FDR} = 0.012) and cognitive strategies (EV: 24.42%, *P*perm = 0.036, P_{FDR} = 0.036). The components significantly discriminate between the two groups of patients with and without NSSI. **(C)** The weight of significant items of each profile. * $p < 0.05$. EV, explained variance.

latent profiles of psychosocial factors, emotion dysregulation, and cognitive emotion regulation strategies. This method involved sparseness within the latent profiles and performed simultaneous dimension reduction to enable categorical classification with a specific focus on feature selection (30–34), and has been used successfully in the field of clinical assessment scales (35, 36), neuroimaging (35) and metabolomics (37), with the features range from 10 to 1,000. Here, the sPLS-DA identified components most associated with NSSI. The internal "loading" of each component measured how these features combine internally. Permutation tests (10,000 times) adjusted by false discovery rate (FDR) correction were used to test the statistical significance of the explained variance (EV) by the components.

A moderated mediation analysis was conducted to assess the complex associations of NSSI, psychosocial factors, emotion dysregulation and cognitive regulation strategies. R package Mediation (38) was used to test whether the association between psychosocial factors and NSSI (binary variable) can be mediated by emotion dysregulations and modulated by cognitive strategies. In the model, psychosocial factors were defined as an independent variable, the NSSI was defined as a dependent variable, the emotion dysregulation was defined as a mediator variable and the cognitive strategies were defined as a moderator variable. Patients' age, sex, SAS, and SDS were controlled as covariates in our model. The method of Distribution of the Product was used to assess the coefficient of mediating effect, *ZaZb*, and its significance based on the distribution of the product with a 95% confidence interval (CI) that did not include zero. The moderated effect further determined whether cognitive strategies moderated the mediating path. Simple effect analysis calculated conditional indirect effects to test whether the indirect effect of emotion dysregulation disturbance varied under different levels of

cognitive strategies. According to previous studies (39), two levels of cognitive strategies were defined, including low (one standard deviation below the mean) and high (one standard deviation above the mean) levels.

3 Results

3.1 Demographic and clinical characteristics

The study included 122 subjects with depression, with no statistically significant differences in age and gender between the groups. However, the levels of anxiety and depression were significantly higher in the NSSI+ group ($p < 0.001$). NSSI+ group exhibited more childhood trauma exposure ($p = 0.002$), worse family functioning ($p = 0.006$), higher neuroticism ($p = 0.003$) and worse psychological resilience ($p = 0.021$) than NSSI− participants. NSSI+ individuals demonstrated higher levels of alexithymia ($p = 0.003$) and anhedonia ($p = 0.041$), and more difficulties in emotion regulation ($p < 0.001$). Meanwhile, patients with NSSI tended to use maladaptive emotion regulation strategies ($p = 0.002$). The demographic and the characteristics of all measures in NSSI+ and NSSI− participants were presented in Table 1 and Supplementary Table S1.

3.2 NSSI-related profiles in psychosocial factors, emotion dysregulation, and cognitive regulation strategies

The NSSI-related psychosocial and emotion regulation profiles were identified through sPLS-DA (Figures 2B,C). An NSSI-related psychosocial profile identified through sPLS-DA was characterized by high neuroticism, more childhood trauma, poor family functioning, and low psychological resilience (EV: 29.02%, $P_{perm} < 0.001$, $P_{FDR} = 0.001$). Emotion dysregulation related with NSSI exhibited high levels of alexithymia, anhedonia, and emotional regulation difficulties (EV: 24.42%, $P_{perm} = 0.036$, $P_{FDR} = 0.036$). Maladaptive strategies of cognitive regulation, including self-blame, catastrophizing, and rumination, explained 24.42% variance of origin data structure ($P_{perm} = 0.008$, $P_{FDR} = 0.012$).

3.3 Moderated mediation model

The moderated mediation analysis examined the interaction between psychosocial factors and NSSI through emotion dysregulation, moderated by cognitive regulation strategies (Figure 3A). The results revealed that the psychosocial profile was positively associated with the emotion dysregulation profile ($a = 0.224$,

TABLE 1 Demographic and clinical characteristics.

	Total ($N = 122$)	NSSI + ($N = 56$)	NSSI − ($N = 66$)	t/χ^2	p-value
Gender				3.697	0.055
Male	27 (22.1%)	8 (29.6%)	19 (70.4%)		
Female	95 (77.9%)	48 (50.5%)	47 (49.5%)		
Age	26.0 ± 8.6	24.6 ± 7.7	27.2 ± 9.1	−1.686	0.094
SAS	45.4 ± 9.1	48.5 ± 9.3	42.8 ± 8.1	3.569	<0.001***
SDS	53.2 ± 10.6	56.8 ± 10.0	50.1 ± 10.1	3.697	<0.001***
CTQ	47.1 ± 14.0	51.3 ± 15.3	43.5 ± 11.6	3.125	0.002**
FAD	28.6 ± 7.2	30.5 ± 6.8	27.0 ± 7.3	2.803	0.006**
NEOFFI					
Neuroticism	32.9 ± 7.2	34.9 ± 6.9	31.1 ± 7.0	3.067	0.003**
Extraversion	17.0 ± 6.8	16.2 ± 7.2	17.7 ± 6.5	−1.190	0.236
Openness	27.4 ± 5.4	27.2 ± 5.3	27.6 ± 5.5	−0.409	0.683
Conscientiousness	35.1 ± 16.8	34.1 ± 18.1	35.9 ± 15.6	−0.591	0.556
Agreeableness	26.7 ± 5.0	25.8 ± 5.1	27.5 ± 4.8	−1.846	0.067
CD-RISC	42.6 ± 16.8	38.8 ± 18.2	45.8 ± 14.8	−2.346	0.021*
TAS	58.3 ± 11.7	61.6 ± 10.8	55.4 ± 11.8	2.990	0.003**
IRI-C	53.4 ± 12.2	53.4 ± 12.0	53.4 ± 12.4	0.028	0.978
SHAPS	30.2 ± 8.0	31.8 ± 8.1	28.8 ± 7.8	2.071	0.041*
DERS	54.6 ± 13.8	59.0 ± 13.2	50.9 ± 13.3	3.355	<0.001***
CERQ					
Adaptive strategies	51.1 ± 8.3	51.2 ± 8.5	51.1 ± 8.1	0.092	0.927
Maladaptive strategies	49.1 ± 10.2	52.2 ± 9.9	46.5 ± 9.8	3.164	0.002**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; scale scores are mean ± standard deviation.
SAS, self-rating anxiety scale; SDS, self-rating depression scale; CTQ, Childhood Trauma Questionnaire; FAD, Family Assessment Device; NEOFFI, NEO Five Factor Inventory; CD-RISC, Connor-Davidson Resilience Scale; TAS, Toronto Alexithymia Scale; IRI-C, Interpersonal Reactivity Index-C; SHAPS, Snaith-Hamilton Pleasure Scale; DERS, The Difficulties in Emotion Regulation Scale; CERQ, Cognitive Emotion Regulation Questionnaire.

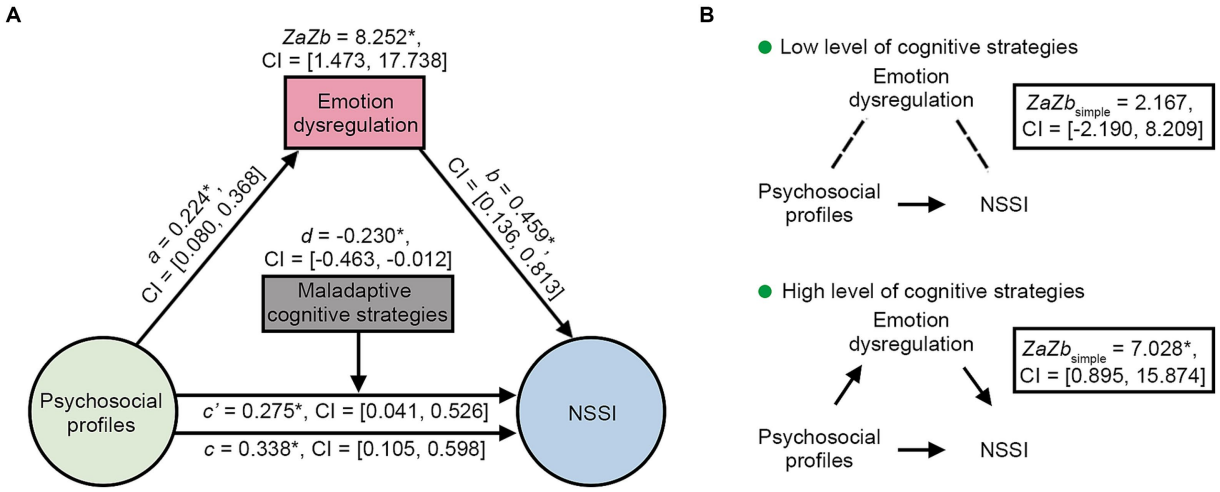

FIGURE 3
Moderated mediation model. **(A)** The emotional impairments were partially mediated the relationship between the psychosocial profiles and the NSSI, and the mediating effect was significantly moderated by cognitive strategies. **(B)** Simple effect analysis showed that the mediating effect of emotional impairments was significant when NSSI-related negative cognitive strategies is high. * $p < 0.05$. CI, confidence interval; NSSI, non-suicidal self-injury.

CI = [0.080,0.368]). The psychosocial profile was also positively associated with NSSI ($c = 0.338$, CI = [0.105,0.598]), as was the emotion dysregulation profile ($b = 0.459$, CI = [0.136,0.813]). The relationship between the psychosocial profile and NSSI was partially mediated by the emotion dysregulation profile ($ZaZb = 8.252$, CI = [1.473,17.738]). The mediated effect was moderated by maladaptive cognitive regulation strategies ($d = -0.230$, CI = [−0.463, −0.012]). As shown in Figure 3B, Simple effect analysis further revealed that the mediating effect of emotion dysregulation was significant under high levels of maladaptive cognitive strategies ($ZaZb_{simple} = 7.028$, CI = [0.895,15.874]), while it was not significant under low levels of maladaptive cognitive strategies ($ZaZb_{simple} = 2.167$, CI = [−2.190,8.209]).

4 Discussion

The present study explored internal combinations and external interactions within NSSI-related risk factors. The results identified a psychosocial profile characterized by high neuroticism, low psychological resilience, adverse childhood trauma and poor family communication. Additionally, an emotion dysregulation profile was associated with high levels of alexithymia, anhedonia, and emotional regulation difficulties. Emotion dysregulation partially mediated the association between the psychosocial profile and NSSI, and this mediating effect was moderated by maladaptive cognitive emotion regulation strategies. These findings provide a new perspective on understanding the composition and interactions of NSSI-related risk factors.

The observed psychosocial characteristics of heightened sensitivity and emotional instability, coupled with negative family environment and childhood maltreatment, are consistent with previous research. Neuroticism has been found to be higher in individuals with NSSI compared to those without NSSI (40). Individuals who scored high on neuroticism are more likely to experience anxiety, depression, and mood swings, and they may react strongly to stressful situations and have difficulty coping with challenges (41). Moreover, childhood maltreatment has been extensively studied as a risk factor for NSSI, with a meta-analysis indicating a strong association between childhood maltreatment and NSSI (42). Additionally, family factors, including family functioning and social support, have been linked to NSSI (43), with poor family functioning being associated with an increased risk of NSSI (11, 44–46). Considering the findings from our study and previous research, high neuroticism is associated with negative stress responses and difficulties in various life situations, and it is a possibility that these difficulties in managing emotions and stress can potentially lead to disharmonious relationships with family and their surroundings (47, 48). The present study adds to this understanding by examining the internal combinations of these risk factors related to NSSI.

In addition, we attempted to explore the internal features of emotion dysregulation by combining multiple risk factors, which may have a mediating effect between psychosocial profile and NSSI. Specifically, this internal combination presents a tendency toward worse ability to express and recognize internal and external emotions, increasing pleasure deficit, and more severe emotional regulation difficulties, which has been repeatedly emphasized in this study. A growing body of research also points to the association of different emotion disorders with NSSI. One study has been showed that depression plays a mediating role in the relationship between childhood maltreatment and NSSI, moderated by self-compassion (49). Another study drew a conclusion that emotional regulation mediated the association of borderline personality traits and NSSI in adolescents with depression (50). Borderline personality disorder (BPD) is frequently associated with NSSI and emotion dysregulation is also one of the core characteristics of BPD, which often contributes to self-injurious behaviors (51). These results implied that diverse emotion dysregulation may jointly influence the relationship between complex psychosocial factors and NSSI. Therefore, these findings are additionally illuminating for our understanding of the complex pattern of interactions within NSSI-related risk factors.

Further, we investigated the role of emotion dysregulation as a mediator between psychosocial factors and NSSI. Our results support the integrated theoretical model (7), wherein psychosocial factors contribute to emotion dysregulation, ultimately leading to NSSI (1, 8, 52). Furthermore, the moderating role of cognitive regulation strategies in this model is consistent with the affect regulation hypothesis (13). Maladaptive cognitive strategies in depression may modulate the mediating role of emotion regulation difficulties between psychosocial factors and NSSI. Depressed individuals often exhibit negative thinking styles and cognitive distortions (53), which may exacerbate their emotion regulation difficulties and further increase the risk of engaging in NSSI. Firstly, maladaptive cognitive strategies may exacerbate emotion dysregulation in individuals with depression. For example, individuals who engage in excessive rumination or negative self-talk may experience heightened negative emotions and have difficulty effectively regulating these emotions (54). This, in turn, may increase the likelihood of engaging in NSSI as a maladaptive coping mechanism (55). Secondly, maladaptive cognitive strategies can influence the interpretation and appraisal of psychosocial factors. Individuals with depression who employ cognitive distortions, such as overgeneralization, may perceive psychosocial stressors as more severe or personally threatening (56). This biased perception can further contribute to heightened emotional distress and increase the risk of NSSI. Moreover, maladaptive cognitive strategies may undermine the effectiveness of adaptive coping strategies and problem-solving skills. People who depend on avoiding or suppressing their emotions may find it challenging to effectively deal with psychosocial stressors or reach out to supportive sources for assistance (57). This can perpetuate a cycle of emotion dysregulation and increase the likelihood of engaging in NSSI as a maladaptive response. Therefore, a lower level of maladaptive cognitive strategies can buffer the effects of emotion dysregulation on NSSI development (58). Here, the involvement of adaptive cognitive strategies in this moderating process has not been demonstrated, possibly explained by their less frequent use in the current sample, which is consistent with findings from previous research in NSSI (59, 60) and depression (61, 62). However, it is important to note that the potential positive effects of adaptive strategies cannot be ruled out. Further research is needed to explore their role in influencing the relationship between psychosocial factors and NSSI. In summary, maladaptive cognitive strategies have the potential to moderate the mediating role of emotion dysregulation on the association between psychosocial factors and NSSI in depression. Understanding the interplay between these factors can provide valuable insights for the development of targeted interventions and treatment approaches that address cognitive processes, emotion regulation skills, and psychosocial stressors in individuals at risk for NSSI in the context of depression.

In addition to exploring the influencing factors of NSSI in depression (50), depression has also been proposed to mediate the relationship between the risk factors, such as childhood maltreatment, and NSSI (49). In this paper, although the levels of anxiety and depression were higher in NSSI+ individuals than NSSI− individuals in the current study, the depression symptoms appeared to be independent of the role of all the risk factors and modulators. These findings emphasize the importance of cognitive factors in patients with depression and provided deeper insights into the complex interactions between internal vulnerability factors and external risk factors that contribute to NSSI, as well as the relationship of symptoms of mood disorders and NSSI.

Several issues still need to be considered. Firstly, the sample size is relatively small so we cannot explore the potential effects of gender and age on NSSI (63, 64), and especially in the context of moderating effects, may result in relatively insufficient statistical power (65). Conducting studies with larger sample sizes in the future would be beneficial. Secondly, incorporating structured scales to assess NSSI frequency and severity would enhance the findings of the present study. Thirdly, since the co-occurrence of depressive disorders and BPD is a well-documented phenomenon (66), we cannot definitively rule out the possibility that some of the outpatient participants included in our study may indeed have concurrent BPD or other personality disorder diagnoses due to the time constraints inherent in outpatient visits.

In conclusion, this study identified internal combinations and external interactions within NSSI-related risk factors. The results found a psychosocial profile characterized with high neuroticism, childhood trauma, negative family environment and low psychological resilience, along with an emotional dysregulation profile consisting of high alexithymia, anhedonia, and emotional regulation difficulties. Emotion dysregulation partially mediated the relationship between this psychosocial profile and NSSI, and this mediating effect was moderated by maladaptive cognitive regulation strategies. Cognitive-behavioral therapy (CBT) (67) is a type of psychotherapy that can help individuals identify and replace maladaptive cognitive strategies with more adaptive ones. It has been shown to be effective in treating a variety of mental health conditions, including depression and anxiety. In addition to CBT, other techniques that can help improve maladaptive cognitive strategies include mindfulness-based interventions, Acceptance and Commitment Therapy (ACT), and dialectical behavior therapy (DBT). These techniques can help individuals become more aware of their thoughts and feelings, accept them without judgment, and learn how to respond to them in a more adaptive way. These findings have implications for the prevention, treatment, and rehabilitation of NSSI and may inspire future clinical interventions for NSSI in depression.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Peking University Sixth Hospital Medical Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

YG: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. YX:

Formal analysis, Methodology, Visualization, Writing – review & editing. ML: Writing – review & editing. LY: Writing – review & editing. PS: Writing – review & editing. XL: Resources, Writing – review & editing, Data curation. HY: Funding acquisition, Resources, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1279108/full#supplementary-material

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Non-suicidal self-injury in adolescents with mood disorders and the roles of self-compassion and emotional regulation

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Objective: We aimed to investigate the characteristics and psychological mechanism of non-suicidal self-injury (NSSI) in adolescents with mood disorders. We examined how self-compassion and emotional regulation affected NSSI and tested the mediating role of self-compassion in the link between emotional regulation and NSSI.

Method: We recruited outpatient and inpatient adolescent patients with bipolar and related disorders or depressive disorders (DSM-5), with a focus on NSSI. We also recruited healthy controls from the community. We collected demographic and clinical data. The Adolescent Self-injury Questionnaire, Self-compassion Scale (SCS), and Emotion Regulation Questionnaire (ERQ) were used to assess the frequency and severity of NSSI, level of self-compassion, and emotional regulation.

Results: In total, we recruited 248 adolescent patients with mood disorders ($N = 196$ with NSSI, and 52 without NSSI) and 212 healthy controls. NSSI was significantly associated with the female sex, lower levels of education and less use of cognitive reappraisal strategies, lower levels of self-warmth, and higher levels of self-coldness. Multivariate analysis of variance showed that there were significant differences in the scores of ERQ, cognitive reassessment score, and the scores of SCS among the three groups, but no statistical differences in expressive suppression score among the three groups. Self-warmth had a mediating effect between cognitive reappraisal and NSSI behavior.

Conclusion: NSSI is prevalent among adolescent patients with mood disorders in clinical settings, especially among girls and those with lower levels of education and less cognitive reappraisal strategies. More clinical attention is needed. Self-compassion and its factors may mediate the association between emotional regulation and NSSI. Clinical implications and future research directions were discussed.

KEYWORDS

adolescents, non-suicidal self-injury, self-compassion, emotional regulation, mood disorder

1 Introduction

The fundamental instinct to avoid pain and injury is crucial to the survival of individuals and species. Even though there is such evolutionary motivation, some people inexplicably inflict harm upon themselves. Non-suicidal self-injury (NSSI) refers to the intentional damage of one's body tissue without a suicidal intention and for reasons that are not socially or culturally accepted (1, 2). The three most commonly reported types of NSSI are cutting, hitting, and burning, which may cause minor to severe injuries (3). NSSI is highly prevalent in adolescence, with the global lifetime rate estimated at 17.2% (4) and this rate is even higher in China, standing at 22.3% (5). Although non-suicidal self-injury does not usually lead to suicide, it is associated with an increased risk of suicide attempts and suicide compared to the general population (6–9).

The clinical importance of NSSI has been increasingly acknowledged in the past decade (10, 11). The detection rate of NSSI is higher in the clinical population, and it is common in patients with mood disorders (especially major depressive disorder) and borderline personality disorder (12). NSSI is listed as a "condition requiring further study" in DSM-5, calling for more research. Emerging evidence has linked NSSI not only to psychological distress but also to physiological dysregulation, such as altered inflammatory markers and HPA axis abnormalities, which have been implicated in the pathology of mood disorders and may also contribute to the etiology of NSSI (13). Additionally, individuals with a positive history of NSSI were found to be associated with poorer clinical outcomes and an increased likelihood of treatment resistance (14).

NSSI is a multidimensional clinical phenomenon, and the mechanisms for its occurrence and maintenance are not yet fully explored in adolescence (15). Adolescence is a special period of growth, and the level of impulsivity and emotional reactivity increases due to the brain development process. The occurrence of adolescent NSSI is related to individual factors, family factors, social environment factors, and neurobiological factors, including inflammatory processes and HPA axis dysfunction (13, 16). The complexity of NSSI is further underscored by its association with treatment challenges, indicating that a history of NSSI may serve as a marker for the need for specialized intervention strategies (14).

1.1 NSSI and emotional regulation

The role of emotional regulation in NSSI is of research interest. Gratz argues that the ultimate characteristic of adaptive emotional regulation is the ability to flexibly adapt emotional regulation strategies to a given situation (17). Emotional regulation consists of the ability to process and modulate affective experience and is the most commonly cited motive for NSSI (18, 19). Previous studies have shown that adolescents often use NSSI as a coping strategy to reduce or remove overwhelming and/or unwanted emotions, such as anger, sadness, guilt, or shame. NSSI can also serve other functions, such as expressing distress, punishing oneself, influencing others' behavior, or seeking attention and support (20–23).

NSSI is a self-injury behavior that adolescents use to cope with overwhelming and/or unwanted emotions, inflict self-punishment, express distress, retaliate against others or seek attention, and manipulate others' behavior (20–23). However, NSSI is a maladaptive emotional regulation strategy and can have negative consequences for mental health. Therefore, it is important to teach adolescents other emotional regulation strategies that can help them healthily manage their emotions. Some examples of emotional regulation strategies are: talking with friends, exercising, meditating, receiving therapy, journaling, getting enough sleep, addressing any personal illness, and paying attention to negative thoughts that follow strong emotions. These strategies can help adolescents reduce their emotional vulnerability and volatility, and decrease their emotional suffering.

Relieving negative emotions has long been considered a primary function of NSSI (17). Individuals who experience emotional dysregulation, especially those with increased emotional reactivity and those who have difficulty accessing effective emotional regulation strategies, are at increased risk for engagement in NSSI (19). Although the established association between emotion dysregulation and NSSI supports the emotion-regulating function of NSSI, how NSSI serves this function remains unclear (19). The Emotional Regulation Questionnaire (ERQ) (24) was developed to assess cognitive reappraisal and expression inhibition, and it has been widely used to evaluate individuals with NSSI (17).

1.2 Emotional regulation, self-compassion and NSSI

In the evolving dialogue on mental health related to NSSI, the dynamic interplay between emotional regulation and self-compassion has emerged as a focal point of contemporary research. The underlying mechanisms of emotional regulation are postulated to converge intrinsically with elements of self-compassion, a juncture that appears to be critical in both the onset and perpetuation of NSSI behaviors.

Self-compassion refers to how we relate to ourselves in instances of perceived failure, inadequacy, or personal suffering (25). Neff's conceptualization is the most adopted in academic research (26), where self-compassion has three dimensions: showing kindness toward oneself in the face of distress or adversity rather than judgment, understanding difficulties as part of a larger human experience rather than feeling isolated, and holding painful thoughts in mindful awareness rather than over-identifying with them (27). Self-compassion is an adaptive way of relating to the self when confronted with personal mistakes, inadequacies, or difficult life situations, without attempts to avoid or suppress undesirable emotions or engage in self-critical thoughts (25). Some studies showed that self-compassion is significantly associated with mental health in adolescent populations (25).

Research has shown having more self-compassion may enhance one's emotional regulation skills, which may reduce the need for NSSI as a coping strategy. On the other hand, lacking self-compassion may impair one's emotional regulation abilities, which may increase the likelihood of NSSI as a way of escaping or expressing negative emotions (9, 28–31). Therefore, it is important to examine how emotional regulation and self-compassion interact and influence NSSI to gain a deeper and more comprehensive understanding of this behavior. This understanding may help us design more effective interventions that can prevent or treat NSSI by fostering emotional regulation and self-compassion.

Although studies have examined the role of emotional regulation in individuals with NSSI, few studies have examined the link between

self-compassion and NSSI. To the best of our knowledge, there are no studies on emotional regulation and self-compassion involving clinical samples with NSSI. Based on the above, the goals of the present study were: (1) to examine the clinical features of adolescents with NSSI in clinical settings; (2) to investigate whether self-compassion and emotional regulation differ among adolescent mood disorder patients with and without a history of NSSI and healthy controls; (3) to explore whether self-compassion and emotional regulation predict a history of NSSI; and (4) to investigate whether self-compassion mediates the relationship between emotional regulation and NSSI.

In this study, we hypothesized that the adolescents with NSSI would have the weakest level of emotional regulation and self-compassion, which would be significantly correlated with NSSI; and self-compassion would play a mediating role in the relationship between emotional regulation and NSSI.

2 Materials and methods

2.1 Participants

Two types of participants were included in our study: adolescent patients and healthy controls. Patients were recruited from the adolescent clinic in the outpatient department and adolescent inpatient unit of Beijing Anding Hospital. Healthy controls were recruited from a middle school. We used posters and social media outlets to recruit participants. The study period was from December 2020 to July 2022.

The inclusion criteria for the patient group were: (1) ages between 10 and 19 years; (2) Meet the DSM-5 diagnostic criteria for either bipolar and related disorders or depressive disorders; (3) The patient or legal guardian agreed to provide informed consent to participate in the study. The exclusion criteria included: (1) intellectual disability; (2) organic brain disease or serious physical disease; (3) patients who had received electroconvulsive therapy (ECT) within 3 months before enrollment. Of note, one focus of the study was NSSI, therefore all patients underwent assessment for NSSI and were divided into two groups for further analysis.

The healthy control participants were students recruited from a middle school in Liaoning province. The inclusion criteria were: (1) ages between 10 and 19 years old; (2) No known history of mental illness or personality disorder; (3) Denied a history of NSSI; (4) The student or their guardians agreed to provide informed consent. The exclusion criteria were: (1) those with organic brain disease or serious physical disease; (2) Positive family history of mental illness.

The study was approved by the ethics committee of Beijing Anding Hospital affiliated with Capital Medical University and carried out according to the declaration of Helsinki (32). Before inclusion in the study, we received written informed consent from all participants and their parents/legal guardians.

2.2 Measures

The clinical diagnoses were made by certified psychiatrists and patients were approached by trained research staff. The purpose and significance of the study were fully explained to them by staff and research staff collected data from patients and healthy controls. Some research instruments were self-administered by participants (see below). All researchers participating in the assessment underwent consistency training.

2.2.1 Sociodemographic variables

Sociodemographic variables were assessed using a brief questionnaire covering sex, age, race, education levels, academic records, only child status, family structure, parental education, and family income.

2.2.2 Non-suicidal self-injury behavior

We evaluated NSSI according to the diagnostic criteria for NSSID in the *DSM-5* (1): (1) engagement in NSSI on 5 or more days in the past year; (2) the expectation that NSSI will solve an interpersonal problem, provide relief from unpleasant thoughts and/or emotions, or induce a positive emotional state; (3) the NSSI is not socially sanctioned or restricted to minor self-injurious behaviors; (4) the presence of NSSI-related clinically significant distress or interference across different domains of functioning. Subjects assessed for NSSI diagnosis were included in the group with NSSI, and the rest were included in the group without NSSI.

2.2.3 The frequency and severity of NSSI

The engagement of NSSI was measured by responses to "Have you ever in your past 12 months purposefully hurt yourself without the intention of killing yourself," to which participants responded yes or no; this represented the outcome variable for primary analyses.

The frequency and severity of NSSI were evaluated using the Adolescents Self-Harm Scale (33). The scale contains 19 items, including 18 types of intentional NSSI and an open question. The number of NSSIs and the degree of physical injury were evaluated. The number of NSSI was divided into the following four levels: 0 times, 1 time, 2–5 times, 5 times, and above; The degree of injury to the body was classified into 5 levels: none, mild, moderate, severe, and extremely severe. The total score of NSSI behavior is multiplied by the number of NSSI times the level of injury degree. A higher total score indicates a higher severity of self-injury. The homogeneity coefficient of the questionnaire was 0.85, which had good reliability and validity (18).

2.2.4 Self-compassion scale-Chinese version

The Self-Compassion Scale (SCS) (34) is the most common instrument to evaluate self-compassion, combining the positive and negative subscales of the SCS, termed self-compassion (self-warmth) and self-criticism (self-coldness) respectively, has been demonstrated to be a valid way of measuring self-compassion through factor analysis (35–38) The Chinese version has been tested and shown with good reliability and validity (39).

2.2.5 Emotional regulation

The Emotional Regulation Questionnaire (ERQ) consists of 10 items and contains two dimensions (24): cognitive reappraisal (6 items) and expressive suppression (4 items). The ERQ employs a 7-point Likert scale, with higher scores reflecting more frequent use of the respective emotional regulation strategy. The Chinese version has shown excellent psychometric properties (40).

Participants completed the questionnaire, and the research staff could help them only if they had any questions about its instructions or content.

2.3 Statistical analysis

We used the SPSS21.0 statistical software package and Mplus8.3 for statistical analysis. Categorical data were expressed as [number of cases (%)], and measurement data as [mean ± standard deviation]. Chi-square tests and Single factor analysis of variance were used to compare the differences among the three groups. Correlation analysis, multiple linear regression, and binary logistic regression were used to investigate the relationship between the above variables and NSSI (Yes/No). We set $\alpha = 0.05$ as the inspection level and $p < 0.05$ as the significant difference.

3 Results

3.1 Participant and procedure

We recruited 248 adolescents with mood disorders in outpatient and inpatient settings, 196/248 (79%) reported a history of NSSI, and 52 denied NSSI, and 212 healthy controls in a middle school. Participants were predominantly female ($n = 292$, 63.5%) and with a mean age of 15.63 (SD = 1.67).

The majority (53.3%) of the sample was in high school, with others identifying as middle school or below (37.9%) or college or higher (7.4%). The remaining 1.5% of participants did not provide information regarding their education. Nearly half (48.9%) of the sample regarded their academic records as average, and others rated their academic performance as excellent (6.7%), good (22.0%), poor (15.4%), and very poor (7.0%), respectively. The majority of participants (52.6%) grew up as an only child, and 82.8% grew up in a core family. Nearly half of the participants' parents had middle school or below education (father: 44.3%, with one lacked information; mother: 43.7%). Supplementary Table S1 shows the comparisons of the demographic data of the three groups.

3.2 The assessment of NSSI behavior

There were 196 subjects in the NSSI group, 83.7% were female, and 91.8% had a high school education or below. The family structure of 83.7% of subjects was core family. The score distribution of the Self-Injury Questionnaire in participants is shown in Figure 1. The most frequent NSSI behaviors were as follows: scratching the skin with glass (83.2%), hitting the wall or something hard by hand (83.2%), scrapping the skin to bleed (78.6%), or poke the wound to prevent healing (62.8%), scratch themselves (62.8%) (see Table 1).

The evaluation results of NSSI scores in the NSSI group showed that a higher total score indicates a higher severity of self-injury. It can be seen from the score distribution in this study that the NSSI of most participants was at a low level (see Figure 1).

3.3 Intergroup comparison of scores related to emotional regulation

Multivariate analysis of variance showed that there were significant differences in the scores of ERQ and cognitive reappraisal scores among the three groups, but no statistical differences were found in expressive suppression scores among the three groups. The Bonferroni correction was used and we found that, in terms of cognitive reappraisal dimension, the score of the NSSI clinical group was significantly lower than that of the clinical group without NSSI ($p < 0.01$), and the score of the non-NSSI group was significantly lower than that of the healthy group ($p < 0.01$). See Table 2 for details.

3.4 Intergroup comparison of scores related to self-compassion

Multivariate analysis of variance showed that there were significant differences in the total scores of SCS, self-warmth, and self-coldness among the three groups.

After Bonferroni corrections, we found that the scores of self-warmth were significantly lower ($p < 0.01$) in those with NSSI ($M = 32.08$, SD = 8.17) compared to those without ($M = 36.75$, SD = 10.46) and healthy controls ($M = 44.32$, SD = 7.68). The scores of self-coldness were significantly higher ($p < 0.01$) in patients with NSSI ($M = 52.06$, SD = 7.60) compared to those without NSSI ($M = 47.88$, SD = 10.81) and healthy controls ($M = 37.31$, SD = 8.39). See Table 2 for details.

3.5 Correlations between main variables

Table 3 shows the correlation results between NSSI behavior and the main variables. Variables significantly correlated with the NSSI behavior were cognitive reappraisal, expressive suppression, self-warmth, and self-coldness. Furthermore, both the total scores of ERQ and SCS also significantly correlated with NSSI.

3.6 The analysis of the mediating effect model

We examined the potential mediating effects of self-compassion on the association between emotional regulation and NSSI.

Step 1: To test the predictive effect of the independent variable on the dependent variables. Logistic regression analysis showed that the regression equation had statistical significance ($\chi 2 = 75.74$, $p < 0.01$), and the joint explanatory power (R^2) was 0.15. Cognitive reappraisal negatively predicted NSSI (OR = 0.88, $p < 0.01$), meaning the probability of NSSI would decrease by 12% for every increase by 1 in the cognitive reappraisal score. Thus, cognitive reappraisal was a protective factor for NSSI.

Step 2: To test the predictive effects of independent variables on mediating variables. Linear regression analysis showed that the equation was statistically significant ($F_{\text{self-warmth}} = 311.99$, $p < 0.01$, $R^2 = 0.41$; $F_{\text{self-coldness}} = 92.29$, $p < 0.01$, $R^2 = 0.17$). Cognitive reappraisal positively predicted self-warmth ($B = 0.87$, $p < 0.01$), and negatively

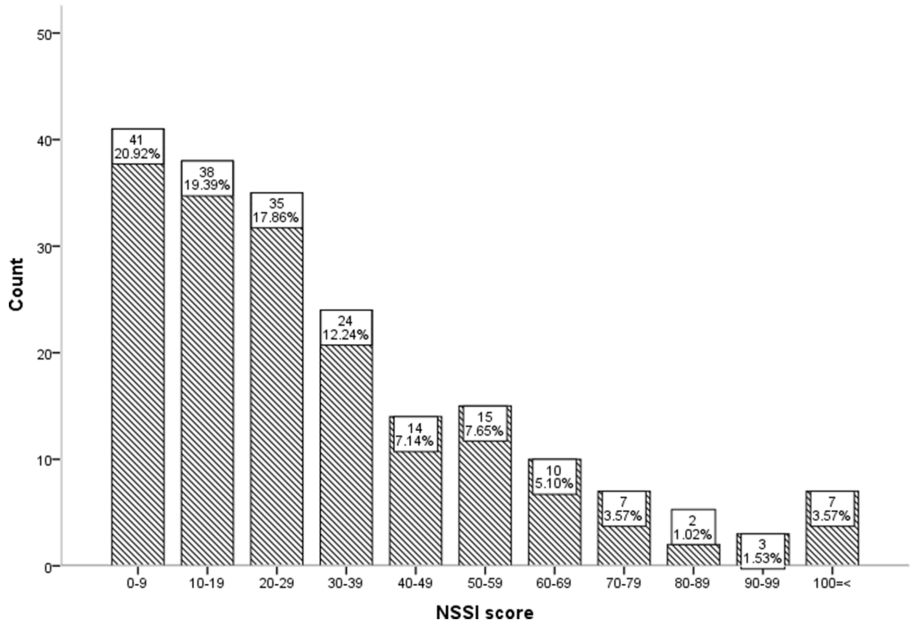

FIGURE 1
Distribution of NSSI scores in the NSSI Group.

TABLE 1 Means of NSSI.

NSSI	%
Scratch the skin with glass	83.2
Hit the wall or something hard with their hand	83.2
Scrape the skin to cause bleeding	78.6
Intentionally poke a wound to delay its healing	62.8
Scratch themselves	62.8
Pull out their hair	53.1
Tighten their wrist and other parts with a rope	46.4
Bite themselves	45.9
Hit an object on the head	45.4
Rub the skin to cause bleeding	43.9
Strike themselves	42.9
Pierce objects into the skin or underneath nails	38.3
Inscribe words or patterns on their body	37.2
Prick their body with needles, nails, etc.	31.6
Allow others to hit or bite them	30.6
Burn/scald the skin with cigarette butts, lighters, etc.	14.8
Touch a flame or ignite it with tthe hand	10.2
Expose themselves to electric shock	5.6

predicted self-coldness ($B = -0.61$, $p < 0.01$). The regression analysis of self-warmth to self-coldness showed that the regression equation had statistical significance ($F = 260.14$, $p < 0.01$), $R^2 = 0.36$. Self-warmth negatively predicted self-coldness ($B = -0.65$, $p < 0.01$).

Step 3: Included mediating variables to test the predictive effect of independent variables and mediating variables on the dependent variable. Logistic regression analysis results were shown in Table 4, the total regression equation had statistical significance ($\chi 2 = 216.66$, $p < 0.01$), $R^2 = 0.38$. Self-warmth negatively predicted NSSI behavior (OR = 0.93, $p < 0.01$). Self-coldness positively predicted NSSI behavior (OR = 1.12, $p < 0.01$). However, cognitive reappraisal was no longer significant in predicting NSSI behavior ($p = 0.098$).

Mplus 8.3 was used to analyze the specific indirect effects of the mediation effect model, and the product distribution method was used to obtain 95% CI. It showed that self-warmth had a significant mediating effect between cognitive reappraisal and NSSI behavior in Route 1. In Route 2, self-coldness had no significant mediating effect between cognitive reappraisal and NSSI behavior. In Route 3, self-warmth and self-coldness had a chain mediating effect between cognitive reappraisal and NSSI behavior. See Table 5.

We also tested the mediating effects of self-warmth and self-coldness between expressive suppression and NSSI behavior. Logistic regression analysis showed that the regression equation had no statistical significance ($\chi 2 = 3.66$, $p > 0.05$), $R^2 = 0.01$, and expressive suppression was not significant in predicting NSSI (OR = 1.04, $p > 0.05$).

4 Discussion

To the best of the authors' knowledge, this is the first study to use the two-factor model of self-compassion in a clinical sample of adolescents with mood disorders and NSSI in mainland China.

We examined the frequency and patterns of NSSI in this large clinical sample. We also investigated whether emotional regulation and self-compassion were associated with NSSI and the effects of

TABLE 2 Means, standard deviations across groups, and ANOVA between-subject effects on emotion regulation and self-compassion dimensions.

Variables	NSSI group ($N = 196$) M ± SD	Non-NSSI group ($N = 52$) M ± SD	Healthy group ($N = 212$) M ± SD	F	*Post-hoc*
ERQ total score	38.82 ± 8.79	41.31 ± 9.81	44.25 ± 9.54	17.58**	1 < 3
Cognitive reappraisal	21.46 ± 6.77	24.31 ± 7.85	27.97 ± 6.28	48.43**	1 < 2 < 3
Expressive suppression	17.36 ± 5.22	17.00 ± 5.71	16.29 ± 5.01	2.22	
SCS total score	58.02 ± 13.25	66.87 ± 18.84	85.00 ± 12.73	199.10**	1 < 2 < 3
Self-warmth	32.08 ± 8.17	36.75 ± 10.46	44.32 ± 7.68	113.19**	1 < 2 < 3
Self-coldness	52.06 ± 7.60	47.88 ± 10.81	37.31 ± 8.39	161.83**	1 > 2 > 3

ERQ, Emotion Regulation Questionnaire; SCS, Self-compassion Scale. * = $p < 0.05$, ** = $p < 0.01$. 1 = NSSI group, 2 = Non-NSSI group, 3 = Healthy group.

TABLE 3 Correlations analysis among variables in all samples (including healthy controls).

Variables	1	2	3	4	5	6	7
1 ERQ Cognitive reappraisal	-						
2 ERQ Expressive suppression	0.12*	-					
3 ERQ total score	0.83**	0.59**	-				
4 SCS Self-warmth	0.63**	−0.05	0.47**	-			
5 SCS Self-coldness	−0.41**	0.20**	−0.22**	−0.61**	-		
6 SCS total score	0.58**	−0.14**	0.38**	0.88**	−0.91**	-	
7 NSSI behavior	−0.41**	0.10*	−0.26**	−0.55**	0.58**	−0.64**	-

ERQ, Emotion Regulation Questionnaire; SCS, Self-compassion Scale. * = $p < 0.05$, ** = $p < 0.01$.

TABLE 4 Analysis of the effects of cognitive reappraisal, self-warmth, and self-coldness on NSSI behavior.

Variable	B	S.E.	P	OR	95%CI
Reappraisal	−0.04	0.02	0.098	0.97	0.93 ~ 1.01
Self-warmth	−0.08	0.02	0.000	0.93	0.89 ~ 0.96
Self-coldness	0.11	0.02	0.000	1.12	1.08 ~ 1.15
Constant	−1.53	1.09	-	-	-

B, Regression coefficient; S.E., Standard error of the coefficient; P, Probability value (significance level); OR, Odds ratio. 95%CI: 95% confidence interval for the odds ratio.

self-compassion and emotional regulation on the occurrence of NSSI. We replicated and extended previous findings and provided data to support the roles of emotional regulation and self-compassion in NSSI among adolescent patients with mood disorders.

4.1 The key features of NSSI in adolescent patients with mood disorders

Consistent with the findings in the literature, we found in our clinical samples that NSSI is a common occurrence among those with mood disorders (41, 42). We also found that NSSI was more frequently seen in female patients, in concordance with previous studies (43). Previous studies have found gender differences in the ability and style to regulate negative emotions. During socialization, men and women face different expectations and also develop different emotional needs. Men are generally more likely to use emotional regulation strategies of cognitive reappraisal, while women are more likely to use rumination and are more prone to NSSI. Female adolescents who engaged in NSSI mainly did so for emotional regulation and self-control, while male adolescents were more likely to seek impulsive pleasure. The possible explanations for gender differences in adolescent NSSI include (a) biological factors: hormonal (e.g., androgens and estradiol) differences between males and females may influence gender effects on NSSI; (b) social differences in emotion regulation strategies between males and females: research has shown that females were more likely than males to engage in emotion regulation strategies, and NSSI was of the strategies.

4.2 Emotional regulation and NSSI

Emotional dysregulation is generally agreed to be an important risk factor for NSSI16. In our study, we showed that adolescents with mood disorders who reported NSSI were less likely to utilize cognitive re-appraisal, and cognitive reappraisal was significantly inversely correlated with NSSI. This is consistent with previous findings. Voon et al. noted that greater use of cognitive reappraisal was associated with a lower frequency and medical severity of NSSI (44, 45). Cognitive re-appraisal is often considered more adaptive compared with expressive suppression in maintaining psychological well-being and functioning (46).

Contrary to the findings on cognitive reappraisal and NSSI, there was no statistical difference in expressive suppression scores among the three groups, while expressive suppression was significantly positively correlated with NSSI. Previous studies also found that NSSI was associated with a higher level of expression suppression (47). Of note, our sample was a group of Chinese adolescents, and the Chinese

TABLE 5 The mediating effects of self-warmth and self-coldness.

Route	Value	95%CI	Relative/%
Route 1: Cognitive reappraisal-(self-warmth)-NSSI	0.872*(−0.078) = −0.068	−0.11 ~ −0.03	40.00
Route 2: Cognitive reappraisal-(self-coldness)-NSSI	−0.066*0.109 = −0.007	−0.03 ~ 0.01	4.12
Route 3: Cognitive reappraisal-(self-warmth)-(self-coldness)-NSSI	0.872*(−0.623)*0.109 = −0.059	−0.09 ~ −0.04	34.71
Total indirect effect	−0.135	−0.18 ~ −0.10	79.41
Direct effect	−0.035	−0.08 ~ 0.01	20.59
Total effect	−0.17	−0.22 ~ −0.13	-

Values in the 'Value' column are computed by multiplying the coefficients of the specified mediation routes. 95%CI: 95% confidence interval for the odds ratio.

culture is well known to discourage the expression of one's inner emotions. A few studies suggested that individuals from Eastern, interdependent cultures (e.g., Chinese) tend to down-regulate their emotions using emotional suppression strategies to preserve interpersonal harmony (48–50). One previous study suggested that expressive suppression decreases emotion responding more rapidly than cognitive reappraisal (51), but it may lead to increased negative affect and increased risk of NSSI and could lead to detrimental long-term consequences (22, 52, 53).

This corroborates with the findings of earlier research that those engaging in NSSI have a deficiency in their ability to regulate emotions (54, 55). Empirical studies on the link between emotional dysregulation and NSSI generally support their association (19). Findings from a meta-analysis suggested that higher levels of emotional dysregulation in all eight dimensions were associated with increased risk of NSSI, emotional reactivity, and limited access to effective emotion-regulating strategies were most strongly associated with NSSI (19). All dimensions of emotional dysregulation were associated with NSSI engagement, but different dimensions of emotional dysregulation varied in their strengths of associations with NSSI (19). More research needs to be conducted to understand the correlation between different dimensions of emotional regulation and NSSI.

4.3 Self-compassion and NSSI

We found significant differences in the scores of self-warmth and self-coldness among the three groups. Self-warmth was negatively correlated with NSSI; self-coldness was positively correlated with NSSI. Adolescents with higher levels of self-coldness and lower levels of self-warmth were more likely to engage in NSSI. Earlier research also showed that people with a higher level of self-criticism and aversion to compassion for themselves are more apt to engage in NSSI (15, 28, 56). It suggested that those who tend to be overly harsh on themselves, isolating themselves and deeply connecting with negative emotions, may be more vulnerable to NSSI.

Self-criticism plays an important role in understanding vulnerability to NSSI in Chinese adolescents. In mainland China, self-criticism was found to predict depression through the mediating role of a specific stressor (57). Emotional disposition characterized by a harsh self-critical attitude and an inability to experience compassionate feelings toward the self may make adolescents more likely to fall into negative emotional states in the face of stressful life events (15). NSSI may emerge as an attempt to punish and condemn the self-viewed as bad, flawed, unworthy, and undesirable, and to regulate negative emotions linked to this hated self (15). Self-punishment has often been subsumed by the positive reinforcement function of NSSI (22). Laboratory studies have shown that factors such as self-criticism or self-punishment motivation instantiate the desire for pain and punishment (58). Hooley et al. found that only self-criticism was significantly associated with pain endurance (59).

Self-compassion involves aspects of a self-to-self relationship (i.e., how individuals emotionally respond, cognitively understand, or pay attention to their suffering) and is not focused on a self-to-other relationship (25). Self-compassion may operate as an adaptive psychological process and useful emotional regulation strategy that can cope with adverse or difficult situations (25, 56, 60). A recent study demonstrated that a greater capacity for self-compassion was associated with reduced occurrences of self-harm behaviors (61). Xavier et al. found that fear of self-compassion was a significant independent contributor to predicting the frequency of NSSI among adolescents (62).

4.4 Self-compassion as a mediator between emotional regulation and NSSI

We found that adolescents with lower levels of self-warmth and higher levels of self-coldness were more likely to engage in NSSI, and we showed that self-warmth was a significant mediator between cognitive reappraisal and NSSI engagement in all three subsets. Furthermore, the mediating role of self-warmth between cognitive re-appraisal and NSSI engagement was validated by the mediation analysis of the subset only including adolescents with mood disorders and NSSI, in which self-warmth fully mediated the relationship between cognitive re-appraisal and NSSI severity. These findings indicated that individuals with higher levels of self-warmth may be better able to utilize cognitive re-appraisal strategies to manage negative emotions and reduce the likelihood of self-injury.

Previous studies have shown that individuals who struggle with emotional regulation are more likely to engage in NSSI (17, 22). Our results suggest that self-compassion plays an important mediating role in the relationship between emotional regulation and self-injury, which has rarely been included in earlier studies (28, 29). By providing a more accepting and self-friendly approach to emotional experience, self-compassion may act as a protective factor to reduce the negative impact of emotional regulation difficulties on NSSI (28,

56, 63–66). The mediating role of self-compassion may suggest that adolescents with high levels of self-compassion are more likely to use strategies such as mindfulness and self-kindness to regulate their emotions rather than resort to self-injury. Although self-compassion cannot cure NSSI, it can be a valuable tool for managing and reducing the incidence of NSSI.

Notably, we showed that self-warmth and self-apathy adequately mediated the relationship between cognitive reappraisal and self-injection-related behavior, respectively, in subgroups including adolescents with mood disorders and NSSI adolescents and healthy controls. Given that self-warmth and self-coldness are two dimensions of self-compassion and are highly correlated, no strong conclusions can be drawn about their relative importance. Previous studies have found that individuals with lower levels of self-coldness in a community sample may be better at managing their emotions, and emotional dysregulation adequately mediates the relationship between self-coldness and NSSI (58).

The findings of our mediation analysis both confirm and extend previous studies. Although previous studies conducted in college and community settings have shown that emotional dysregulation fully mediates the relationship between self-coldness and NSSI (28). The current study using a clinical sample confirmed that both self-warmth and self-coldness are complete mediators between emotional regulation and self-injury.

5 Limitations

Our findings should be interpreted in light of the following limitations. First of all, although we approached all patients in the outpatient clinic and inpatient unit, our sample may not be reflective of all clinical patients in the same period. We made all potential participants aware that one of the research focuses was NSSI and this might have attracted more patients NSSI to participate in the study as evidenced by the high number in the NSSI group and relatively low number in the non-NSSI group. Second, we matched the three groups on age and family structure. However, due to the difficulty in collecting samples from the healthy control group, we could not control for other factors that might influence the psychological status of adolescents, such as gender distribution, only-child status, and parental education level. Thus, caution is needed when generalizing the findings of this study. Third, as it is well-documented, NSSI is frequently associated with borderline personality disorder (67) which may also be associated with the measures of emotional regulation and self-compassion. Unfortunately, due to the time limit of the assessments, we were unable to collect data on the diagnosis. Our findings represent a general overview and may not account for nuances or specific characteristics associated with particular mood disorders or personality disorders. Future research with a more detailed categorization of disorder types could provide insights into the relationship between specific disorders and the variables of interest in our study. Finally, like all cross-sectional, self-report studies, this study shares the same limitations, such as recall bias, difficulty in inferring causality, etc.

6 Clinical implications

Our findings highlight the role of self-compassion in the relationship between cognitive re-appraisal and NSSI, which may have several implications. One of the main approaches of all treatment strategies for individuals with emotional regulation difficulties is to improve the awareness of these individuals about the processes they use to perceive and regulate emotions (17). Based on our results, therapies that enhance self-compassion and cognitive restructuring would be beneficial for improving emotion regulation and reducing maladaptive emotional regulation processes (e.g., dissociation, rumination, and self-criticism) in this population. Compassion-focused approaches (68) may be especially suitable for addressing fears of compassion and increasing distress tolerance in adolescents with NSSI (22).

7 Conclusion

In conclusion, we found that NSSI was prevalent in adolescents with mood disorders, especially among girls and those with lower levels of education. Our findings also suggest that emotional dysregulation is a common risk factor for NSSI (29, 69), while self-compassion is a potentially protective factor against NSSI (15, 56). Self-compassion may be an adaptive way of coping with emotions that helps prevent negative self-schema from being activated after experiencing negative emotions. Based on our findings, interventions targeting emotional regulation, mindfulness, and self-compassion skills to patients may be important for treating NSSI patients. Especially for female adolescent patients, teaching them about cognitive reappraisal strategies and self-compassionate attitudes may be beneficial. Future studies should be based on a larger sample and conduct prospective studies to explore the potential mechanisms, including psychological and neurobiological mechanisms, by which self-compassion affects the relationship between emotional regulation and NSSI in adolescents, to provide further information on the occurrence, maintenance, and recovery of NSSI.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

JL conceived the research hypothesis, designed the study, collected the data, and wrote the main part of this paper. J-tL assisted in the data collection and analysis and drafted the results section. MZ participated in the research design and the enrollment of subjects. SM participated in the enrollment of subjects. H-fL assisted in writing the background and discussion sections of the paper. Y-lT and Y-yF provided critical comments related to the interpretation of the study findings and revised the paper. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

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Emotion dysregulation links pathological eating styles and psychopathological traits in bariatric surgery candidates

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Objectives: Approximately one-third of bariatric surgery patients experience weight regain or suboptimal weight loss within five years post-surgery. Pathological eating styles and psychopathological traits (e.g., emotion dysregulation) are recognized as potential hindrances to sustain weight loss efforts and are implicated in obesity development. A comprehensive understanding of these variables and their interplays is still lacking, despite their potential significance in developing more effective clinical interventions for bariatric patients. We investigate the prevalence of and interactions between pathological eating styles and psychopathological traits in this population.

Materials and methods: 110 bariatric surgery candidates were characterized using the Binge Eating Scale (BES), Hamilton Depression/Anxiety Scales (HAM-D/A), Barratt Impulsiveness Scale (BIS-11), Experiences in Close Relationships (ECR), Difficulties in Emotion Regulation Scale (DERS). We analyzed these variables with multiple logistic regression analyses and network analysis.

Results: Patients with pathological eating styles showed more pronounced anxiety/depressive symptoms and emotion dysregulation. Network analysis revealed strong connections between BES and DERS, with DERS also displaying robust connections with HAM-A/D and ECR scales. DERS and attention impulsivity (BIS-11-A) emerged as the strongest nodes in the network.

Discussion: Our findings demonstrate the mediating role of emotion dysregulation between pathological eating styles and psychopathological traits, supporting existing literature on the association between psychopathological traits, insecure attachment styles, and pathological eating behaviors. This

research emphasizes the significance of emotion regulation in the complex network of variables contributing to obesity, and its potential impact on bariatric surgery outcomes. Interventions focusing on emotion regulation may thus lead to improved clinical outcomes for bariatric patients.

KEYWORDS

obesity, bariatric surgery, eating style, emotion regulation, network analysis

1 Introduction

Obesity is a metabolic and neuroendocrine condition characterized by an excessive accumulation or abnormal distribution of body fat, related to health complications. The etiology of obesity is complex and multifactorial, characterized by the interplay between biological and psychosocial factors (1). Bariatric surgery refers to a variety of inner gastrointestinal surgical techniques that were first intended to help patients who were morbidly obese lose weight. However, the advantages of bariatric surgery go far beyond weight loss and include a significant improvement in type 2 diabetes, hypertension, dyslipidemia, and a decrease in overall mortality. Bariatric surgeries, performed laparoscopically, can be classified into: restrictive (gastric banding and sleeve gastrectomy), malabsorptive (biliopancreatic diversion and mini gastric bypass) and mixed. Restrictive interventions are based on gastric volume reduction, malabsorptive ones are aimed at reducing the size of the stomach by modifying its digestive process, and mixed interventions, such as gastric bypass, reduce the volume of the stomach pouch and the surface area intestinal destined for absorption. Bariatric surgery has significant evidence of efficacy and safety (2) and it currently represents the best intervention for obesity in terms of weight reduction, complication control, and improvement of the quality of life (3).

A thorough psychological assessment, with particular attention to pathological eating styles, can be a useful clinical tool for managing treatment before and after bariatric surgery (4) In the present study, conducted on an Italian sample, we referred to the following taxonomy of eating styles proposed by the Italian Society of Surgery of Obesity and Metabolic Diseases: emotional eating, binge eating, qualitative eating, quantitative eating, gorging, and snacking (3). Details about the main pathological eating styles are provided in the Supplementary Material.

Preoperative psychological assessment is critical for bariatric surgery candidates, because it may help stratify patients based on risk of weight regain after surgery and other post-surgical outcomes (5). For an effective treatment for obesity, it is essential to consider and, ideally to treat, the underlying psychopathology maintaining abnormal eating styles (6). The psychological profile of obese patients is often characterized by anxious and depressive symptoms, impulsivity, insecure and poor attachment quality, low self-esteem, and body dissatisfaction (7). The presence of these psychopathological traits could lead to food consumption as a dysfunctional coping strategy in response to negative emotions, in absence of effective emotion regulation strategies, resulting in development of obesity (8). During the eligibility evaluation for bariatric surgery, emotion regulation and emotion recognition are seldom assessed, although neurobiological processes concerning self-regulation, including control over eating behaviors, are strongly influenced by emotions (9). Emotion regulation can be defined as the "attempt to influence which emotions we have, when we have them, and how these emotions are experienced or expressed" (10). If emotion regulation fails, self-regulation in other areas, like control over eating behaviors, may fail as well (11), hence the importance of emotion dysregulation in pathological eating behaviors, besides in other psychiatric disorders (12). Impulsiveness is also a common trait in patients who present dysregulation in food intake, especially those diagnosed with Binge Eating Disorder, whose psychological profile is characterized by significant impulsivity levels (13). Therefore, the exploration of emotion regulation and impulsivity is crucial in obese patients seeking bariatric surgery (14). Increasing evidence suggests that insecure attachment plays a crucial role in the development of obesity (15). Research indicates that insecure attachment, either anxious and avoidant, is positively associated with emotion dysregulation and can predict disordered eating behaviors, particularly in women (16, 17). In this regard, attachment history could be a key factor to consider in the prevention and treatment of overweight and obesity. Children whose caregiver is unreliable and unresponsive to their needs, may turn to food as a coping mechanism, in absence of alternative functional strategies to manage their emotions. This attitude frequently persists even into adulthood (18). In this regard we hypothesized that the main psychological factors which maintain pathological eating behaviors are emotion dysregulation, impulsivity, and insecure attachment styles.

Nevertheless, it is currently unclear how emotion dysregulation, impulsivity, and insecure attachment styles contribute to the development and maintenance of eating behaviors that can lead to obesity. Understanding these mechanisms is therefore relevant in order to improve bariatric surgery outcomes. To fill this gap, we

assessed psychopathological traits and eating behaviors in a sample of bariatric surgery candidates,and applied a network analysis to clarify the interplay between psychopathological traits and eating behaviors. A network statistical approach is essential for investigating the complex interplay between emotion regulation difficulties, pathological eating behaviors, and psychopathological traits in individuals who are candidates for bariatric surgery, as it enables the identification of key nodes within the network that can be targeted for intervention, leading to more effective treatments. A network analysis specifically allows to identify the variables within the psychological profile to be addressed for intervention to prevent weight regain, providing a framework that may help to improve the long-term outcomes of bariatric surgery (19).

2 Materials and methods

2.1 Population

110 consecutive subjects (mean age: 45.04 years, standard deviation: 10.44 years, 77% females) were prospectively recruited from the multidisciplinary obesity surgery center of the Fatebenefratelli Sacco Hospital in Milan, between January 2019 and December 2021. Subjects were included if they were scheduled for bariatric surgery, according to SICOb (the Italian Society of Surgery for Obesity and Metabolic Diseases) criteria for bariatric surgery (detailed in the Supplementary Material). They were excluded if they were younger than 18, if they did not speak Italian, or if they did not consent. They underwent a clinical interview to exclude any mental disorders comorbidity, to measure psychopathological traits, and to assess eating behavioral styles. Thus, for instance, patients were included if they presented binge eating style, but not if they presented the full-blown Binge Eating Disorder. Patients signed an informed consent, and their identity was protected. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Fatebenefratelli Sacco Hospital ("psycBAR36", 2020).

2.2 Eating behavioral styles and psychopathological traits

During the evaluation of the surgery eligibility, patients were thoroughly monitored through a multi-disciplinary medical consultation (with dietologists, gastroenterologists, psychiatrists, and psychologists). In particular, a psychiatrist (PL) and psychotherapist (MS) clinically assessed and classified the eating behavior styles for each subject, through detailed clinical interviews involving specific questions to assess the presence of the following eating behavioral styles: emotional eating, binge eating, quantitative, qualitative (or external) eating, gorging, and snacking. Details about such clinical interviews are provided in the Supplementary Material. Various psychopathological traits were investigated using specific clinical scores for psychopathological traits. The Difficulties in Emotion Regulation Scale (DERS) was employed to assess emotion regulation difficulties. The Hamilton Depression Scale (HAM-D) and Hamilton Anxiety Scale (HAM-A) were used to measure levels of depression and anxiety, respectively. To evaluate binge eating behaviors, we used the Binge Eating Scale (BES). Impulsivity was assessed using the Barratt Impulsiveness Scale (BIS-11), which was further divided into subscales. The subscales included: Attention (BIS-11, A), Motor impulsivity/impulsiveness (BIS-11, Im), Self-control (BIS-11, Ac), Cognitive complexity (BIS-11, Cc), Perseverance (BIS-11, P), and Cognitive Instability (BIS-11, IC). Attachment styles were evaluated using the Experiences in Close Relationships - Revised (ECR-R) scale, with two subscales of attachment styles for avoidance and anxiety (Av/An).

Details about these clinical scores for psychopathological traits are provided in the Supplementary Material.

2.3 Statistical analyses

The categorical variables were described by absolute and relative frequencies, while the continuous variables by means of median and interquartile range, given their non-Gaussian distribution (evaluated with the D'Agostino and Pearson tests). Differences in the distribution of clinical scale scores between patients with and without the different dysfunctional eating habits were analyzed with independent-samples Mann-Whitney U. After quantifying missing data (Supplementary Table 3), we used the multiple imputation method to generate five complete datasets. Then, six separate multiple logistic regression models (including the original dataset) were run on multiply imputed datasets, with eating behavioral styles (quantity, quality, snack, gorge, binge, emotional eating) as dependent variables and gender and psychopathological traits (DERS, HAM-D/A, BES BIS-11, ECR-R) as independent variables. The results of the six analyses were then combined and we report below the results of the pooled analysis after multiple imputation. Statistical analyses were run in SPSS© version 23. We adjusted the results for multiple comparisons using the Bonferroni correction for multiple comparison. In our case, the adjusted significance threshold is a p_{corr} value of 0.05/6 = 0.008.

To examine the relationship between eating disorder-specific scales (BES), psychiatric scales (HAM-D and HAM-A), and psychological/personality scales (BIS-11, ECR-R, and DERS), in our sample of candidates to bariatric surgery, we applied network analysis in R (https://www.Rproject.org/, version 3.6.3.), following the methods outlined in the tutorial paper by Epskamp et al. (2017) (20). This method mainly employs the free R packages *bootnet* and *qgraph*. In summary, a pairwise Markov random field network model was employed, allowing for the estimation of undirected edges, without implying any causal inference or direction in association, along with their accuracy. Additionally, centrality indices of nodes were estimated to determine their stability among the variables composing the network. The data used in the model were cross-sectional and did not follow a normal distribution. To address this, a "nonparanormal transformation" (20) was applied to convert the data into normally distributed form. In order to retain more robust edges in our sample and ensure interpretability, a "least absolute shrinkage and selection operator" (21) regularization technique was utilized. Furthermore, the Extended Bayesian Information Criterion (22, 23) was set to 0.5.

Lastly, robustness analyses were performed using the R package *bootnet* to ensure the stability and precision of the results. To evaluate the accuracy of the estimated edges, nonparametric bootstrapping (24) was performed, providing confidence intervals at the 95% level. To assess the role of each variable in the network, we calculated three centrality indexes (node strength, closeness, and betweenness). Node strength is a measure of how strongly a variable (which constitutes a node) is directly connected to other variables in the network (i.e. the total weighted connections that a variable has with other variables in the network) (25). Closeness centrality, i.e. the inverse of the sum of distances between the focal node and all other nodes in the network, measures how quickly information spreads from one variable to others in the network. The higher the closeness centrality value, the more central a variable is within the network, since variables with a high closeness score present the shortest distances to all others (26). Betweenness centrality quantifies the extent to which a variable acts as a bridge or mediator between other variables in the network, by measuring the number of times a node lies on the shortest path between other nodes. A higher betweenness centrality value suggests that the variable plays a crucial role in connecting different parts of the network (25).

3 Results

3.1 Characteristics of the sample

Our sample included 85 women and 25 men (total: 110, median age 47 years). The most frequent pathological eating style was the achievement of gratification with large quantity of food (n=78, 70.9%), followed by emotional eating (n=74, 68.5%), achievement of gratification based in food quality (very salty or sweet) (n=66, 60%), snacking (n=59, 53.6%), gorging (n=46, 41.8%), and binge eating (n=18, 16.4%). In 92.7% of cases (n=102) patients presented 2 or more pathological eating behaviors. 31.9% (n=30) of patients showed moderate to severe BES scores (Table 1).

3.2 Distribution of psychopathological traits between eating styles

As detailed in Supplementary Tables 2A–F, we compared the distribution of psychopathological traits between patients with and without the different dysfunctional eating styles.

Higher scores in different BIS-11 domains were found among patients with gorging than in those without this eating style (BIS-11, A, attention, p=0.012; BIS-11, Im, motor impulsivity, p=0.029; BIS-11, Ac, self-control, p=0.001; BIS-11, P, perseverance, p=0.031).

Patients with binge and emotional eating showed higher scores in: BES (respectively, p<0.001 and p=0.030); ECR-R (avoidant: respectively, p=0.038 and p=0.051; anxious: respectively, p=0.019 and p=0.009); DERS (respectively, p=0.038 and p=0.056); HAM-D (p=0.012 and p=0.001) and HAM-A (p=0.012 and 0.001). Patients seeking quantitative gratification have higher scores in HAM-A (p=0.014).

The following findings survived adjustment for multiple comparisons: higher scores in BIS-11, Ac (self-control) among patients with gorging eating style (U=1220, p_{corr}<0.008); higher scores in BIS-11, A (attention, U=545, p_{corr}<0.008) and Im (motor impulsivity, U=518, p_{corr}<0.008) among patients with qualitative eating style; higher scores in BES among patients with binge eating style (U=918, p_{corr}<0.001); and higher scores in HAM-D (U=1422, p_{corr}=0.001) and HAM-A (U=1421, p_{corr}=0.001) in patients with emotional eating style.

3.3 Results of logistic regressions

The logistic regression analysis yielded several significant findings before correction for multiple comparisons (Supplementary Table 4). For a one-unit increase in BIS-11-Ac (self-control domain of BIS-11), the odds of gorge eating style increased by 24% (95% CI [1.003, 1.53], p=0.047). For a one-unit increase in BES, the odds of binge eating style increased by 19% (95% CI [1.024, 1.374], p=0.024). Lastly, males were almost 5 times more likely to have a quantitative eating style as compared to females (95% CI [1.053, 22.099]), while their odds of having an emotional eating style were 24% lower (95% CI [0.076, 0.748]). There were no other significant findings.

TABLE 1 Sample characteristics, Continuous variables: Difficulties in Emotion Regulation Scale (DERS), Experiences in Close Relationships Questionnaire - Revised-Avoidance/Anxiety (ECR-Av/An), Hamilton Depression Scale (HAM-D), and Hamilton Anxiety Scale (HAM-A), Binge Eating Scale (BES), Barratt Impulsiveness Scale (BIS-11). BIS-11 is further divided into factors, including Attention (BIS-11, A), Motor impulsiveness (BIS-11, Im), Self-control (BIS-11, Ac), Cognitive complexity (BIS-11, Cc), Perseverance (BIS-11, P) and Cognitive Instability (BIS-11, IC).

Variable	Mean (SD)	Median (25%-75% percentile)
Age	45.04 (10.44)	47.00 (36.50-53.50)
BES	*13.46 (8.64)*	13.00 (6.75-20.00)
BIS-11, A	*12.51 (3.92)*	13.50 (9.25-16.00)
BIS-11, Im	*17.94 (6.23)*	19.00 (12.00-23.75)
BIS-11, Ac	13.18 (3.32)	14.00 (11.00-15.00)
BIS-11, Cc	*12.95 (2.97)*	13.00 (11.25-15.00)
BIS-11, P	10.08 (3.42)	11.00 (7.00-13.00)
BIS-11, Ic	*7.81 (2.77)*	8.00 (6.00-10.00)
BIS-11, Total	*74.48 (17.79)*	80.50 (57.25-88.75)
ECR-Av-mean	3.00 (1.00)	3.00 (2.22-3.61)
ECR-An-mean	*5.82 (2.28)*	5.58 (4.20-7.11)
ECR-Av	53.01 (18.01)	53.00 (40.00-65.00)
ECR-An	*54.41 (22.19)*	52.00 (38.00-67.00)
DERS	80.05 (23.98)	76.00 (60.75-95.00)
HAM-D	*10.81 (7.97)*	9.00 (5.00-16.00)
HAM-A	*10.88 (8.58)*	9.00 (4.00-14.00)

No result of the logistic regression analysis survived adjustment for multiple comparisons.

3.4 Results of network analysis

3.4.1 General characteristics of the network structure

The network includes the following psychopathological traits: DERS, HAM-D/A, BES, BIS-11, ECR (Figure 1). The correlation matrix between the variables is shown in Supplementary Figure 1.

Network structure showed that all psychopathological traits were connected, either directly or indirectly, with each other through positive associations. However, psychopathological traits within the same domain were generally connected more strongly than across domains. For instance, impulsiveness scores formed an interconnected cluster that was almost isolated from the rest of the network, apart from a weak connection with BES and DERS. HAM-D and HAM-A were strongly interconnected with each other, as well as ECR-R scores. Regarding connections across domains, BES was most strongly connected with DERS, which was in turn robustly connected with HAM-A/D and ECR-R. This pattern of connectivity was confirmed by the network showing that the shortest path between the BES and HAM-A/D scales was indeed through DERS (Figure 2).

3.4.2 Centrality indexes

According to the centrality indexes analysis (Figure 3), the strongest nodes in the network were DERS and BIS-11-A (Attention impulsivity). Of note, the high node strength of BIS-11-A seems to be due to the strong connections within the BIS-11 subscores, while DERS strength derives mainly from diverse connections with the remaining variables. BIS-11-C, BIS-11-Ac, and BES had the lowest node strengths.

Closeness and betweenness were highly correlated in the network. This correlation indicates that the variables that are influential in spreading information quickly throughout the network (high closeness centrality) are also likely to be important in facilitating communication and interactions between different nodes (high betweenness centrality).

The variables with highest closeness and betweenness were DERS, BIS-11-C, BIS-11-Ac, and BES.

These variables act therefore as critical intermediaries, linking different clusters or groups within the network and enabling the flow of information between them.

Further details on stability of centrality indices (Supplementary Figure 3), as well as networks showing the shortest paths between BES and other variables are available in Supplementary Information (Supplementary Figures 4-6).

3.4.3 Robustness analysis

We assessed the accuracy and stability of edge-weights through robustness analyses (Supplementary Figure 2). These analyses employed bootstrapped confidence intervals for estimated edge-weights within the network encompassing ED-specific scales (BES), psychiatric scales (HAM-D and HAM-A), and psychological and personality scales (BIS-11, ECR, and DERS). These robustness analyses revealed the presence of relatively wide bootstrapped confidence intervals, suggesting a need for caution, especially when interpreting weaker edges. However, it's noteworthy that the sample values predominantly fall within the bootstrapped confidence intervals, and the bootstrap mean values generally align well with the sample values. These outcomes collectively indicate reasonably accurate estimations and offer results that can be sensibly interpreted.

The average correlations between centrality indices (strength and betweenness) were examined across networks generated by dropping varying proportions of the data through 2500 iterations.

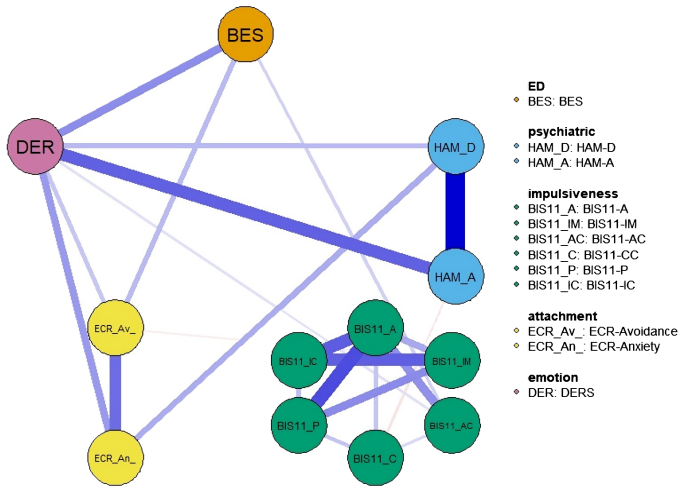

FIGURE 1
Network structure. The variables include eating disorder-specific scales (BES), psychiatric scales (HAM-D and HAM-A) and psychological and personality scales (BIS-11, ECR and DER). Item groups are differentiated by color. Edge colors represent the direction of associations (blue for positive, red for negative), and edge widths indicate the strength of these associations.

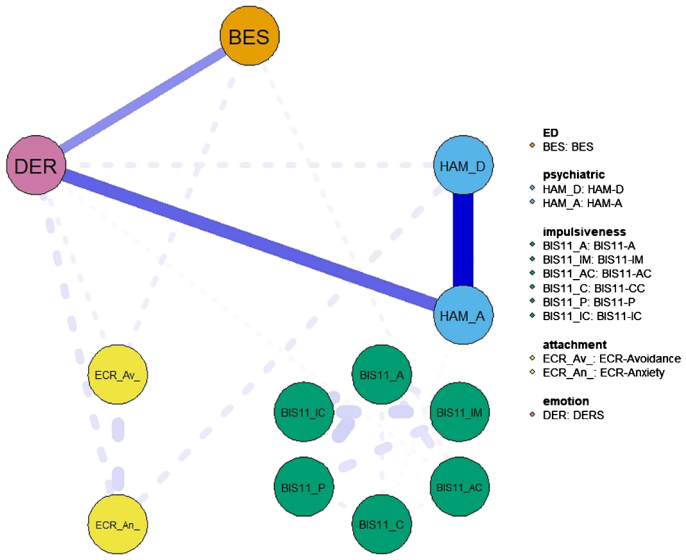

FIGURE 2
Network showing the shortest path between the BES and Hamilton depression and anxiety scales. The variables include eating disorder-specific scales (BES), psychiatric scales (HAM-D and HAM-A) and psychological and personality scales (BIS-11, ECR and DER). Item groups are differentiated by color. Edge colors represent the direction of associations (blue for positive, red for negative), and edge widths indicate the strength of these associations.

The findings indicate that the central stability coefficient, which signifies the maximum drop proportions necessary to maintain a correlation of 0.7 in at least 95% of the sample, was 0.365 for strength and 0 for betweenness (Supplementary Figure 3). It is important to note that networks with dependable centrality should exhibit a stability coefficient equal to or greater than 0.25, ideally surpassing 0.5 for centrality estimates (27). Consequently, particular caution is warranted when interpreting these results and the centrality of betweenness, which may lack stability.

4 Discussion

The purpose of the present study is to provide novel evidence on the association between pathological eating styles and

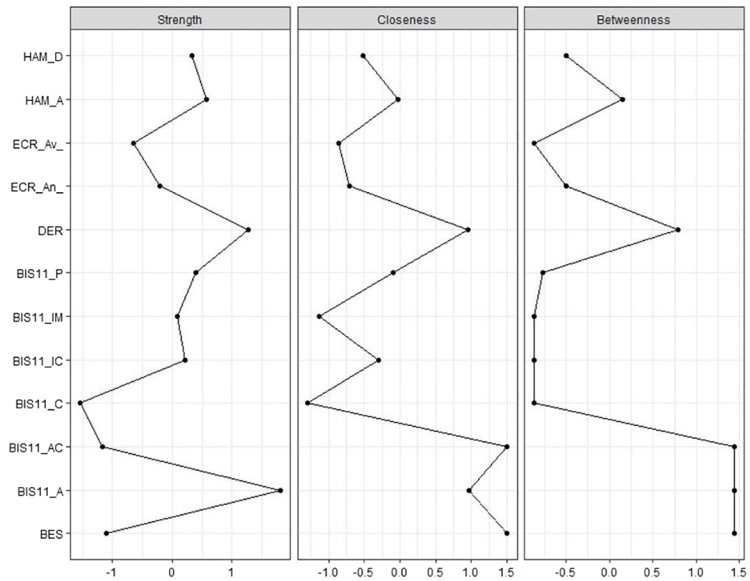

FIGURE 3
Centrality indexes (node strength, closeness and betweenness) of eating disorder-specific scales (BES), psychiatric scales (HAM-D and HAM-A) and psychological and personality scales (BIS-11, ECR and DERS) in our sample of patients candidate to bariatric surgery. standardized z-scores are shown on x-axis.

psychopathological traits, employing network analysis in a sample of bariatric surgery candidates. The findings of the current study highlight the importance of considering these interconnected factors when assessing and treating individuals with pathological eating behaviors and, specifically, those who are candidates for bariatric surgery.

Finally, we found that subjects with binge eating and emotional eating had a higher psychopathological burden with higher scores on different scales (DERS, HAM-D, HAM-A, BES, and ECR-R). More in detail, our network analysis shows that emotion regulation difficulties have a pivotal role in linking the positive association between anxious attachment style and binge eating, as well as the association between binge eating and symptoms of anxiety and depression. This is in line with existing literature, which shows that emotion dysregulation may be a crucial underlying mechanism linking insecure attachment to emotional eating and other dysfunctional eating styles in bariatric patients (28). In fact, a meta-analytic review (29) highlights how an insecure attachment of the anxious type is significantly associated with dysfunctional eating behaviors such as: binges, bulimic symptoms, consumption of unhealthy food, and emotional eating, as compared to a safe attachment. For these individuals food becomes a self-regulation and self-assurance tool, highlighting the link between emotion regulation and food seeking. These results therefore suggest that psychological interventions aimed at reducing emotion dysregulation may help decrease dysfunctional eating behaviors in bariatric surgery candidates (30). In our study, impulsivity emerged as the other significant factor in the pathophysiology of dysfunctional eating behaviors, specifically gorging. In fact, patients who engaged in gorging had higher scores in the self-control domain of the Impulsiveness Scale. The relationship between impulsivity and pathological eating may be also linked by emotion dysregulation (14).

Our study shows that network analysis represents a promising approach for the exploration of the mechanisms underlying the psychological profile of bariatric surgery candidates. Although little literature (31) is currently available on network analysis applied to bariatric surgery, there is novel evidence on the use of network analysis in the field of eating disorders (EDs) (32–38). Solmi and colleagues applied network analysis to assess ED-specific symptoms, psychiatric symptoms, and general clinical variables on a sample of patients diagnosed with EDs. Their results suggested the central role of drive for thinness, interpersonal functioning, ineffectiveness, interoceptive awareness, and affective symptoms in EDs (39). Although this study does not specifically treat bariatric patients, it stresses like our study how a network approach may highlight a maintaining psychopathologic loop which appears to involve, but transcends, dimensions peculiar to the ED-psychopathology. Similar to our study, these findings' clinical implications rely on understanding this psychological profile, underlying eating symptoms, in order to prevent relapses.

Monteleone and colleagues applied for the first time a network approach to bariatric surgery candidates to explore the interplay between eating symptoms, personality traits, and anxiety. In line with our findings, their study stressed the importance of incorporating psychological variables into the pre-surgery assessment, as well as considering them as potential targets for psychotherapeutic interventions before and after surgery (31) Instead, differently from our study, their research includes the administration of a specific instrument, the Temperament and Character Inventory-Revised (TCI-R) (40) that comprehensively assesses the patient's personality profile, allowing a detailed overview of the personological traits of this clinical population. They also combined the network analysis approach with prognostic data. A deeper personological assessment and a longitudinal perspective could therefore be future perspectives for our study. Calugi & Dalle Grave used a network analysis to assess the interplay between psychosocial variables in a large sample of patients with obesity, stressing how this innovative approach allows an in-depth exploration of their complex clinical profile (38). In contrast to our study, their sample does not include bariatric patients and they have only evaluated psychosocial factors associated with obesity, not including personality traits. Their network analysis, however, considered also the internalized weight stigma in patients seeking treatment for obesity, which emerged as one of the most relevant variable in their network, together with interpersonal sensitivity, and shape-weight concern. A growing body of research (32–38) applied network analysis to EDs, even though not specifically on bariatric surgery candidates, their implications are consistent with ours in stressing the interplay between eating behaviors and psychopathological traits and the need to implement a network approach. Our results confirm the need for a multidisciplinary approach to bariatric surgery, implementing psychiatric and psychological interventions in order to discover and treat pathological eating behaviors and psychopathological traits such as emotion dysregulation, impulsivity, anxiety, and depression, that can be either the cause of obesity or of weight-regain (41, 42).

The present network analysis suggests that emotion dysregulation links the relationship between dysfunctional eating patterns and symptoms of anxiety and depression. In conclusion, this study highlights the importance of a comprehensive psychological assessment for patients seeking bariatric surgery as it identifies the presence of multiple pathological eating behaviors and psychopathological traits. In this regard, the present study stresses the utility of a network approach to understand the psychological background of bariatric candidates and develop tailored interventions that address specific nodes in the network, potentially improving the long-term success of bariatric surgery and reducing the risk of relapse into pathological eating behaviors.

4.1 Clinical implications

Our findings have quickly translatable clinical implications, because interventions on emotion regulation can act as therapeutic targets to break the vicious cycle between dysfunctional eating patterns, emotion dysregulation, and anxious-depressive symptoms in line with previous research (43). This also suggests that interventions that target impulsivity and emotion regulation, such as cognitive-behavioral therapy (44) or mindfulness-based interventions (45), may be beneficial in treating pathological eating behaviors in patients seeking bariatric surgery (e.g., mindfulness for emotional eating) (46).

4.2 Limitations

The cross-sectional design and reliance on self-report questionnaires may represent limitations of the study's ability to infer causality or temporal dynamics and the monocentric nature of the study may limit its generalizability to other populations. Further research is needed to investigate the associations between eating styles and psychopathological traits, particularly in relation to the risk of excessive weight gain or dysfunctional eating following bariatric surgery and to test the replicability of these findings in other ethnic groups, as well as address potential sources of inequality. It is crucial to assess whether emotion regulation difficulties persist or re-emerge after surgery and their impact on pathological eating styles and weight outcomes in the long term. In particular, longitudinal randomized control trials are needed to evaluate whether treatments targeting emotion regulation difficulties and/or dysfunctional eating styles may improve the outcomes of bariatric surgery, as well as patients' psychopathological traits.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics Committee of Fatebenefratelli Sacco Hospital ("psycBAR36", 2020). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

LS: Data curation, Visualization, Writing – original draft, Writing – review & editing. AB: Conceptualization, Investigation, Writing – original draft, Writing – review & editing. PL: Conceptualization, Investigation, Methodology, Supervision, Writing – review & editing. MS: Conceptualization, Investigation, Methodology, Writing – review & editing. MZ: Conceptualization, Funding acquisition, Methodology, Writing – review & editing. BD: Conceptualization, Funding acquisition, Methodology, Writing – review & editing. GR: Data curation, Formal analysis, Software, Supervision, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1369720/full#supplementary-material

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Corrigendum: Emotion dysregulation links pathological eating styles and psychopathological traits in bariatric surgery candidates

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obesity, bariatric surgery, eating style, emotion regulation, network analysis

A Corrigendum on

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In the published article, there was an error in the legends for Figures 1 and 2 as published. The last part of both figure legends originally read: "The color of the edge indicates the size of the association (blue for positive associations; red for negative associations)."

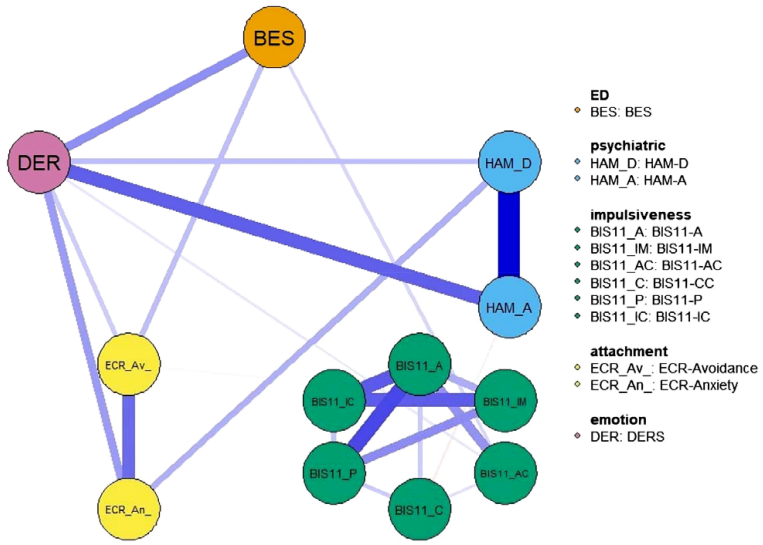
The corrected legends appear below.

FIGURE 1 Network structure. The variables include eating disorder-specific scales (BES), psychiatric scales (HAM-D and HAM-A) and psychological and personality scales (BIS-11, ECR and DER). Item groups are differentiated by color. Edge colors represent the direction of associations (blue for positive, red for negative), and edge widths indicate the strength of these associations.

FIGURE 2 Network showing the shortest path between the BES and Hamilton depression and anxiety scales. The variables include eating disorder-specific scales (BES), psychiatric scales (HAM-D and HAM-A) and psychological and personality scales (BIS-11, ECR and DER). Item groups are differentiated by color. Edge colors represent the direction of associations (blue for positive, red for negative), and edge widths indicate the strength of these associations.

The authors apologize for this error and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

Publisher's note



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Network structure. The variables include eating disorder-specific scales (BES), psychiatric scales (HAM-D and HAM-A) and psychological and personality scales (BIS-11, ECR and DER). Item groups are differentiated by color. Edge colors represent the direction of associations (blue for positive, red for negative), and edge widths indicate the strength of these associations.

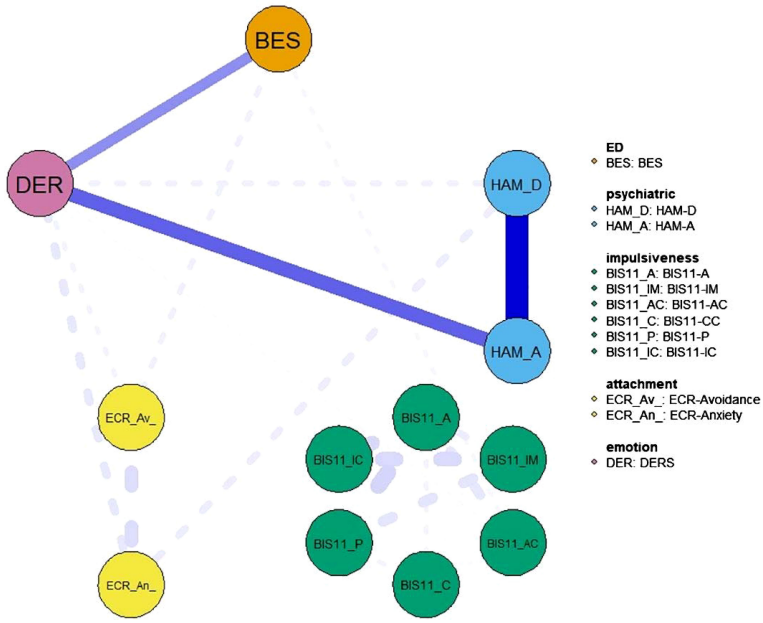

FIGURE 2
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An examination of the mediating role of maladaptive emotion regulation strategies in the complex relationship between interpersonal needs and suicidal behavior

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Background: Studies have shown that psychological factors, notably interpersonal needs and emotion regulation, play a significant role in suicidal behavior. Interpersonal needs are significant contextual components that affect emotion regulation and contribute to a wide range of dysfunctional behaviors, such as suicidal behavior. It has been postulated that emotion regulation mediates the associations between proximal and distal risk factors of suicidal behavior.

Method: The sample consisted of 340 community-dwelling individuals (62.5% women; SD = 0.48) with an age range of 18 through 55 (M = 30.23; SD = 8.54) who completed the interpersonal needs questionnaire, the suicide behaviors questionnaire-revised, and the cognitive emotion regulation questionnaire. The Structural Equation Modeling (SEM) approach was utilized to evaluate a mediation model.

Results: The findings indicate that interpersonal needs (i.e., perceived burdensomeness r = .55, p <.01 and thwarted belongingness r = .25, p <.01) and putatively maladaptive cognitive emotion regulation strategies (i.e., self-blame; r = .38, p <.01, catastrophizing; r = .55, p <.01, rumination; r = .40, p <.01, and other blame; r = .44, p <.01) have strong associations with suicidal behavior, and these strategies have a mediating effect on the association between interpersonal needs and suicidal behavior.

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Conclusions: Our findings show that contextual-interpersonal needs, which underpin suicidal behavior, are significantly influenced by maladaptive emotional processes. Thus, therapeutic outcomes might be enhanced by focusing on the content of the associated cognitions and trying to reduce maladaptive regulatory processes like rumination and catastrophization.

KEYWORDS

suicidal behavior, interpersonal needs, emotion, cognitive emotion regulation strategies, structural equation modeling

Introduction

Suicide is a highly complicated and multidimensional problem (1) that has significant public health implications globally for both clinical and nonclinical groups (2, 3). According to estimates from the World Health Organization (WHO), suicide is one of the leading causes of death worldwide, taking the lives of over 700,000 people annually (4).

Prospective suicide research has demonstrated that psychological factors are the most important indicators of suicidal behavior [e.g., 5–8], with interpersonal needs (9, 10) and emotion regulation (ER) (11–13) among the most prominent ones. Interpersonal needs are one of the critical contextual elements that affect human behavior and constitute a significant portion of dysfunction throughout mental illnesses [e.g., 10, 14]. Joiner's (2005) Interpersonal Theory of Suicide is a prominent conceptual paradigm in this regard (15). As per Joiner's theory, suicide desire is featured by two distinct sets of interpersonal cognitions: thwarted belongingness and perceived burdensomeness. Thwarted belongingness signifies an individual's belief that they lack meaningful relationships with others, whether if nobody appears to care or even because others care but cannot empathize with the individual's actual status and complex feelings (e.g., an individual who experienced sexual harassment and rape). Perceived burdensomeness refers to an individual's belief that they make no substantial contributions to the world but rather serve as an encumbrance to others. Empirical evidence on these factors has shown their prognostic value for suicidal behavior, with many studies revealing that the two-way interaction of perceived burdensomeness and thwarted belongingness explains a significant portion of suicidal desire (10, 16, 17).

The ER capacity is crucial for psychological development and functioning and is defined as strategies used to affect the experience and modify emotions, which might also entail mechanisms such as suppression and cognitive reappraisal of a distressing incidence (18). Linehan (1993) described "emotion dysregulation as excessive emotional vulnerability, heightened reactivity to emotion cues, and slow return to emotional baseline" (19). Notably, several models of psychopathology have shown strong links between psychopathology and emotion dysregulation (20–22). In fact, emotion dysregulation has been linked to a number of psychiatric conditions, namely depression (23, 24), non-suicidal self-injury [NSSI; 25], and, most importantly, suicidal behavior (11–13). Considering the transdiagnostic (26) and context-dependent [e.g., 27] nature of emotion dysregulation, extant theories explaining mechanisms of its escalation in severe problem behaviors (such as suicidal ideation and attempt) are critical for inspection.

Recent contemplations in the ER literature point to the necessity of considering the context (28–31), which has been largely overlooked in studies of ER and its associations with psychopathologies (28). All emotions serve an interpersonal function (32, 33); thus, emotion dysregulation may be a critical feature of the interpersonal theory of suicide paradigm. Also, it has been linked as a potential risk factor for the theory's key elements, namely, suicide desire. Existing research indicates an association between greater levels of suicide desire and increased levels of emotion dysregulation (11–13). Individuals who are easily dominated by emotion dysregulation (i.e., poor ER capacities) can be more vulnerable to suicidal desire (16). Consequently, emotion dysregulation may be a significant risk factor for the urge to terminate one's life.

In the literature, cognitive strategies, including rumination, self-blame, other-blame, and catastrophizing, consistently have been associated with negative emotions like depression, anxiety, stress, and anger [34, p 1046]. Accordingly, we will consider them maladaptive ER strategies in this study. Though evidence is sparse, these strategies may be the mechanisms by which hindered interpersonal needs increase the likelihood of suicidal behavior. For each putatively maladaptive ER strategy, the phenomenology is described below, as well as their probable associations to suicidal thought and behavior and how each strategy may pertain theoretically to perceived burdensomeness and thwarted belongingness.

The propensity to react to distress by dwelling/concentrating upon the origins and repercussions of one's difficulties without engaging in active problem-solving is known as rumination [See The Response Style Theory; 32]. Depressive rumination is a contemporaneous/prospective indicator of depression [e.g., 35, 36] and suicidal ideation and behavior [e.g., 37, 38]. Recent research has consistently highlighted the association between

rumination and suicidal ideation and/or behavior, regardless of methodology, samples, or measurements (39). Depressive rumination has been implicated in deteriorating well-being and feelings of life satisfaction among older adults by escalating perceived burdensomeness (40). Moreover, significant interactions have been observed between brooding (a subtype of rumination) and thwarted belongingness, as well as between perceived burdensomeness, brooding, and gender on suicide risk (41).

Catastrophizing refers to particular thoughts accentuating the dread of what you have experienced (34). Previous research has indicated positive associations between catastrophizing and suicidal behavior [e.g., 12, 42], although this concept's association with suicidal behavior has been studied principally in the context of pain catastrophization. Consequently, there is a well-established link between suicidality and pain catastrophizing. Only Shim et al. explored the association between perceived burdensomeness and catastrophizing and suicide concerning interpersonal needs (43). They demonstrated that the link between pain catastrophizing and suicide was mediated by perceived burdensomeness. However, this cognitive distortion (i.e., catastrophizing) seems to play a more critical and neglected role in perceiving obstructed interpersonal needs. As defined in the literature, cognitive distortion is an excessive or unreasonable thinking pattern that contributes to the genesis or maintenance of psychopathologies (44). It is found that cognitive distortions (e.g., negative evaluation of self) are associated with suicidal thinking (45). Catastrophizing, as an exaggerated, maladaptive ER strategy, can be evident in the perception of burdensomeness and thwarted belongingness as significant cognitive distortions of interpersonal needs. These distortions may be perceived unduly, contributing to the amplification of suicidal thoughts and behavior. As a result, the possible associations between interpersonal needs and catastrophizing may be both detrimental and conducive to suicidal ideation/behavior.

Self-blame is defined as the act or thoughts of blaming yourself for what you have gone through (34). According to empirical evidence, prolonged negative thinking, such as self-blame, might increase the likelihood of suicidal thoughts and behaviors (46, 47) and also other psychopathologies [e.g., depression; 47]. Findings from MMPI profiles of individuals lost to suicide suggest that excessive self-blaming is a self-defeating behavior that increases the possibility of completed suicide compared to individuals who died by other causes (48). This could be elucidated by drawing on Baumeister's contention that suicide might be seen as an attempt to flee from painful self-awareness. When individuals encounter situations that significantly deviate from their personal expectations or societal standards, it can trigger a cascade of reactions, potentially leading to avoidant behaviors and, at the extreme, suicidal behavior. Recognizing their shortcomings leads to negative emotional responses, prompting a desire to avoid both self-awareness and the emotional distress it entails (49). Also, it has been demonstrated that self-blame might lead to chronic distress and suicidal behavior among sexual assault survivors (50). The interpersonal theory of suicide proposes that self-blame and a sense of being neglected by others are elements that contribute to thwarted belongingness and perceived burdensomeness [for more details, see; 7, 50]. Indeed, perceived burdensomeness has been conceptualized as comprising a degree of self-hatred, as evidenced by the existence of self-blame and low self-esteem.

Other blame refers to the idea of blaming others or your surroundings for the experience you have had (34). Other blame has received little research attention among individuals at high risk of suicide thus far. Horesh et al., in their investigation of suicide risk and coping styles, found that psychiatric patients utilized suppression and other blame coping styles more frequently than other maladaptive strategies (51). The majority of evidence of blaming others as a maladaptive ER strategy contributing to suicidal behavior has been revealed in the retrospective suicide notes. Studies analyzing suicide notes found that the most prevalent reasons for blaming others were being wrongfully accused, being stubborn, and feelings of disagreement/hatred, respectively (52), and three major themes in suicide notes were found, indicating a failed relationship and an attempt to escape from this situation (53). These are associated with interpersonal needs, comprising impeded belongingness, alienation, and burdensomeness, all of which contribute to blaming oneself/others for failures and possibly lead to suicidal thoughts.

Bonding interpersonal needs and emotion regulation and current study

According to earlier meta-analytic findings, which indicated larger effect sizes for maladaptive ER strategies (e.g., rumination) in psychopathology and abnormal behavior and smaller effect sizes for adaptive ER strategies (e.g., reappraisal) (20), we solely took into account maladaptive ER strategies in the current investigation and our model. We attempted to associate and position variables of interest according to the process model of emotion [emotion regulation as an information processing model; 54] and the heuristic transdiagnostic model of ER (55). The authors delineated this heuristic by concentrating on the supposedly maladaptive ER strategy of rumination. They hypothesized, particularly, that in the setting of a perceived threat, rumination possibly contributes to the onset of anxiety disorders, but when rumination meditates in a high sensitivity to alcohol context, it can contribute to substance abuse or, when mediating sadness-loss-derived mood can lead to depression. Using this paradigm as a foundation, we also considered that maladaptive ER strategies in the context of hindered interpersonal needs (i.e., perceived burdensomeness and thwarted belongingness) would possibly lead (i.e., mediate) to suicidal behavior. It is important to mention that we considered interpersonal needs as contextual factors of suicide and maladaptive ER strategies as the processes through which these cognitive susceptibilities/distortions are mediated toward suicidal behavior.

We hypothesized that the proposed model for associations of interpersonal needs with suicidal behavior through the mediating role of maladaptive ER strategies would fit the data well. Specifically, we hypothesized that i) perceived burdensomeness would be positively associated with suicidal behavior, ii) perceived burdensomeness indirectly (through maladaptive ER strategies) would be associated with the suicidal behavior, iii) thwarted

belongingness would be positively associated with suicidal behavior, and iv) thwarted belongingness indirectly (through maladaptive ER strategies) would be associated with suicidal behavior.

In conclusion, the interpersonal theory of suicide emphasizes the role that perceived burdensomeness and thwarted belongingness have triggering roles in suicide behaviors, and emotion dysregulation may play a mediation role in these relationships. Rumination, catastrophizing, self-blame, and other blame are instances of maladaptive ER strategies that may act as conduits via which unmet interpersonal needs influence suicidal behavior. Through maladaptive ER strategies, this study attempts to evaluate these correlations and hypothesizes the direct and indirect impacts of thwarted belongingness and perceived burdensomeness on suicidal behavior. By elucidating these relationships, we seek to enhance understanding of suicide risk factors and inform more effective prevention and intervention strategies. This sets the stage for our methodology section, where we detail our approach to examining these complex dynamics empirically.

Method

Participants

The current study is a cross-sectional study using a sample of 345 individuals (62.5% women; SD = .48) with an age range of 18 through 55 (M= 30.23; SD = 8.54) from Iran's capital, Tehran. During the data collection phase, 18 (5%) participants were excluded from the research due to prior diagnoses (self-reported) of bipolar disorder, serious head injury, depressive disorder, personality disorders, anxiety disorders, or other psychiatric conditions. A total of 340 individuals completed the online surveys. After screening for missing values, five (1.4%) incomplete/corrupted data sets were eliminated from the data pool. Finally, the analysis included 128 men's (37.5%) and 212 women's (62.5%) data. The age range was 18–55 for men (M = 24.69) and women (M = 24.41). In this sample, education was classified into six levels: high school or lower (n = 4, 1.1%), diploma (n = 67, 18.9%), associate (n = 22, 6.2%), bachelor's (n = 153, 43.1%), master's (n=86, 24.2%), and Ph.D. (n = 23, 6.5%).

Measures

The Suicide Behaviors Questionnaire-Revised

[SBQ-R; 56] is a reliable questionnaire for identifying individuals at risk of suicide-related thoughts and behavior. The acceptable and appropriate sensitivity (80%) and specificity (91%) of the measure among psychiatric inpatients have been reported (56). Also, it has been shown that its validity and reliability are robust among different cultures and languages, and it is a valid questionnaire for assessing suicide-related thoughts and behavior (57). The questionnaire is comprised of four items, each assessing a distinct aspect of suicidal behavior and thought. Item 1(*have you ever thought about or attempted to kill yourself)?* assesses lifetime suicidal ideation or suicide attempts, item 2 (*how often have you thought about killing yourself in the past year*)*?* assesses the frequency of suicidal ideation over the last year, item 3 (*have you ever told someone that you were going to commit suicide, or that you might do it)?* assesses the risk of suicide attempt, and eventually, item 4 (*how likely is that you will attempt suicide someday*)? measures the self-reported probability of suicidal behavior in the future. The overall score ranges from 3 to 18. Suicidality is regarded as high when the score is greater than 7 in the general population and 8 in individuals with mental illnesses (56). For the Persian version of the SBQ-R, Amini-Tehrani et al. reported composite reliability and average variance extracted values of .87 and .63, respectively (58). Cronbach's alpha for SBQ-R was .78 in the current study. Confirmatory factor analyses in this study showed that the one-factor first-order model fit the data satisfactorily [$\chi^2(2)= 2.08$, p = .35; CFI= 1; TLI= 1; RMSEA = .011, 90% CI (.001 to.106); SRMR= .014, Figure 1].

The Interpersonal Needs Questionnaire

[INQ; 17, 59] is developed for application by researchers looking into the etiology of suicidal ideation and behavior and clinicians looking for a suicide risk estimation model based on the interpersonal theory of suicide. It is used in both research and therapeutic settings to assess the themes of thwarted belongingness (e.g., "*These days other people care about me*") and perceived burdensomeness (e.g., "*These days I feel like a burden on the people in my life*"). The original INQ comprises 25 items, although other abbreviated versions (i.e., 10, 12, 15, 18) have been developed thus far. According to Hill and Pettit, the 15 and 10-item versions have been reported to have the highest internal consistency and congruence with exploratory factor analysis models (60). To answer the INQ, respondents indicate the extent to which each question is accurate to them lately (on a 7-point Likert scale). Higher ratings indicate greater thwarted belongingness and perceived burdensomeness. Good reliability (α = .90) has been

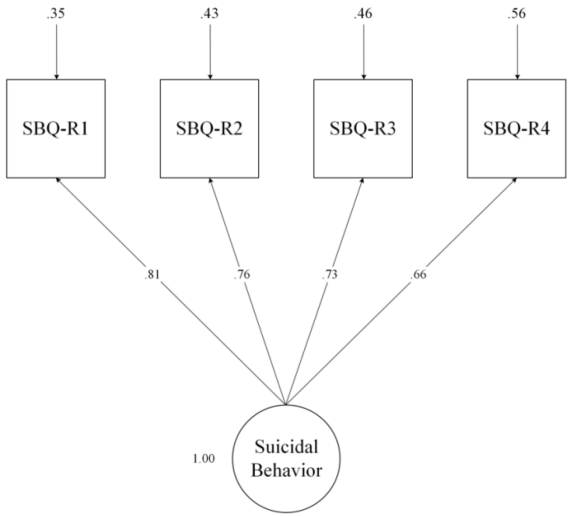

FIGURE 1
One-factor first-order confirmatory factor analyses of Suicide Behaviors Questionnaire-Revised (SBQ-R).

reported for this measure (54, 59). In the Persian version of INQ, three items (9, 11, and 12) were excluded from the questionnaire due to low factor loading values. Two-factor structure and good reliability results (Cronbach's α >.60) have been reported for both factors in the Persian version (61). In this study, Cronbach's α for total INQ was.82, For perceived burdensomeness subscale.93, and thwarted belongingness subscale was.83. Confirmatory factor analyses in the current study showed that the two-factor first-order and one-factor second-order hierarchical model fit the data satisfactorily [$\chi^2(52)$= 83.35, p = .004; CFI= .98; TLI= .97; RMSEA = .04, 90% CI (.024 to.057); SRMR= .035, Figure 2].

The Cognitive Emotion Regulation Questionnaire

[CERQ-18; 34] was established to evaluate cognitive emotion regulation strategies following stressful life situations (62). It is comprised of nine dimensions, each including four items: *positive reappraisal, acceptance, positive refocusing, perspective taking, perspective taking, blaming others, catastrophizing, rumination, and self-blame.* It includes a 5-point Likert scale ranging from 1 "(almost) never" to 5 "(almost) often," with scores between 4 to 20, with higher scores betokening a higher usage of that particular strategy. We used the short Persian form of the CERQ, which has 18 items (2 items for each dimension) and has been demonstrated to have good psychometric properties (Cronbach's spanned between.64 to.92), equivalent to the long version's (63). As the literature suggests that maladaptive strategies might mediate the effects on psychopathology and behavioral disorders [for review see; 22], we employed the maladaptive ER strategies subscales in our investigation. Overall Cronbach's alpha for the CERQ was .75, with the following for each subscale: Self-blame .78, Rumination .69, Catastrophizing .76, and Other-blame .86. Confirmatory factor analyses in this study showed that the four-factor first-order and one-factor second-order hierarchical model fit the data satisfactorily [$\chi^2(17)$ = 94.16, p <.001; CFI= .9; TLI= .83; RMSEA = .11, 90% CI (.091 to.14); SRMR= .022, Figure 3].

Procedure

Data was collected via Google Docs and a social media advertising link, and the data-collecting period spanned from September to December 2022. To ensure the integrity of our data, we implemented a series of rigorous measures. These included monitoring IP addresses and utilizing CAPTCHA verification to deter automated responses, as well as restricting submissions to one per device through Google Forms. To further enhance data quality, we employed data-cleaning algorithms to identify and remove duplicates. Additionally, randomized response techniques were integrated into our survey design to minimize response bias and encourage genuine responses. We provided explicit instructions to participants, emphasizing the importance of truthful reporting. Furthermore, we offered support services and contact information for individuals in need of assistance, including a debriefing statement to provide guidance post-survey completion. These comprehensive efforts aimed to mitigate risks to data quality and ensure the authenticity and reliability of our findings. Participants were informed on the consent form that their responses would be kept confidential and processed anonymously and that their participation was entirely voluntary, with the opportunity to discontinue at any point. The project complied with the Helsinki Declaration, was approved by the University of Maragheh, and was subject to the local council for ethics in clinical research evaluation.

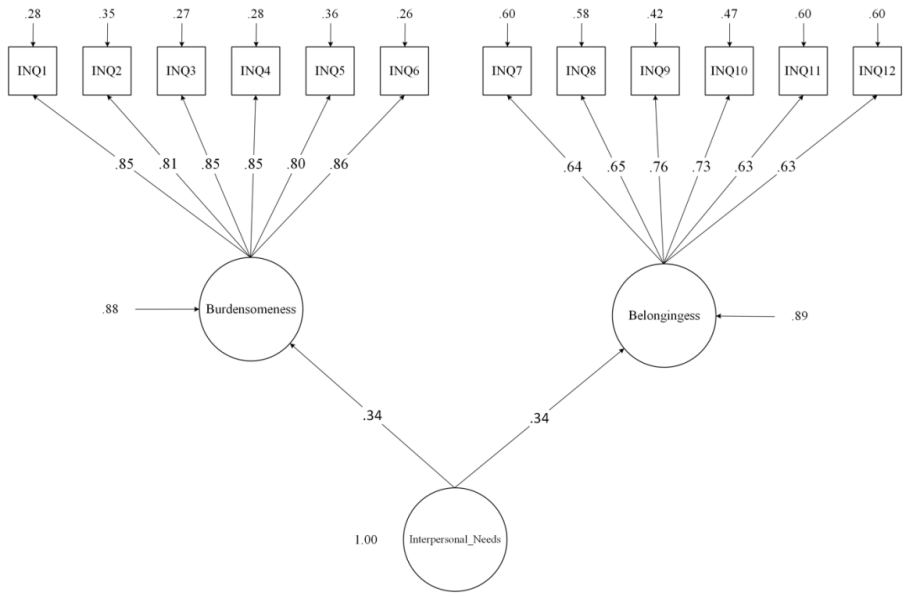

FIGURE 2
Two-factor first-order and one-factor second-order confirmatory factor analyses of the Interpersonal Needs Questionnaire (INQ).

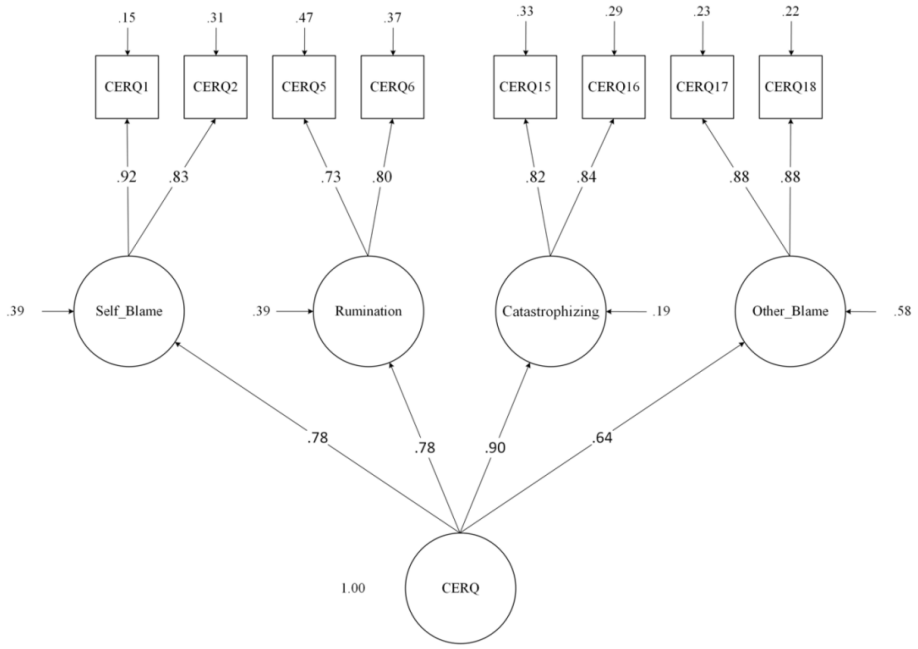

FIGURE 3
Four-factor first-order and one-factor second-order confirmatory factor analyses of the Cognitive Emotion Regulation Questionnaire (CERQ-18) (maladaptive strategies).

Statistical analysis procedure

G*Power software (64) was employed to determine the sample size needed to attain sufficient power (.80) for a small effect size (.02) for the conceptual model based on the number of predictor variables (Figure 4). Statistical software SPSS 28.0.1 (65) and Mplus 8.8 (66) were used to analyze the data, and the following five procedures were then followed:

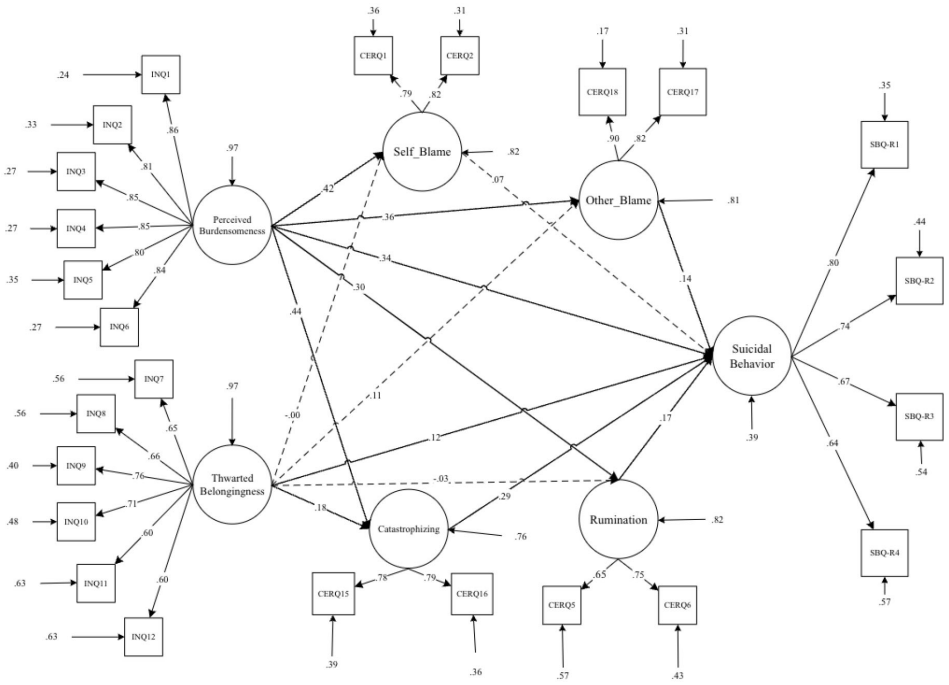

FIGURE 4
Path diagram of the hypothesized structural model for interpersonal needs, maladaptive cognitive emotion regulation strategies, and suicidal behavior.

1st Step. For the preliminary analysis, all variables were inspected for missing values, outliers, and assumptions (67). The assumption of normality was marginally supported by the questionnaire subscales, which exhibited no discernible skewness. The sample size was appropriate; thus, no changes were necessary (68).

2nd Step. Using Cronbach's alpha, the internal consistency of the SBQ-R, INQ, and CERQ-18 was assessed (69, 70). Here, a correlation value of at least .70 was considered to be a sufficient degree of item internal consistency (71). To corroborate the theoretical construct's breakdown into a certain number of subcomponents, second-order confirmatory factor analysis was performed on each measure used in this study.

3rd Step. To test *a priori* models of the scales' factorial validity, we used CFA employing Weighted Least Squares Mean-Variance (WLSMV) (72, 73). The "goodness-of-fit" of the models was then assessed using the statistical tests and index values listed below: the Comparative Fit Index (CFI) where coefficients > .95 indicating good fit (74), Chi-square/degree of freedom CMIN/DF—where values < 5.0 indicate good fit (75), the Tucker-Lewis index (TLI), coefficients > .95 (76) and the Root Mean Square Error of Approximation (RMSEA ≤ .06 suggests good fit) also indicated good fit (75, 77). Additionally, the fit indices of all models and the multivariate skewness in our data were adjusted using the Satorra-Bentler scaled chi-square test statistic, which corrects for non-normality and improves model fit assessment accuracy (78).

4th Step. In the conceptual model (Figure 4), the interpersonal needs indicators (perceived burdensomeness and thwarted belongingness) were included as exogenous variables, while suicidal behavior indicators were treated as endogenous variables. Additionally, maladaptive emotion regulation (ER) strategies such as self-blame, rumination, catastrophizing, and other blame were included as mediators. Originally, the model included direct pathways from 'self-blame' and 'other-blame' to 'suicidal behavior.' However, in the modified model, 'self-blame' and 'other-blame' were regressed on 'rumination' and 'catastrophizing thinking.' This adjustment was made to account for the indirect effects of rumination and catastrophizing thinking on suicidal behavior through the mediation of blaming self/other attributions. By regressing self-blame and other blame on rumination and catastrophizing, the model suggests that these cognitive processes may contribute to higher levels of self-blame and other blame. Consequently, this increase in blame attributions could elevate the risk of experiencing suicidal behavior. Therefore, addressing rumination and catastrophizing may be crucial, as they indirectly influence suicidal behavior through their impact on blame attributions (Figure 5).

5th Step. Traditional indirect, direct, and total effects—all effects employed in conventional mediation research—as well as their standard errors, are obtained using the MODEL INDIRECT command in Mplus 8.8 (79). It should be noted that using maximum likelihood estimation (MLR) with robust standard errors (73), the mediator model was evaluated in models 1 and 2.

Results

The descriptive statistics and bivariate correlations between interpersonal needs, suicide behaviors, and cognitive emotion regulation indicators are presented in Table 1. As evident in Table 1, all bivariate correlations related to the observed indicators

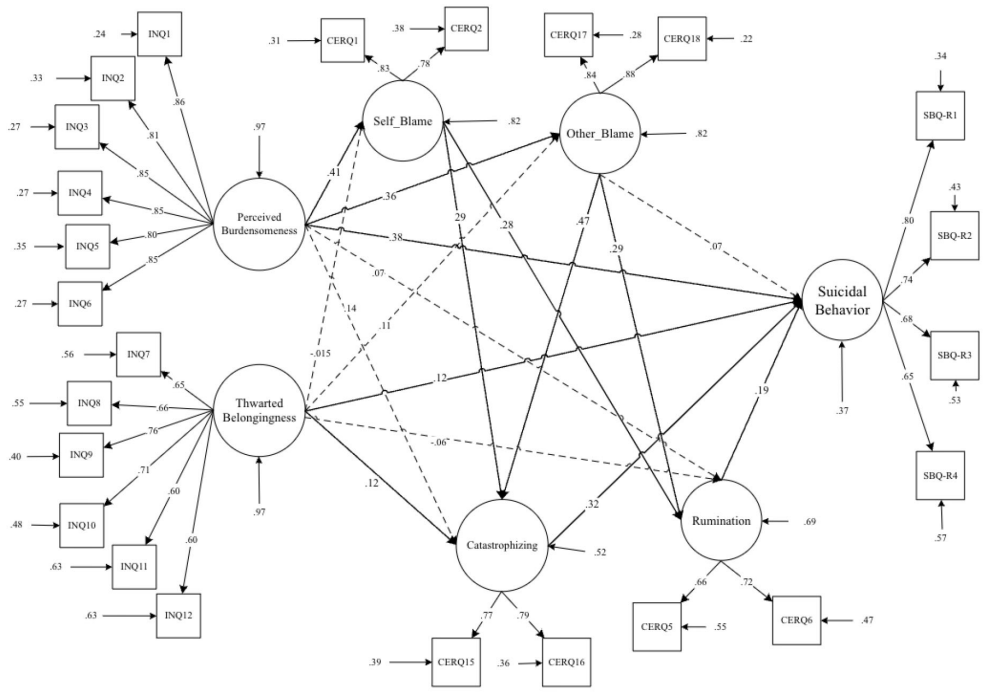

FIGURE 5
Path diagram of the Modified structural model for interpersonal needs, maladaptive cognitive emotion regulation strategies, and suicidal behavior.

TABLE 1 Means, standard deviations, and bivariate correlations between interpersonal need, maladaptive cognitive emotion regulation strategies, and suicidal behavior.

Variable	M	SD	1	2	3	4	5	6	7	8
1. Suicidal Behavior	5.46	2.91	1							
2. Interpersonal Needs Total	31.96	10.84	.52**	1						
3. Perceived Burdensomeness	10.26	6.53	.55**	.68**	1					
4. Thwarted Belongingness	21.69	7.99	.25**	.80**	.11*	1				
5. Maladaptive Cognitive Emotion Regulation Strategies total	18.95	4.87	.62**	.38**	.46**	.13*	1			
6. Self-Blame	4.24	1.80	.38**	.22**	.36**	.01	.66**	1		
7. Other Blame	3.81	1.44	.44**	.31**	.34**	.14**	.66**	.21**	1	
8. Rumination	6.32	1.80	.40**	.19**	.26**	.05	.74**	.27**	.31**	1
9. Catastrophizing	4.57	1.76	.55**	.36**	.37**	.18**	.79**	.33**	.46**	.48**

*p <.05, **p <.01.

are significant. Accordingly, it indicates that the conceptual model has solid conceptual and statistical underpinnings for investigating the hypothesized causal model for mediation analysis. As a result, we investigated a latent variable mediation model based on observed variables (Figures 4, 5 and Table 2).

Mediation analyses

The goodness-of-fit results for two nested-mediator models are summarized in Table 2. Initially, a theory-driven specified model (M_1: Table 2 and Figure 4) did not meet the previously specified fitting criteria. Consequently, M_1 was modified into M_2. By incorporating direct paths from self-blame and other-blaming to catastrophizing and rumination, the aim was to better capture the relationships between these variables. This adjustment acknowledged the potential for self-blame and other blame to directly influence catastrophizing and rumination, which in turn may impact suicidal behavior (M_2: Table 2 and Figure 5).

As indicated in Table 2, the modified model (M_2) significantly improved the model fit compared to the original specification (M_1). The two competitive nested models were evaluated according to the parsimony principle, with M_2 being identified as the most effective model. This suggests that the incorporation of direct paths from self-blame and other blame to catastrophizing and rumination enhanced the model's explanatory power and provided a better fit to the data (M_2: Table 2 and Figure 5).

Results of Table 3, Figure 5 show a significant direct association between perceived burdensomeness and suicidal behavior (β = .38), thwarted belongingness and suicidal behavior (β = .12), rumination and suicidal behavior (β = .19), and finally between catastrophizing and suicidal behavior (β = .32). Findings from Table 4 suggest that self-blame, other blame, rumination, and catastrophizing have a mediating role in the association between perceived burdensomeness and suicidal behavior ($p < .05$).

According to Tables 3, 4, it is evident that thwarted belongingness exhibits a direct effect only on catastrophizing and suicidal behavior ($p < .05$). This suggests that individuals who perceive a lack of belongingness are more likely to experience catastrophizing and engage in suicidal behaviors.

Furthermore, the analysis indicates that the association between thwarted belongingness and suicidal behavior was not mediated through maladaptive components of cognitive-emotional regulation ($p > .05$). This implies that while thwarted belongingness directly influences catastrophizing and suicidal behavior, it does not operate through the pathways of maladaptive cognitive-emotional regulation strategies such as self-blame, rumination, catastrophizing, and other blame.

Discussion

The interpersonal needs dimensions (i.e., perceived burdensomeness and thwarted belongingness) share the

TABLE 2 Modification indices for the mediated model of interpersonal needs, maladaptive cognitive emotion regulation, and suicidal behavior.

Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR	Base model	ΔS-Bχ^2(Δdf)
M_1	583.80	304	1.9	.93	.92	.051(.045 -.057)	.082	-	-
M_2	486.25	301	1.62	.953	.946	.042(.035 -.048)	.067	M1	81.89**(3)

M_1 = structural equation modeling of pathways from interpersonal needs to suicidal behavior: mediating maladaptive cognitive emotion regulation; M_2 = in the modified model, 'self-blame' and 'other blame' were regressed on 'rumination' and 'catastrophizing.' This adjustment suggests that the levels of self-blame and other blame are influenced by the extent of rumination and catastrophizing experienced by individuals. This approach allowed us to investigate the indirect effects of blame attributes on suicidal behavior through these cognitive processes. χ^2 = Chi-square, df = degrees of freedom = χ^2/df = normal chi-square, TLI = Tucker–Lewis index, CFI = comparative fit index, SRMR = standardized root mean square residual, RMSEA = root mean square error of approximation, $\Delta\chi^2$ = difference between minus twice log likelihoods between the full and the nested models, **p <.01. In our analysis, age, sex and marital status were included as covariates in both models to account for their potential influence on the outcomes.

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TABLE 3 Standardized direct effects of interpersonal needs and cognitive emotion regulation on suicide behaviors.

Paths	Direct effect	*p*
Perceived Burdensomeness → Suicidal Behavior	**.38**	.001
Thwarted Belongingness → Suicidal Behavior	**.12**	.020
Rumination → Suicidal Behavior	**.19**	.006
Catastrophizing→ Suicidal Behavior	**.32**	.001
Self-Blame → Suicide Behavior	Fixed to zero	–
Other Blame → Suicidal Behavior	.07	.35
Perceived Burdensomeness → Self-Blame	**.41**	.001
Thwarted Belongingness → Self-Blame	-.015	.81
Perceived Burdensomeness → Rumination	.07	.37
Thwarted Belongingness → Rumination	-.06	.41
Self-Blame → Rumination	**.28**	.001
Other Blame → Rumination	**.29**	.001
Perceived Burdensomeness → Catastrophizing	.14	.073
Thwarted Belongingness → Catastrophizing	**.12**	.047
Self-Blame → Catastrophizing	**.29**	.001
Other Blame → Catastrophizing	**.36**	.001
Perceived Burdensomeness → Other Blame	**.36**	.001
Thwarted Belongingness → Other Blame	.11	.094

CI, confidence intervals. Age, sex, and marital status were incorporated as covariates. Significant paths are highlighted in bold. The coefficients are presented in the standardized format.

characteristic of being connected to emotional distress [e.g., 80], and individual differences in ER are transdiagnostic risk factors linked to psychopathology, which indicates individuals regulate their emotions and deal with emotional pain differently (81). From this angle, a study into associations between interpersonal needs and ER might aid in a clearer grasp of the reasons why people exhibit an upsurge in suicidal behavior (82).

The current study seeks to examine the direct and indirect pathways from perceived burdensomeness and thwarted belongingness to suicidal behavior through maladaptive ER strategies among an Iranian population. Our data and model modification appeared harmonious with previous studies demonstrating that interpersonal needs and maladaptive ER strategies are associated with suicidal behavior (12, 83). Those who strictly employ maladaptive strategies to regulate their emotions routinely go through prolonged and more intense episodes of distress or are more likely to engage in self-deteriorating behaviors [e.g., 84, 85]. In terms of direct effects, it was observed that both other blame and self-blame showed insignificance concerning suicidal behavior. This finding may seem somewhat unexpected. However, when examining the indirect effects, interesting pathways emerged through these strategies toward suicidal behavior.

The results suggest significant connections, revealing that perceived burdensomeness can lead to self-blame and other

TABLE 4 Indirect standardized effects of interpersonal needs and maladaptive cognitive emotion regulation strategies on suicidal behavior.

	coefficient	P
Effects from Perceived Burdensomeness to Suicidal Behavior		
Total	**.59**	.001
Total Indirect	**.22**	.001
Perceived Burdensomeness → Rumination → Suicidal Behavior	.014	.37
Perceived Burdensomeness → Catastrophizing → Suicidal Behavior	.044	.07
Perceived Burdensomeness → Other Blame → Suicidal Behavior	.024	.34
Perceived Burdensomeness → Self-blame → Rumination → Suicidal Behavior	.022	.049
Perceived Burdensomeness → Other Blame → Rumination → Suicidal Behavior	.019	.043
Perceived Burdensomeness → Self-blame → Catastrophizing → Suicidal Behavior	.038	.005
Perceived Burdensomeness → Other Blame → Catastrophizing → Suicidal Behavior	.054	.007
Effects from Thwarted belongingness to Suicidal Behavior		
Total	**.17**	.001
Total Indirect	.054	.12
Thwarted Belongingness → Rumination → Suicidal Behavior	-.012	.43
Thwarted Belongingness → Catastrophizing → Suicidal Behavior	.039	.072
Thwarted Belongingness → Other Blame → Suicidal Behavior	.007	.43
Thwarted Belongingness → Self-blame → Rumination → Suicidal Behavior	-.01	.81
Thwarted Belongingness → Other Blame → Rumination → Suicidal Behavior	.01	.16
Thwarted Belongingness → Self-blame → Catastrophizing → Suicidal Behavior	-.01	.81
Thwarted Belongingness → Other Blame → Catastrophizing → Suicidal Behavior	.02	.11
Effects from Self_Blame to Suicidal Behavior		
Total	.15	.001
Total Indirect	.15	.001
Self-Blame → Rumination → Suicidal Behavior	.052	.03
Self-Blame → Catastrophizing → Suicidal Behavior	.092	.001
Effects from Other Blam to Suicidal Behavior		
Total	.27	.001
Total Indirect	.21	.001
Other blame → Rumination → Suicidal Behavior	.054	.02
Other Blame → Catastrophizing → Suicidal Behavior	.15	.001

Bold Font: Indicates significant paths. Age, sex, and marital status were included as covariates. The coefficients are presented in the standardized format.

blame, which then contribute to rumination, ultimately culminating in suicidal behavior. This observation suggests that individuals who perceive themselves as a burden and attribute this perception to personal or external inadequacies may become trapped in a detrimental cycle of rumination, exacerbating their risk of suicidal behavior.

Previous findings in the literature indicate that self-blaming is a prevalent, dysfunctional practice that increases the risk of suicidal behavior (48), and it is proposed that perceived burdensomeness may be a manifestation of distress resulting in self-blame and other shame-related emotions (9).

Our research findings enrich the existing literature by providing a deeper comprehension of how maladaptive ER processes contribute to the pathways leading to suicidal behavior. While previous studies primarily focused on the presence of maladaptive strategies and cognitive content such as self-blame and other-blame, our research highlights the significance of repetitive negative thinking (i.e., rumination) as a crucial factor in driving individuals toward suicidal behavior. This perspective suggests a shift from merely acknowledging the existence of negative content to recognizing the detrimental impact of processing such content on psychopathological outcomes. This finding can also be understood within the framework of the cognitive attentive syndrome (86, 87), where negative content, such as feelings of burdensomeness, self-blame, or blaming others, when processed within a pattern of negative thinking (e.g., rumination), can result in adverse consequences. Indeed, according to the new waves of cognitive behavior therapy (e.g., acceptance and commitment therapy, dialectical behavior therapy), the way individuals process negative content can play a more detrimental role in psychopathology rather than the mere presence of negative content (88–90).

Internalized emotions of self-loathing, contempt, and burdensomeness may result in disengagement and isolation from others owing to a sense of not belonging (38). This is in line with previous research on the links between thwarted belongingness, perceived burdensomeness, and analogous constructs and suicidal behavior. For instance, Rogers et al. (2021) observed that thwarted belongingness accounted for the relationship between anger and suicidality, which is an emotion that is highly and maladaptively regulated by the other-blame strategy. Also, it has been found that perceived burdensomeness is responsible for the association between guilt and suicide risk, which is highly related to self-blame (38, 91).

Our findings highlight the complex interactions of perceived burdensomeness, self-blame, and other blame attributions, explaining how these variables interact to intensify catastrophic thinking and increase the risk of suicidal behavior. This finding is consistent with the larger framework of the cognitive attentive syndrome, as well as the tendency in the ruminative process that has been documented. In this context, the constant threat monitoring and the propensity to catastrophize internal/external incidents may amplify the already unsettling negative content (i.e., perceived burdensomeness, self-blame, other blame), making it harder to deal with and accelerating the emergence of psychopathological symptoms. These findings also could appropriately be explained by O'Connor et al.'s (2016) integrated motivational–volitional model of suicidal behavior (92). As per this theory, dysfunctional social conflicts and emotions of being knocked down (as a source of other blame) contribute to feelings of entrapment (a perceived incapacity to escape or be freed from uncomfortable situations)—and, eventually, suicidal thoughts and behavior.

In line with this Shim et al. (2017), examined the connection between perceived burdensomeness, catastrophizing, and suicide in relation to interpersonal needs. They showed that perceived burdensomeness mediates the link between pain catastrophizing and suicide (43).

In a seminal examination, Abdollahpour Ranjbar et al. (12) reported that depressed women with a history of suicide attempts use catastrophizing as an ER strategy more frequently than merely suicide ideators and healthy controls. However, catastrophizing as a cognitive distortion (i.e., excessive or unreasonable thinking pattern) and maladaptive ER strategy can be affected by other psychopathogenic thinking patterns. In the suicidal behavior context, it can include perceived burdensomeness and thwarted belongingness as cognitively distorted ways of perceiving individuals' milieu and their interactions with others. Thus, additional research is required to investigate the mediating and moderating effects of catastrophizing in the context of perceived burdensomeness and thwarted belongingness, as well as how exaggerated and catastrophized these cognitions are seen by individuals at high risk of suicidal behavior.

Our finding for the mediating role of rumination between perceived burdensomeness and thwarted belongingness and suicidal behavior was found to be counterintuitive, and rumination did not mediate this association. Nevertheless, as mentioned above, our data provides a more nuanced mediating role for rumination. The results also indicated that rumination could mediate the association between self-blame and other blame with suicidal behavior. Roughly all of the previous studies account for a robust association between rumination and suicidal behavior (39). This finding aligns with the concept of "self-critical rumination" (93) or self-blame rumination, as described in the literature. Various studies have demonstrated its correlation with psychological difficulties, including depression, anxiety, and feelings of anger (94). Also, different studies showed the mediating role of rumination between other blame and adverse mental health outcomes like pathological personality traits (95) and suicidal ideation (96). Rogers et al. (2021) reported a strong relationship between suicide-specific rumination and suicidal intent, and this construct was connected to suicidal intent in addition to other suicide risk factors (e.g., thwarted belongingness, perceived burdensomeness, suicide ideation, etc.). As a result, greater research into this crucial overlooked field of study (i.e., probable associations between interpersonal needs and ruminative processes) in suicide studies appears to be more than essential.

Clinical implications

Our results might have a number of clinical implications. Those who have high scores in perceived burdensomeness and thwarted belongingness and have a higher than regular inclination to blame others, ruminate, and catastrophize more can be more prone to suicidal behavior. Our findings may help clinicians think of these dispositions in their suicidal patients, with the potential therapeutic objective of

enhancing supportive systems, amending cognitive distortions, and diminishing the use of maladaptive ER strategies that are found to be associated with disproportionate suicidal ideation and behavior. It expands the findings of Slee et al. (2008), who found that ER strategies are associated with suicidal behavior beyond and over depression (97). Accordingly, psychotherapeutic approaches that try to diminish suicidal behavior again may work better when they address both maladaptive ER strategies and depression symptoms.

Cognitive therapy, for instance, has shown efficacy in breaking the association between depressive symptoms and maladaptive cognitions, such as self-blame and worthlessness (98). Furthermore, psychotherapists may benefit from addressing specific suicide-related cognitions, such as low self-esteem and self-blame, to mitigate the risk of recurrent depressive episodes and chronic suicidal ideation (99).

In summary, while our study contributes to the growing body of literature on suicidal behavior, future research should aim to replicate and extend these findings in diverse populations and clinical settings. Adopting a cautious and nuanced approach to clinical interpretation will be essential in translating these findings into effective interventions for at-risk individuals.

Limitations and further research

We were limited in how widely we could interpret our data because of the cross-sectional research design. In light of this, it is impossible to establish whether perceived burdensomeness and thwarted belongingness are causing suicidal behavior with the mediation of emotional processes. The use of just self-report assessments, which might be improved by more in-depth interviews and other measurements, is another potential drawback in our study. Additionally, cultural variations should be taken into account, at least for ER. Recent research has focused on the cultural differences in ER (100–102), and it is found that there are also differences in the Iranian culture [e.g., 103–106]. Future study endeavors can venture beyond cultural confines to investigate the practicality of the suggested framework. Examining gender variations within this paradigm may help us better understand how various groups' manifestations of ER strategies and interpersonal needs vary.

In addition, concentrating on high-risk populations provides a chance to evaluate the prevalence and significance of interpersonal needs as well as how they interact with maladaptive emotion regulation in the intricate web of suicide conduct. Research projects of this kind may have the capacity to provide insights into focused treatments and preventative measures catered to the particular requirements of populations that are at risk. Finally, our data was imbalanced in terms of comprising a higher number of women. Thus, the generalizability of results should be of future research concern, which uses a proportionate number of genders and also more robust methodologies, including longitudinal designs.

Conclusion

Our findings suggest that maladaptive cognitive ER strategies play a significant role in the contextual-interpersonal needs that underlie suicidal behavior. The therapeutic setting might use these findings to customize treatment interventions for those with suicidal behavior. As a result, we hypothesize that improving therapeutic outcomes would result from concentrating on the content of associated cognitions (i.e., perceived burdensomeness & thwarted belongingness), together with attempts to lessen the detrimental regulatory processes, such as rumination and catastrophization.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, upon reasonable request.

Ethics statement

The studies involving humans were approved by Maraghe University of Medical Sciences. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

HAR: Study design, Conceptualization, Investigation, Project administration, Data curation, Methodology, Formal analysis, Validation, Visualization, Writing – original draft, Writing – review & editing, Resources. MB-B: Data curation, Investigation, Project administration, Methodology, Resources, Writing – review & editing. SF-N: Data curation, Project administration, Resources, Writing – review & editing. IH: Methodology, Validation, Visualization, Writing – review & editing. MHA: Supervision, Conceptualization, Methodology, Data curation, Visualization, Formal analysis, Writing – original draft, Writing – review & editing. ME: Supervision, Conceptualization, Writing – review & editing, Validation, Visualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Emotion-related impulsivity and suicidal ideation and behavior in schizophrenia spectrum disorder: a pilot fMRI study

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Introduction: Suicidal ideation and behavior (SIB) are serious problems in people with schizophrenia spectrum disorders (SSD). Nevertheless, relatively little is known about the circuitry underlying SIB in SSD. Recently, we showed that elevated emotional impulsivity (urgency) was associated with SIB in SSD. Here we examined brain activity in people with SSD and elevated SIB.

Methods: We tested 16 people with SSD who had low SIB and 14 people with high SIB on a task in which emotion regulation in response to affective pictures was implicitly manipulated using spoken sentences. Thus, there were neutral pictures preceded by neutral statements (NeutNeut condition), as well as negative pictures preceded by either negative (NegNeg) or neutral (NeutNeg) statements. After each picture, participants rated how unpleasant each picture was for them. The latter two conditions were compared to the NeutNeut condition. We compared the emotion-regulated condition (NeutNeg) to the unregulated condition (NeutNeut). Statistics were threshold using threshold free cluster enhancement (TFCE).

Results: People in the low SIB group showed higher activation in this contrast in medial frontal gyrus, right rostral anterior cingulate, bilateral superior frontal gyrus/DLPFC, and right middle cingulate gyrus, as well as right superior temporal gyrus.

Discussion: This study provides clues to the neural basis of SIB in SSD as well as underlying mechanisms.

KEYWORDS

suicidal ideation and behavior, schizophrenia spectrum disorder, emotion regulation, fMRI, urgency

Introduction

Suicidal ideation and behavior (SIB) are substantially elevated in schizophrenia spectrum disorders (SSD), with up to 40% of people with SSD having a lifetime suicide attempt (SA; (1, 2) and 5–6% dying by suicide (3–5), but that rate may be as high as 10% (6). This rate is at least as high as in major depressive disorder (7). Our recent work suggests that emotion-related impulsivity (urgency) is an important determinant of SIB, at least in SSD (8).

Urgency refers to rash action in the context of strong emotions and is measured using the Urgency, (Lack of) Premeditation, (Lack of) Perseverance, and Sensation Seeking Scale [UPPS; (9)]. Urgency has been further divided into positive urgency (PU; positive emotions) and negative urgency (NU; negative emotions), leading to the development of the UPPS-P (10). In a meta-analysis (11), urgency was found to be the impulsivity dimension most correlated with psychiatric conditions characterized by high levels of SIB, including alcohol/substance use disorders (12). Urgency may underlie (13) a recently identified superordinate general psychopathology ("*p*") factor that may explain psychiatric disorders better than the traditional 3 factor model of internalizing, externalizing, and thought disorders (14).

We have extended these findings to SSD (8, 15). Earlier studies of impulsivity and aggression in SSD offered mixed results (16–18), but none examined urgency, as emotion had been explicitly excluded from some of the more commonly used measures, such as the Barratt Impulsiveness Scale (19). We found that NU and PU were selectively elevated in SSD with large effect sizes ($d > 1.2$; (15) and were related to self-reported aggression.

Recently, we found that SI is strongly correlated with NU in SSD, even more strongly than with depressive symptoms (8). We also found that NU completely mediated the relationship between depressive symptoms and SI, suggesting NU may be a pathway linking depression to SIB in SSD. Moreover, NU correlated with lifetime suicide attempts ($r_s = 0.48$, $p = 0.003$).

Several MRI studies have examined SIB in SSD, most with small sample sizes. Structural MRI studies report lower gray matter density in left orbitofrontal (OFC) and superior temporal cortices in SSD attempters compared to nonattempters (20), higher bilateral volume of inferior frontal white matter in SSD attempters compared to psychiatric and healthy controls (21), and larger amygdala volumes, which was also correlated with self-directed aggression, in suicide attempters compared to psychiatric and healthy controls (22). Attempters with SSD have also been found to have lower cortical thickness in right dorsolateral prefrontal cortex (DLPFC) and superior temporal cortex compared with non-suicidal patients (23). The largest structural imaging study on SIB in psychoses (24) found lower gray matter volume in bilateral superior and middle frontal cortex, inferior and superior temporal cortex, left superior parietal regions, and right insula and thalamus. These preliminary findings suggest morphological differences in cognitive control and affective processing related to SIB.

SIB in SSD has also been evaluated using fMRI, implicating some of the same brain regions. In a study of patients with self-harm history, patients without self-harm histories, and controls (25), those with a history of self-harm showed activation intermediate to that of the other two groups (controls were highest) in right DLPFC and left ventral posterior cingulate during the no-go condition of a go/no-go task. Activation in right DLPFC correlated with severity of suicidal ideation in the self-harm group. In subjects with recent-onset SSD, Minzenberg et al. (26) found that those with past suicidal ideation had higher functional connectivity (FC) between the dorsal anterior cingulate cortex (dACC) and the precuneus during conflict monitoring. Moreover, the intensity of suicidal ideation at its worst point was associated with higher FC between the dACC and both the medial parietal lobe and striatothalamic nuclei. Past suicidal behavior was associated with reduced dACC FC in lateral and medial PFC, parietal, and temporal cortical areas. Although these studies identified the cortical changes associated with SIB in SSD patients, we still do not understand the role of urgency in SIB and the neurobiological pathways underlying these relationships.

As initially proposed, NU was posited to involve emotionally relevant circuitry, including the OFC and ventromedial prefrontal cortex (vmPFC), as well as the amygdala (10). Studies have since confirmed and expanded on regions implicated in this circuitry. In a resting state fMRI study, urgency (mean of NU and PU) was positively related to the amplitude of low frequency fluctuations in the lateral OFC, vmPFC, right DLPFC, left inferior frontal gyrus, and middle frontal gyrus, and posterior cingulate cortex/precuneus in healthy volunteers (27). In social drinkers, NU mediated the relationship between amygdala and right OFC activation in response to negative emotion pictures as well as general risk-taking (28). Recently, in a transdiagnostic sample, Elliott et al. (29) found that the local gyrification index (a ratio of the amount of cortex buried in sulci to the amount visible on the surface) of lateral OFC correlated with "feelings trigger actions," a measure highly similar to urgency.

We previously found that urgency is correlated with reduced cortical thickness in ventral prefrontal and limbic regions, including the rostral anterior cingulate (rACC) and frontal pole, as well as lateral and medial OFC in SSD (15). Moreover, we found that higher urgency correlates with lower resting state FC in these regions.

Urgency has been related to dysfunctional emotion regulation (ER), which includes the explicit strategies used to control one's experienced emotions (30). People with SSD have substantial deficits in ER (31, 32). Moreover, NU and maladaptive ER strategies are positively correlated (33). Finally, a number of the regions implicated in urgency are also associated with emotion regulation (34, 35). There may also be neurobiological correlates between urgency and ER, specifically among frontotemporal and limbic regions.

The development of paradigm measures of urgency is in its infancy and has had mixed success (36, 37); there are no validated fMRI tasks for NU in SSD. Here, we used an emotion regulation task in which participants performed implicit reappraisal of affective pictures based on spoken sentences that preceded those images (38, 39). Based on the literature, we predicted that people in the high SIB group would show lower activation on the task compared to those with low SIB in regions related to emotion regulation. We also determined whether activation on this task was associated with NU.

Material and methods

Thirty-five patients with SSDs from our prior work (8) provided clinical data for the current study. Inpatient and outpatient participants were recruited from Rockland Psychiatric Center and referred by other researchers. Of these, we had a final imaging sample of 30 participants: two of the participants could not hear the spoken statements, one participant could not tolerate scanning, one participant showed excessive data loss (>45% censored volumes, see below) and one showed low temporal signal to noise ratio (tSNR) = 59.5, which was 3.84.SDs below the group mean (168.88 ± 28.52).

The Columbia Suicide Severity Rating Scale (40) entails a semi structured interview and review of medical records to assess past year and lifetime SIB and was used to form two groups. The low SIB group (n = 16) was comprised of people with scores of 1 or less (lifetime) on the C-SSRS and with no lifetime suicide attempts. The high SIB group (n = 14) consisted of people with scores of 3+ in the past 12 months and/or at least two lifetime suicide attempts. This measure also provided data on suicide attempts. The final neuroimaging sample was 30, of whom 16 were in the low SIB group and 14 were in the high SIB group.

DSM-5 diagnosis was confirmed by either the Mini International Neuropsychiatric Interview, v. 7.0.2 (41) or the Structural Clinical Interview for DSM-5 (42). Twenty-three participants had schizophrenia and 7 had schizoaffective disorder. Medication dosages were converted into chlorpromazine (CPZ) equivalents (43). We also compared the number of people taking first generation antipsychotics, second generation antipsychotics, or both. People with recent (past 3 months) substance use disorders were excluded from the study. All procedures were approved by the Nathan Kline Institute Institutional Review Board and all participants signed informed written consent.

Measures

The Beck Scale for Suicidal Ideation [BSSI; (44)] is a 21-item questionnaire that asks participants about past-week suicidal ideation and attempts. The first 19 items provided a score for suicidal ideation.

We administered the UPPS-P scale (9, 10) that measures NU and PU. We have extensive experience using this scale in SSD.

Positive and Negative Syndrome Scale [PANSS; (45)] provides data on positive, negative, depression, cognitive, and excitement factors (46) and was used to assess past-week psychopathology. We also computed the Excited Component [PANSS-EC; (47)].

The participants described above were tested on an fMRI task which implicitly manipulated emotion regulation in response to affective pictures using neutral and negative sentences preceded by spoken statements (38, 39). The task was programmed in E-prime, v. 2.0 (Psychology Software Tools, Pittsburgh, PA) and was rear-projected to participants in the scanner.

MRI acquisition

Scanning took place at NKI's Center for Biomedical Imaging and Neuromodulation (CBIN) using a Siemens 3T TiM Trio and a 32-channel head coil. We collected an anatomical scan (MPRAGE) to provide cortical thickness measurements and to allow intersubject registration of functional images. Sequence parameters are provided in Table 1.

fMRI task

Participants viewed full-frame negative and neutral pictures from the International Affective Pictures System (IAPS; (48)) presented for 3 seconds each. Neutral pictures were preceded by a spoken neutral statement (NeutNeut), whereas negative pictures were preceded by either negative (NegNeg) or neutral (NeutNeg) spoken statements. These sentences were presented over a 7-second window. The participant then rated the unpleasantness of the picture using the Self-Assessment Manikin (49); up to 5 seconds, self-paced). Between the picture offset and the rating screen, there was a variable delay of 0.5 - 1.5 seconds. There were 22 pictures in each condition; the task was presented in two blocks of approximately 9 min (66 trials total) with equal numbers of trials for each condition in each block. The order of trial presentation was randomized for each participant. To avoid effects of sedation, study assessments were not done within 12 hours of PRN medication administration.

Image processing

fMRI data were preprocessed using AFNI (50). We used AFNI's *afni_proc.py* metascript to perform motion correction, registration of images into standard space, and spatial smoothing (4mm FWHM Gaussian kernel), as well as regression of nuisance covariates (12 motion parameters). Finally, data were scaled to percent signal change (PSC). The regression of nuisance parameters was done in the deconvolution step. Next, we created stimulus onset regressors (convolved with a BLOCK function) for each condition (NeutNeut, NeutNeg, NegNeg) at time of sentence onset and time of picture onset, to construct a general linear model (GLM) based on the PSC images. We also created a regressor for the onset of the rating screen using a

TABLE 1 Parameters of sequences used.

Scan	TR/TE (ms)	TI (ms)	Matrix	FOV[1]	Slices	Thick[1]	GRAPPA	MB[2]
MPRAGE	2530/2.3	1340	256^2	250	176	1	2	–
Resting/task	1400/30	–	90^2	180	64	2	2	4

[1]Thickness and FOV in mm; [2]MB, multiband factor.

gamma variate function. Image frames with more than 0.9mm of motion with respect to the prior frame were censored. Motion parameters and their derivatives were nuisance regressors, as were rating onset times. Analyses were limited by a mask in which 70% of participants had data. We computed a contrast between NeutNeg-conditions for the time of picture onset. Data were thresholded at $p < 0.05$, corrected, using threshold-free cluster enhancement (51).

Results

Demographic data are shown in Table 2. SIB Groups did not differ in age, sex, education, or medication dosages.

The behavioral dependent measure was the difference in unpleasantness ratings for NegNeg vs. NeutNeg trials. We would expect unpleasantness ratings to be higher for NegNeg because of the buffering effect of the neutral statements. Ratings were lower for NeutNeg than NegNeg trials [$t(28) = -5.28$, $p < 1.3 \times 10^{-5}$] suggesting that participants could perform the task. Thus, the task worked as designed. Ratings did not differ between groups ($|t| < 1.22$, ps <.23).

Participants in the high SIB group had lower activation in the right anterior cingulate cortex/BA 32 [MNI coordinate = (11, 35, 20)] compared to the low SIB group. Urgency-relevant circuitry also was activated in the NeutNeg > NeutNeut contrast between groups (Figure 1), demonstrating reappraisal-related activation in the left superior medial frontal gyrus and superior frontal gyrus (SFG) as well as right middle cingulate, superior frontal gyrus, superior temporal gyrus, and DLPFC. Within-group analyses show that people in the high SIB group showed deactivation in these regions, whereas those in the low SIB group showed a weaker pattern of elevated activation in these regions at a more liberal threshold of p = .005 and cluster size of 9, because of the smaller group sizes (see Supplementary Figures 1, 2). Consistent with recent studies (15, 27), activation in right middle cingulate, right superior temporal gyrus, and right DLPFC correlated significantly and negatively with NU ($r_s < -0.37$, $p < 0.042$). A voxelwise analysis of these correlations was inconclusive, possibly owing to the low power to detect correlations (Supplementary Figure 3).

Discussion

In this study, we showed that compared to those with SSD and low levels of SIB, people with SSD and high levels of SIB had lower BOLD activation in several regions on an emotion regulation task. These regions included medial frontal gyrus, right rACC, bilateral superior frontal gyrus/DLPFC, and right middle cingulate gyrus. We also found that activation in right middle cingulate, right superior temporal gyrus, and right DLPFC were significantly and

TABLE 2 Demographic variables in people in the high and low SIB groups.

Variables	Low SIB Group	High SIB Group	Statistic		$d/\eta^2/w$
	M (SD)	M(SD)	$t/U//\chi^2$	p	
Age (years)	40.1 (11.0)	42.1 (10.3)	-0.50	.62	-0.18
Sex (M/F)	14/2	12/2	0.02	.65	0.02
Education (years)[1]	3.9 (1.6)	4.9 (1.4)	-1.66	.11	-0.66
Handness (RH/LH)[2]	14/2	11/2	0.05	0.82	0.04
CPZ Equivalents[3] (mg)	936.4 (1017.3)	1576.9 (764.7)	-1.42	.17	-0.71
C-SSRS SI (life)	0 [0,1]	5 [4,5]	176[4]	<.001**	0.90
C-SSRS Attempts (life)	0 [0,0]	3 [1,8]	224[4]	<.001**	0.88
C-SSRS SI (past year)	0.12 (0.34)	1.36 (1.28)	-3.50	.003**	-1.32
C-SSRS Attempts (past year)	0 [0,0]	0 [0,0]	112[4]	1.00	0.00
BSSI Suicidal Ideation	0 [0,8]	4 [0,14]	175.5[4]	.007**	0.34
Negative Urgency (total)	23.0 (8.0)	31.8 (7.4)	-3.12	.004**	-1.14
Positive Urgency (total)	26.5 (10.1)	30.1 (10.8)	-0.95	.20	-0.34
PANSS Negative Scale	17.8 (8.6)	14.4 (4.8)	1.20	.35	0.49
PANSS Excitement Scale	8 [6,19]	11 [6,17]	162.5[4]	.034	0.16
PANSS Cognitive Scale	13.5 [7,21]	12.5 [5,17]	81.5[4]	.21	0.06
PANSS Positive Scale	10.9 (4.9)	13.3 (4.7)	-1.37	.18	-0.50
PANSS Depression Scale	9.8 (4.7)	14.8 (4.4)	-3.00	.006**	-1.10

CPZ equivalents (43); FG, first generation antipsychotic; SG, second generation antipsychotic; C-SSRS, Columbia-Suicide Severity Rating Scale (40); LH, Left-handed; RH, right-handed; BSSI, Beck Scale for Suicidal Ideation (52); PANSS, Positive and Negative Syndrome Scale (45, 53); *Significant at p <.05; **Significant at p<.01. [1]Missing for 14 subjects; [2]Missing for 11 subjects; [3]Missing for 11 subjects; [4]Mann-Whitney U test; descriptive statistics presented for each group are median and [minimum, maximum].

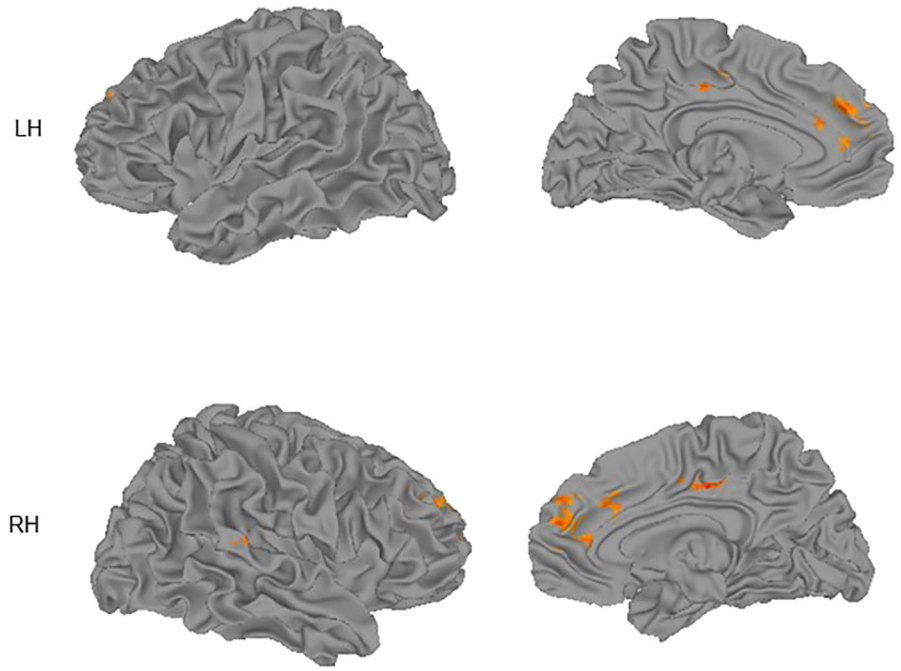

FIGURE 1
Group differences (low SIB group > high SIB group) in activation for the Neutral/Negative – Neutral/Neutral contrast superimposed on cortical surface maps. Surfaces shown are lateral (left column) and medial (right column) for left (LH) and right (RH) hemispheres. Images thresholded using nonparametric threshold-free cluster enhancement (TFCE).

negatively correlated with negative urgency. This adds to the growing literature on the neural circuitry underlying NU.

Although the present task has been viewed as tapping implicit emotional reappraisal (39), rather than urgency, it may nonetheless be a good urgency proxy task because 1) it evokes strong negative affect that can lead to reflexive emotional regulatory responses (33), 2) these responses are correlated with NU (33), 3) many of the brain activation deficits seen in the high SIB group correlate with urgency, and 4) it has no floor effects. At present, there is only one cognitive task (an emotional stop signal task) that has been validated against negative urgency measures (36); however, it has not been tested in SSD.

Negative urgency is elevated in SSD (15), and this elevation is related to SIB, even after accounting for depressive symptoms (8). Thus, the current study extends our prior results regarding violence in schizophrenia and are consistent with other studies of the circuitry associated with urgency in other disorders. The regions that showed activation differences are also implicated in emotion regulation (34, 35). The ability to regulate one's emotions effectively plays a key role in SIB and has been established as a known deficiency in SSD (31, 54–56). Interestingly, the low SIB group showed positive activation in these regions, whereas the high SIB group showed negative activation (i.e., deactivation). This suggests that the relevant circuitry is highly disrupted in the high SIB group in a manner that could predict SIB.

The NegNeg and NegNeg vs. NegNeut analyses did not show significant differences, despite differences showing up on the behavioral measure. It is possible that the range of activation on these contrasts were restricted given that both NegNeg and NeutNeg contained negatively valanced pictures as compared to the NeutNeut condition. Disentangling these relationships will be the subject of future research.

As can be seen in Figure 1, activation in midline regions is represented on both hemispheres. This is the case because in Table 3 we report peak locations. However, the midline clusters we detected extended into the other hemisphere, suggesting that both left and right midline regions contribute to the observed activation.

Existing literature (e.g., 57) has established disturbances in frontal-cortical regions and their interacting networks, which may present clinically as disturbances in the control of emotions and behavior, occasionally presenting as SIB in those with SSDs. Consistent with the findings in the present study emphasizing the role of lower activation in the medial frontal gyrus in our high SIB group, Minzenberg et al.'s (57) study found an inverse relationship between suicidal ideation and activation in this region as well as in the left rostral pole and the right dorsal anterior cingulate gyrus. In SSD patients, the lower activation, specifically in the medial frontal gyrus and other frontal-cortical regions, has been linked to impaired goal representation, which was associated with increased suicidal ideation. The medial frontal gyrus has also been associated with several cognitive processes associated with emotion regulation and urgency, including decision making, reasoning, and discrimination (58), suggesting that disruptions in this region could play a key role in the dysregulation experienced in SSD populations with high SIB. As previously discussed, this dysregulation and inability to apply traditional coping mechanisms has been shown to lead to increased rates of urgency, particularly NU. The current findings are consistent with our prior findings that urgency is correlated with lower right frontal pole thickness in SSD (15). These frontal cortical regions are therefore important regions of interest for continuing research focusing on pathologies stemming from emotion dysregulation and urgency.

TABLE 3 Clusters showing significant differences in activation between low and high SIB groups.

Region	Talairach Coordinates (mm)	Size (voxels)	*t*
L Medial frontal gyrus/BA9	-1, 45, 24	375	4.76
R Rostral anterior Cingulate/BA32	11, 35, 12	154	4.22
R Middle cingulate/BA24	3, -21, 38	94	5.66
R Superior temporal gyrus	57, -35, 14	23	4.48
L Superior frontal gyrus	-13, 51, 32	12	4.08
R Superior frontal gyrus/ middle frontal gyrus (DLPFC)	29, 39, 30	11	3.84
R Superior frontal gyrus/BA10	27, 57, 14	9	4.31
R Superior frontal gyrus/BA9	25, 47, 30	9	3.73

Additionally, we found decreased activation in the right rACC cortex in individuals with SSD and high levels of SIB. In previous studies, we found that urgency was correlated with reduced cortical thickness in the rACC in SSD. This finding is novel, as we are aware of no previous research establishing the link among rACC, suicidality, and SSD. Our results converge, however, with findings that rACC cortex dysfunction is tied to treatment response in major depressive disorder (MDD), with higher regional activity being associated with better treatment reactivity (59). In several past studies, long-term treatment resistance in MDD was found to be associated with increased hopelessness and suicidal ideation (60, 61). Differences in anterior cingulate cortex with SSD have been noted both anatomically and physiologically (62). Our data suggest that hypoactivation in the region is associated with poor emotion regulation, possibly through urgency.

The present study's finding of decreased BOLD activation in the DLPFC in SSD individuals with high SIB compared to low SIB is consistent with the results of prior work (23) and fits into past literature implicating the region in urgency (27). Moreover, we found that lower DLPFC activation was associated with higher levels of negative urgency. Past studies have shown that cortical thinning in the DLPFC may impact fronto-thalamic functioning, which could affect both cognitive and emotional control processes (23). These kinds of disturbances have been shown to lead to suicidal behavior in MDD through the disinhibition of emotional responses, and a reduced ability to adapt to stressful behavior (63). These kinds of responses are formally similar to urgency, but Jia et al. (63) did not examine urgency in their study. Although the findings in this latter study do not extend to patients with SSD in the current work, similar differences found in the superior frontal gyrus have been reported, not just in MDD, but in suicide attempters with SSD as well as other psychiatric disorders (64). Cortical thickness differences in superior temporal gyrus have also been associated with suicide attempters (23) in SSD, consistent with the present study.

We further found decreased activation in the middle cingulate gyrus in the high vs. low SIB group. Previous work has established lower functional connectivity in subjects with suicidal ideation in the right posterior cingulate gyrus region, including both middle cingulate gyri, left transverse temporal gyrus, right supramarginal gyrus, left inferior parietal gyrus, and right superior temporal gyrus (65). These regions have been identified as part of a network involved in theory of mind and memory retrieval, and further associated with suicidal ideation when functional connectivity is impaired (65). Although no study has yet investigated the causal relationship between dysfunction in this network and suicidality, there is significant evidence for this network's relationship to SIB, independent of MDD severity (65). Their finding for the right superior temporal gyrus is consistent with our finding that low activation in this region was associated with higher levels of urgency. It is also consistent with cortical thickness findings by Besteher et al. (23) in SSD. The presence of deactivation within the high SIB group, along with comparable unpleasantness ratings between groups, clarifies that this group was engaged in the task.

Negative urgency has been previously conceptualized as a loss of impulse control due to emotion regulation deficits (66). Neuroimaging studies of negative urgency have additionally related smaller cortical thickness in the dorsomedial PFC as well as the right temporal pole to urgency, emphasizing the neurobiological link between urgency and emotion regulation deficits (15, 18). Consistent with this idea, we previously published on the present sample, showing elevated urgency in people with higher SIB vs. lower levels of SIB in SSD (8).

Although differences in regions like the ACC are implicated in SSDs broadly, these effects cannot be attributed to the disorder itself. Rather, this study suggests that other factors, such as the compounding effects of emotion regulation defects and/or increased negative urgency contribute to heightened SI. One possibility noted earlier is that urgency is an outcome of poor emotion regulation (e.g., (66). Future studies comparing these findings in SSD to SI in other psychiatric disorders could help determine the diagnostic specificity of our fMRI results.

The findings in the current study suggest that hypoactivation in regions of the brain primarily responsible for emotion regulation and cognitive control may be associated with and contribute to increased suicidality. Moreover, activation in several of these regions is correlated with higher levels of urgency. In a study comparing siblings with SSD to healthy siblings, findings suggest impaired emotion regulation in SSD, accompanied by activation in the DLPFC, medial PFC, ACC, and amygdala (67). Hypoactivity within these regions has been associated with compromised cognitive control and emotion regulation within SSD patients (67). This emotion regulation deficit and its relationship to urgency may be a key mechanism leading to increased suicidality within this population.

Urgency has been shown to be elevated in a number of populations (11). In addition, others have found that elevated negative urgency is elevated in people with bipolar disorder and

ideation, in one study (68), and attempts in another study (69). The effects in these studies were larger for negative than positive urgency, possibly highlighting the importance of intolerance of negative emotions in SIB transdiagnostically.

Limitations

This study has several limitations. First, the sample size is small; it will be important to replicate these findings in a larger sample. For this reason, we were not able to test within-group correlations between brain activation and urgency. Additionally, we did not have a healthy or psychiatric control group (e.g., MDD); the specificity of our findings to SSD will need to be examined in a direct comparison. Furthermore, time since most recent suicide attempt was highly variable but was at least 6 months across participants. It will be of interest to study individuals with more recent attempts to examine emergent suicidal ideation. We also lacked power to test effects of racial group (70), sex (71) and lacked information on sexual identity (72), which are risk factors for SIB. The participants were chronically ill and were all on antipsychotic medication. It will be important to study SIB in first episode SSD, as this is a particularly high-risk population for SIB (73, 74). Finally, although activation in 3 extracted regions of group differences showed significant negative correlations with negative urgency, the voxelwise analysis of this relationship, which avoids issues of "double dipping" [e.g., (75)] was inconclusive, possibly due to low statistical power in this analysis.

Conclusions

SIB in SSD has been under-studied. Here, we showed that during an emotion regulation task involving implicit reappraisal of negative pictures, activation was lower in the high SIB than low SIB group in several frontotemporal regions. These regions have been associated with emotion regulation processes, but interestingly, much of this activation was associated with lower levels of urgency. The deficit of activation in the high SIB group implies that the neural circuitry supporting emotion regulation is impaired and implicates this process in SIB. Moreover, the relationship between urgency and activation on the task suggests neural substrates for elevated urgency, as we previously reported (15). These results suggest important behavioral and brain targets for interventions that can be aimed at reducing SIB in schizophrenia.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Nathan S. Kline Institute for Psychiatric Research Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MH: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing. KE: Data curation, Investigation, Project administration, Writing – review & editing, Writing – original draft. ZP: Data curation, Investigation, Project administration, Writing – review & editing. AS: Writing – review & editing, Data curation, Investigation, Project administration, Supervision, Validation. ES: Writing – review & editing, Data curation, Formal analysis, Investigation, Project administration, Resources, Validation. AA: Conceptualization, Methodology, Writing – review & editing. DI: Conceptualization, Supervision, Writing – review & editing.

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Conflict of interest

In the last 10 years, DI has served as a consultant for Alkermes, Allergan, Angelini, Autobahn, Axsome, Biogen, Boehringer Ingelheim, the Centers for Psychiatric Excellence, Clexio, Delix, Jazz, LivaNova, Lundbeck, Neumora, Otsuka, Precision Neuroscience, Relmada, Sage Therapeutics, and Sunovion. He has received grant support paid to his institutions from Alkermes, AstraZeneca, BrainsWay, LiteCure, NeoSync, Otsuka, Roche, and Shire. Dr. MH consults on NIH grants and with the Kessler Research Foundation. Dr. AA has received consultant fees from Minerva Neurosciences Inc.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1408083/full#supplementary-material

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Urgency Theory in the context of broader emotion theories: a conceptual review

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Negative and positive urgency are two closely related personality traits that reflect the tendency for an individual to engage in maladaptive risk-taking in response to extreme negative and positive emotions, respectively. However, other prominent emotion theories describe how emotions contribute to adaptive, rather than maladaptive, decision-making. This conceptual review considers how Urgency Theory can be integrated with these broader existing emotion theories. We proceed as follows: a) briefly define what is meant by emotions in science and summarize basic human neuroscience underlying emotions; b) briefly describe select theories and research linking emotions to adaptive decision-making, including brain correlates of this effect; c) review Urgency Theory, including contrasting evidence that emotions lead to maladaptive outcomes and brain correlates of this effect; d) discuss how urgency can be integrated into theories that view emotions as both adaptive and maladaptive for decision-making; and e) propose future directions to advance research in this field. We identified four, not mutually exclusive, viable options to integrate Urgency Theory into existing theories: urgency as model-free emotion regulation, urgency as being driven by incidental emotions, urgency as a reflexive response to emotions, or urgency as an individual difference factor. We conclude that although all four options are viable, individual difference and model-free emotion regulation have the most empirical support to date. Importantly, the other two options are less well-researched. Direct tests comparing these integrations is necessary to determine the most accurate way to integrate urgency with existing emotion theories. We believe that this research can identify mechanisms underlying urgency and help inform future intervention and prevention development to reduce negative effects of urgency across numerous maladaptive behaviors and clinical disorders.

KEYWORDS

urgency, decision-making, emotions, adaptive, maladaptive urgency and broader emotion theories

Introduction

The experience of emotions is fundamentally adaptive; emotions serve to focus attention to relevant stimuli and prepare the body for action in response to such stimuli (e.g., 1–3). Because of their ubiquitous nature, emotions have long been the focus of psychological study, with research suggesting that they influence a number of explicit and implicit factors related to action, including decision-making (e.g., 4), risk/reward estimations (e.g., 5), attention (e.g., 6), persistence in goal pursuits (e.g., 7), fight vs. flight vs. freeze reactions (e.g., 8), and job performance (e.g., 9).

Cyders and Smith (10) proposed a novel integration of emotions with impulsive response, which they coined "urgency." Key rationale for Urgency Theory is that emotions undermine adaptive decision-making (e.g., 4, 11–14), through less discriminative use of information (15–17), increased distractibility (18), and an increased focus on short-term, rather than long-term, goal pursuits (19). However, there is opposing evidence that emotions can improve, rather than undermine, decision-making. For example, mild increases in positive affect improve problem solving skills (20, 21), such as cognitive flexibility (22, 23), verbal fluency (24), and problem solving (25, 26). There are also anecdotal examples of emotions leading to adaptive behaviors, such as seeking out treatment. Integrating Urgency Theory with broader emotion theories can advance understanding of how and why urgency may contribute to maladaptive outcomes, which can be important for future intervention and prevention development.

Emotions – key terms, definitions, and basic neuroscience

We rely on the classic conceptual framework of Russell (27) to briefly define and differentiate between constructs to be used in the remainder of this review. Core affect, in the Russell (27) framework, is a general term that encompasses both discrete emotions and more diffuse moods. Emotions are discrete experiences directed at or about a specific event, person, or situation (referred to as an object) that are usually shorter in duration, whereas moods refer to a period of prolonged diffuse affect that is not necessarily directed at a specific event, person, or object (27). Ekman (28) describes several factors that make up the experience of core affect; however, here we focus on two independent dimensions relevant to the current review, valence (i.e., pleasure to displeasure) and arousal (i.e., activated/energetic to deactivated/calm). Most discrete emotions can be placed upon these two continua. For example, high arousal and high pleasure represent elation and happiness, high arousal and high displeasure represent distress or anger, low arousal and high pleasure represent calm, and low arousal and high displeasure represent sadness or lethargy. Barrett and colleagues (29) describe the valence dimension as making up the mental representation of emotion, whereas arousal is related to the physical sensations of affect.

Theories suggesting that emotions contribute to adaptive decision-making

Emotions help us set priorities for attention and action and can facilitate adaptive choices and action plans. Pinker (30) said it best: "Most artificial intelligence researchers believe that freely behaving robots will have to be programmed with something like emotions merely for them to know at every moment what to do next" (p. 374). This focusing of attention prepares the individual to respond to meet that emotion. For example, without emotions, we might not know whether to prioritize responding to an email (neutral emotional valence and low emotional arousal in most cases, although there surely are some exceptions to this) or calling a friend whose partner recently passed away (negative emotional valence and high emotional arousal for both the friend and the individual). The negative valence and arousal in the second situation focus attention on the most pressing need and motivates behavior toward the more salient task (and away from the more emotionally-neutral task).

Early neuroscience theories on how emotions affect decision-making focus on distinct systems for affect and cognition, with emotions localized in the limbic system (e.g., 31). A meta-analysis by Kober and colleagues (32) summarized that subcortical activations in the amygdala, ventral striatum, thalamus, hypothalamus, and periaqueductal gray are most commonly found in studies of emotion generation, with an important relationship between these subcortical regions and medial regions of the prefrontal cortex, which may play an important role in the cognitive generation of emotional states. An additional meta-analysis by Lindquist and colleagues (33) concluded that emotions are experienced in the brain through an interacting set of brain regions associated with not only emotion, but also cognition and perception. Phelps and colleagues (34) conclude that multiple neural circuits underlie how emotions influence decision-making depending on a number of contextual factors, including type of emotion or affect experienced and the type of decision-making under study (e.g., risky decisions, social decisions, etc.) (34).

Here, we briefly describe select theories documenting an adaptive role of emotions for decision-making, highlighting potential mechanisms of such an effect and levels of affect at which this effect may occur. For a broader review, see Lerner and colleagues (35).

Somatic marker hypothesis

The Somatic Marker Hypothesis, first proposed by Damasio and colleagues (36), suggests that deficits in decision-making seen in individuals with damage to their ventromedial prefrontal cortex are due, in part, to their inability to use emotional signaling to evaluate decisional options. Damasio sees emotions as a key,

functional part of adaptive decision-making, as somatic markers signal that attention is needed to a particular decision and then help one to evaluate the value of potential responses or decisions (36, 37). Negative somatic markers lead to avoidance of a particular potential response, whereas positive somatic markers lead to approach of an incentive (36, 37). Thus, when somatic markers are absent, decision-making is more random and less advantageous (36). The Somatic Marker Hypothesis proposes that the representation and regulation of emotions in the brain occurs not only in the limbic system, but also in regions of the brain thought to underlie decision-making and planning (e.g., the ventromedial prefrontal cortex, the somatosensory cortices, the basal ganglia, and the insula; 38), suggesting that emotions result from brain sensory input, and shape decision-making and planning, at a neural level (39).

Affect heuristic theory

Affect Heuristic Theory proposes that people use affect heuristics, defined as "representations of objects and events in people's minds that are tagged to varying degrees of affect," to guide decision-making (40). When people make decisions, they consult their pre-existing affect heuristics, which makes decision-making more efficient (40). A recent neuroimaging study found co-activation in the left insula, left inferior frontal gyrus, and left medial frontal gyrus was inversely related to the use of an affect heuristic, suggesting that affect heuristics may be negatively related to giving into momentary affective urges (41).

Affect-guided planning and anticipation

According to Davidson (19), adaptive emotion-based decision-making functions through emotions being linked with more adaptive goals (i.e., the anticipated positive affect, or reduction of negative affect, associated with job success) rather than less adaptive ones (i.e., the reduction of immediate stress through binge eating). Davidson (19) proposes that the prefrontal cortex is responsible for mental representation of goals; when emotions occur, they can be inconsistent with such goals (e.g., when job success is incompatible with disordered level substance use) or they can be consistent with long-term goals (which Davidson calls "affect-guided planning). When emotions are inconsistent with long-term goals, the prefrontal cortex should attempt to override signaling. Asymmetries in prefrontal cortex function appear to distinguish between those who engage in affect-guided planning and those who do not (e.g., 42, 43), suggesting that the ability to maintain anticipated emotions for adaptive pursuits especially in the face of strong, more immediate reinforcers relies on left prefrontal cortex function (19).

Broaden and build theory

The Broaden and Build Theory (44), describes the function of positive emotions as to expand one's thoughts and action urges (i.e., to make one's thinking and behavior more creative, more open, and more explorative). Such expansion then allows the individual to develop new skills, resources, and relationships, which are adaptive for survival and produce more positive emotional experiences in return. In Fredrickson's (44) theory, positive emotions are adaptive in that they broaden life experiences and build in new adaptive responding patterns. There is good evidence that positive emotions function to improve decision-making. Fredrickson (45) posits that "positive emotions transform people for the better" and promote future and psychological wellbeing, whereas negative emotions have been adaptive for survival in life threatening situations, such as fear and avoidance when encountering a large animal. A study found that positive affect predicted more flexible coping strategies, as well as future emotional wellbeing (46). In a study utilizing the broaden and build framework, Reschly and colleagues (47) found that, in a sample of high school students, positive emotions predicted greater student engagement in school and greater adaptive coping, showing that positive emotions have similar positive outcomes in adolescents as well.

Dialectical behavior therapy and wise mind

Dialectical Behavior Therapy was developed originally as a treatment for Borderline Personality Disorder; the therapeutic focus on emotions and their ability for adaptive functioning is housed in the common experience that emotions precipitate maladaptive action or inaction (48). Dialectical Behavior Therapy focuses on the cultivation of "wise mind," in which one can utilize and integrate their own rational thoughts (i.e., "rational mind") and emotional reactions (i.e., "emotion mind") to make adaptive, intuitive decisions. There is evidence of adaptiveness of emotions as integrated into Dialectical Behavior Therapy. "Wise mind" has been shown to be important for treatment engagement and success (e.g., 49, 50). Kristeller and Jordan (49) found that a mindfulness-based eating awareness training program increased wise mind, which then led to increases in spirituality, well-being, and improved overall self-regulation. Kearney and colleagues (51) suggest that a meditation intervention increased unactivated pleasant, but not activated pleasant, emotions over time, and decreased both activated and unactivated unpleasant emotions; thus, concluding that the cultivation of wise mind might facilitate both unactivated pleasant emotions and better treatment outcomes for a variety of clinical disorders.

A review of Urgency Theory: emotions contribute to maladaptive decision-making

Development of urgency theory

Research identifying urgency began with the appreciation that impulsivity describes multiple, separate domains of behavior (52). Whiteside and Lynam (52) took an empirical approach and factor analyzed existing impulsivity measures to identify the common,

underlying factors of impulsivity. Results of their factor analysis produced four distinct impulsive traits: sensation seeking (i.e., the tendency to seek out novel and exciting experiences), lack of planning (i.e., the tendency to act without thinking), lack of perseverance (i.e., the inability to remain focused on a task), and urgency (i.e., the tendency to respond rashly in response to extreme emotional states). From these results, Whiteside and Lynam (52) created the UPPS Impulsive Behavior Scale, which has shown usefulness across various populations and has been translated into several languages (e.g., 53–56).

Research then provided evidence that urgency was not a unitary construct and was instead comprised of two separate, albeit related, constructs of negative and positive urgency (57). This led to the addition of a positive urgency subscale into a revised version of the UPPS scale (The UPPS-P Impulsive Behavior Scale; 58). This revised scale is widely used to measure impulsive personality and, like the original scale, has been shown to produce valid and reliable estimates of impulsive behavior traits across age, gender, clinical populations, and language (59–63).

Urgency Theory posits that rash action is thought to occur in response to a specific and discrete experience of emotion that is directed to a specific situation, person, or object (10). When one is experiencing emotions intensely, the loss of available cognitive resources and the interference with rational decision-making increases the likelihood that one's actions will be ill-advised or rash (10). The exact mechanisms of how urgency imparts risk remain of debate. Billieux and colleagues (64) suggested that urgency is driven by poor ability to inhibit prepotent responses during emotional contexts. Eben and colleagues (65) suggested that negative emotions may create a discrepancy between one's current state and desired state. Previous work suggested that urgency was not explained by the interaction of over-reactivity of emotion and lack of planning (e.g., 66). However, later neuroimaging evidence found that urgency is related to increased brain response to negative images (67). Other work suggests that urgency may be driven by over-reactivity to emotional triggers, combined with a deficient ability to regulate this response (64).

Urgency is related to maladaptive risk-taking behaviors

Negative and positive urgency are both associated with involvement in a variety of risky behaviors (10); however, there are some unique associations with different risk-taking behavior across these traits that are important to highlight. Negative urgency is more highly related to increased drinking quantity (i.e., number of drinks consumed in a single drinking episode), drinking to cope, and development of an Alcohol Use Disorder (68, 69). Research has also shown that negative urgency is a strong predictor of severity of problems across a variety of domains including medical, employment, social, family, psychiatric, and substance and alcohol use in those with a substance use disorder (70). Additionally, negative urgency has been shown to predict problems such as pathological gambling, increased eating problems, self-harm behaviors, risky sexual behavior, compulsive shopping, and craving for cigarettes (71–75).

Positive urgency has also been linked to risky behavior. For example, research has also shown that individuals are prone to engage in heavy and high-risk drinking, pathological gambling, and binge eating when experiencing elevated positive mood states (76–78). Positive urgency uniquely predict risky drinking, risky sexual behavior, and increased drug use in first year college students compared to negative urgency (79, 80). Positive urgency is also associated with increased risk-taking behavior among children (81).

Urgency is related to psychopathology

Urgency has been implicated as a unique risk factor for and as a characteristic of psychopathology. As Johnson and colleagues (82) concluded, "A large body of work indicates that urgency is more robustly related to psychopathology than are other forms of impulsivity … Collectively, this work is beginning to transform psychopathology research to focus on integrating these domains [negative and positive urgency]." Negative urgency has been proposed as a common transdiagnostic endophenotype for a number of ill-advised risk behaviors and clinical disorders (67) and has been associated with disordered eating, Borderline Personality Disorder symptoms, nonsuicidal self-injury, substance use disorder, and aggression (83–85).

Borderline Personality Disorder symptoms are often associated with urgency due to the emotional and impulsive nature of the disorder. Martin and colleagues (86) identified a relationship between insight and urgency within Borderline Personality Disorder: Increased levels of positive urgency were associated with increased clinical insight, meaning the more the patient experienced positive urgency, the more aware of the disorder the patient was, potentially driven by self-reflectiveness, which may have implications for treatment outcomes. Urgency also predicts a more severe course of externalizing behaviors such as earlier onset of alcohol use, alcohol dependence, and smoking cessation difficulty (87–89). Johnson and colleagues (82) assert that negative urgency predicts symptoms worsening (e.g., more drinking problems) over time during negative emotional states, while positive urgency predicts more alcohol use during positive emotional states. These effects were still present even when controlling for other forms of impulsivity or emotionality. Similarly, Howard and Khalifa (90) posit that urgency contributes to the severity and is a core feature of personality disorders and may, in turn, help to explain the link between personality disorders and violence.

Emerging research has also linked urgency with internalizing psychopathology. Research suggests that urgency predicts depression and anxiety symptoms, suicidality, and obsessive thoughts in Obsessive Compulsive Disorder with similar effect sizes between negative and positive urgency, indicating both positive and negative emotions play a strong role in psychopathology (85, 91). In addition, positive and negative urgency were found to mediate the relationship between Post-Traumatic Stress Disorder symptoms and risky behaviors (92).

These patterns of associations with psychopathology have also been replicated in a sample of children and adolescents. in that urgency broadly predicts a range of psychopathology such as conduct disorder, depression, panic and anxiety, and attention deficit hyperactivity disorder (ADHD) – inattentive symptoms (93). Additionally, urgency has been studied as a link in the relationship between adult ADHD and the severity of alcohol dependence, suggesting that those with ADHD may drink to cope when struggling to regulate their emotions (94). Urgency has also been found to be associated with serious suicidal ideation in 9- and 10-year-old children and is particularly salient in White children compared to Black and other race children (95).

Urgency has been implicated in psychotic psychopathology, such as Bipolar Disorder and Schizophrenia. Johnson and colleagues (96) found that urgency was associated with self-harm, suicidal ideation, and suicide attempts with negative urgency being the strongest predictor of suicidal ideation within those with Bipolar I Disorder. The relationship between urgency and suicidal behaviors was still present when controlling for major depression and other psychopathology. Negative and positive urgency are elevated in those with remitted Bipolar I Disorder and schizophrenia (97, 98). Muhtadie and colleagues (98) found that those with Bipolar I Disorder were more likely to engage in impulsive behaviors if they were high in positive urgency, over and above other facets of impulsive personality. Further, positive urgency is elevated in first degree relatives of those with schizophrenia, which may be a characteristic to target in treatment to prevent the development of schizophrenia in first degree relatives (99).

Urgency and treatment outcomes

Recently, urgency has been found to influence and impede the effectiveness of substance use disorder treatments. Hershberger and colleagues (100) conducted a meta-analysis of studies reporting UPPS-P traits at the beginning of cognitive-behavioral treatment for substance use disorders and found that negative urgency (along with lack of planning) at treatment admission predicted poorer response at the end of treatment. This study also found that UPPS-P traits did not change markedly in treatment, necessitating a more directed approach to reducing these traits. In another study, positive urgency was related to increased (rather than decreased) alcohol use and problems following a text-based intervention for 21st birthday drinking (101). Manasse and colleagues (102) similarly found that individuals with higher negative urgency at baseline experienced slower and less pronounced benefit from treatment. There is much more to understand concerning how and why urgency might impede or worsen the effects of treatment and how best to intervene to reduce the negative effects of urgency (see 103).

One construct or two?

While there is strong evidence to suggest that negative urgency and positive urgency are two distinct constructs (10, 104–106), there is still debate about whether these two constructs are better understood as one tendency. Recently, there has been contradictory evidence supporting both sides of this debate. First, Cyders and Smith (104) tested multiple models of the UPPS-P and found that the model designating positive and negative urgency as one factor did not fit the data well, but that the model designating them as sub-factors under a broader urgency factor fit the data best. This was also supported in another study using a more diverse and representative sample (62). Another recent study examined alternative factor models of impulsivity within the UPPS-P to determine whether the five facets of the UPPS-P were independent from one another using confirmatory factor analysis and found that the five-factor model was supported (107). Additionally, Goh and colleagues (108) examined the UPPS-P model of impulsivity utilizing network analysis and found support for "five conceptually distinct and differentially related dimensions" indicating that positive and negative urgency are two distinct constructs.

However, it may be beneficial to conceptualize urgency as one construct. Support for this perspective comes from evidence that the two traits are highly correlated and may be theoretically indiscernible from one another (85, 91, 109, 110). Specifically, Billieux and colleagues (110) concluded that the two facets of urgency converge as a single cluster using item-based network analysis and that it may be more efficient to examine urgency as one construct. Additionally, the high correlation between negative and positive urgency, usually in the range of 0.6 to 0.8, suggests that these two traits may have more shared than distinct variance. In the end, it may be that the distinctiveness of the two traits may be difficult to establish, and it may depend on the sample in which they are measured, the outcomes under examination, and how the traits may cluster together in any particular dataset.

Empirical brain correlates of urgency

Although still in relatively early stages, the empirical research concerning brain correlates of urgency has identified a number of key structures and circuits that contribute to cognitive control, emotions, and salience (see a review by 111). To date, the majority of these studies have primarily focused on negative urgency, rather than positive urgency. Greater dorsolateral prefrontal cortex activation was associated with negative urgency during a simple cognitive control task, indicating that those high in urgency may use greater cognitive resources in cognitive control tasks (112, 113). This may indicate that those high in urgency may use greater cognitive resources during cognitively demanding tasks, making it more difficult to engage in cognitive control (114). Increased right insula activation was related to negative urgency in a decision-making task in which the subject made a risky decision over a safe decision (115). Activation in the orbitofrontal cortex, which is associated with emotion-based learning and decision-making (see reviews by 116, 117), has been found to be significantly related to negative urgency in response to valenced mood images (118). Research has shown that negative urgency relates to increased activation in the left amygdala, a region involved in negative

emotion processing, in response to negatively valenced images (118). Increased negative urgency has been linked to a smaller left ventral striatum and lower regional gray matter volume in the right temporal pole (119).

Studies that include positive urgency often report overlapping neuroanatomical correlates with negative urgency, indicating that emotional dispositions to rash action are implicated within the same regions, regardless of the valence of the emotion (see review by 111, 120). These shared neural correlates are indicated by high gray and white matter intraclass correlation analyses and a similarity of significant regions in linear mixed effect models (120). However, in elastic net analyses, positive urgency was better predicted by structural MRI than negative urgency, despite their overlapping neural correlates (120). Positive urgency has been implicated in greater left frontal asymmetry from the right anterior cingulate cortex, the medial frontal gyrus, and the right inferior frontal gyrus in EEG studies (121, 122). Positive urgency has also been shown to be related to decreased dopamine receptor availability in the bilateral nucleus accumbens, putamen, and caudate (123).

Theories suggesting that emotions contribute to both adaptive and maladaptive decision-making: integrating Urgency Theory

Several theories model the capacity of emotions to be *both* adaptive and maladaptive for decision making, depending on contextual and situational factors. We review four such theories here that we believe provide viable, albeit different, approaches for integrating Urgency Theory into the broader emotion literature.

Integration using model-based and model-free emotion regulation

Emotion regulation refers to one's ability to cope, change, or respond to an emotional experience, and moves through a number of stages and processes, including selection of an emotional experience to modify, attention to a situation, cognitive appraisal of an emotional experience, and an attempt to modulate or respond to the situation (e.g., 124). Although much of the literature on emotion regulation has focused on the modification of negative emotions, some have highlighted the importance of regulating positive emotions as well (e.g., 125), in that maintaining or increasing positive emotional experiences may underlie resilience. Emotion regulation theories propose that emotions that are regulated can be adaptive, whereas emotions that are not regulated may lead to more maladaptive coping (which would be referred to as emotion dysregulation; e.g., 126, 127). For example, a person experiencing depression might be motivated to seek out help, which would be an adaptive emotion-guided response. However, ongoing depression that does not fuel help- or treatment-seeking can be quite maladaptive; such maladaptive responses might be driven, in part, by a lack of awareness of emotions (e.g., 128).

There are several emotion regulation strategies that have been linked to positive outcomes. For example, emotion reappraisal (i.e., "modifying the emotional meaning and impact of a situation that elicits emotion," 129) of both positive and negative emotions is associated with fewer depressive symptoms, greater self-esteem, life satisfaction, and overall wellbeing (129). Reappraisal has also been shown to decrease negative emotions and increase positive emotions in lab paradigms and when using self-report measures (129, 130). Additionally, individuals that utilize reappraisal report having closer relationships due to the increased likelihood of them sharing their emotions (129, 131), illustrating that emotion reappraisal can be adaptive and, in turn, lead to positive outcomes. MacDonald and colleagues (132) found that rapid improvement in emotion regulation strategies significantly increased posttreatment binge/purge abstinence, decreased depression symptoms, and decreased eating disorder-related cognitive psychopathology at posttreatment for individuals diagnosed with Bulimia Nervosa or Purging Disorder. A creative laboratory-based experiment (133) sought to determine the contexts that influence the adaptiveness of negative emotions, finding that negative emotions linked to context (e.g., being sad in the face of a family member passing away) produce more adaptive responses and were associated with better psychological health and adjustment. Thus, this suggests that negative emotions that match the current needs of an individual and that are successfully regulated are and can be adaptive, whereas those that do not match the current needs or are not regulated can be maladaptive.

Etkin and colleagues (134) propose that the decision to engage in emotion regulation is linked to the predicted outcomes of that regulation – in this way, emotion regulation strategies that are linked to a desired outcome are engaged in, whereas those that are associated with costs are avoided. There is continual updating of these assessments over time, and value predictions (i.e., predictions one makes about the relative cost-benefit of an emotion regulation strategy) that are discrepant with one's current experiences are considered "prediction errors" (134). The authors explain this within the context of model-based and model-free control: In model-free control, one makes a decision based on one's current assessment of prediction errors – i.e., the discrepancy between one's desired state and their current state – which is efficient but not flexible. In contrast, in model-based control, one makes a decision by applying prior knowledge, which is less efficient, but more optimal. The authors propose different underlying circuits related to model-based and model-free emotion regulation, such that model-free emotion regulation may be driven by ventral anterior cingulate cortex and ventromedial prefrontal cortex interactions with limbic-emotional circuits, whereas model-based emotion regulation is governed by frontoparietal regions (e.g., ventral lateral prefrontal cortex, dorsolateral prefrontal cortex, parietal cortex, and supplementary motor areas) interacting with limbic-emotional circuits (134).

Empirical evidence integrating urgency

The literature overall has supported the idea that urgency and emotion (dys)regulation are related (92, 135–143). Some have suggested that urgency is driven, in part, by low levels of emotion regulation (64). Others have found negative relationships between negative urgency and the use of adaptive emotion regulation strategies (112) and that differing levels of urgency within individuals results in different kinds of emotion regulation strategies (144). In addition, research in the brain shows overlap in regions implicated in emotion regulation and urgency. A recent review documented that emotion regulation is underpinned by the lateral prefrontal cortex and the amygdala (145), regions that overlapped with cognitive control and emotion regions related to urgency (see review by 111).

There is one only empirical study directly testing the idea of urgency as model-free emotion regulation. Jara-Rizzo and colleagues (146) conceptualized negative urgency as a sign of poor emotion regulation (also supported by 112), and found that negative urgency is related to emotional suppression, but not reappraisal. The authors suggest that negative urgency results from model-free emotion dysregulation (146), such that model-based emotion regulation may result in emotions facilitating adaptive decision-making, whereas model-free emotion regulation may result in emotions producing more maladaptive decision-making. Such a proposal is viable, based on previous work showing a relationship between brain activity in the ventromedial prefrontal cortex in response to alcohol cues and both negative urgency (e.g., 118) and model-free emotion regulation (134). We see the model-based and model-free framework as an interesting way to guide future investigations aimed at better integrating Urgency Theory with models of emotion regulation and adaptive decision-making.

The mood maintenance hypothesis and the affect infusion model: integration using integral and incidental emotions

Two contrasting theories suggest opposite effects across positively and negatively valenced states and are considered jointly here. The Mood Maintenance Hypothesis suggests that positive mood improves decision-making, producing less risky decisions, whereas negative moods lead to less adaptive decision-making and more risk-taking, in the pursuit of obtaining a reward and bettering one's mood (147, 148). In contrast, the Affect Infusion Model suggests that positive affect produces less adaptive decision-making, through attending to the positive cues in the environment which may make one overly optimistic about an outcome; whereas negative affect leads to more adaptive decision-making, through attending to the negative cues in the environment and acting in ways to avoid subsequent negative outcomes (149). An interesting study by Grable and Roszkowski (150) found more support for the Affect Infusion model, suggesting that negative affect may be more linked with adaptive decision-making and that positive affect may be more linked with maladaptive decision-making.

Lerner and colleagues (35) propose how integral and incidental emotions may explain how similar emotional valence states may produce differential effects on decision-making while different emotional valence states may produce similar effects on decision-making. Integral emotions are emotions that arise from the situation or decision at hand, and are thought to underlie decision-making in models, such as the Somatic Marker Hypothesis (151). Lerner and colleagues (35) summarize the research on integral emotions as largely providing evidence that emotions benefit and improve decision-making (although there is some evidence that integral emotions can bias decision-making when they do not reflect reality and that in these cases, they can override more rational courses of action; see a review by 152). Incidental emotions, on the other hand, are emotions that carry over from another situation and influence later decisions (35), a process known as the carryover of incidental emotion (e.g., 153, 154). Lerner and colleagues (35) summarize the research on incidental emotions as largely providing evidence for the biasing effects of incidental emotions, a process by which a more diffuse mood continues to bias decision-making even outside of the primary event or situation which activated the initial emotion response.

Empirical evidence integrating urgency

There is no existing empirical evidence directly linking urgency with integral and incidental emotions. However, the idea of integral and incidental models may guide attempts to integrate Urgency Theory and adaptive emotion-guided decision-making. It's possible that adaptive emotion-guided decision-making is influenced largely by integral emotions, whereas more maladaptive, urgency-like decision-making is influenced largely by incidental emotions. Phelps and colleagues (34) suggest that incidental emotion effects on decision-making may be driven by impaired function of the PFC, or shifting neural processes in regions, such as the orbitofrontal cortex, that assess subjective value. Although there is more work to do in this regard, these underlying brain correlates seem to overlap with regions related to negative urgency (e.g., see 118). This may suggest viability of viewing urgency as a mechanism underlying the detrimental effects of incidental emotions on decision-making. Evidence from neuroimaging work shows that the amygdala may underlie task-independent processing of emotions, whereas the ventromedial prefrontal and somatosensory cortices may be involved in more direct processing of emotions (155). Urgency shows relationships with amygdala functioning (118), indirectly supporting the integration of urgency with incidental processing. However, evidence also links urgency with the ventromedial prefrontal cortex (118), suggesting that urgency may not be reflected by the distinction between incidental and integral processing.

Integration using reflexive responsivity to emotions

Carver and colleagues (156) proposed a model wherein emotions are responded to thoughtfully, which would be associated with more adaptive outcomes, or reflexively, which would be associated with less adaptive outcomes. Reflexive responses can be rash action (like in the case of urgency) or rash inaction (e.g., not seeking out treatment for depression, as in the example above) (156). Thus, emotions that are responded to thoughtfully produce adaptive responses. Carver's theory can serve to integrate across Urgency Theory and theories that highlight the adaptiveness of emotions for decision-making. Adaptive or maladaptive responses to emotions might be better subsumed as reflexive or thoughtful behavioral action or inaction (and reflexive and thoughtful responses can be either adaptive or maladaptive in nature). In this model, adaptive emotion-guided decision-making would be represented as thoughtful responses, whereas urgency can be better understood as a marker of reflexive responses to emotions (whether by action or inaction; as supported by 157).

Empirical evidence integrating urgency

There are mixed empirical data to suggest that urgency and reflexive responses to emotions are similar constructs. Smith and colleagues (157) found that urgency appears to be a marker of reflexive responses to emotions as proposed by the Carver model, in that urgency can relate to both rash action and rash inaction; the common factor here appears to be the focus on alleviation of distress or focusing on the immediate emotion rather than the underlying cause of the emotion itself (157). A 2018 study found that negative urgency was associated with using more reflexive emotion regulation strategies, providing support for Smith et al.'s findings (144). However, a recent study by Sperry and colleagues (158) utilizing Ecological Momentary Assessment (EMA) to examine the link between affect and impulsivity did not find an association between internalizing/externalizing psychopathology and momentary links between affect and impulsivity, suggesting that urgency and reflexive responses to emotion may not be the same thing. There is much more research to be done to determine the validity of this option as explaining the integration of these theories, but it is nonetheless a viable and interesting future avenue of investigation.

Integration using individual difference theory

Individual difference theories posit that there are variations across people on numerous factors that drive behavior, including personality, intelligence, and emotionality. These differences can be driven by temperament, learning, or even underlying biological, genetic, or neural underpinnings (e.g., 159). Urgency was proposed as an individual difference tendency (10), suggesting that Urgency Theory is not universal, but rather only applies to a subset of the population.

Empirical evidence integrating urgency

There is much literature to support the idea that urgency is an individual difference trait (see a review by 160). However, there is also evidence that works against the idea that urgency is an individual difference variable, including that urgency can change in response to treatment or intervention (e.g., 100, 161). This undermines the idea that it is a stable, trait-like construct (e.g., 162, 163), although some suggest that individual differences can change over time (e.g., 164). Thus, although the fact that urgency can change doesn't completely rule out the idea that it is a relatively stable individual difference variable, it is a consideration. Although the field overwhelmingly models urgency as a trait, other approaches have treated urgency as a state-like construct that can be manipulated in the laboratory (see a review by 165).

Conclusion and future directions

In this conceptual review, we conclude that Urgency Theory can be integrated into broader emotion models that include both adaptive and maladaptive effects of emotions on decision-making. We highlight four, not mutually exclusive, possibilities: urgency as a function of model-free emotion (dys)regulation (134); urgency reflecting a reliance on incidental, rather than integral, emotions (as reviewed by 35); urgency as a reflexive, rather than purposeful, response to emotions (156); or urgency as an individual difference tendency that may only apply to a subset of the population.

Although all these possibilities are viable, there is little empirical evidence to inform which, if any, of the theories proposed here best reflect truth. There is no research directly comparing or integrating these constructs into one model; filling this gap is an important future research direction. Some evidence testing these theories is better well-developed than others, suggesting greater viability for some approaches than others; however, other theories are under-researched, suggesting that they may still be viable but require additional empirical study. Measuring these constructs using multiple methods, including self-report, behavioral responding, and neuroimaging, as well as examining the inter-relations among these constructs by testing multiple factor models, would have the most impact in filling this gap. Identifying how and why urgency imparts risk can facilitate development and testing of effective interventions to decrease maladaptive risk-taking, identification of those at risk for maladaptive risk-taking, and matching of interventions to those at risk. Whether or not Urgency can be validly integrated into the above models has impact for how best to intervene.

To date, the most supported integrative theory is that urgency is an individual difference tendency (see a review by 160). This is also the most well-researched theory. Although overwhelmingly supported, studies exist modeling urgency as a state-like behavior,

which may undermine the trait-like view of urgency. In all, it appears that urgency is best conceptualized as a trait, where individuals exist on a continuum (i.e., some have high levels, some low levels, and some in the middle), where the higher the trait, the more the individual engages in maladaptive action while experiencing emotional states. Evidence in the treatment literature suggest that urgency changes very little during treatment (100, 161), supporting the idea that urgency is trait-like and may be difficult to change, suggesting that targeting urgency in a treatment setting may not be a viable approach. Clinically, if urgency is best represented as an individual difference tendency, it would be most effective to identify those high in urgency to receive targeted interventions to reduce urgency-related risk-taking and maladaptive behaviors.

The second best supported integrative theory is urgency model-free emotion dysregulation, with the field generally conceptualizing urgency as associated with higher levels of emotion dysregulation (although the exact mechanism of this relationship is not yet well known). More work is needed to better understand if urgency and emotion dysregulation are the same thing, or if they are two separate, though related, constructs that influence one another or are related due to the presence of a third factor. There is one only empirical study directly testing the idea of urgency as model-free emotion regulation; this study supported the idea of urgency as model-free emotion (146). Replication of this finding is important. Clinically, if urgency is a function of model-free emotion (dys) regulation (134), this would suggest that urgent behaviors may be reduced through a more purposeful use of previous learning structure in the selection of emotion regulation strategy rather than relying on reacting to one's current state. One study (92) applied emotion regulation skills training and found reductions in both urgency and emotion dysregulation, supporting this integration and intervention approach.

The final two theories have less empirical support. The data connecting urgency to a reflexive response to emotions is mixed. Clinically, if urgency reflects a reflexive response to emotions, this would suggest that slowing down and making the decision-making process explicit might be a viable way to interrupt urgent behaviors. However, more direct empirical tests of this integration are necessary to determine if this approach might be effective. The mixed evidence may suggest that there are individual differences in urgency, further supporting the individual difference integration. Finally, to date, no empirical studies have directly tested the integration of urgency with incidental emotions, so a conclusion cannot be made as to the viability of this approach at this time. This integration is supported by theory and overlapping brain regions, but direct empirical tests are needed to determine if this approach is feasible. Clinically, if urgency reflects a reliance on incidental emotions, this would suggest the viability of reducing urgent behaviors through reorienting one's attention away from unrelated emotional experiences and toward ones that are applicable to one's current state. This would need to be tested before clinical application.

As this was a conceptual review, other potential ways to integrate Urgency Theory may exist. We hope that this review catalyzes future empirical research aimed at understanding how best to integrate urgency into these (or other) theories. Although all four options are viable based on existing empirical evidence and theory, individual difference and model-free emotion (dys) regulation have the most support. Importantly, the other two options are less well-researched. Direct tests comparing these integrations would be necessary to determine the most accurate way to integrate urgency with existing emotion theories. We believe that this research can identify key mechanisms underlying urgency and help inform how best to target and modify urgency to reduce its negative effects across numerous maladaptive behaviors and clinical disorders.

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LF-F: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. CP: Writing – original draft, Writing – review & editing. MC: Conceptualization, Funding acquisition, Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Contexts of urgency may go beyond emotion

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Introduction: Urgency has been defined as the tendency towards rash speech and behavior in the context of emotion. Measures of Urgency have been found to have robust predictive power for psychopathologies and problematic behaviors. In the current study, we question whether emotions are unique drivers of urgency, or if emotions are potent exemplars of contexts that lead to rash speech and behavior. The Emotion Specific model and the Broader Contexts model correspond with these two conceptualizations of urgency, and they frame our pre-registered hypotheses.

Methods: Participants from two well-powered samples (n = 600,n = 588) completed 9 modified items from the Urgency and Positive Urgency scales to assess rash responses in each of four contexts – "Upset," "Excited," "Tired," and "Hungry" – and a fifth "In General" set. After data cleaning, we used principal components analysis to construct a unidimensional, 4-item set that was applied to capture impulsive behavior across the five contexts.

Results: We found that this research tool, called the Contexts of Impulsive Behaviors (CIBS), replicated in the second dataset, and it had adequate internal reliability in both samples. Although the Emotion Specific model was supported by the fact that the Upset context had a greater mean and greater variance than the Tired and Hungry contexts, most results supported the Broader Contexts model. That is, CIBS contexts were highly intercorrelated, and bivariate correlations with psychopathology were not significantly different across contexts. In partial correlations, effects of the Upset and Excited contexts were partially or fully statistically mediated by the Tired and Hungry contexts.

Discussion: These findings suggest that emotions are potent contexts for impulsive behaviors. At the same time, those with high urgency are vulnerable to impulsivity in other contexts, such as fatigue and hunger, that challenge the regulatory functions of the prefrontal cortex. Limitations, future directions, and clinical implications are discussed.

KEYWORDS

emotion, impulsivity, psychopathology, self-control, urgency

Introduction

In recent decades, statistical and theoretical advances have converged on the prevailing idea that impulsivity is not a unitary construct, but rather a set of separable dimensions (1, 2). One of the most replicable and influential multidimensional models of impulsivity suggested that some people have a trait-like propensity to act impulsively when experiencing strong emotions, as captured on the factor-analytically derived UPPS-P scale (2, 3). The (Negative) Urgency (NU) and Positive Urgency (PU) scales from the UPPS-P are comprised of items designed to capture tendencies toward rash speech and behavior prompted by negative and positive emotions, respectively. Beyond their inherent relevance to personality science, Urgency measures have been influential in clinical psychology because of their robust predictive validity for a broad range of internalizing psychopathologies – including depression, disordered eating, and suicidal ideation (4–8) – and externalized maladaptive behaviors – including aggression, risky sexual behaviors, gambling problems, non-suicidal self-injury, suicidal actions, and substance abuse (9–15). Urgency is now considered a transdiagnostic risk factor for psychopathology (16, 17).

Based on the clinical validity of urgency measures, much effort has been invested to understand *how* emotional and self-regulatory systems operate and interact among persons with severe urgency. One logical starting point is the idea that urgency is a behavioral manifestation of heightened emotional reactivity (i.e., generating emotions more strongly on average) (18, 19). Laboratory investigations of this model, however, have not provided strong support. Several studies have found that individuals with higher urgency do not show greater subjective or psychophysiological responses to standardized stress or positive mood inductions (20–23). Other work has demonstrated that effects of urgency remain when controlling for neuroticism, a trait-based operationalization of stronger emotional reactivity (24, 25). While heightened emotional reactivity is likely a factor that can compound the adverse effects of urgency, it does not seem to be requisite for its emergence.

Another prominent model posits that urgency stems from deficits in inhibitory control circuitry (26). Although a meta-analysis showed that inhibitory control task performance relates to urgency in clinical samples with primary inhibitory control deficits, such as those with traumatic brain injury and attention deficit/ hyperactivity disorder (27, 28), these correlations are weak in student and community samples (29). Theory, though, has emphasized that inhibitory control would be of particular importance in the context of heightened emotion (26, 30). Consistent with this idea, two studies using "emotional" stop-signal tasks found that Urgency correlated with response inhibition on trials with emotional stimuli but not on trials with neutral stimuli (31, 32). A third study found that among participants with higher Urgency, even minor increases in pupil dilation – a physiological marker of arousal – predicted a decay in accuracy on an anti-saccade task (23). In addition to these findings in response inhibition tasks, researchers using risky decision-making tasks have found that sexual cues (33), pharmacological manipulation of physiological arousal by yohimbine (34), and laboratory stress induction (35) all led to more risky behavior for participants with more severe Urgency. Parallel findings have been observed in fMRI studies (see 36, 37), in that Urgency has been tied to differential profiles of cognitive control circuitry during response inhibition tasks involving emotional stimuli (38–40). Taken together, these studies suggest that one mechanism of urgency may be the fragility of inhibitory control systems when they are pushed outside of "cold" (i.e., calm) states into states of high arousal.

If the key ingredient for urgency is fragile inhibitory control circuitry, then other contexts beyond emotions and physiological arousal that have been shown to affect those circuits may lead to similar patterns of unconstrained behavior. Fatigue due to lack of sleep is one plausible candidate. Neuroimaging studies have shown that experimental induction of sleep deprivation causes reduced activation of inhibitory control brain networks and poorer cognitive task performance (41–43). Weaker functional connectivity between prefrontal cortex and amygdala, a circuit thought to exert inhibitory control over emotional responses, has also been found following sleep deprivation (44). Hunger is another physiological context that can affect prefrontal functioning. A recent systematic review found significant decrements in inhibitory control task performance following experimental fasting in 68% of published studies (45). Of the cognitive domains reviewed, inhibitory control was the most consistently impaired after fasting. Stated differently, if urgency reflects the influence of emotion on an already fragile inhibitory control circuitry, one might expect that other challenges to this circuitry could similarly prompt rash behavior in those who demonstrate urgency.

In the current study, we aim to test the idea that a fuller conceptualization of urgency may go beyond the traditional focus on emotional contexts of impulsive action. That is, although emotion is a common and potent context of decays in inhibitory control for those with urgency, fragility in inhibitory control circuitry may also be vulnerable to other contextual challenges, such as fatigue and hunger. We frame this line of inquiry using two guiding questions:

1. Are emotion contexts of impulsive behaviors distinct from broader challenges to inhibitory control, such as hunger and fatigue?
2. Is a tendency toward impulsive behavior that is contextualized by emotions a stronger predictor of psychopathology than tendencies toward impulsive behavior in broader physiological contexts, such as hunger and fatigue?

To investigate these questions, we define two contrasting models that yield our pre-registered hypotheses. The Emotion Specific model predicts that impulsivity in the context of emotion is more common than and statistically distinct from trait-like tendencies to act impulsively when tired or hungry. The Emotion Specific model also predicts that emotion-context impulsivity confers greater risk for psychopathology than do trait-like tendencies to act impulsively when tired or hungry. Conversely, the Broader Contexts model predicts that trait-like vulnerabilities to emotion and broader physiological contexts will be similarly common and highly correlated. The Broader Contexts model also

predicts that emotion-context impulsivity and impulsivity in broader physiological contexts will confer similar risk for elevated psychopathology.

To test the Emotion Specific and Broader Context models, we create a set of items that are modified from the Urgency and Positive Urgency scales to allow for tests of emotional and broader physiological contexts. We do not intend to improve upon nor displace existing Urgency measures. Instead, we validate this research tool so that it can be used to conduct our specific pre-registered analyses to test the levels of endorsement and variability for each context, and the correlations of the contexts with psychopathology. We consider bivariate correlations of impulsivity in each context with psychopathology, and then we consider whether impulsivity in emotion contexts shows unique correlations when controlling for impulsivity in physiological contexts. In assessing correlations with psychopathology, we focus on depression as an internalizing syndrome that has been shown to relate to Urgency and aggression as an externalizing dimension that has been shown to relate to Urgency (46–48).

Materials and method

The pre-registration for this study is available: (https://aspredicted.org/V2Y_G5Z). Both studies were approved by the university Committee for the Protection of Human Subjects. All participants completed informed consent before study procedures.

Participants and procedures

The data used in the current investigation were collected as part of two larger studies that recruited from an undergraduate research participation program at a large public university between 09/2021 – 04/2022. By this time, the university had returned to primarily in-person classes following the COVID-19 lockdown. To test the reproducibility of our findings, the data from these two samples are kept separate in all data cleaning and analysis steps. We refer to Sample 1 and Sample 2 to differentiate the samples. The data collection and analysis methods are highly parallel across these two samples, and we clearly note where any differences exist.

Recruitment was conducted via online advertising to all students enrolled in Psychology classes. Students were excluded from participation if they were under the age of 18. Participation was fully remote. Participants received partial course credit as compensation for their participation. We expected that we would need to check the unidimensionality of the items to be used in our research. Thus, we aimed for final samples of 400 participants because factor analyses are very stable and replicable at these sample sizes. These sample sizes also provide ample power for our correlational analyses. We expected at least small-to-medium sized correlations (i.e., above .20). Even with half the sample size (N = 200), G*Power indicates that we can detect bivariate r's and partial r's of .25 with power of .80 (49). Even more important, the replication design of this research provides an explicit check of the assumption that we have sufficient power to address the present research questions.

In both samples, pre-screening procedures were used to attempt to oversample for low base-rate behaviors that might reflect problems with self-control of different forms. Sample 1 pre-screening focused on students who reported a history of behaving in a sexually coercive manner on the Sexual Coercion in Intimate Relationships Scale (50), and Sample 2 pre-screening focused on students who reported a history of suicidal ideation on the Columbia Suicide Severity Rating Scale (51). Students who met these pre-screening criteria were sent an email inviting them specifically to participate in the study. To allow for recruitment across the full range of impulsivity, study participation was also fully available for other students in the research participation program. Our pre-screening attempts were not successful: base rates of sexual coercion were too low to support analyses. 99.3% of participants scored between 0 and 1 on the 6-point Sexual Coercion in Intimate Relationships Scale. In a deviation from our pre-registered analysis plan, given the key goal of testing the reproducibility of our results and the low base rates of behaviors endorsed on both scales, we do not include analyses of the sexual coercion or suicidal ideation measures here. Analyses of the Three Factor Impulsivity scale with suicidal ideation are provided in a previous publication (52).

Sample 1 had a total size of 598, and Sample 2 had a total size of 586.

Measures

Initial item set to measure broader contexts of impulsivity

To represent a broad range of content related to urgency, we initially selected nine item probes from the Urgency and Positive Urgency measures (2, 53). To select items, two impulsivity researchers reviewed the content of each item, and considered applicability to the hunger or tired context. As an example, items concerning "Hard to resist acting on feelings" and "When rejected say things later regret " are hard to tailor to the hunger and tired context, and so were omitted. Items concerning "Have trouble resisting cravings" may have a unique meaning in the context of hunger, and so were omitted. We modified the selected probes to remove emotional contexts specified in the original items (e.g., "I often make matters worse because I act without thinking when I am upset" was modified by removing the "when I am upset" specifier). Instead, participants were instructed to answer each of the 9 Urgency probes while recalling times when they experienced each of four contexts – "Upset," "Excited," "Tired," and "Hungry." We also included a fifth, "General," item set that asked how true the statements were for their life "in general" without regard to particular contexts. To be consistent with work on the Three-Factor Impulsivity Scale (54), participants rated each of these 45 self-report items on a 5-point Likert scale, ranging from 1 (I agree a lot) to 5 (I disagree a lot).

Three factor impulsivity index

To validate our Contexts of Impulsive Behaviors research tool against well-validated measures of impulsivity, we collected the Three Factor Impulsivity Index (TFII; 54). Here, we focus on the Feelings Trigger Action and Lack of Follow Through scales, which

are well-validated and have replicable structures using factor analysis (15, 55).

The Feelings Trigger Action (FTA) scale contains 26 items from the Negative Urgency scale (e.g., "I often make matters worse because I act without thinking when I am upset"; 2), the Positive Urgency scale (e.g., "When I am really excited, I tend not to think of the consequences of my actions"; 53), and Reflexive Reactions to Feelings scale (e.g., "I generally act on my feelings instantly"; 54). The Lack of Follow Through (LFT) scale is composed of 19 items from the Distractibility and Lack of Perseverance scales (2, 54), for example, "Its hard for me to keep my mind from wandering."

The Three Factor Impulsivity Index items used 5-point Likert scales from 1 (I agree a lot) to 5 (I disagree a lot). While FTA items measure impulsive behaviors in the context of strong emotions, LFT items do not include references to emotions. The LFT scale has shown strong psychometric properties and is statistically distinct from measures of Urgency (54, 55). For these reasons, LFT has been used as a conceptually-adjacent, control comparison to demonstrate specificity of effects in studies of Urgency (23, 56). We included LFT for this purpose. Multiple studies have shown that FTA scores are more robustly related to early adversity (54), depression (46), multiple facets of suicide risk (7, 52), suicide attempt history (15), and internalizing symptoms (55) than the LFT scale. LFT has also been validated against psychopathology indices, including ADHD (57). After reverse-scoring negatively keyed items, FTA and LFT scores were calculated by averaging across their 26 and 19 items, respectively.

Center for epidemiologic studies depression scale – revised

The Center for Epidemiologic Studies Depression Scale-Revised (CESD-R) was used to capture current depressive symptom severity (58). The CESD-R consists of 20 items covering affective, cognitive, and somatic symptoms of depression, for example, "I lost interest in my usual activities." The CESD-R is internally reliable and has strong convergent and divergent validity (58, 59). Participants are asked to rate the frequency of experiencing each symptom over the past week on a 4-point Likert scale ranging from 1 (Rarely or none of the time, Less than 1 day) to 4 (Most or all of the time, 5–7 days). After reverse-scoring negatively keyed items, CESD-R depression scores are calculated by averaging across the 20 items.

Bryant aggression questionnaire

The Bryant Aggression Questionnaire is a short form of the Buss-Perry Aggression Questionnaire (AQ) designed to cover tendencies toward anger and aggressive behavior, for example "I have threatened people I know" (60). The BAQ was developed using factor analysis to identify four 3-item subscales, and has shown more robust psychometric characteristics than the original AQ. Participants are asked to rate how characteristic each statement was for them on a 5-point Likert scale ranging from 1 (Extremely uncharacteristic of me) to 5 (Extremely characteristic of me) and subscales are scored as the mean of the 3 items. Here, we focused on the three subscales previously shown to be correlated with Urgency: Physical Aggression, Verbal Aggression, and Anger subscales, omitting the Hostility subscale (61). As all 3 subscales have been found to correlate with Urgency, and we had no differential hypotheses for the three subscales, we computed a total BAQ scale by averaging the three subscales.

Analysis plan

Data cleaning

As stated in our pre-registration, we excluded participants using equivalent criteria in the Sample 1 and Sample 2. Participants were excluded from data analysis if they met one or more of the following criteria: 1) Failed one or more "catch" trials (e.g., "On this item, respond with Never"), 2) completed the full survey in fewer than 500 seconds, 3) did not answer (i.e., had missing data) one or more items on the 45-item Broader Contexts of Impulsivity Item Set, or 4) demonstrated careless responding on the Broader Contexts of Impulsivity Item Set by either providing the same response to every item or having average scores for both positively and negatively keyed items below 2.0 or 4.0 on the 1–5 response scale. Participants with missing data on the LFT, CESD-R or Bryant, whose data was otherwise acceptable, were excluded from the analyses that used those respective measures only.

Sample 1: construction of the Contexts of Impulsive Behaviors

In Sample 1, we first checked whether the 9 item probes selected from the Urgency and Positive Urgency measures formed a unidimensional item set in each context. Using principal components (PC) analysis, the 9 items were not unidimensional in any of the 5 contexts. Instead, they measured more than one factor, as indicated by both the scree test and parallel analysis. As an example, we have included the results for the Hungry context, showing the loadings of the 9 candidate items on the three unrotated components, in Appendix B in the online materials. Specifically, items 2, 1, 5, 7, and 9 all showed clear simple structure: they all loaded above .70 on the first principal component, and none had a loading of .35 or above on the other two components. In contrast, the remaining four items (8, 4, 3, and 6) were factorially complex: They all had loadings below .70 on the first principal component as well as substantial loadings on at least one of the two other components. In fact, one of these items (i.e., "I feel like I cant stop myself from going overboard") loaded only .11 on the first unrotated component, which captures the core Urgency factor assumed to underlie all the items. Several other items had substantial secondary loadings on the second or third component (e.g., "Others are shocked or worried about the things I do"), indicating that they measured other aspects of behavior in addition to a single dimension of individual differences in impulsivity.

These issues with dimensionality were apparent not only in the Hungry context but also in the other three contextualized ratings as well as in the General ratings. Because we needed a unidimensional item set as a tool for our pre-registered analyses, we selected only those item probes that showed simple structure, measuring only the

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intended primary factor and did so consistently in the four context-specific instructions as well as the General instructions.

The results of the PC analyses for all 9 items and in all 5 contexts are summarized in Table 1. The results were clear and consistent across all the contexts. The five items shown in the upper part of Table 1 all had average loadings across the 5 contexts above .70, had loadings of at least.68 in every context, and showed simple structure (i.e., no cross-loadings above .35). In contrast, none of the 4 remaining items in the lower part of Table 1 met these three conditions. Finally, when we reviewed this empirically selected set of 5 items, we noted that it included two items that were highly redundant, both asking about actions one later regrets. Thus, as indicated in Table 1, we retained only the shorter and simpler item of the two (i.e., "I will often say things that I later regret"), resulting in a 4-item research tool.

These steps were completed using only the sample from Sample 1 in an exploratory (i.e., data-driven) analysis. Then, these 4 items were examined again in Sample 2 to test for replicability (results described below). Following the selection and validation procedures, we refer to the final item set as the Contexts of Impulsive Behaviors (CIBS) research tool. Table 2 contains the full set of 20 items, that is, each of the 4 final impulsivity items rated in each of the 5 contexts.

Sample 2: replicating the unidimensional Contexts of Impulsive Behaviors

As described above, the 4-item CIBS was developed in the Study 1 sample. Thus, we used Sample 2 to test whether our item selection procedure replicated and resulted in a unidimensional item set. Specifically, to evaluate unidimensionality, we report (a) the loadings of the 4 items on the first unrotated principal component (expected to be .70 or above), (b) the percent of variance accounted for by the first principal component (expected to be greater than 50%), and (c) the fit statistics for the unidimensional model tested with confirmatory factor analysis (CFA); good fit is indicated by CFI and TLI values of .90 and above, RMSEA values of .08 and below, and SRMR values of .05 and below. For each CFA, we chose to fix item 1 to the latent factor for identification since it had the highest average loadings on the first, unrotated principal component in Sample 1 (Table 1).

In addition, we evaluated the internal reliability of the resulting unidimensional item set using Cronbach's alpha. Adequate internal reliability ($\alpha > 0.75$) was required prior to continuing with our pre-registered analyses. Going beyond the pre-registration, we calculated the average inter-item correlation (AIC) of each context as a second indicator of internal consistency. AIC is not affected by the number of items in the scale; therefore, it can be a better index of internal reliability for brief self-report scales (62). We set an AIC of greater than 0.4 as our standard of evidence for high internal consistency in our unidimensional item set.

Contexts of Impulsive Behaviors characteristics and predictive validity

After replicating the CIBS and examining its reliability, we conducted our pre-registered analyses, designed to compare evidence for and against the Emotion Specific and the Broader Contexts models of urgency. We conducted analyses identically in Sample 1 and Sample 2. All tests were two-tailed with alpha = 0.05. We clearly state when analyses were not pre-registered and include justification for adding them.

To begin, we consider whether emotion-context impulsivity was more common, or showed more pronounced individual differences than did impulsivity in other contexts. We conducted paired samples *t* tests to test for significant differences among the means of the five CIBS contexts, as well as LFT. Going beyond the pre-registration, we also calculated Cohen's *d* to provide effect sizes for these differences of sample means. We used paired Pitman-Morgan tests to test whether the sample variances of these contexts differed significantly. To condense the number of tests, we deviated

TABLE 1 Sample 1: loadings on the first unrotated principal component for the 9 candidate Items in four specific contexts and in general.

Item #	Item Text	Upset	Tired	Hungry	Excited	General	Average
Items showing simple structure and average loadings across contexts above .70							
2	*I will often do things I later regret in order to make myself feel better now.*	**.82**	**.81**	**.82**	**.84**	**.84**	**.82**
1	**I often make matters worse because I act without thinking.**	**.87**	**.83**	**.82**	**.82**	**.75**	**.82**
5	**I will often say things that I later regret.**	**.79**	**.78**	**.74**	**.74**	**.76**	**.76**
7	**I think of the consequences of my actions. (R)**	**.80**	**.76**	**.79**	**.75**	.68	**.75**
9	**I cant seem to stop what I am doing even though it is making me feel worse.**	**.73**	**.73**	**.76**	**.71**	**.71**	**.73**
Factorially complex items with average loadings across contexts below .70							
6	*Others are shocked or worried about the things I do.*	**.71**	.62	.66	**.76**	.70	.69
3	*I do not have trouble controlling my impulses. (R)*	.67	.66	.49	.56	.66	.61
4	*I have trouble resisting my cravings (for food, cigarettes, etc).*	.56	.55	.54	.49	.56	.54
8	*I feel like I cant stop myself from going overboard.*	.19	.13	.11	.00	.04	.09

The item text of the four items selected in Sample 1 are shown in bold. The items not selected are shown in italics. Loadings above .70 are shown in bold.

TABLE 2 Final item set of the Contexts of Impulsive Behaviors.

Please rate how true the following statements are for your life in general.	
1.1	I often make matters worse because I act without thinking. [NU]
1.2	I will often say things that I later regret. [NU]
1.3	I think of the consequences of my actions. (R) [PU]
1.4	I can't seem to stop what I am doing even though it is making me feel worse [NU]
Now, we want you to think about times when you are feeling upset. Please rate how true the following statements are for you when you are upset	
2.1	I often make matters worse because I act without thinking.
2.2	I will often say things that I later regret.
2.3	I think of the consequences of my actions. (R)
2.4	I can't seem to stop what I am doing even though it is making me feel worse
Now, we want you to think about times when you are feeling very excited. Please rate how true the following statements are for you when you are very excited.	
3.1	I often make matters worse because I act without thinking.
3.2	I will often say things that I later regret.
3.3	I think of the consequences of my actions. (R)
3.4	I can't seem to stop what I am doing even though it is making me feel worse.
Now, we want you to think about times when you have not had enough sleep. Please rate how true the following statements are for you when you have not had enough sleep.	
4.1	I often make matters worse because I act without thinking.
4.2	I will often say things that I later regret.
4.3	I think of the consequences of my actions. (R)
4.4	I can't seem to stop what I am doing even though it is making me feel worse.
Now, we want you to think about times when you are feeling hungry. Please rate how true the following statements are for you when you are hungry.	
5.1	I often make matters worse because I act without thinking.
5.2	I will often say things that I later regret.
5.3	I think of the consequences of my actions. (R)
5.4	I can't seem to stop what I am doing even though it is making me feel worse.

Four items were adapted from measures of Positive Urgency [PU] and Negative Urgency [NU] and applied to Five Contexts: Upset, Excited, Tired, Hungry, and General.

from our pre-registration and only tested differences among contexts with adjacent means and variances. To bolster these tests and utilize our replication design, we also calculated a rank-order correlation of the means and variances of the contexts.

Significantly higher mean scores and variances for emotion contexts than the other contexts would be consistent with the Emotion Specific model, reflecting that emotion is a context that is separable and with more power to evoke impulsive behaviors. Findings that emotion contexts, but not broader physiological contexts, would have significantly different means and variances compared to the LFT scale, would also be consistent with the Emotion Specific model. In contrast, finding that broader CIBS contexts are as or more common than CIBS emotion contexts would be consistent with the Broader Contexts model. Findings that emotion and broader CIBS contexts would have significantly different means and variances compared to the LFT scale, would also be consistent with the Broader Contexts model.

We also considered the intercorrelations of the CIBS contexts. We did not pre-register hypotheses for this analysis; however, relatively low correlations between the CIBS emotion contexts and broader physiological CIBS contexts could be interpreted as evidence in favor of the Emotion Specific model. On the other hand, comparable intercorrelations within and between these context types could be interpreted as evidence in favor of the Broader Contexts model.

Next, we examined the bivariate correlations of CIBS and LFT with psychopathology. Our choice of correlation coefficient matched the distributional properties of each psychopathology measure. To compare the strengths of the magnitude of correlations for the CIBS contexts and LFT on psychopathology, we used bootstrapping (1000 random samples with replacement) to build 95% confidence intervals around each correlation coefficient. Correlation coefficients were considered to be significantly different from each other if the 95% confidence intervals did not overlap one another. The Emotion Specific model predicted that emotion-context impulsivity would have significantly larger effect sizes with psychopathology than impulsivity in broader physiological contexts and LFT. The Broader Contexts model predicted that bivariate correlations of CIBS emotion contexts and CIBS broader contexts on psychopathology would all be significantly larger than LFT, and they would not be significantly different from one another.

Although the bivariate correlations of CIBS with psychopathology scales were of primary interest, we also aimed to understand the unique (i.e., non-shared) variance of the CIBS contexts on psychopathology. In our pre-registration, we stated that we would use multivariate linear models to examine the effects of the CIBS emotion contexts controlling for the broader physiological CIBS on psychopathology scales. To provide comparable information, we ultimately decided to present partial correlations because they are simpler tests of unique effects on psychopathology. The Emotion Specific model predicted that CIBS emotion contexts would significantly correlate with psychopathology when controlling for impulsivity in broader contexts; in contrast, the Broader Contexts model predicted that the unique effects of CIBS emotion contexts on psychopathology would be statistically mediated by impulsivity in broader contexts.

Going beyond the pre-registration, we tested whether impulsivity in emotion and broader contexts predicted psychopathology when controlling for the "General" CIBS. We included this analysis because of the sizable direct effects of the "General" CIBS on psychopathology. In the case that effects of emotion contexts, but not broader physiological contexts, remained significant when controlling for the "General" CIBS, this analysis would provide evidence for the Emotion Specific model. In the case that all effects of CIBS emotion contexts and

CIBS broader physiological contexts on psychopathology remained significant when controlling for the "General" CIBS, this analysis would provide evidence for the Broader Contexts model. We also tested whether impulsivity when tired or hungry predicted psychopathology when controlling for emotion-context impulsivity. Last, we tested the impact of controlling for LFT, which has frequently been considered in previous studies of emotion-context impulsivity and psychopathology. Both models predicted the same outcome – that CIBS would correlate significantly with psychopathology when controlling for LFT.

Results

Data cleaning

In Sample 1 (S1), quality assurance led to the exclusion of 196 participants: 43 for skipping one or more items on the Broader Contexts of Impulsivity Item Set, 26 participants for completing the survey too quickly, 119 participants for incorrectly answering one or more "catch trials," and 8 participants for other forms of careless responding. In Sample 2 (S2), quality assurance led to the exclusion of 184 participants: 43 participants for skipping one or more items on the Broader Contexts of Impulsivity Item Set, 31 participants for completing the survey too quickly, 98 participants for incorrectly answering one or more "catch trials," and 12 participants for other forms of careless responding. After completing these data cleaning procedures, Sample 1 had a final size of 402, and Sample 2 had a final size of 402. Young women comprised the majority of both samples (S1: M_{age} = 20.5, SD_{age} = 2.18, 76% women; S2: M_{age} = 20.7, SD_{age} = 2.86, 76% women). Asian/Asian American (S1: 46%, S2: 51%), White/European American (S1: 31%, S2: 28%) and More Than One Race/Other (S1: 17%, S2: 16%) were the most common racial identities represented in the two samples. Table 3 summarizes the sociodemographic characteristics of the final samples.

TABLE 3 Sociodemographic characteristics of the final samples.

Sample characteristics	Sample 1		Sample 2	
	n	%	*n*	%
Final sample size	402		402	
Gender				
Woman	304	75.6	304	75.6
Man	91	22.6	92	22.9
Non-Binary	5	1.2	6	1.5
Declined to respond	2	0.5	0	0
Race				
American Indian/ Alaska Native	3	0.7	2	0.5
Asian/Asian American	183	45.5	204	50.7
Black/African American	4	1.0	3	0.7
More than one race/Other	68	16.9	65	16.2
Native Hawaiian/ Pacific Islander	1	0.2	0	0
White/European American	126	31.3	111	27.6
Declined to respond	17	4.2	17	4.2
Ethnicity				
Hispanic or Latina/o	76	18.9	80	19.9
Not Hispanic or Latina/o	311	77.4	298	74.1
Other	7	1.7	15	3.7
Declined to respond	7	1.7	9	2.2
School Year				
Freshman	69	17.2	62	15.4
Sophomore	54	13.4	57	14.2
Junior	146	36.3	147	36.6
Senior	125	31.1	128	31.8
Graduate/Other	8	2.0	8	2.0

Sample 2: replication of the 4-item contexts of impulsive behaviors

To test whether our item selection procedure had successfully resulted in a unidimensional research tool for each of the 5 contexts, we used the data from Sample 2 as a replication sample. Table 4 reports the results. First, the factor loadings of the 4 items on the first unrotated factor were all substantial in size and averaged .81 across the 4 items as well as the 5 contexts. In fact, all but one of these 20 item loadings were above .70, indicating the items shared more than 50% of their variance with the impulsivity factor we intended to measure. Second, Table 4 reports the percent of variance accounted for by the first principal component, which averaged 64% across the 5 contexts, indicating that this principal dimension captured almost 2/3 of the total variance. Third, CFAs tests showed that the single-factor model generally fit the data very well, as summarized in Table 4: The CFI and TLI values for the 5 contexts were all above .94, the SRMR values were all below .05, and all but one of the 5 RMSEA values were below .08. On all indicators considered, then, we found considerable evidence that the CIBS measured a unidimensional construct in an independent replication sample.

As shown in Table 2, the final four probes included, "I often make matters worse because I act without thinking," "I will often say things that I later regret," "I think of the consequences of my actions [reverse coded]," and "I cant seem to stop what I am doing even though it is making me feel worse." The Cronbach's alpha and average interitem correlations (AIC) for the 4-probe CIBS provided evidence of strong internal consistency (all αs > 0.75, all AICs > 0.40) for all five contexts. As shown in Table 5, the internal consistency estimates from Study 1 were very closely replicated in Sample 2: the five alpha values were within .02 of one another and the AIC values were within .04 of one another. Internal consistency of the existing measures – CESD-R, BAQ, FTA, and LFT – were strong (all αs > 0.80, Table 5).

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TABLE4 Testing the unidimensionality of the Contexts of Impulsive Behaviors in sample 2: principal component loadings for all 4 items, % of total variance explained, and confirmatory factor analysis fit statistics for the single-factor model in five contexts.

	Upset	Tired	Hungry	Excited	General	Mean across contexts
PC1 Loadings						
Item 1	.87	.86	.84	.85	.85	.85
Item 2	.86	.84	.80	.83	.83	.83
Item 3	.82	.81	.79	.76	.74	.78
Item 4	.75	.73	.76	.78	.66	.78
Mean Across Items	.83	.81	.80	.81	.77	.81
Total Variance Explained	68%	66%	63%	65%	60%	64%
CFA Fit Statistics						
CFI	1.00	1.00	0.99	0.98	1.00	0.99
TLI	1.00	1.00	0.97	0.94	1.00	0.98
RMSEA	.000	.000	.074	.115	.000	.038
SMR	.002	.004	.019	.027	.014	.013

CFA, Confirmatory Factor Analysis; CFI, Comparative Fit Index; PC1, First unrotated principal component; RMSEA, Root Mean Square Error of Approximation; SMR, Standardized Root Mean Square Residual; TLI, Tucker-Lewis Index.

Contexts of Impulsive Behaviors characteristics and predictive validity

Context-level means and standard deviations across the five CIBS contexts are reported in Table 5. In contrast to LFT, which was normally distributed, all five CIBS contexts were right skewed (Figure 1). Visual inspection of these distributions indicated that it was relatively rare for participants to score at the extreme high end of any of the contexts, as expected. Although it was common for participants in these samples to report moderate levels of LFT or impulsivity in response to feeling upset, most participants endorsed low levels across the CIBS. Tendencies to act impulsively were particularly uncommon when feeling excited. In both Sample 1 and Sample 2, reports of impulsive behaviors captured by the CIBS were most common when Upset, followed by Tired, Hungry, General, and Excited. This rank-order correlation of 1.0 provides evidence of replication for this pattern of relative commonality across the contexts we studied. Consistent with prior meta-analytic work on

TABLE 5 Means, standard deviations, and alpha reliabilities for the Contexts of Impulsive Behaviors in five contexts, the lack of follow through scale, the CESD-R depression scale, and the bryant aggression questionnaire in sample 1 and sample 2.

	Mean		Standard Deviation		Cronbach's Alpha		Average Interitem Correlation	
	S1	S2	S1	S2	S1	S2	S1	S2
CIBS								
Upset	2.70	2.65	1.15	1.11	.85	.84	.60	.57
Tired	2.50	2.43	1.08	1.06	.82	.82	.54	.54
Hungry	2.32	2.26	1.04	1.00	.82	.81	.54	.51
Excited	2.02	1.99	0.90	0.93	.80	.82	.49	.53
General	2.09	2.10	0.87	0.89	.77	.77	.46	.46
Average	*2.33*	*2.29*	*1.01*	*1.00*	*.81*	*.81*	*.53*	*.52*
FTA	2.57	2.58	0.74	0.70	.93	.92	.34	.31
LFT	2.86	2.87	0.72	0.76	.91	.92	.34	.36
CESD-R	1.93	1.95	0.58	0.56	.92	.92	.37	.36
Aggression	1.86	1.84	0.70	0.72	.84	.86	.38	.40

Aggression, Bryant Aggression Questionnaire; CESD-R, Center for Epidemiologic Studies Depression Scale – Revised; LFT, Lack of Follow Through Scale; S1, Sample 1; S2, Sample 2; CIBS, Contexts of Impulsive Behavior.

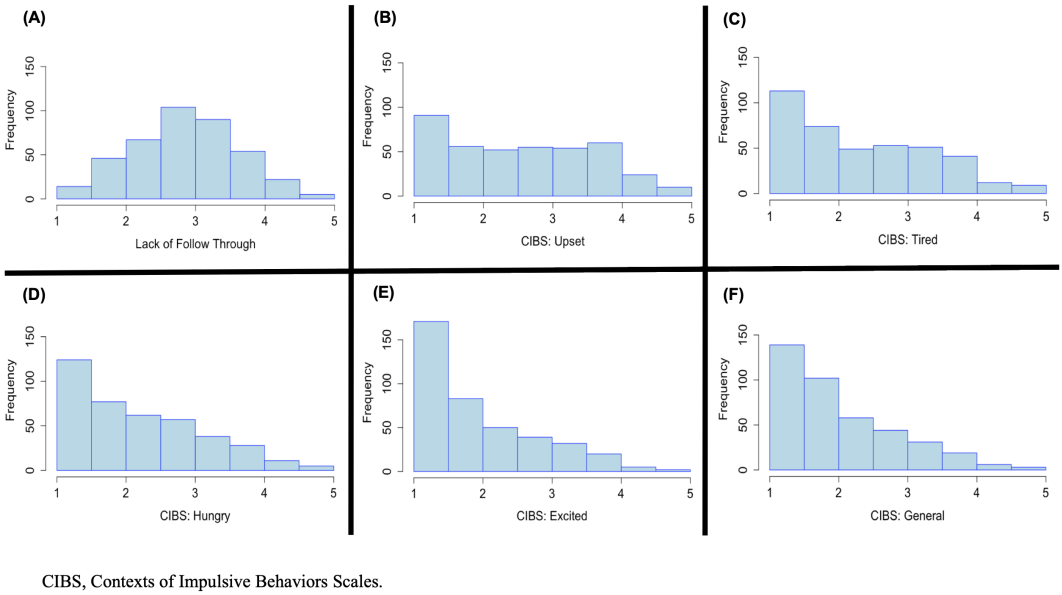

FIGURE 1
Histograms depicting the univariate distributions of **(A)** Lack of Follow Through, and the five Contexts of Impulsive Behaviors (CIBS): **(B)** Upset, **(C)** Tired, **(D)** Hungry, **(E)** Excited, and **(F)** General in Study 2.

Urgency (63), we found small mean-level differences in the CIBS between men and women (Cohen's *d*: -0.21 – 0.20, Women > Men defined as a positive value).

Paired *t* tests demonstrated that the mean of LFT was greater than Upset, the highest CIBS mean. All adjacent CIBS means were significantly different from one another; however, Cohen's *d* was between 0.10 and 0.28, meaning that sizes of these differences were small. These results replicated in Sample 2 (Table 6A). Paired Pitman-Morgan tests demonstrated that LFT had less variance than General, the lowest CIBS variance. Within the CIBS, variance comparisons followed a similar order to comparisons of the means. Upset had the highest variance, followed by Tired, Hungry, Excited, and General. However, unlike the comparisons of CIBS means, none of the adjacent comparisons of CIBS sample variances were significantly different in both Sample 1 and Sample 2 (Table 6B). Our efficient testing method of adjacent comparisons was not sensitive to the possibility of significant differences in non-adjacent comparisons.

All impulsivity and psychopathology measures used in this analysis formed continuous distributions, so we used Pearson's correlations to test the strengths of bivariate effects. CIBS contexts were highly intercorrelated in both Sample 1 and Sample 2, with Pearsons *r* ranging from 0.52 – 0.70, all *p*s <.001 (Table 7). Of interest, CIBS Upset and CIBS Excited, the two emotion-related contexts, were not more highly correlated with one another than they were with the other three CIBS contexts, as indicated by overlapping 95% confidence intervals. As expected, correlations of CIBS and FTA were large with Pearson's *r* ranging from 0.62 – 0.79 and stronger than correlations of CIBS and LFT with Pearson's *r* ranging from 0.36 – 0.49, as indicated by non-overlapping 95% confidence intervals.

All bivariate correlations of CIBS with psychopathology indices were of moderate to high strength, *r*s = .24 to.47, ($p < 0.001$; Table 8A). Our key comparisons of the bivariate effects of emotion versus broader physiological CIBS contexts on psychopathology indicated no significant differences. That is, as shown in Table 8A, the 95% confidence intervals around all the bivariate effects of the five CIBS contexts on psychopathology overlapped one another. In contrast to our prediction, CIBS contexts did not have stronger bivariate correlations with depression symptoms than LFT did. The effect of CIBS General on aggression was significantly larger than the effect of LFT, but comparisons of other CIBS contexts and LFT were null.

Tables 8B–D display the results from partial correlations testing unique effects of CIBS on psychopathology. Overall, the effects of the CIBS emotion contexts on psychopathology were attenuated when controlling for broader physiological CIBS contexts (Table 8B). Though the Upset context accounted for unique depression variance in Sample 1 when controlling for the Tired and Hungry contexts, this unique effect was not significant in Sample 2. The same pattern across Samples 1 and 2 was found when examining the unique effect of the Excited context on depression when controlling for the Tired and Hungry contexts; that is, the Excited context accounted for unique depression variance in Sample 1 but not Sample 2. Unique effects of emotion-context impulsivity on aggression were more robust. Across both samples, the Upset and Excited contexts each accounted for unique variance in aggression when controlling for the Tired and Hungry contexts.

Going beyond the pre-registered analyses, we examined the unique effects of CIBS Tired and Hungry contexts when controlling for the CIBS emotion contexts (Table 8C). Mirroring the partial correlations above, the correlations of CIBS Tired and Hungry on psychopathology were partially or fully attenuated when controlling for the CIBS emotion contexts. Across both samples, the Tired and Hungry contexts accounted for unique variance in depression when

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TABLE 6 Comparing the means and variances of adjacent Contexts of Impulsive Behaviors and Lack of Follow Through.

Panel A. Comparisons of means using paired samples t tests and effect sizes as Cohen's d values.				
	Cohen's *d*		95% Confidence Interval	
	S1	S2	S1	S2
Upset > Tired	0.23	0.26	0.13 – 0.33	0.16 – 0.36
Tired > Hungry	0.22	0.19	0.12 – 0.32	0.09 – 0.29
Hungry > General	0.28	0.20	0.18 – 0.38	0.10 – 0.30
General > Excited	0.10	0.14	0.00 – 0.20	0.04 – 0.24
Upset > LFT	0.15	0.20	0.05 – 0.25	0.11 – 0.30
Panel B. Comparisons of variances using paired Pitman-Morgan tests.				
	s^2_1, s^2_2		95% Confidence Interval	
	S1	S2	S1	S2
Upset > Tired	1.32, 1.16	1.22, 1.12	0.99 – 1.32	0.95 – 1.26
Tired > Hungry	1.16, 1.07	1.12, 1.01	0.94 – 1.24	0.95 – 1.29
Hungry > Excited	1.07, 0.82	1.01, 0.87	1.11 – 1.55	0.98 – 1.38
Excited > General	0.82, 0.76	0.87, 0.78	0.93 – 1.25	0.95 – 1.28
General > LFT	0.76, 0.52	0.78, 0.58	1.22 – 1.72	1.14 – 1.60

LFT, Lack of Follow Through Scale; S1, Sample 1; S2, Sample 2; s^2_1, variance of variable 1; s^2_2, variance of variable 2.

controlling for the emotion contexts. The Tired and Hungry contexts accounted for unique variance in aggression in Sample 1, but not in Sample 2.

We also examined the unique effects of CIBS emotion and broader physiological contexts on psychopathology when controlling for the CIBS General item set (Table 8D) and LFT (Table 8E). In both Sample 1 and Sample 2, the General item set fully attenuated the effects of the Upset and Excited contexts on depression and aggression. The Tired and Hungry contexts explained unique variance in depression when controlling for the General item set in Sample 1, but not in Sample 2. Across 10 partial correlations, the unique effects of CIBS on depression and aggression remained significant when controlling for LFT, with one exception. When controlling for LFT, the Excited context accounted for unique variance in depression scores in Sample 1, but not in Sample 2.

Discussion

The primary aim of these two studies was to adjudicate among two competing models of urgency: the Emotion Specific model,

TABLE 7 Zero-order correlations (Pearson's *r*) and 95% confidence intervals among the Contexts of Impulsive Behaviors and Lack of Follow Through scale.

	Upset	Tired	Hungry	Excited	General	FTA	LFT
Upset	–						
Tired	.69 [.63-.73] .68 [.62-.73]	–					
Hungry	.58 [.51-.64] .63 [.57-.69]	.70 [.65-.75] .64 [.58-.70]	–				
Excited	.58 [.51-.64] .56 [.49-.63]	.59 [.52-.65] .65 [.59-.70]	.53 [.45-.59] .52 [.44-.59]	–			
General	.67 [.61-.72] .70 [.64-.74]	.65 [.59-.70] .69 [.63-.73]	.63 [.57-.68] .62 [.56-.68]	.67 [.62-.72] .64 [.58-.70]	–		
FTA	.67 [.61-.72] .73 [.68-.77]	.65 [.59-.70] .67 [.61-.72]	.63 [.56-.68] .62 [.56-.68]	.63 [.56-.68] .62 [.56-.68]	.79 [.74-.82] .75 [.70-.79]	–	
LFT	.41 [.32-.49] .42 [.34-.50]	.36 [.27-.44] .44 [.35-.51]	.39 [.30-.47] .37 [.28-.45]	.37 [.28-.45] .38 [.30-.46]	.49 [.42-.56] .48 [.40-.56]	.48 [.40-.55] .49 [.41-.56]	–

Sample 1 (top) and Sample 2 (bottom); FTA, Feelings Trigger Action; LFT, Lack of Follow Through.

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TABLE 8 Pearson's *r* and 95% confidence intervals for zero-order and partial effects of the Contexts of Impulsive Behaviors with depression and aggression.

Panel A. Zero-Order Correlations of the Contexts of Impulsive Behaviors and the Lack of Follow Through (LFT) Scale with Psychopathology							
		Upset	Tired	Hungry	Excited	General	LFT
CESD-R	S1	.38 [.29-.46]	.43 [.34-.50]	.39 [.30-.47]	.36 [.27-.44]	.47 [.39-.54]	.50 [.43-.57]
	S2	.30 [.21-.39]	.32 [.23-.41]	.28 [.19-.37]	.26 [.17-.35]	.43 [.35-.51]	.47 [.39-.54]
Aggression	S1	.37 [.28-.45]	.39 [.30-.47]	.35 [.26-.43]	.37 [.28-.45]	.47 [.39-.55]	.27 [.18-.36]
	S2	.31 [.21-.39]	.31 [.22-.39]	.24 [.15-.33]	.32 [.23-.41]	.42 [.34-.50]	.24 [.14-.33]
Panel B. Partial Correlations of the Emotion-Related Contexts of Impulsive Behaviors and Psychopathology, Controlling for Tired and Hungry							
		Upset			Excited		
CESD-R	S1	.11 [.01-.20]			.13 [.03-.23]		
	S2	.09 [-.01-.19]			.05 [-.05-.15]		
Aggression	S1	.13 [.04-.23]			.17 [08.-.27]		
	S2	.13 [.03-.22]			.16 [.07-.26]		
Panel C. Partial Correlations of the Tired and Hungry Contexts of Impulsive Behaviors and Psychopathology, Controlling for Upset and Excited							
		Tired			Hungry		
CESD-R	S1	.20 [.11-.29]			.19 [.09-.28]		
	S2	.14 [.04-.23]			.10 [.00-.19]		
Aggression	S1	.15 [.05-.24]			.13 [03.-.22]		
	S2	.06 [-.04-.16]			.02 [-.08-.12]		
Panel D. Partial Correlations of Contexts of Impulsive Behaviors and Psychopathology, Controlling for General							
		Upset	Tired	Hungry	Excited		
CESD-R	S1	.10 [-.00-.19]	.18 [.08-.27]	.14 [.04-.23]	.07 [-.03-.17]		
	S2	.00 [-10.-.10]	.04 [-.06-.14]	.02 [-.08-.12]	-.03 [-.13-.07]		
Aggression	S1	.08 [-.02-.18]	.12 [.02-.21]	.07 [-.02-.17]	.08 [-.02-.18]		
	S2	.02 [-.08-.12]	.03 [-.07-.13]	-.02 [-.12-.07]	.08 [-.02-.17]		
Panel E. Partial Correlations of the Contexts of Impulsive Behaviors and Psychopathology, Controlling for Lack of Follow Through							
		Upset	Tired	Hungry	Excited	General	
CESD-R	S1	.22 [.13-.31]	.31 [.21-.39]	.25 [.15-.34]	.23 [.13-.32]	.30 [.21-.39]	
	S2	.13 [.04-.23]	.15 [.06-.25]	.13 [.04-.23]	.10 [-.00-.19]	.27 [.17-.36]	
Aggression	S1	.30 [.20-.38]	.33 [.23-.41]	.28 [.18-.36]	.30 [.21-.39]	.41 [.32-.49]	
	S2	.23 [.14-.32]	.23 [.14-.32]	.17 [.08-.27]	.26 [.17-.35]	.36 [.27-.44]	

Sample 1 (top) and Sample 2 (bottom); Aggression, Bryant Aggression Questionnaire; CESD-R, Center for Epidemiologic Studies Depression Scale – Revised.

which highlights the uniqueness of emotional states as contexts for impulsive behavior, in contrast to the Broader Contexts model, which posits that broader physiological factors, might prompt impulsive behavior. Our results begin to address a key question in the impulsivity literature: Are emotions a special class of contexts for impulsive behavior, and therefore a necessary component of the urgency construct – as predicted by the Emotion Specific model – or does this trait reflect less specific susceptibility to a range of state-level regulatory challenges, consistent with the Broader Contexts model? We conducted several pre-registered analyses to evaluate the relative merits of these alternative frameworks.

First, we conducted PCA of self-report items pertaining to contextual impulsivity in a discovery sample, which yielded an internally reliable and unidimensional four-item solution. This four-item solution was replicated in a second sample with similarly strong reliability and fit on single factors within each of our specified

contexts – Upset, Tired, Hungry, and Excited, as well as a General item set that captured the urgency-like rash action without reference to contextual antecedents. We refer to the empirically-derived composite of these four-probe item sets as the "Contexts of Impulsive Behaviors" (CIBS). Consistent with the idea that LFT and Urgency measure distinct phenomena that contribute separate but overlapping variance to psychopathology (64, 65), the CIBS contexts only moderately correlated with LFT and demonstrated distinct distributions across two well-powered adult samples. In service of our primary aim to understand the specificity of impulsive responses, we have constructed this very brief, 4-item impulsive behavior research tool that was not only highly reliable but also strictly unidimensional upon replication, both in general and for 4 contexts (upset, tired, hungry, and excited).

Although the Emotion Specific model was supported by differences in the distribution of the Upset context, which had a larger mean relative to the Tired and Hungry contexts, most analytic results aligned with the Broader Contexts model. Compared to scores on the Excited context, means and variances of the Tired and Hungry contexts were more similar to the Upset context. That is, people were more likely to report that they engaged in rash action when they were tired or hungry than when they were excited. CIBS contexts were also highly intercorrelated, to the extent that they approached maximum possible effect sizes allowed by the internal reliability of these measures. Perhaps most importantly, emotion, hunger, and tiredness had statistically equivalent bivariate effects on internalizing and externalizing psychopathology. Not only were the effects on psychopathology comparable, but there was little evidence for unique, independent pathways. Partial correlations indicated (partial or full) statistical mediation of the Upset and Excited contexts effects on psychopathology by scores on (a) the Tired and Hungry contexts as well as (b) the General item set. Correlations between CIBS scores and psychopathology were nominally higher in Sample 1 than in Sample 2, yet the rank order of means and variances and the overall patterns of effects across contexts were highly consistent.

Overall, we found that individuals with high levels of Urgency tended to endorse vulnerability to varied contextual challenges to self-regulation. Although emotion – particularly in the negative valence domain – will certainly prompt rash action among many people, most of these individuals will also struggle with impulsive behavior secondary to hunger and tiredness. These findings do not override the importance of emotion as a key prompt of disinhibition. That is, intense emotions remain clear and potent prompts for impulsive behavior captured by Urgency measures; however, just as the urgency construct was previously expanded to include positive emotional contexts (53), these two studies provide evidence that supports revising theoretical models of urgency to further broaden its scope.

Although emotion, hunger, and fatigue may seem qualitatively distinct, we chose these contexts because each has been shown to influence circuitry involved in inhibitory control. Therefore, our findings are consistent with the idea that urgency may reflect a broader fragility of inhibitory control circuitry, which is unimpaired under ideal conditions, but becomes overwhelmed under conditions of high physiological arousal or depleted cognitive resources. Caution is warranted though, as we were not able to test inhibitory control directly in this study and so have no direct evidence of mechanisms. Indeed, one possibility is that hunger and exhaustion lead to greater emotionality, which then is reflected in impulsive behavior.

Despite obtaining results consistent with the Broader Contexts model of urgency, there may be value to retaining conceptually dissociable constructs (and accompanying measures) of trait impulsivity in emotion- and broader physiological-contexts. While the observed intercorrelations among CIBS scores were substantial, there remained important differences in the means and variability of the subscale distributions. From a practical perspective, there is clinical utility to examining contexts of problematic behavior more granularly, for example, to develop personalized intervention strategies specific to a clients particular pattern of dysregulation. Also of ecological relevance, some people are likely to experience certain types of contexts more frequently due to structural factors inherent to specific environments or circumstances (e.g., shift work). Fortunately, one positive implication of this work is the idea that interventions targeting urgency may be more broadly efficacious (e.g., emotion regulation skills & implementation intentions; 61, 66). For people who struggle with emotion as a precipitant for undesirable behavior, therapists might do well to consider other contexts known to challenge inhibitory control, to ideographically map key contexts for each client. Together, these findings are consistent with lay conceptualizations of impulsive acts involving diverse antecedents, including but not limited to emotions – for instance, as evidenced by widespread use of the term "hangry" (a portmanteau of hungry and angry) to explain disinhibited behavior, or "cranky", which is often used to indicate poor control in the face of exhaustion.

Researchers have long assumed that emotion dysregulation is the core concept underlying the explanatory power of Urgency scales, which beautifully integrate the interactive influences of emotion and self-control on behavioral outcomes. Our findings, in which we used the probes without a specific context ("in general") though, suggest the Urgency scales might also perform well in predicting clinical outcomes due to the consequences of the forms of poor constraint covered, e.g., making regrettable choices, speaking inappropriately, etc. That is, we found that when we asked participants to rate their tendencies using the CIBS item probes "in general", the resultant scores were as or more powerfully related to psychopathology than were the context-specific subscales. This may come as a surprise, since Urgency items *sans* emotion resemble the Lack of Premeditation scale from the UPPS (i.e., acting without thinking), and Lack of Premeditation typically has smaller correlations with psychopathology than Urgency does (6). One important distinction is that the CIBS General (i.e., urgency *sans* emotion) still contains the themes of "regret," "making matters worse," and "consequences," and the Lack of Premeditation items do not. Although we are not equipped to test for separability of the CIBS General and the Lack of Premeditation scale in this study, we see this as an intriguing future direction for those interested in assessing the "active ingredients" of the urgency construct, as it pertains to its robust predictive validity.

Several limitations should be considered when interpreting these two studies. Contrary to expectations and prior work, depression (as evaluated by the CESD-R) was not more strongly related with Urgency than LFT. Here, it is worth noting that previous research has shown that current depression symptoms

exert deleterious impact on processes implicated in LFT, including attention, motivation, and persistence (67, 68). This highlights the importance of longitudinal studies. One such study found that Urgency was a stronger long-term predictor of depression than LFT; however, more work is needed to disentangle cognitive impacts of current depression from those captured by Urgency and LFT (69).

Beyond the unexpectedly large effect of LFT on depression, generalizability of our results might be constrained by narrow representation in the recruited undergraduate samples. Notably, with escalating levels of depression among young persons, rates of psychiatric syndromes in college students now approximate those in the general population (70). Indeed in considering generalizability, it is important to note that these data were gathered during the COVID-19 pandemic. Although participants had returned to mostly in-person classes at the time of their participation in the current studies, trait impulsivity correlated with increased internalizing symptoms during the COVID-19 pandemic (71, 72). The relative magnitudes of the effect sizes found with internalizing symptoms in this study could have been influenced by the fact that the impacts of the COVID-19 pandemic were still very proximal.

Beyond sample characteristics, our data also rely on retrospective self-report measures, and are thus prone to subjective (e.g., interpretive, recall) biases inherent to such assessment modalities. For example, retrospective urgency measures might blur distinctions among various contexts of past impulsive behavior or the temporal order of impulsivity-relevant antecedents and consequences. Future work in this area should also account for potential influences of social desirability, e.g., the perceived acceptability of impulsive acts across different contexts.

Our findings suggest directions for future research. Although we provide evidence that the validity of impulsivity assessment may be improved by inquiring about a greater variety of precipitants to rash actions, the contexts studied here (emotions, hunger, and fatigue) are not exhaustive. Among the many potentially important contexts, intriguing research suggests that stress may have unique effects compared to mood inductions on inhibitory processes, and we did not consider stress here (73–75). More research is needed to understand which physiological contexts do and *do not* prompt the trait-like tendency toward impulsive action traditionally captured by the Urgency scale. By studying points of overlap on this more detailed contextual topography, future researchers may be able to generate more comprehensive models of urgency.

The current work is also limited in the range of psychopathology dimensions studied. Future work might assess a broader range of psychopathologies, and particularly those that have been shown to be uniquely tied to Positive Urgency in previous studies, such as alcohol use disorder (25) and mania (76). With this, it will be important to consider that particular contextual factors may confer greater vulnerability for certain individuals (perhaps especially at specific points in time), e.g., hunger in food-insecure populations. Ecological momentary assessment (EMA) may be an especially promising approach to explore these proposed future directions. EMA would address memory biases and facilitate temporal disambiguation of apparently concomitant precipitants of dysregulation (e.g., see 77, 78). Perhaps most importantly, EMA work would enable person-specific modeling that could ultimately inform clinical intervention and prevention efforts. Intriguing EMA findings from Sharpe et al. (79) suggest, for example, that within-person models might provide the strongest evidence for Negative and Positive Urgency as dissociable processes and constructs. Finally, there are multiple competing models of how contextual forces may influence disinhibition, including the depleted cognitive resource model (19, 80), the neurobiological salience model (81, 82), and the integrated model of stress, executive control, and psychopathology (75). Broadening the focus to an array of contexts while directly assessing inhibitory control and attentional circuitry and performance may help in considering the relative contributions of these types of processes.

In sum, we interpret these findings to suggest that people with elevated Urgency are likely vulnerable to various sources of disrupted self-regulation, beyond intense affect. Rather than de-emphasize the importance of emotion-related impulsivity to psychopathology, we argue that results of our pre-registered analyses justify expanding this construct to more fully capture the diversity of contextual influences on inhibitory failures that produce impulsive action. This new perspective ought to guide researchers to consider a broader range of forces that might adversely influence prefrontal inhibitory control mechanisms (and executive functioning in general).

With replication and extension, we see these findings as having clinical implications as well. Overall, they highlight the need for clinicians to consider a broader range of contexts for impulsive behaviors. Interventions such as Dialectical Behavior Therapy provide techniques for coaching clients to consider both physiological and emotional antecedents to behaviors of concern, and so might be particularly helpful in light of this broader set of possible contexts to consider (83, 84). We hope the findings will also guide clinicians to consider interventions that build resilience to a wider array of contexts that commonly prompt impulsivity.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: ResearchBox (#2750): https://researchbox.org/2750&PEER_REVIEW_passcode=MQDIIC.

Ethics statement

The studies involving humans were approved by UC Berkeley Committee for Protection of Human Subjects. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

ME: Conceptualization, Formal analysis, Investigation, Methodology, Software, Visualization, Writing – original draft,

Writing – review & editing. OJ: Formal analysis, Methodology, Writing – original draft, Writing – review & editing. JA: Conceptualization, Writing – original draft, Writing – review & editing. SJ: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1412001/full#supplementary-material

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Negative and positive urgency as pathways in the intergenerational transmission of suicide risk in childhood

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Introduction: Parental suicide attempts and suicide death increase suicide risk in their offspring. High levels of impulsivity have been observed in families at high risk for suicide. Impulsivity, a highly heritable trait that is especially elevated in childhood, is frequently measured with the UPPS-P Impulsive Behavior Scale, which includes negative urgency, positive urgency, sensation seeking, premeditation, and perseverance. Our study examined the association between the UPPS-P facets and suicide ideation (without suicide attempts) and suicide attempts at baseline and first-time endorsement within the next two years in childhood. We also examined how the UPPS-P facets mediated the association between parental suicide attempts and suicide death and offspring first-time suicide ideation and attempts at follow-up.

Methods: The sample was 9,194 children (48.4% female; 9-10 years old) from the Adolescent Brain Cognitive Development (ABCD) study, assessed yearly three times. At Time 1 (T1), caregivers reported on suicide attempts and suicide deaths (combined) of the biological parents. Caregivers and children reported on suicide ideation and attempts in the KSADS-PL DSM-5 at each time point, T1 and follow-up (T2 and/or T3). The Short UPPS-P Scale (child-report) assessed the impulsivity facets at T1, which were computed as latent variables.

Results: At T1, 6.7% of children had a parent who had attempted or died by suicide. Most UPPS-P facets were associated with suicide ideation and attempts at T1 and T2/T3. In adjusted models, parental suicide attempts and suicide death were associated with offspring negative and positive urgency. In mediation models, parental suicide attempts and suicide death had an indirect effect on offspring first-time suicide ideation at T2/T3 through negative urgency (OR = 1.04; 95% CI, 1.01-1.08) and positive urgency (OR = 1.03, 95% CI, 1.01-1.05). Similar results were found for first-time suicide attempts at T2/T3.

Discussion: Our findings support an impulsive pathway in the familial transmission of suicide risk. For all youth, interventions that target multiple

UPPS-P facets may help prevent or reduce suicide risk. For offspring whose parents have attempted or died by suicide, clinicians should pay particular attention to children who impulsively act on extreme emotions, as they may be at higher suicide risk.

KEYWORDS

suicidal ideation, suicide attempts, familial transmission, impulsivity, UPPS-P, childhood

1 Introduction

Childhood suicide is on the rise in the US, where suicide is the 5th leading cause of death for children ages 5-12 years since 2017 (1). The age group of 10-to-14-year-olds experienced the largest increase in suicide deaths from 1999 to 2014 compared to other age groups (2). From 2007 to 2015, children ages 5-11 accounted for 42% of emergency department visits for suicide ideation (SI) and suicide attempts (SAs) among 5-to-18-year-olds (3), highlighting the scope of suicide risk in childhood. Thus, it is imperative to identify early precursors of suicide risk to improve the detection and assessment of children at high risk for suicide and inform developmentally appropriate intervention targets.

Having a parent who has ever attempted suicide or died by suicide increases the offspring's risk for SI and SA (4–6) and is linked to attempting suicide earlier relative to offspring whose parents have never attempted suicide or died by suicide (7–9). The elevated levels of impulsivity observed in clinical samples of individuals with high family loading for suicidal behavior suggest that impulsivity may be a potential pathway in the transmission of suicide risk (8, 10, 11). However, the direct association between parental SA and suicide death (SD) and impulsivity in their children has not been examined. Genetic and environmental factors support this association. Impulsivity is a highly heritable trait, with genetic effects especially pronounced in childhood (12, 13). Furthermore, parental mental health problems are well-known risk factors for child maltreatment (14–16), which in turn are linked to heightened impulsivity in the offspring (17) and subsequent suicide risk (18). A recent study has also documented family conflict as a potential pathway through which parental mental health problems may increase impulsivity in their offspring (19). Additional support comes from studies that have focused on offspring externalizing problems, which are characterized by manifestations of poor impulsive control, such as high levels of impulsivity (20–22). Studies show an association between parental SA and suicide death (SD) and offspring externalizing problems across the lifespan, including alcohol or substance use disorders, ADHD, and delinquent behavior (23–28). All together, these findings suggest that parental SA/SD may be associated with offspring impulsivity, which in turn may play a role in the familial transmission of suicide risk.

Elevated levels of impulsivity have been observed among individuals with suicidal thoughts and behaviors across the lifespan (29, 30), or who have died by suicide, especially at younger ages (31). However, trait impulsivity is a broad and heterogeneous construct that captures different developmental processes with unique behavioral manifestations (32). From Whiteside and Lynam (2001) (33) and subsequent work (34, 35) emerged the UPPS-P model and associated scale to parse out the heterogeneity of trait impulsivity. This model proposed five facets: negative urgency ("the tendency to act rashly in response to distress or negative affect"), positive urgency ("the tendency to act rashly in response to extreme positive affect"), lack of premeditation ("the tendency to act without thinking"), lack of perseverance ("the inability to remain focused on a task"), and sensation seeking ("the tendency to seek out novel and thrilling experiences") (35, p. 807; 36, p. 3). Adult studies using the UPPS-P model, which are largely cross-sectional and mostly focused on SI, have found significant associations between the impulsivity facets and suicide risk in adjusted models (29). Negative urgency has received the strongest support, showing a significant association with both SI and SA in models that account for other variables (37–40) and at least one additional UPPS-P facet (41–45). While the association between lack of premeditation and lack of perseverance and SI has received some support (37–39, 43, 46, 47), the association between sensation seeking and suicidal thoughts and behaviors is less robust (37–39, 41–43, 48, 49). The few studies that include positive urgency provide initial evidence for its association with SI and SA (39, 49).

Despite the elevated levels of impulsivity in childhood (50), only three studies have examined the UPPS-P model in youth. In two adolescent samples, emotion-based impulsivity, but not lack of premeditation, was significantly associated with SAs (44, 51). The only study with a child sample focused on negative and positive urgency and found that both facets were cross-sectionally associated with lifetime SI (52). As such, no prior studies have examined the cross-sectional and longitudinal associations between the five impulsivity facets and suicide risk in childhood.

Regarding the possible association between parental SA/SD and the UPPS-P facets, the few studies that have examined childhood maltreatment or adverse childhood experiences (ACEs), which include parental death and psychopathology, have identified

significant associations between those adversities and perseverance and, especially, negative urgency (17, 53).

Ascertaining the role of the five impulsivity facets on suicidal thoughts and behaviors and the intergenerational transmission of suicide risk is needed to inform developmentally appropriate prevention and intervention responses to break the intergenerational cycle. Thus, this study tested the association between the UPPS-P facets and lifetime SI and SA at baseline, and first-time endorsement of SI and SA during the next two years. A second aim of the study was to examine how the UPPS-P facets mediated the association between parental SA/SD and offspring first-time endorsement of SI and SA at follow-up (Figure 1). For all UPPS-P facets, we anticipated finding a cross-sectional and prospective association between negative urgency and offspring SI and SA. This impulsivity facet would mediate the association between parental SA/SD and offspring first-time SI and first-time SA. In the absence of studies in youth and the lack of prospective studies, we did not have specific hypotheses about how the other UPPS-P facets would relate to parental SA/SD and offspring SI and SA.

2 Materials and methods

2.1 Sample

The study included a subsample of 9,194 children (48.4% female; 55.5% non-Hispanic White) from the Adolescent Brain Cognitive Development (ABCD) study, a US population-based longitudinal study of 9 to 10 years old children (n = 11,868 at baseline or time 1). At time 1 (T1), children were 47.8% female, 52.0% non-Hispanic White, 15.0% non-Hispanic Black, 20.3% Hispanic, 2.1% non-Hispanic Asian, 10.5% non-Hispanic Other Races (unweighted proportions). The ABCD sample was largely recruited through public, private, and charter elementary schools. A population neuroscience approach to recruitment was adopted by employing epidemiologically informed procedures to ensure demographic variation in its sample (54, 55). Eligibility for the ABCD Study was determined by each of the 22 research sites. Details about the study procedures, sampling, and recruitment are described in prior work (54, 56, 57). Caregivers provided informed consent and permission for the child's participation in the study and children provided assent.

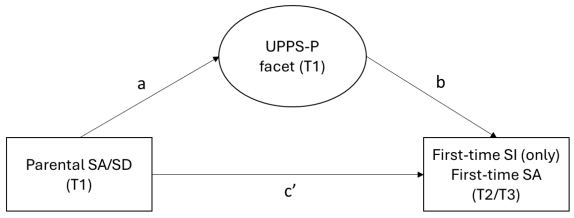

FIGURE 1
Mediation model testing the a path (from predictor to mediator), the b path (from mediator to outcome, adjusting for predictor) and the c' path (from predictor to outcome, adjusting for mediator). Offspring first-time suicide ideation excludes children who had ever attempted suicide. SI, suicide ideation; SA, suicide attempt; SD, suicide death; T, time.

In the current study, we included data from the first three assessments, T1 (baseline), T2 (1-year assessment) and T3 (2-year assessment), conducted between 2016 and 2021. Children with complete data on parental SA/SD at T1 and the suicide outcomes across assessments were included in this study (see Supplementary Figure 1). The final sample size was 9,194. The informants were biological mothers (87.4%), biological fathers (9.8%), adoptive parent (0.7%), custodial parent (0.7%) and others (1.3%). Missing values in the covariates ranged between 0 (Race/ethnicity) and 59 (Family structure). Compared to included children, excluded children (n = 2,674) had a higher proportion of non-Hispanic Black, Hispanic, or non-Hispanic other (p <.001), single-caregiver family (p <.001), and internalizing problems (p = .008). Excluded children also experienced more financial adversity (p = .002). They did not differ in lifetime SI (with no SA) (p = .148), lifetime SA (p = .243), parental SA/SD (p = .974), and biological sex (p = .207) at T1.

The Institutional Review Board (IRB) of Yeshiva University (WCG) approved the study procedures. The ABCD Study was approved by the central IRB of the University of California.

2.2 Measures

2.2.1 Parental history of SA/SD

At T1, caregivers reported about the lifetime history of SA or suicide death of each one of the biological parents on the Family History Assessment Module Screener (FHAMS) (58, 59): "Has any blood relative of your child ever attempted or committed suicide?" Positive responses for biological mothers and fathers were combined such that if either parent had attempted suicide or died by suicide, parental SA/SD was coded as 'yes.'

2.2.2 Offspring suicide ideation and suicide attempts

On a computerized version of the Kiddie Schedule for Affective Disorders and Schizophrenia–Present and Lifetime Version (K-SADS-PL) – DSM-5, children (at T1, T2 and T3) and caregivers (at T1 and T3) reported on the presence or absence of past and current SI and SA at each yearly assessment. These questions were not asked to caregivers at T2. The K-SADS-PL DSM-5 is a structured interview used to assess criteria for psychiatric disorders according to the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5; American Psychiatric Association, 2013) (60, 61). For each informant, the presence of either past or current SI or SA was combined and coded as lifetime SI or lifetime SA, respectively, at each assessment (T1, T2, and T3). The study included four outcomes and two time periods: baseline (T1) and follow-up (T2 and/or T3). At T1, we examined presence of 'lifetime SA', and presence of lifetime SI with no lifetime SA, which was coded as 'lifetime SI (only)'. Regarding the outcomes at follow-up, children with no lifetime SI at T1 who endorsed lifetime SI at T2 and/or T3 and absence of a lifetime SA at any assessment were coded as 'first-time SI (only)' at T2/T3. Children with no lifetime

SAs at T1 who endorsed a lifetime SA at T2 and/or T3 were coded as 'first-time SA' at T2/T3 (62).

2.2.3 Impulsivity facets

At T1, children completed the Short UPPS-P Impulsive Behavior Scale, a self-report scale with 20 items rated on a four-point Likert scale: (1) disagree strongly, (2) disagree some, (3) agree some, and (4) agree strongly (63–65). Items assess the five facets described in the UPPS-P model, negative urgency, positive urgency, (lack of) premeditation (reverse coded), (lack of) perseverance (reverse coded), and sensation seeking. The Short UPPS-P Scale has shown good validity, reliability, and measure invariance in youth (63, 66–68). Exploratory and confirmatory factor analyses with children and adolescent samples support the five-factor structure proposed in the model (63, 65, 68, 69). Twenty-three cases were excluded due to missing data in all or almost all items. Of the included children, ten children were missing one or two items (Supplementary Figure 1).

2.2.4 Covariates

We selected socio-demographic and clinical variables that have been associated with impulsivity, SI or SA in childhood, including child's biological sex, race and ethnicity, family structure, child's internalizing problems, and financial adversity (50, 52, 62, 70). These variables were reported by caregivers at T1. Race and ethnicity were combined in one unique variable with four categories: Non-Hispanic White, Non-Hispanic Black, Hispanic, Non-Hispanic Other (including Asian, American Indian/Alaska Native, and other). Based on prior research, non-Hispanic Black was used as the reference category (62). Financial adversity was assessed through caregiver report, using a seven-item checklist that assesses the inability to meet basic needs due to financial problems in the past year. The scores on this questionnaire reflect the total number of items endorsed (No/Yes) (e.g., inability to access medical care, lack of sufficient access to food, having gas or electricity shut off for nonpayment, inability to pay rent or mortgage). A total mean score was calculated by summing and averaging the seven items (range: 0-1). If a participant had four or more missing items out of the seven items, their total score was coded as missing (n = 17). Caregivers answered a question about their marital/living arrangements. Their responses were dichotomized to capture 'family structure' as married/co-habiting *vs*. single-caregiver family (i.e., single, widowed, divorced, separated). Children internalizing problems were assessed via caregiver report using the Child Behavior Checklist for Ages 6-18 years (CBCL/6-18). Items include problems with anxiety, depression, withdrawal, and somatic complaints in the past 6 months. The items, scales, and norms were scored following the ASEBA Manual (71). Raw scores were converted to t scores. A t score of 65 or higher was used as the clinical cutoff point. Using the date of interview at T3 (2-year assessment), we created a dichotomous variable to identify children who completed T3 assessment after the COVID-19 pandemic was officially declared worldwide on March 11, 2020 (72). All variables, except for COVID-19, were associated with at least one of the outcomes and were included as covariates (Supplementary Table 1).

2.3 Data analysis

First, we described the prevalence of parental SA/SD, outcomes, and covariates. Rao-Scott adjusted chi-squared test was used to examine the association between parental SA/SD and lifetime SI (only) and lifetime SA at T1, and first-time SI (only) and first-time SA at T2/T3. Logistic regression analyses were used to examine the association between parental SA/SD and each outcome, adjusting for child's sex, race/ethnicity, internalizing problems, family structure, and financial adversity.

Confirmatory factor analysis (CFA) was used to identify shared variation in the UPPS-P items as measured via latent factor scores to reduce measurement error (73). The goodness-of-fit indices used to assess model fit were the root mean square error of approximation (RMSEA, a measure of absolute fit that tests the difference between the model and the data per model degrees of freedom), the Comparative Fit Index (CFI, an indicator of fit compared to the null model), and the SRMR (Standardized Root Mean Square Residual, a measure of the discrepancy between the observed and predicted covariance matrix). Model fit was deemed adequate if the RMSEA was ≤.05, CFI was ≥.95, and SRMR was <.05 (74, 75). When models needed to be adjusted based on these criteria, covariance standardized residuals were examined for values greater than +/- 2.5. Of the two indicators with the largest standardized residual and modification indices, the indicator whose removal improved the goodness-of-fit statistics the most was removed from the model. Given our large sample size, we did not use the values of the $\chi 2$ test and associated p and degrees of freedom to assess model fit because its significance is highly sensitive to the size of the sample (76).

The univariate associations between each UPPS-P facet (latent variable) and each outcome, lifetime SI (only) and lifetime SA at T1, and first-time SI (only) and first-time SA at T2/T3, were examined using structural equation modeling (SEM) (Model 1). Each model was further adjusted for child's sex, race/ethnicity, internalizing problems, family structure, and financial adversity (Model 2). In Model 3, the five facets were entered simultaneously, adjusting for the covariates.

Finally, causal mediation modeling using SEM was used to calculate the indirect effect of parental SA/SD on first-time SI (only) and first-time SA at T2/T3 through each UPPS-P facet (Figure 1) (77). In models adjusting for the covariates, we first examined the association between parental SA/SD and each UPPS-P facet (a path) and between the UPPS-P facets and each outcome adjusting further for parental SA/SD (b path). Then, we examined the association between parental SA/SD and first-time SI (only) and first-time SA at T2/T3, adjusting for each UPPS-P facet (c' path). The indirect effect of parental SA/SD through each UPPS-P facet was tested using bootstrapping with a resampling of 100. Causal mediation with dichotomous outcomes can only be tested with one mediator at a time (77).

Analyses were conducted in MPlus (Version 8.10). We accounted for the survey procedures using ranked propensity scores as weights and research sites as clusters (provided by the ABCD study at T1) in all the analyses. The inclusion of weights allows for the evaluation of less biased estimates to compensate for

underrepresentation or overrepresentation within the sample based on individual and household variables (i.e., age, sex, race/ethnicity, family income, marital status, household size, parents' work force, and Census Region) (55). We used data from the ABCD Annual Release 4.0 and 5.0 (78, 79).

3 Results

3.1 Parental SA/SD and offspring suicide ideation (only) and suicide attempts

The prevalence of the study variables is displayed in Table 1. In this sample, 6.7% percent of children had a biological parent who had attempted suicide or died by suicide at T1: mothers (n = 314, 4.0%), fathers (n = 196, 2.4%) or both (n = 24, 0.3%). At T1, 13% of children reported lifetime SI and 1.2% lifetime SA. At T2/T3 (ages range: 9.7-13.8 years old), 8.9% of children reported first-time SI and 1.7% reported a SA for the first time.

As Figure 2 shows, a higher proportion of children with parental SA/SD reported lifetime SI and lifetime SA at T1, and first-time SI and first-time SI SA at T2/T3 compared to children whose parents have not attempted suicide or died by suicide. In models adjusted for the covariates, parental SA/SD remained associated with lifetime SI and lifetime SA at T1, and first-time SI at T2/T3 (Table 2).

TABLE 1 Prevalence of the study variables.

	Unweighted count	Weighted % (SE)
Outcomes		
Lifetime SI (only) at T1	1,183	13.0 (0.6)
Lifetime SA at T1	93	1.2 (0.1)
First-time SI (only) at T2/3	842	8.9 (0.3)
First-time SA at T2/3	147	1.7 (0.2)
Parental SA/SD		
No	8,660	93.4 (0.7)
Yes	534	6.6 (0.7)
Sex		
Female	4,361	48.4 (0.6)
Male	4,832	51.5 (0.6)
Race/ethnicity		
Non-Hispanic Black	1,179	11.4 (2.3)
Non-Hispanic White	5,095	55.8 (5.8)
Hispanic	1,812	23.1 (6.1)
Non-Hispanic Other	1,108	9.6 (1.4)
Family structure		
Single-caregiver family	2,183	30.4 (2.3)
Married/cohabiting	6,952	69.6 (2.3)
COVID-19		
No	6,689	73.8 (1.7)
Yes	2,498	26.2 (1.7)
Internalizing problems		
No	8,391	90.3 (0.8)
Yes	801	9.7 (0.8)
Financial adversity		
M (SD)	0.07	0.01

SI, suicide ideation; SA, suicide attempt; SD, suicide death; T, time.

3.2 Confirmatory factor analysis

The five-factor structure of the Short UPPS-P Scale was identified using CFA. Based on the goodness-of-fit indices (Supplementary Table 1), three factors: lack of premeditation, positive urgency, and sensation seeking, needed to be modified. Following the procedure explained earlier (Supplementary Tables 2, 3), item 35 for positive urgency, item 16 for lack of premeditation, and item 21 for sensation seeking were removed[1]. The final loadings for each factor exceeded .40 (Table 3). The covariance matrix supported the discriminant validity of the five factors (Supplementary Table 4). The fit indices for the five-factor model were adequate (RMSEA= .030; CFI = .946; SRMR = .033).

3.3 Association between UPPS-P facets and SI (only) and SA

In unadjusted models (Table 4, Model 1), all UPPS-P facets (latent variables) were associated with lifetime SI and lifetime SA at T1. All facets, but sensation seeking, predicted first-time SI and first-time SA at T2/T3. These associations remained significant after adjusting for child's sex, race/ethnicity, internalizing problems, family structure, and financial adversity (Table 4, Model 2). The associations between negative urgency and SAs at baseline and follow-up had the highest ORs and no overlapping confidence intervals with other UPPS-P facets (e.g., positive urgency, lack of premeditation).

When the five latent variables were entered simultaneously in the model (Model 3), negative urgency and lack of premeditation were independently associated to lifetime SI at T1. Negative urgency was the only facet that was uniquely associated with first-time SI at T2/T3 (Table 4, Model 3). Model 3 could not be run for lifetime SA at T1 and first-time SA at T2/T3 given the large standard errors,

1 Watts et al. (2020) (63) tested the psychometric properties of the Short UPPS-P scale with this sample at T1. In their CFA, the authors also had to remove the item "I would like to learn to fly an airplane" given its low performance, which questions the validity of this item to assess sensation seeking in childhood. We removed two additional items, probably due to using a stricter RMSEA and differences in the sample size between the studies.

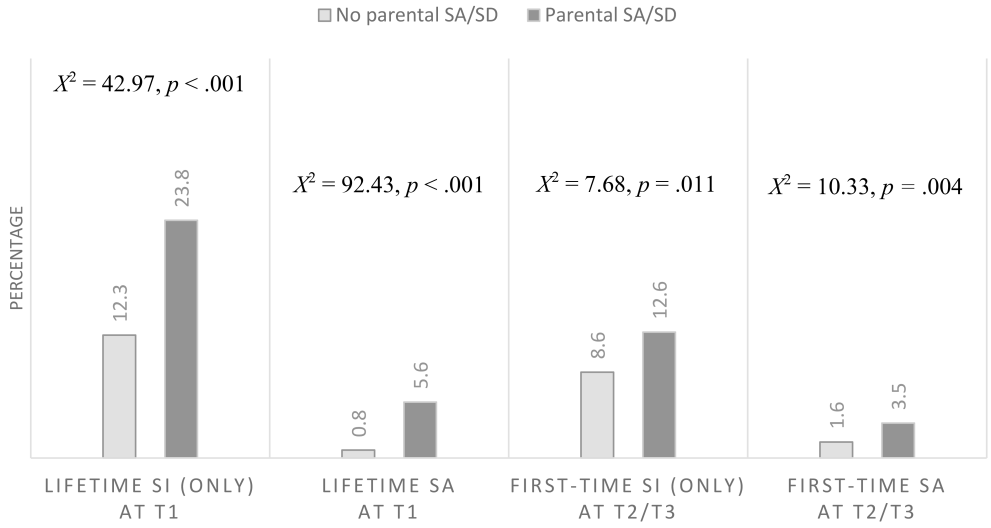

FIGURE 2
Association between parental suicide attempts or suicide death (SA/SD) and offspring suicide outcomes, suicide ideation (SI) and suicide attempt (SA), at each time point, Time 1 (T1) and Time 2 and/or 3 (T2/T3) (X axis). Second-order Rao-Scott adjusted Chi-square statistic reported. Percentages and crosstabs adjusted for weights and clusters. Light grey bars represent offspring whose parents did not attempt or die by suicide. Dark grey bars represent offspring whose parents attempted or died by suicide.

which is generally a result of a small number of cases where the dependent variable equals 0 or equals 1.

For informational purposes, the associations between negative urgency, all the covariates and each suicide outcome (Table 4, Model 2) are presented in Supplementary Table 5.

3.4 Mediation models

Finally, we tested how the UPPS-P facets mediated the association between parental SA/SD and first-time SI (only) and first-time SA at T2/T3 (Figure 1; Table 5). In models adjusting for the covariates, parental SA/SD was associated with negative urgency and positive urgency (a path). Both negative and positive urgency were associated with first-time SI and first-time SA at T2/T3, when the models were further adjusted for parental SA/SD (b path). Parental SA/SD had a significant indirect effect on first-time SI at T2/T3 through negative urgency (OR = 1.04; 95% CI, 1.01-1.08) and positive urgency (OR = 1.03, 95% CI, 1.01-1.05). Parental SA/SD also had a significant indirect effect on first-time SA at T2/T3 through negative urgency (OR = 1.14, 95% CI, 1.05-1.27) and positive urgency (OR = 1.05, 95% CI, 1.01-1.11) (Table 5; Figure 3).

4 Discussion

In this study, we examined the association between the UPPS-P facets and suicidal thoughts and behaviors and first-time endorsement within the next two years in a large US representative sample of children ages 9 to 10 years at baseline. In models adjusting for socio-demographic and clinical variables, all UPPS-P facets were cross-sectionally associated with SI and SA at baseline. At follow-up, all but sensation seeking, predicted first-time SI and first-time SA. However, when all facets were included in the same model, only negative urgency and lack of premeditation remained associated with lifetime SI at baseline and negative urgency with first-time SI at follow-up. In the mediation models, parental SA/SD had an indirect effect on first-time SI and first-time SA at follow-up through negative and positive urgency.

Our findings provide a close examination of the five impulsivity facets and contribute to clarifying their association with SI (only) and SA, cross-sectionally and prospectively, strengthening the conclusions that can be drawn about these associations. All UPPS-P facets were associated with SI and SA at baseline and follow-up, except for sensation seeking, after accounting for internalizing problems and other socio-demographic variables. As

TABLE 2 Association between parental SA/SD and offspring suicide outcomes.

	Time 1		Time 2 and/or Time 3	
	Lifetime SI (only)	Lifetime SA	First-time SI (only)	First-time SA
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Parental SA/SD	**1.64 (1.23, 2.19)**	**4.14 (2.57, 6.66)**	**1.45 (1.07, 1.95)**	1.47 (0.82, 2.64)

Significant results (p <.05) are bolded. SI, suicide ideation; SA, suicide attempt; SD, suicide death. Models adjusted for child's sex, race/ethnicity, internalizing problems, family structure, financial adversity, weights, and clusters.

TABLE 3 Factor analysis of the Short UPPS-P Impulsive Behavior Scale.

		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Item 7	When I feel bad, I often do things I later regret in order to make myself feel better now.	.515				
Item 11	Sometimes when I feel bad, I keep doing something even though it is making me feel worse.	.525				
Item 17	When I am upset, I often act without thinking.	.508				
Item 20	When I feel rejected, I often say things that I later regret.	.657				
Item 35	When I am in a great mood, I tend to do things that can cause me problems.		–			
Item 36	I tend to act without thinking when I am very, very happy.		.686			
Item 37	When I get really happy about something, I tend to do things that can lead to trouble.		.715			
Item 39	I tend to lose control when I am in a great mood.		.713			
Item 6	I like to stop and think about things before I do it.			.665		
Item 16	I try to take a careful approach to things.			–		
Item 23	I am very careful.			.488		
Item 28	I tend to stop and think before doing things.			.834		
Item 15	I finish what I start.				.499	
Item 19	I tend to get things done on time.				.659	
Item 22	I am a person who always gets the job done.				.727	
Item 24	I almost always finish projects that I start.				.546	
Item 12	I enjoy taking risks.					.541
Item 18	I like new, thrilling things, even if they are a little scary.					.525
Item 21	I would like to learn to fly an airplane.					–
Item 27	I would like to ski very fast down a high mountain slope.					.435

Factor 1 = Negative urgency, Factor 2 = Positive urgency; Factor 3 = (Lack of) premeditation (reversed coded) Factor 4: (Lack of) perseverance (reversed coded); Factor 5: Sensation seeking.

hypothesized, negative urgency emerged as an important UPPS-P facet, showing an independent association with SI (only), lifetime and first-time, and relatively strong associations with lifetime and first-time SA. Negative urgency captures the tendency to act impulsively when experiencing extreme negative emotions (33). Noteworthy, its association with SI and SA was minimally affected by the addition of internalizing problems to the model, which captured the presence of child's anxiety, depressive and withdrawal symptoms, and somatic complaints in the past 6 months. Although internalizing problems and negative urgency are related (32, 80), it could be that children act impulsively when experiencing surges in negative affect (i.e., state) regardless of their daily levels of internalizing problems (i.e., trait). Our findings highlight the independent contribution of negative (and positive) urgency to suicide risk and point toward the need of providing children with specific strategies to utilize when they are experiencing surges in affect, regardless of their valence. Studies able to capture state *vs*. trait urgency or affect (e.g., ecological momentary assessment *vs*. one-time questionnaires) (81) may be able to further shed light on the association between negative urgency and suicide risk in childhood.

Additionally, poor emotion regulation strategies, problem-solving difficulties, and low distress tolerance have also been observed in individuals with elevated levels of negative urgency. These processes have been distinctively associated with the UPPS-P facets in mostly adult studies (41, 82–88). In a study with youth, ages 13-19, negative urgency was associated with less use of appropriate emotion regulation strategies and an increased use of inappropriate strategies, whereas lack of premeditation and perseverance were associated with an increased use of inappropriate strategies only (87). Among children with high negative urgency, it is possible that the desire to terminate their extreme negative emotions, in the context of experiencing emotion regulation or problem-solving difficulties to regulate them, may lead children to consider suicide or attempt suicide as a way to cope with the distress. Whether deficits in emotion regulation lead to higher levels of negative urgency (82) or vice versa (85, 86) has yet to be examined in longitudinal studies. It is possible that the direction of these associations varies by developmental period. The development of emotion regulation strategies and problem-solving skills begins in childhood and continues through young adulthood (89–91). Given impulsivity is a highly heritable trait that

TABLE 4 Association between UPPS-P facets (latent variables) and suicide outcomes in the offspring.

	Lifetime SI (only) at T1			Lifetime SA at T1	
	Model 1[a]	Model 2[b]	Model 3[c]	Model 1[a]	Model 2[b]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Negative urgency	**2.92 (2.29, 3.72)**	**2.60 (2.07, 3.27)**	**2.41 (1.62, 3.61)**	**10.66 (5.62, 20.22)**	**7.88 (3.95, 15.71)**
Positive urgency	**1.56 (1.37, 1.76)**	**1.49 (1.32, 1.69)**	0.90 (0.73, 1.13)	**1.87 (1.37, 2.55)**	**1.53 (1.16, 2.01)**
Lack of premeditation	**2.51 (2.12, 2.97)**	**2.23 (1.93, 2.59)**	**1.57 (1.32, 1.87)**	**2.78 (1.70, 4.55)**	**2.11 (1.35, 3.30)**
Lack of perseverance	**2.14 (1.73, 2.64)**	**1.80 (1.43, 2.25)**	1.21 (0.84, 1.73)	**4.30 (2.21, 8.35)**	**2.91 (1.60, 5.31)**
Sensation seeking	**1.48 (1.21, 1.82)**	**1.51 (1.23, 1.86)**	1.20 (0.92, 1.57)	**2.47 (1.30, 4.69)**	**2.82 (1.40, 5.68)**
	First-time SI (only) at T2/3			First-time SA at T2/3	
	Model 1[a]	Model 2[b]	Model 3[c]	Model 1[a]	Model 2[b]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Negative urgency	**1.81 (1.46, 2.25)**	**1.79 (1.46, 2.21)**	**1.70 (1.23, 2.35)**	**6.80 (4.52, 10.24)**	**6.44 (3.68, 11.28)**
Positive urgency	**1.33 (1.21, 1.46)**	**1.31 (1.20, 1.44)**	1.03 (0.85, 1.25)	**1.81 (1.26, 2.62)**	**1.60 (1.09, 2.37)**
Lack of premeditation	**1.56 (1.27, 1.92)**	**1.59 (1.30, 1.93)**	1.24 (0.92, 1.68)	**2.07 (1.43, 2.99)**	**1.86 (1.30, 2.65)**
Lack of perseverance	**1.64 (1.38, 1.94)**	**1.65 (1.39, 1.96)**	1.25 (0.93, 1.65)	**2.76 (1.81, 4.23)**	**2.18 (1.44, 3.29)**
Sensation seeking	0.96 (0.82, 1.13)	1.01 (0.85, 1.18)	0.87 (0.72, 1.05)	0.93 (0.54, 1.57)	1.11 (0.68, 1.82)

Significant results are bolded. SI, suicide ideation; SA, suicide attempt; T, time.
[a]Model 1: Adjusted for weights and clusters.
[b]>Model 2: Model 1 adjusted for child's sex, race/ethnicity, internalizing problems, family structure, and financial adversity.
[c]Model 3: Model 2 adjusted for all the UPPS-P facets simultaneously.

is especially elevated in childhood (19, 43), we could hypothesize that high levels of negative urgency may hinder the development of emotion regulation strategies and problem-solving skills, with subsequent bidirectional effects.

Lack of premeditation was also uniquely associated with SI (only) at baseline. Elevated levels of this facet may signal poor cognitive skills, such as difficulties disregarding non-relevant information (92, 93), which may prevent individuals from thinking about effective ways of solving their problems. Indeed, Valderrama et al. (2016) found that lack of premeditation, but not negative urgency, mediated the association between brooding (i.e., "dwelling on the reasons for one's negative mood") and suicide-related risk (47, p. 35). Although our findings regarding the independent association between lack of persistent and lifetime SI were cross-sectional, it could be that children with elevated lack of premeditation struggle to solve problems effectively. Difficulties in

TABLE 5 Mediation models testing the indirect effect of the UPPS-P facets.

	Negative urgency	Positive urgency	Lack of premeditation	Lack of perseverance	Sensation seeking
Parental SA/SD → UPPS-P facet, β (95% CI)	**0.07 (0.03, 0.14)**	**0.10 (0.04, 0.17)**	0.04 (-0.01, 0.10)	0.03 (-0.004, 0.07)	0.04 (-0.02, 0.11)
UPPS facet → First-time (only) SI |adjusted for parental SA/SD, OR (95% CI)	**1.77 (1.51, 2.18)**	**1.31 (1.18, 1.45)**	**1.58 (1.24, 1.91)**	**1.65 (1.29, 1.86)**	1.00 (0.86, 1.18)
Parental SA/SD → First-time SI (only) | adjusted for UPPS-P facet, OR (95% CI)	1.39 (0.97, 1.87)	1.41 (0.98, 1.93)	1.42 (0.97, 1.96)	1.42 (0.99, 1.95)	**1.45 (1.01, 1.01)**
Natural indirect effect (bootstrapping), OR (95% CI)	**1.04 (1.01, 1.08)**	**1.03 (1.01, 1.05)**	1.01 (0.99, 1.05)	1.01 (0.99, 1.04)	1.00 (0.99, 1.01)
Parental SA/SD → UPPS-P facet, β (95% CI)	**0.07 (0.03, 0.14)**	**0.10 (0.04, 0.17)**	0.04 (-0.01, 0.10)	0.03 (-0.004, 0.07)	0.04 (-0.02, 0.11)
UPPS facet → First-time SA, adjusted for parental SA/SD | OR (95% CI)	**6.30 (3.30, 10.26)**	**1.59 (1.12, 2.35)**	**1.83 (1.24, 2.59)**	**2.16 (1.20, 2.88)**	1.12 (0.76, 1.85)
Parental SA/SD → First-time SA | adjusted for UPPS-P facet, OR (95% CI)	1.32 (0.48, 2.24)	1.43 (0.43, 2.21)	1.42 (0.59, 2.41)	1.41 (0.44, 2.31)	1.47 (0.44, 2.29)
Natural indirect effect (bootstrapping), OR (95% CI)	**1.14 (1.05, 1.27)**	**1.05 (1.01, 1.11)**	1.02 (0.99, 1.06)	1.02 (0.99, 1.06)	1.00 (0.99, 1.07)

Significant results are bolded. SI, suicide ideation; SA, suicide attempt; SD, suicide death. Each path was adjusted for child's sex, race/ethnicity, internalizing problems, family structure, financial adversity, weights, and clusters.

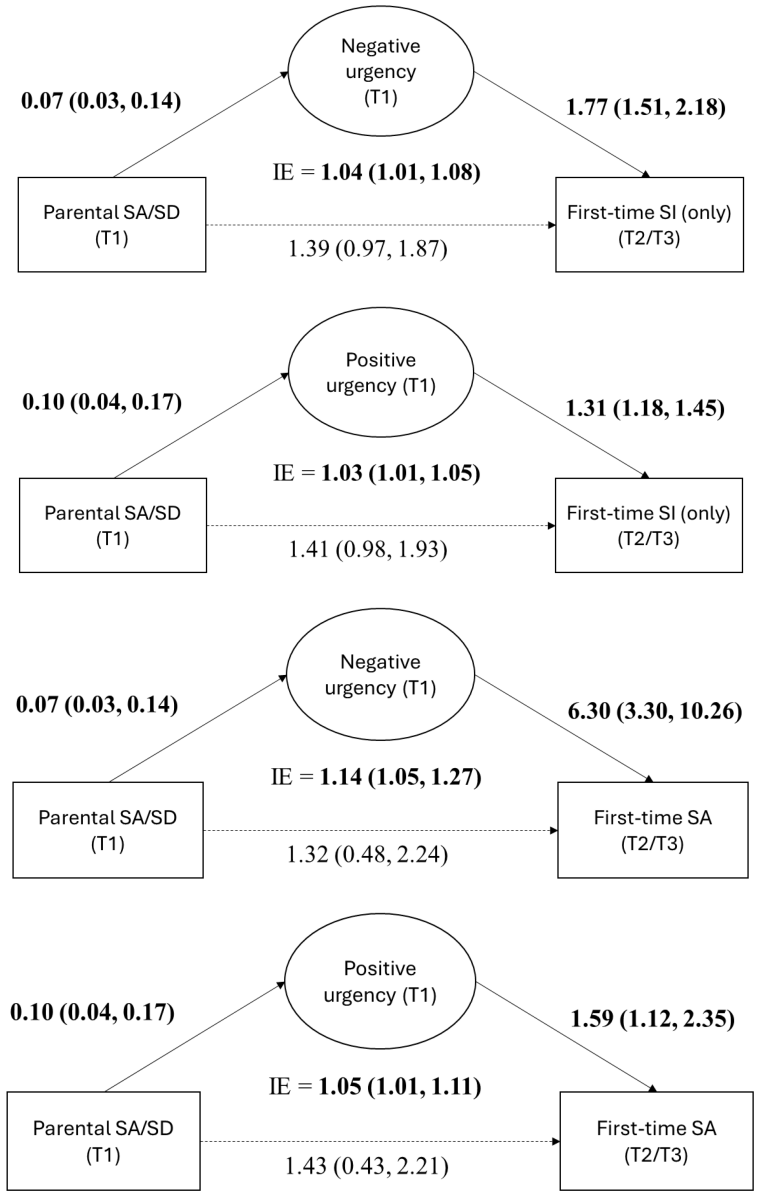

FIGURE 3
Mediation models showing the significant indirect effect (IE) of parental suicide attempts/suicide death (SA/SD) on first-time suicide ideation (SI) and suicide attempts (SA) thought negative and positive urgency on of the UPPS-P facets. The a path is reported as β (95% CI), and the b and c' paths and the indirect effects are reported as OR (95% CI). Significant results are bolded. T, time.

considering the potential consequences of their own actions to regulate their current behavior could lead to more maladaptive or risky behaviors and thoughts about suicide (32, 33). Future studies should examine how the UPPS-P facets distinctively relate to emotion regulation strategies and problem-solving skills and the direction of those associations in youth. Furthermore, how the UPPS-P facets interact with each other to increase suicide risk remains vastly unexplored.

Studies with clinical samples support the presence of high levels of impulsivity within families at risk for suicide (8, 11, 94). Our study was able to parse the UPPS-P facets associated with having a parent who has attempted or died by suicide, thus, those potentially involved in the familial transmission of suicide risk. Parental SA/SD was associated with negative and positive urgency in models that accounted for the covariates. In the mediation models, parental SA/SD had a significant indirect effect on first-time SI (only) and first-time SA at follow-up through both negative and positive urgency facets, although the effect size was small. It could be that parents who have attempted suicide or died by suicide are more likely to act impulsively when experiencing intense emotions. This emotion-based impulsivity may be transmitted from parents to offspring through genetic as well as environmental pathways and increase their suicide risk. In the emotion socialization process, children learn how to regulate their emotions through emotion-centered conversations with adults and observing how adults manage their emotions (i.e., modeling) and respond to the child's own negative

emotions (95, 96). If parents themselves have elevated levels of emotion-based impulsivity and associated deficits in emotion regulation strategies and problem-solving skills, this could impact how their children are learning to self-regulate within the home. Furthermore, parental non-supportive responses to adolescent's negative emotions (e.g., punitive response) have been associated with SI in offspring (97). Given that parental SA and parental SD were asked with the same question, we could not disentangle their independent effects on the UPPS-P facets and suicide outcomes. Recent evidence suggests that these two experiences, and their timing of occurrence, may differently impact offspring mental health problems and suicide risk (28, 98, 99), and as such they could also have different effects on the UPPS-P facets. Futures studies should address this limitation and examine distinct pathways through which these experiences may increase suicide risk in the offspring and include different manifestations of externalizing problems, such as impulsivity, aggression, and inattention (22). Nonetheless, our findings suggest that urgency may be an early marker of risk for suicidal thoughts and behaviors in late childhood, especially among those children with parental history of SA/SD.

Finally, in line with prior studies (4, 5), parental SA/SD was associated with lifetime SI and SA at baseline and first-time SI during the two subsequent years. However, its association with first-time SA was further explained by socio-demographic and clinical factors. Future studies should test whether the prospective association between parental SA/SD and first-time SA emerges in adolescence, as SAs become more prevalent (100), or when an extended follow-up period is considered. Another point of exploration would be to test whether the identified associations between parental SA/SD, the UPPS-P facets, and offspring suicide risk change based on the severity of the SI, as the most frequent SI experienced by the children in this sample was passive SI (62), or the characteristics of the SA, such as the level of lethality or planning, which were not assessed in the ABCD study. Finally, future studies with this and other samples should ascertain whether the identified associations remain relevant considering the increase in mental health problems during adolescence.

This study has several limitations. As previously noted, one of the main limitations concerns the inability to disentangle the effects of parental SA from parental SD, as they were both asked in the same question. Recent evidence suggests that these two experiences may have a different impact on offspring mental health problems, making this an important question for future research. The attrition of mostly children of color or those with socio-economic problems may affect the generalizability of our findings to the general populations. Caregivers were not asked about child's SI and SA during the 1-year assessment (T2), as such, a small proportion of children who did not report suicidal thoughts or behaviors during T2, but whose parents would have reported SI or SA, might have been misclassified. Our outcome was coded as first-time endorsement of SI and SA. While it does not necessarily correspond with the onset of those behaviors, it has clinical value as it captures the first time that children or caregivers were able or willing to disclose. Given the small percentage of children with SAs at baseline and follow-up, we could not run the models with all the UPPS-P facets for these outcomes. Finally, although most informants were biological parents (97.2%), it could be that some of the other informants were not aware about the history of SA/SD in the biological parents, leading to a slight underestimation of parental SA/SD.

5 Conclusions and clinical implications

In sum, our study examined the role of different facets of impulsivity on suicidal thoughts and behaviors in childhood and identified negative and positive urgency as facets that might underly the familial transmission of suicide risk. Our findings have direct implications for the identification, assessment, and intervention of children with suicidal thoughts and behaviors, especially among those with familial risk for suicide. Four out the five UPPS-P faces were associated with SI and SA. As such, across all children, prevention and intervention programs that target impulsivity and emotion regulation strategies, such as Parent–Child Interaction Therapy (101), have the potential to prevent or reduce suicide risk. One such program for schools is the Good Behavior Game, which has already shown promising effects in preventing suicidal thoughts and behaviors (102, 103).

For children whose parents have attempted suicide or died by suicide, elevated levels of emotion-based impulsivity may signal current and future suicide risk. Interventions indicated for these families could target emotion regulation strategies, problem-solving skills, and distress tolerance for both the caregiver and the children. Some UPPS-P facets seem to be more susceptible to change than others. Specifically, negative urgency and lack of premeditation have shown significant reductions after interventions (104, 105). These studies, although conducted with adults with substance use problems, show promising results for targeting the UPPS-P facets in interventions to prevent or reduce suicide risk in youth.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: NIMH Data Archive (NDA) (2021). Adolescent Brain Cognition Development (ABCD) Study. Curated Annual Release 4.0. https://dx.doi.org/10.15154/1523041. NIMH Data Archive (NDA) (2023). Adolescent Brain Cognition Development (ABCD)Study. Curated Annual Release 5.0. http://dx.doi.org/10.15154/8873-zj65.

Ethics statement

The ABCD study involving human was approved by the central IRB of the University of California, San Diego. The institutional review board of Yeshiva University (WCG IRB) approved the present study procedures. The studies were conducted in accordance with the local legislation and institutional

requirements. Written informed consent for participation in the ABCD study was provided by the participants' legal guardians/next of kin. Children provided assent for participation in the ABCD study.

Author contributions

AO-P: Conceptualization, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. AS: Writing – review & editing. JM: Writing – review & editing. LP-R: Conceptualization, Writing – review & editing. LH: Conceptualization, Writing – review & editing. KL: Conceptualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1417991/full#supplementary-material

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Urgency as a predictor of change in emotion dysregulation in adolescents

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Introduction: Adolescence is a key developmental period characterized by increased maladaptive risky behaviors. Two related but distinct constructs, urgency (the tendency to act rashly in response to strong negative or positive emotions) and emotion dysregulation, are important risk factors for engaging in maladaptive risky behaviors. Thus far, research has largely agreed that these two risk factors are highly correlated. However, the causal direction between these constructs is less understood. The goal of the current study is to determine whether urgency predicts emotion dysregulation change among adolescents.

Method: This project is an analysis of 544 youth (49.8% female, M_{age}=14.22, SD=0.52). We tested whether urgency at baseline predicts change in emotion dysregulation over a nine-week period, and whether that relationship differs across boys and girls.

Results: Two multigroup latent change score path analyses found that negative, but not positive, urgency significantly predicted emotion dysregulation change (negative urgency: b= -0.57, p=0.001; positive urgency: b=0.22, p=0.06). There was no evidence of moderation by gender.

Discussion: This work provides initial evidence of a temporal relationship between higher negative urgency and increased emotion dysregulation. The next step is to determine whether negative urgency imparts risk for maladaptive behaviors through its effect on emotion dysregulation. The long-term goal of this program of research is to design and test interventions to reduce the impact of negative urgency for adolescent risk-taking.

KEYWORDS

negative urgency, positive urgency, emotion dysregulation, adolescents, risk-taking

1 Introduction

Adolescence is a key developmental period for the emergence and development of maladaptive risky behaviors (1–4) and is associated with increased emotional lability and risk-taking behaviors (5). Adolescents show marked increases in drinking alcohol, drinking and driving, using substances, engaging in risky sexual behaviors, and many other risk behaviors (2, 6–10). Two related but distinct constructs, urgency (the tendency to act rashly in response to strong negative or positive emotions) and emotion dysregulation, are important risk factors for engaging in maladaptive risky behaviors (11–13). Thus far, research has largely agreed that these two risk factors are related (14–17); however, the causal direction between these constructs is less understood. The goal of the current study is to determine whether urgency predicts emotion dysregulation change among adolescents.

Negative and positive urgency (18) reflect individual difference tendencies toward rash or maladaptive action during extreme emotional states. In adolescents, negative urgency relates to a wide range of maladaptive risk taking, including suicide attempts and non-suicidal self-injury, as well as the onset of binge eating and alcohol, marijuana, cigarette, and other drug use (19–29). Similarly, positive urgency relates to non-suicidal self-injury, and predicts the onset of cigarette, marijuana, and alcohol use (20, 22, 25, 28, 29). Despite these well-established relationships, the mechanism(s) by which negative and positive urgency impart risk are less well understood.

Emotion dysregulation, defined as engaging in a behavior to cope with emotions that is producing a dysfunctional, rather than an adaptive, outcome (30), may be a prime mechanism for how urgency increases maladaptive risk taking in adolescents. Emotion dysregulation is a hallmark symptom of and risk factor for psychopathology (13, 31–33). In youth, emotion dysregulation predicts aggressive behavior, deliberate self-harm, risky sexual behaviors, substance use, and eating pathology (13, 34–40). Interestingly, one study found that psychopathology does not, in turn, predict increases in emotion dysregulation (13), suggesting that emotion dysregulation may be a precursor of psychopathology and not the other way around.

Research has established that urgency and emotion dysregulation are related constructs, with moderate to strong bivariate correlations (r=0.32-0.70) (14–17, 41–47). Some work has conceptualized urgency as poor emotion regulation (48), with others supporting relationships between urgency and the use of fewer appropriate, and more inappropriate, emotion regulation strategies (49). Research has found that negative and positive urgency are significantly associated with emotion dysregulation (16), but that emotion dysregulation is not significantly associated with urgency (15). Importantly, these studies utilized cross-sectional data, so the temporal order of the relationship between urgency and emotion dysregulation cannot be inferred, leaving the causal direction between these constructs unknown.

Additionally, gender may impact the relationship between urgency and emotion dysregulation. First, boys more likely to engage in risky behavior than girls (50). Second, girls begin using emotion regulation strategies more quickly (51) and experience more emotion dysregulation (52, 53) and less emotional clarity, whereas boys have more difficulty with emotional awareness (52, 53). Third, there is some evidence that males may have higher levels of positive urgency (54), and females may have higher levels of negative urgency (55, 56), although some studies have failed to find gender differences in urgency (57, 58).

The current study

The goal of the current study is to determine whether negative and positive urgency predict emotion dysregulation change in adolescents. The underlying theoretical model for the current study proposes that trait urgency is an underlying predisposition that leads to the development of maladaptive risky behaviors, while emotion dysregulation is a set of skills (or lack thereof) that develops in part due to the underlying urgency predisposition, which then further reinforces maladaptive risk. Alternative conceptualizations exist, including conceptualizing urgency and emotion dysregulation as one and the same (14, 15, 48, 59–61). In the absence of experimental or longitudinal work establishing this pathway direction, we relied on theory (18) suggesting urgency as the precursor, as well as general evidence that personality develops temporally earlier (62–65) than emotion dysregulation (51, 66, 67).

Hypotheses

The hypotheses for the current study, supported by the reviewed literature, are as follows:

Hypothesis 1: Baseline negative urgency will significantly predict change in emotion dysregulation from baseline to the follow-up, such that negative urgency will be associated with increased emotion dysregulation. Gender will moderate the relationship, such that the relationship will be stronger in girls than in boys.

Hypothesis 2: Baseline positive urgency will significantly predict change in emotion dysregulation from baseline to the follow-up, such that positive urgency will be associated with increased emotion dysregulation. Gender will moderate the relationship, such that the relationship will be stronger in in girls than in boys.

Methods

This study is a secondary analysis of the Going 4 Goals project (PI: Zapolski), which seeks to determine the effectiveness of a brief adaptation of the skills group component of dialectical behavioral therapy for adolescents (DBT-A) to reduce risky behaviors among high school students who were engaging or at risk of engaging in high-risk behaviors, such as substance use, as identified by school staff (see protocol for full description of Going 4 Goals project, 68). The Going 4 Goals Project included a control sample of students who did not participate in the program but were included to compare changes in study outcomes to those students who did

participate in the program. This study utilizes only the control sample from the parent study who did not receive any DBT-A skills training to eliminate systematic differences between the control and intervention groups due to the DBT-A intervention or pre-morbid risk profiles.

Participants

Participants were 544 ninth-grade high school students who ranged in age from 13 to 15 (49.8% female, M_{Age}=14.22, SD=0.52) from a local public high school in Indianapolis recruited during the school's health class at the beginning of either the Fall or Spring semester (between Fall of 2018 and Spring of 2020). Participants were offered the opportunity to participate while enrolled in a state-mandated health education class at their school.

Measures

Emotion dysregulation

The Emotion Dysregulation Scale short version (EDS-s) is a 12-item self-report measure that examines the construct of emotion dysregulation across three domains: emotional experience, cognition, and behavior (69). Items were scored on a 7-point Likert scale ranging from 1 (not true) to 7 (very true). Example items include "emotions overwhelm me" and "when I'm upset, I have trouble seeing or remembering anything good about myself." This scale was found to have high internal consistency in the current sample (Cronbach's alpha = 0.96), which is consistent with previous research [Cronbach's alpha = 0.93 – 0.95; (69)]. This total score was calculated using a sum of the items. The EDS was completed at baseline and nine weeks later.

Negative urgency

Negative urgency was measured using the negative urgency subscale of the full UPPS-P modified for children [UPPS-PC; (70)]. Items were measured on a 4-point Likert scale from 1 (not at all like me) to 4 (very much like me), such that higher scores are indicative of more impulsive tendencies. One example item is, "When I feel bad, I often act without thinking." The UPPS-PC uses eight items to assess negative urgency. This subscale was found to have good internal consistency in the current sample (Cronbach's alpha = 0.85), which is consistent with previous research of the full UPPS-PC [Cronbach's alpha = 0.81-0.90; (70)]. The total negative urgency score was calculated using a sum of items. Data from the baseline session was used for data analysis.

Positive urgency

Positive urgency, a component of impulsivity, was measured using the positive urgency subscale of the full UPPS-PC (UPPS-PC; 70). The items were measured on a 4-point Likert scale from 1 (not at all like me) to 4 (very much like me), such that higher scores are indicative of more impulsive tendencies with items such as "when I get really happy about something, I tend to do things that lead to trouble." The UPPS-PC uses eight items to assess positive urgency. This subscale was found to have high internal consistency in the current sample (Cronbach's alpha = 0.9), which is consistent with previous research with the UPPS-PC (Cronbach's alpha = 0.81-0.90; 70). The total positive urgency score was calculated using a sum of items. Data from the baseline session was used for data analysis.

Procedure

The school staff sent all students an opt-out consent form letter for parent and/or guardian approval. The letter contained the study purpose, risks, benefits, and inclusion and exclusion criteria. Guardians were asked to sign and return the letter if they did not wish their student to participate and were given a period of two weeks to return the letter. After the two-week period passed, students who wished to participate signed assent forms and completed surveys assessing baseline measurements of the outcome variables. These measures were then collected again nine weeks later. Researchers provided snacks to study participants as incentives for completing the baseline and follow-up surveys.

Data analysis

All analyses were performed in R (71).

Data cleaning

Before beginning data analysis, participants were removed due to missing data at baseline, not providing a response to the gender item, or not identifying as cisgender male or female: Six participants were removed from the data set for not providing a response to the gender demographics item, and an additional five participants were removed for responding as transgender or "other" gender. While it is important to examine gender beyond the male and female binary, the sample of other genders was not large enough to be adequately powered to determine an effect; thus, the decision was to remove them for this analysis. There were 5 other participants removed from the data set due to missing the EDS-s or UPPS-PC at baseline. After removing those participants, there were 528 remaining participants for analysis.

Missing data analysis

The data set was then assessed for missingness. A test for missing completely at random (MCAR) was conducted on each of the variables of interest using Little's test statistic (72). They were each non-significant, indicating that the data missing in the EDS-s and the UPPS-PC were MCAR. The EDS-s was found to have 0.4%

missing data at baseline and 12% missing data at follow-up. The negative urgency subscale and positive urgency subscale each had 0.3% missing data at baseline. Upon a visual inspection of the data set, the missing data at the baseline time points were for individual items within the measures. Thus, given the small amount of missing data and MCAR mechanism, we calculated scale scores using the person mean imputation approach (73). Specifically, a total scale score was calculated for the EDS-s at baseline and follow-up, negative urgency at baseline, and positive urgency at baseline by taking a sum of the individual item scores for each participant. Note that those scale scores were only used in descriptive and preliminary analyses. For the confirmatory factor and latent change score models described below, the target constructs were included as latent variables with missing data on the individual items handled using the full information maximum likelihood estimation method (FIML).

Preliminary analyses

All variables were assessed for normal distribution skewness, kurtosis, and outliers. Previous research indicates that skewness between -2 and +2 and kurtosis between -7 and +7 are considered to be within a normal distribution range (74, 75). Bivariate correlations, t-tests, and an ANOVA were conducted to examine the associations between positive urgency, negative urgency, emotion dysregulation, and sample characteristics with the "psych" package in R (76).

Measurement invariance

Confirmatory factory analysis (CFA) was used to assess the factor structure of the EDS-s at baseline and follow-up and the negative and positive urgency items of the UPPS-PC using the "lavaan" package in R (77). A single-factor model was first fit to the data for each construct with the gender groups combined. Each latent construct was identified using the indicator approach (i.e., fix one of the item loadings to be 1). Model fit was assessed using the comparative fit index (CFI) and the root mean squared error or approximation (RMSEA): RMSEA<0.08 and CFI >0.90 were deemed adequate (78, 79). To ensure that the constructs were comparable across gender groups, measurement invariance of each latent construct between boys and girls was then evaluated using a series of multigroup CFA analyses (78) by sequentially adding equality constraints on parameters across groups: 1) configural (no parameter constraints), 2) weak invariance (factor loadings equated), and 3) strong invariance (factor loadings and intercepts equated). Configural invariance was established if the model fit the data. Weak and strong invariance were evaluated using chi-squared difference tests ($\Delta\chi^2$), as well as changes in CFI and RMSEA (ΔCFI and ΔRMSEA). While there are no set cut-off criteria, the current standard is to accept models that show ΔCFI and ΔRMSEA ≤.01 (80). Note that for the purpose of the current study (compare relationships among latent variables across groups), weak invariance would be sufficient.

Invariance of the EDS-s across time (baseline to follow-up assessments) was evaluated using the same process of adding equality constraints across the two assessment periods (81): 1) configural (no parameter constraints), 2) weak invariance (factor loadings equated), and 3) strong invariance (factor loadings and intercepts equated). The same fit indices as previously mentioned were used to evaluate model fit.

Hypothesis testing

After establishing weak invariance held for all the constructs, two multigroup latent change score models (see Figure 1 for the model specifications) were built to test whether baseline negative and positive urgency predicted change in emotion dysregulation from baseline to follow-up and if the associations differed by gender. All models were estimated using FIML for missing data with the "lavaan" package in R (77). The latent change score models modeled the change as a latent variable, removing the influence of measurement errors and facilitating the use of FIML in dealing with missing data on difference scores (82, 83). The first model allowed the associations to be different across boys and girls, and the second one equated them across groups. Note that for emotion dysregulation, since it was measured at two time points, the residuals on the same item were allowed to be correlated across time. The two models were nested and compared using $\Delta\chi^2$, with a significant result suggesting a moderation effect of gender (i.e., the associations significantly differed across group). As a sensitivity analysis, an additional equality constraint model was run on both positive and negative urgency, in separate models, such that the coefficients were constrained to be equal for negative, but not positive urgency, and vice versa, allowing to examine whether gender moderation occurred for one trait, but not the other. Cohen's guidelines for coefficient β were used to determine the effect size of the relationships between negative and positive urgency and emotion dysregulation (84).

Results

Sample characteristics

Participants were between the ages of 13-16 and, on average, 14 years old (M=14.21, SD=0.52); 74% of the participants were 14 years old. Because of this, age was not included as a covariate in hypothesis testing. The sample was mostly Black or White (31.3% African American/Black, 27.4% White, 0.4% Asian American/Pacific Islander, 1.9% Native American/American Indian/Alaskan Native, 6.3% Other race, and 18.7% more than one race, 24.2% did not respond to race demographic item), mostly not Hispanic/Latino (25.1% Hispanic/Latino), and in ninth grade (100%).

Preliminary analyses

Skewness and kurtosis were within normal limits for each study variable. Means, standard deviations, and correlations of study variables can be found in Table 1. As expected, negative urgency, positive urgency, and emotion dysregulation (both baseline and

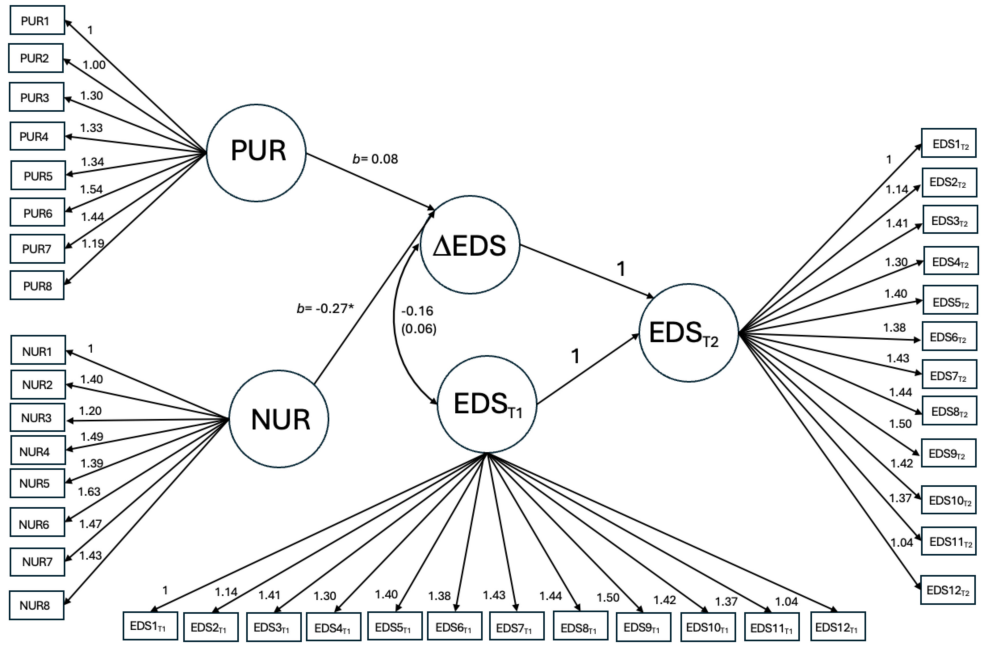

FIGURE 1
Path diagram for the multiple group latent change score model with regression coefficients associated with negative and positive urgency freely estimated across gender. For emotion dysregulation, since it was measured at two time points, the residuals on the same item were allowed to covary across time. For simplicity, these covariances were included in the model but omitted from the graph. Results were similar comparing unconstrained to models with only negative urgency or only positive urgency constrained, although they trended towards having worse fit. NUR=negative urgency, PUR=positive urgency, EDS_{T1}= EDS-s at baseline, EDS_{T2}= EDS-s at follow-up, ΔEDS = change in EDS-s from baseline to follow-up. *p<0.05.

follow-up), showed positive, significant correlations (all *p*'s<0.001). Boys demonstrated lower negative urgency [$t(526)$=-3.23, p=0.001; boys: M=18.21, SD=5.13 and girls: M=19.76, SD=5.82)] and emotion dysregulation at both baseline [$t(526)$= -6.39, p<0.001; boys: M_1 = 36.72, SD_1 = 16.41; girls: M_1 = 46.55, SD_1 = 18.88] and follow-up [$t(458)$= -6.02, p<0.001; boys: M_2 = 35.92, SD_2 = 17.26; girls M_2 = 46.06, SD_2 = 18.84) than girls. There was no difference in positive urgency across gender [$t(526)$= -0.20, p=0.84].

Measurement invariance

First, the factor structure for the EDS-s at baseline and at follow-up supported a single factor fit the data with the two groups combined (baseline: RMSEA = 0.073, 90% CI = [0.063, 0.084], CFI = 0.96; follow-up: RMSEA = 0.058, 90% CI [0.046, 0.070], CFI = 0.98). Three residual covariances were included across six items (items five and nine, items 11 and 12, and items one and nine). For negative negative urgency, two residual covariances were included (items 17 and 26 and items 20 and 30) and a single factor fit the data with the two groups combined (RMSEA = 0.067, 90% CI [0.049, 0.086], CFI = 0.97). For positive urgency, six residual covariances were included (items 38 and 39, items 36 and 40, items 33 and 34, items 35 and 38, items 34 and 36, and items 33 and 36) and a single factor fit the data with the two groups combined (RMSEA = 0.080, 90% CI [0.060, 0.101], CFI = 0.98).

Second, measurement invariance analyses were conducted for each construct (see Table 2). The configural invariance models with

TABLE 1 Means, standard deviations, and correlations of key study variables.

Variable	1	2	3	4	5
1. Age	–				
2. NUR	0.04	–			
3. PUR	0.03	0.55***	–		
4. EDS baseline	0.02	0.66***	0.37***	–	
5. EDS follow-up	0.02	0.57***	0.33***	0.79***	
Mean (SD)	14.22 (0.52)	18.98 (5.54)	17.04 (5.81)	41.62 (18.34)	40.99 (18.75)

NUR, negative urgency; PUR, positive urgency; EDS, emotion dysregulation scale-short.
***p<0.001.

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TABLE 2 Measurement Invariance for Sex (dummy coded against Male).

	CFI	RMSEA [90% CI]	χ^2	ΔCFI	ΔRMSEA	$\Delta\chi^2$
EDS-s Baseline						
Configural	0.96	0.074 [0.063, 0.086]	250.005**			
Weak	0.96	0.070 [0.059, 0.081]	259.357**	0.000	0.000	9.863
Strong	0.96	0.070 [0.059, 0.081]	283.992**	0.004	0.069	24.635*
EDS-s Follow-up						
Configural	0.97	0.065 [0.051, 0.078]	200.587**			
Weak	0.97	0.061 [0.048, 0.074]	209.683**	0.001	0.000	9.096
Strong	0.97	0.063 [0.051, 0.075]	237.149**	0.007	0.081	27.466**
EDS-s Across Time						
Configural	0.93	0.070 [0.065, 0.075]	870.190**			
Weak	0.93	0.068 [0.063, 0.073]	873.662**	0.001	0.000	3.472
Strong	0.93	0.066 [0.061, 0.071]	883.858**	0.000	0.000	10.195
Negative Urgency						
Configural	0.97	0.067 [0.046, 0.087]	78.281**			
Weak	0.97	0.060 [0.040, 0.079]	83.445**	0.002	0.000	5.164
Strong	0.95	0.068 [0.051, 0.085]	111.726**	0.016	0.107	28.281**
Positive Urgency						
Configural	0.98	0.085 [0.063, 0.106]	80.805**			
Weak	0.98	0.072 [0.052, 0.092]	82.365**	0.002	0.000	1.560
Strong	0.98	0.068 [0.049, 0.087]	93.272**	0.001	0.046	10.907

*p<0.05, **p<0.01.

the multiple group CFA also showed an adequate fit. The models with factor loadings equated did not have a significantly different model fit from the corresponding configural models, supporting weak invariance. The strong invariance models showed significantly worse χ^2 for all constructs except for positive urgency. Although ΔCFIs from weak to strong invariance were less than.01 for most of the constructs, ΔRMSEAs were all greater than the threshold, indicating that strong invariance was not established. Based on the result, weak invariance was assumed. Correspondingly, in subsequent hypothesis testing models, item loadings were constrained to be equal across boys and girls, but intercepts were not.

Third, configural invariance of the EDS-s across time showed an adequate fit (see Table 2). The model with the factor loadings equated did not have a significantly different model fit from the corresponding configural model, supporting weak invariance. The strong invariance model did not have a significantly different model fit from the configural model, supporting strong invariance. Thus, strong invariance was established for the EDS-s across time, allowing to the examination of change over time.

Hypothesis testing

The multigroup latent change score analyses found no significant moderation effect of gender. Between the models with the regression coefficients associated with negative and positive urgency equated *vs.* relaxed across boys and girls, there was no significant change in model fit ($\Delta\chi^2$ = 3.785, Δdf = 2, p=0.15). The constrained model (RMSEA = 0.062, 90% CI [0.059, 0.065], CFI = 0.89) revealed that negative urgency (b= -0.27, p=0.02) was significantly associated with change in emotion dysregulation, while the relationship with positive urgency was not significant (b=0.22, p=0.06; see Figure 1). There was also no significant change in model fit when only negative or positive urgency had their coefficients constrained to be equal, although it did trend towards significance (positive urgency coefficients constrained model to unconstrained model: $\Delta\chi^2$ = 3.219, Δdf = 1, p=0.07; negative urgency coefficients constrained model to unconstrained model: $\Delta\chi^2$ = 3.070, Δdf = 1, p=0.08).

Discussion

This study was the first to examine a temporal, predictive relationship between urgency and emotion dysregulation change. Results indicated that baseline negative, but not positive, urgency predicted change in emotion dysregulation across a 9-week period among our sample of 9th grade adolescents. Girls had higher emotion dysregulation scores than boys at both timepoints; however, there was not a main effect of gender in either model, and gender did not significantly moderate the relationship between urgency and emotion dysregulation change.

The negative, significant relationship between baseline negative urgency and change in emotion dysregulation extends previous cross-sectional relationships between negative urgency and emotion dysregulation (14, 16, 17, 42, 44, 46), suggesting that higher negative urgency is associated with increased emotion dysregulation over time. This study provides initial evidence of a temporal relationship, supporting the idea that negative urgency influences the development of emotion dysregulation over time, as suggested by previous theory (18, 64, 65). If this is true, negative urgency may impact how one learns to regulate their emotions through personality-environment translation effects and may serve as one mechanism for how negative urgency impacts risk [e.g., (18)].

The relationship between baseline positive urgency and change in emotion dysregulation was not significant, which is consistent with previous research that indicates that positive and negative urgency relate to some risky behaviors in different ways (15, 47, 85–87). This finding contradicts previous work that suggests that both negative and positive urgency relate to emotion dysregulation (e.g., 42, 44) and have similar risk patterns (11, 88, 89). The effect of positive urgency on emotion dysregulation change fell just short of significance, and was in the opposite direction than hypothesized and than the effect of negative urgency. This may mean that positive urgency has a unique, and as of yet unstudied and not understood, negative impact on emotion dysregulation. However, given the trend-like nature of this effect and the unexpected direction, this should be examined more fully before reaching this conclusion. The use of the EDS-s, which primarily includes items concerning negative emotional states, may have contributed to significant association of negative urgency and null effects of positive urgency in the current study. Future research regarding the relationship between emotion dysregulation and positive urgency may consider assessing emotion dysregulation with positive emotions, such as the DERS-positive (90). Alternatively, since both negative and positive urgency were placed into one model, the residual variance trend with positive urgency, after removing the effect of negative urgency, may be spurious, especially given the high intercorrelation between the two traits.

Although negative urgency had a significant association on emotion dysregulation change, the effect size was small (84) and the study period was brief. Although statistically significant, the small effect may not translate to clinically-significant effects. On the other hand, small effects can be important when they occur with minimal manipulation or when they impact a difficult-to-change outcome (91). Thus, although the effect in this study was small, the fact that it occurred over such a short period of time and without intervention suggests that this effect could be meaningful in broader prospective or interventional studies. A longer follow-up period could provide additional insight into the true impact of urgency on emotion dysregulation across the adolescent period. First, emotion dysregulation develops in early and middle adolescence (51, 52, 67), but the time over which measurable, natural change in emotion dysregulation takes place is less well understood. The brief nine-week period used in the current study may have resulted in smaller effects as there was less change in emotion dysregulation to predict. Second, we chose the direction from urgency to emotion dysregulation based on theory that personality develops temporally before emotion dysregulation, which suggests that urgency may be the precursor (51, 62–67). However, this does not rule out a feedback loop from emotion dysregulation back to changes in urgency, which could then further impact changes in emotion dysregulation over time. Alternatively, others conceptualize negative urgency as being part of emotion dysregulation (14, 48, 61). These additional models should be studied further in future work.

Girls had higher emotion dysregulation scores compared to boys. This finding contradicts prior work that suggests there are no gender differences in emotion dysregulation (92, 93), but supports other findings that girls experience more emotion dysregulation compared to boys (52, 53). This is thought to be due to adolescent boys being less aware of their emotional experience than girls (52, 53). There is extensive work establishing that boys have elevated levels of risk-taking compared to girls (50). For example, adolescent boys are more likely to use drugs (94) and to gamble (95) than adolescent girls. These higher levels of negative urgency and emotion dysregulation in girls found in the present study could lead to higher risk for girls in other domains, such as anxiety and depression (49, 96).

Findings did not support the hypothesis that gender would moderate the relationship between urgency and emotion dysregulation, suggesting that negative urgency relates to emotion dysregulation in the same way across boys and girls. It is unlikely that the null result in the current study was driven by statistical concerns because the large sample allowed for adequate power to test for a small effect and because there was an equal proportion of boys and girls in the sample. However, and importantly, there was a significant relationship between negative urgency and gender, which could mask interaction effects.

The long-term goal of this line of research is to determine how to reduce risk-taking in adolescents. Given the high rate of risk-taking and emotional lability among adolescents (5), this goal addresses an important intervention endpoint. Negative and positive urgency may not be directly intervenable and may even impede treatment response (97–100). Emotion dysregulation could be targeted as a modifiable risk factor (45) to reduce the impact of negative urgency on emotion dysregulation development. One study has sought to do this: Weiss et al. (17) found success in reducing both emotion dysregulation and urgency through an emotion modulation skills training. This study, along with the

current findings, suggest that future research should test whether or not existing effective emotion regulation treatments [see (101)] can also successfully reduce urgency and its impact of risk-taking. A more immediate and practical application of the current study is that clinicians may want to measure negative urgency and emotion dysregulation constructs in youth to better understand why, and under what conditions, youth engage in risk-taking. Both the UPPS-PC and the EDS-s appear to be adequate measures of these constructs in youth that are freely available and require very little time to implement, thus maximizing the benefits and minimizing the costs of additional assessments.

This study is not without limitations. First, we relied on self-report measures, which are limited by how aware, open, and willing participants were to disclose. Emotional awareness is less developed in adolescence (52), which could lead to under-reporting of both urgency and emotion dysregulation. Under-reporting could have reduced the effect size between these constructs detected in the current study. Using caregiver and/or teacher reports and behavioral measures, such as respiratory sinus arrhythmia (33), would provide complementary and potentially more robust relationship effects. Second, this sample was primarily composed of cisgender youth, which may limit generalizability to other gender identities. Third, strong measurement invariance was not fully supported for negative urgency and the EDS-s, suggesting that although comparisons can be made comparing strengths of relationships across boys and girls, boys and girls show mean level differences in these traits and comparisons should only be made with this in mind. Fourth, there could be a third variable responsible for the changes seen in emotion dysregulation across time, such as neuroticism or negative affectivity, which was not examined in the current study. One study found that neuroticism is typically higher in adolescent females than males starting around age 14 (102). Fifth, although participants in this study likely had a wide range of risk behavior engagement, this work should be replicated in clinical samples to ensure generalizability to high-risk adolescents.

In conclusion, this study is the first to establish a predictive temporal relationship between negative urgency and increased emotion dysregulation in adolescents, albeit in a brief timeframe. This work extends previous cross-sectional research and suggests the viability of further prospective work examining this relationship over a longer period of time, incorporating a measurement of risk-taking as the endpoint outcome. Positive urgency may relate to emotion dysregulation differently and should be studied further. Understanding how these constructs are related, and in turn, relate to the development of risky behaviors in adolescents, paves the way for the design and testing of interventions to reduce the impact of negative urgency for adolescent risk-taking.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: Identifiable data on participants under the age of 18. Requests to access these datasets should be directed to Tamika Zapolski, tzapolsk@iu.edu.

Ethics statement

The studies involving humans were approved by Indiana University Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because of the use of a passive parental opt-out and active participant assent process.

Author contributions

LF-F: Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Conceptualization. MW: Writing – review & editing, Project administration, Investigation, Data curation. WW: Formal analysis, Writing – review & editing. MC: Writing – review & editing, Writing – original draft, Supervision, Conceptualization. TZ: Writing – review & editing, Supervision, Resources, Methodology, Investigation, Funding acquisition, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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The Memory and Affective Flexibility Task: a new behavioral tool to assess neurocognitive processes implicated in emotion-related impulsivity and internalizing symptoms

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Background: Cognitive rigidity and working memory impairment are established features of internalizing syndromes. Growing evidence suggests that deficits in *affective control* –cognitive control in the context of emotion – may underpin elevated emotion-related impulsivity in various psychiatric disorders.

Objective: This study examines two components of affective control (affective flexibility and emotional working memory) as potential neurocognitive processes linking emotion-related impulsivity to internalizing psychopathology.

Method: Undergraduate participants (analysis n = 120) completed the Memory and Affective Flexibility Task (MAFT), a novel behavioral assessment designed to assess hot cognition in affective flexibility and emotional working memory performance, alongside self-report measures of impulsivity and symptoms of internalizing disorders.

Results: Structural equation modeling suggested that less accurate working memory during neutral trials (cool cognition) was associated with more symptoms of internalizing psychopathology. However, effects of hot working memory and affective flexibility were not significantly related to emotion-related impulsivity or psychopathology scores.

Conclusions: Although findings provide no support for the validity of MAFT indices of hot cognition, these results replicate and extend work on the importance of cool working memory and emotion-related impulsivity as correlates of psychopathology.

KEYWORDS

affective flexibility, anxiety, cognitive control, depression, emotion regulation, emotion-related impulsivity, internalizing, switching

1 Introduction

There is a growing shift in psychopathology research toward transdiagnostic approaches that transcend traditional psychiatric boundaries (1–3). These approaches aim to identify common mechanisms that underlie a wide range of psychological symptoms, offering a more integrative view of psychopathology that incorporates perspectives from neuroscience and behavioral genetics (4). Evidence continues to accumulate for the reliability and validity of transdiagnostic models of nosology (5) and treatment (6–11), underscoring their potential to reshape understanding of mental illness. Despite these promising advances, a considerable proportion of patients remain unresponsive or have considerable residual symptoms following treatment [e.g., (12)], highlighting the urgent need to identify more precise targets for effective interventions (11, 13–16).

Emotion-related impulsivity (ERI), characterized by impulsive behavior and cognition in response to heightened emotions, has emerged as a transdiagnostic factor across psychopathologies (17–23). ERI encompasses two subconstructs: (1) Feelings Trigger Action (FTA), defined as tendencies toward rash speech and action during strong emotional states; and (2) Pervasive Influence of Feelings (PIF), involving susceptibility to dysregulated cognition and motivation in response to aversive emotions (20, 24–26). Derived from factor analysis, FTA primarily includes items from the Negative and Positive Urgency scales (23, 27), whereas items comprising PIF mainly pertain to cognitive and motivational consequences of negative affect (24–26). FTA and PIF tend to be moderately correlated, consistent with theory that both involve poor constraint in the context of heightened emotion. FTA and PIF have both shown strong validity in relation to clinical outcomes (20, 28–32). In studies using path modeling and multivariate regression to consider conjoint effects, FTA better predicts externalizing syndromes and suicide attempts, whereas PIF better predicts internalizing syndromes and suicidal ideation (26, 28–32). Together, these two facets of ERI confer generalized risk for internalizing and externalizing psychopathology (20). An important next step in this line of inquiry is to better understand *how* this loss of constraint may occur.

From a neuropsychological perspective, cognitive control deficits have been theorized to contribute to ERI (17, 24), given the critical role of cognitive control in self-regulation of emotion, cognition, and goal-directed behavior (33). Latent variable models indicate that cognitive control tasks reliably map onto three core domains: inhibition, cognitive flexibility (i.e., set-shifting or task-switching), and working memory updating (34). These three domains are strongly interrelated, such that they load onto a higher-order common factor, supporting the "unity and diversity" model of cognitive control (33, 34).

Investigations into ERI and cognitive control have largely focused on response inhibition (35). Such studies suggest that the effects of FTA (and its constituent Urgency scales) on standard metrics of motor response inhibition are weak outside of clinical populations (36). Less work has examined how ERI relates to cognitive control processes other than response inhibition. This gap is surprising given that deficits in working memory and shifting are found across psychiatric diagnoses (22, 37, 38). In the only study of ERI and cognitive flexibility that we have identified, the authors relied on a self-report measure of the latter construct that corresponds poorly with behavioral indices of switching (39). Some evidence suggests an association of ERI with poorer working memory performance (40, 41), yet null findings have also emerged (42).

In studies that have considered hot cognition, several studies have shown that deficits in one form of affective control– emotional response inhibition –are strongly associated with FTA and Urgency [(43–48, but also see (49)]. Comparatively little is known, however, about other facets of affective control, such as emotional flexibility and emotional working memory, in relation to ERI. This gap deserves empirical attention for several reasons. It is well-established that working memory and flexibility are adversely influenced by heightened stress (50, 51). Indeed, meta-analytic work suggests that working memory may be the facet of cognitive control most vulnerable to stress (50, 51). Furthermore, working memory performance is disrupted by emotional information processing in clinical populations – with most evidence derived from samples with internalizing psychopathology (52–54). Although fewer studies are available, lower affective flexibility has been reported among those with psychological symptoms (55), including those with anxiety (56, 57), depression (58–60), as well as processes shown to increase risk for internalizing disorders, such as worry (57) and rumination (61). Hot working memory and affective flexibility are a natural focus for exploration of processes underlying ERI and internalizing psychopathology.

Much of the available neuropsychological literature has focused on FTA and the Urgency scales. The behavioral correlates of PIF, in contrast, have received less empirical attention. Despite this discrepancy, PIF has shown stronger relationships with internalizing symptoms (31), rumination (30), and suicidal ideation severity (28, 62). While it is plausible that FTA and PIF are both linked to disruption in affective flexibility *and* emotional working memory (17, 39, 40), dysfunction in emotional working memory may have special relevance for PIF. This is because PIF has been shown to be tied to more problematic responses to even low levels of stress (30). Given the sensitivity of working memory to stress (50), we hypothesized that PIF, as compared to FTA, would uniquely relate to poorer hot working memory. This prediction of a stronger tie of hot working memory with PIF than FTA is also consistent with the stronger ties of PIF with internalizing disorders, which are tied to hot working memory.

The current study aims to address two major gaps in the literature bridging ERI, cognitive/affective control, and internalizing conditions. First, we provide novel evidence considering hot and cool cognition, and of working memory and affective flexibility, conjointly. Second, we consider PIF and FTA conjointly. We theorize that affective control processes partially drive relationships between ERI and internalizing psychopathology (see Figure 1).

In service of these aims, we sought to develop and validate a novel behavioral assessment tool, the Memory and Affective Flexibility Task (MAFT) to index affective flexibility and emotional working memory. To our knowledge, this is the first task designed to concurrently evaluate these two key affective control processes. We designed the task, though, by integrating

features of well-established paradigms commonly used to assess working memory and cognitive flexibility: the *n*-back (63) and task-switching (64).

Based on our proposed model of ERI and its neurocognitive underpinnings in relation to internalizing symptoms (Figure 1), the present study tests the following hypotheses (see attached preregistration materials), seeking to establish convergent and divergent validity of the MAFT as a novel behavioral assay of affective flexibility and emotional working memory, as well as to extend prior work implicating affective control as a key factor explaining the robust links between ERI and psychopathology:

Hypothesis 1. Both facets of ERI (PIF and FTA) will be independently associated with (a) higher levels of internalizing symptoms and (b) diminished affective flexibility on the MAFT.

Hypothesis 2. PIF will also be associated with worse emotional working memory performance on the MAFT.

Hypothesis 3. MAFT performance on indices of affective flexibility and emotional working memory will be inversely associated with internalizing symptoms [independent of ERI; see (65)].

Hypothesis 4. Multivariate structural equation modeling (SEM) will reveal parallel indirect statistical effects of (a) affective flexibility and emotional working memory on internalizing symptoms through PIF and (b) affective flexibility on internalizing symptoms through FTA. Stated differently, we expect that emotional working memory will show indirect effects on internalizing only through PIF.

In addition to (a) replicating prior studies indicating a particularly strong link between PIF and symptoms of internalizing disorders, and (b) extending previous work implicating emotional response inhibition in FTA and psychopathology, this research will further elucidate the role of distinct affect-related inhibitory processes with plausibly greater relevance to the *cognitive* component of ERI (i.e., PIF) and its relationship with internalizing symptoms associated with depression and anxiety.

2 Materials and methods

All study procedures were approved by the University IRB before data collection began. An earlier version of the hypotheses and analyses is available in the attached preregistration materials.

2.1 Participants and procedures

The study sample comprised of 130 undergraduate students aged 18-47 years from a major public university who received course credit for their involvement (see Table 1). Ten participants were excluded for multiple indicators of poor attention (e.g., failure on at least 2 out of 3 "attention check items", performance below chance on the MAFT), leaving an analysis sample of 120. As shown in Table 1, *n*'s vary slightly by measure. Scores for questionnaires were coded as missing for one participant who failed to correctly

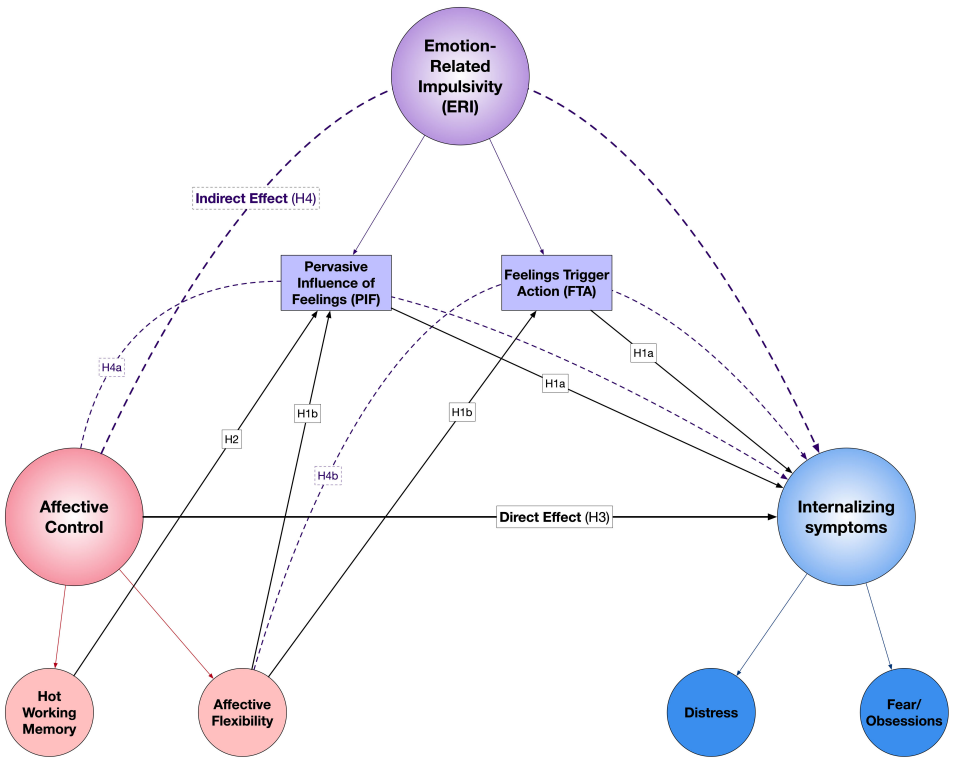

FIGURE 1
Neurocognitive Model of Emotion-Related Impulsivity and Internalizing Psychopathology.

respond to at least two out of three "attention check" items embedded in self-report questionnaires. MAFT switch scores were coded as missing for 4 participants who attained < 50% accuracy across the positive and negative switch trials. All participants in the sample attained < 50% omission error rates on MAFT *n*-back trials. One participant did not complete the IDAS-II.

Participants predominantly identified as female and endorsed a fairly diverse racial/ethnic background that was generally representative of the broader student population. We recruited interested individuals from a departmental research participant pool based on responses to an online prescreening survey, which included the Urgency scale of the abbreviated UPPS-P (66) to oversample individuals with elevated ERI. Students who reported elevated Urgency (i.e., scores greater than 3.5 out of 5) were actively invited to participate. To capture the full range of ERI, recruitment was also fully open to other students in the research participation program. Following an online assessment via Qualtrics software (67), participants who passed embedded attention checks were invited to a 2.5-hour laboratory session, in which they provided written informed consent before completing a series of neuropsychological assessments, including the MAFT, and several other tasks not considered here.

2.2 Measures

2.2.1 Three-Factor Impulsivity Index

The Three-Factor Impulsivity Index (TFII; 25) is a 54-item self-report measure that evaluates three latent factors of impulsivity derived from factor analysis. These latent factors comprise the aforementioned subordinate facets of ERI, *Feelings Trigger Action* (FTA) and *Pervasive Influence of Feelings* (PIF), as well as *Lack of Follow Through* (LFT), a third construct representing trait impulsivity independent of emotion. TFII respondents rate statements about reflexive behavioral (FTA) and cognitive (PIF) reactivity to emotions, as well as about impulse control unrelated to affect (LFT), on a Likert scale from 1 ("I disagree A LOT") to 5 ("I agree A LOT"). Research supports the TFII's robust three-factor structure, which demonstrates high internal consistency (McDonald's ω = 0.90-0.95 in this sample) as well as shared and unique associations with psychiatric disorders and physical exercise (68), underscoring its validity as a comprehensive measure of impulsivity (25). Consistent with prior work, TFII scores in this sample were moderately intercorrelated, with the strongest association observed between the two facets of ERI.

TABLE 1 Demographic characteristics (N = 120).

	M or *n*	*SD* or %
Age	21.45	4.2
Education	14.45	1.36
Gender		
Female	103	86.67%
Male	15	12.50%
Nonbinary	1	0.83%
Race/Ethnicity		
American Indian or Alaskan Native	2	1.67%
Asian	54	45.00%
Black or African	1	0.83%
Hispanic, Latino/a, or Spanish	13	10.83%
Middle Eastern or North African	3	2.50%
White	29	24.17%
Mixed race or Multiracial	16	13.33%
Not reported/Other	2	1.67%

M, Mean; *SD*, Standard Deviation.

2.2.2 Revised Inventory of Depression and Anxiety Symptoms

The revised Inventory of Depression and Anxiety Symptoms (IDAS-II; 71) is a 99-item questionnaire designed to assess the frequency and severity of symptoms across the internalizing spectrum. Respondents are asked to indicate the extent to which they have experienced each symptom over the preceding two weeks, on a five-point scale from "Not at all" to "Extremely". The Factor analyses of the IDAS-II have consistently identified latent dimensions of *Distress*, *Fear/Obsessions, and Well-Being* (69–72). Here, we focus on Distress and Fear/Obsessions, as the core symptom domains of the internalizing disorders.

2.2.3 Memory and Affective Flexibility Task (MAFT)

The MAFT (Figure 2) is a novel, timed, computer-based, behavioral assessment designed to measure emotional working memory and affective flexibility. On each MAFT trial, participants were instructed to respond via keypress to an image from the International Affective Picture System [IAPS; (73)]. Participants had to determine their response based on the two main trial types, which probed working memory and affective flexibility. The working memory (i.e., "n-back") trials followed standard n-back procedures, during which participants were asked to respond via keypress whether a given image was identical (a "match") or not ("mismatch") to a target image shown n trials earlier (where n = 1-3) in the sequence. On affective flexibility (i.e., "switch") trials, participants were instead asked to respond via keypress according to the emotional valence of the presented image as either "positive" or "negative."

Text instructional cues distinguished he working memory vs. switch trial types. On "n-back" trials, IAPS images were shown without any text. On "switch" trials, the text "POSITIVE or NEGATIVE?" appeared above the IAPS image. All IAPS images were presented for 1500 milliseconds (ms), and participants were given a 4500 ms window to respond (equivalent to the trial duration/stimulus onset asynchrony; see Figure 2). Participants used four keys in total to respond – "Match," "Mismatch," "Positive," and "Negative."The MAFT consisted of 198 trials separated into nine experimental blocks. Participants completed

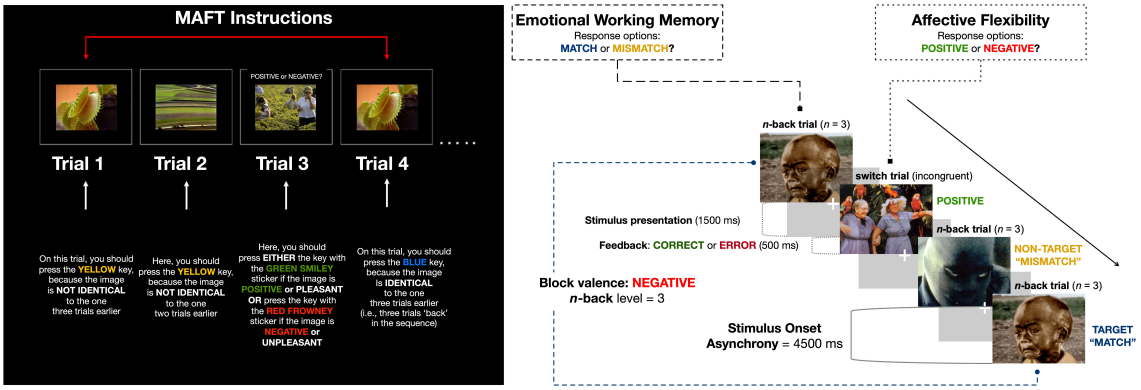

FIGURE 2
Memory and Affective Flexibility Task (MAFT) Schematic.

three, valence-specific, blocks – positive, negative, neutral – for each level of n-back difficulty (n = 1, 2, and 3-back trials). Each block contained 20 + n trials to account for the number of "mismatch" stimuli shown before the first possible target "match" stimulus. Before proceeding to the experimental blocks, participants were asked to complete two initial practice blocks with trial-level feedback (presented for 500 ms). The practice blocks were repeated until the participant achieved an accuracy threshold of at least 70% on n-back trials at the n=1 and n=2 levels (11 trials at the n = 1 condition and 12 trials in the n = 2 condition).

Within each block, ~60% of trials were n-back trials (i.e., 12 + n trials); four were "match" trials and the rest were "mismatch" trials. The emotional valences of all n-back trials were congruent with the block type. The remaining 8 trials, ~40%, were switch trials of alternating emotional valence. N-back and switch trials were interspersed in pseudo-random order to minimize predictability.

For each trial, an image was drawn randomly from the IAPS stimulus battery without replacement. The Negative (reverse-coded for valence comparison) and Positive image sets were approximately matched on standardized ratings of arousal (negative M = 5.94, SD = 0.77; positive M = 5.22, SD = 1.02) and valence intensity (negative M = 7.22, SD = 1.04; positive M = 7.15, SD = 0.79); Neutral images were chosen for their comparatively low arousal (M = 2.88; SD = 0.57) and intermediate valence ratings (M = 4.98; SD = 0.30). The MAFT was programmed by the lead author for implementation in Inquisit 6.0 stimulus presentation software (74) and is available upon request.

The MAFT yielded accuracy and reaction time performance metrics that could be parsed by emotional valence and n-back difficulty. Accuracy for n-back trials was calculated as the proportion of correct "match" trial hits and "mismatch" trial rejections. Accuracy for switch trials was calculated as the proportion of positive IAPS stimuli classified as positive and negative IAPS stimuli classified as negative. Reaction time (RT) was calculated as the average speed of correct responses, for both n-back and switch trials. Before calculating RT, we excluded trials in which a person responded too quickly to be considered a genuine reaction to the stimulus (< 200 ms) and those without a response within the 4500 ms window. Then, Z-scores were generated for each participant and trial-level outlier RTs (> |3|) were trimmed.

Although our major focus was on emotional working memory and affective flexibility across positive and negative emotional valence, switch trials with neutral images were included with the goal of providing additional information about evaluation of stimuli without salient emotional content. We hoped to consider the percentage of neutral IAPS stimuli (on switch trials) classified as negative as an index of subjective interpretive bias, rather than accuracy. Overall, neutral stimuli on switch trials were primarily categorized as "positive" (M = 0.64, SD = 0.11), consistent with previous research using a parallel index from the emotional stop-signal task [see (44)]. As noted by one reviewer, though, the forced choice of assigning negative or positive ratings to these neutral pictures is problematic. We do not consider these scores further here.

After developing the task design, pilot work was conducted to evaluate the speed of trials, the number of trials to feasibly incorporate to avoid fatigue, and the clarity of instructions. The task was adjusted in small ways after each round of this informal feedback.

2.2.4 Statistical analyses

We used JASP version 0.19.1 (75) for all statistical analyses and assumption checks, as well as Python version 3.12.4 (76) for data cleaning and processing before hypothesis-testing.

Next, we performed analyses for hypothesis-testing. Here, we acknowledge several deviations from our pre-registered statistical approach (see attached). Primarily, we incorporated more comprehensive pre-processing procedures at a trial level, and by considering overall accuracy rates, rather than adhering to our original plan to remove outliers defined at +/-2.5 SDs from the mean. We made this decision to preserve the ability to consider valid individual differences in task performance. Second, we reduced analytic repetition by incorporating planned regressions into a broader structural equation modeling (SEM) framework. Third, we relied on factor scores rather than narrower scales from the IDAS-II.

We used SEM to test our proposed conceptual model of ERI, MAFT metrics of affective control, and internalizing symptoms from the IDAS-II (Figures 1, 3). Bivariate correlations of key variables were performed as preliminary analyses. Our SEM model used robust

calculation of standard errors, which are less influenced by outliers and heteroscedasticity. Variables were standardized before entry, and we used full information maximum likelihood (FIML) to impute missing values. To examine hypothesized pathways of affective flexibility and emotional working memory through FTA and PIF, we calculated parameter estimates associated with indirect effects of MAFT metrics on internalizing dimensions. Significant indirect effects would suggest that some portion of the relationship between two variables (e.g., affective inflexibility and depression) is explained by shared variance between the predictor, an intermediary variable (e.g., ERI), and the outcome (e.g., depression). We focus on the specific regression coefficients as tests of our mediational model hypotheses.

3 Results

Descriptive statistics for key study variables are provided in Table 2. The distributions for most of the MAFT summary metrics approximated normality, with two exceptions: Switch accuracy scores for negative stimuli were negatively skewed and leptokurtic, and negative response bias scores were also leptokurtic.

3.1 MAFT performance

Accuracy of working memory performance across different *n*-back levels and valence categories is depicted in Figure 4. As expected, participants demonstrated poorer accuracy on *n*-back trials as working memory demand (i.e., the *n*-level) increased, $F(1.79, 173.97) = 9.634$, $p < 0.001$, $\eta^2 = 0.01$.

Accuracy rates were lower for emotional *n*-back trials with negative and positive images as compared to those with neutral stimuli, $F(1.93, 219) = 45.52$, $p < 0.001$, $\eta^2 = 0.277$, as Table 2 and Figure 4 demonstrate. Participants were also less accurate when prompted to classify negative images relative to positive stimuli on switch trials, $F(1, 115) = 6.14$, $p < 0.05$, $\eta^2 = 0.051$ (Figure 5).

Figures 6A, B portray the relatively slower response speed for negative stimuli in n-back and switch trials. Participants had significantly slower RTs for negative *n*-back trials compared to those with positive and neutral stimuli, $F(1.87, 119)^1 = 11.19$, $p < 0.001$, $\eta^2 = 0.09$ (Figure 6A). Similarly, switch trial RTs were significantly slower when evaluating negative images relative to positive ones, $F(1, 115) = 9.89$, $p < 0.01$, $\eta^2 = 0.08$ (Figure 6B).

Intercorrelations among MAFT summary metrics are presented in Table 3. Because Shapiro-Wilks tests suggested non-normality, Spearman's correlations were used. Consistent with the hypothesized separability of these indices, most accuracy scores showed small to moderate correlations. We observed a small but significant association between accuracy for positive and neutral *n*-back trials. In addition, accuracy on the positive switch trials was correlated significantly with switch accuracy on the negative trials, and with accuracy on *n*-back trials with negative and neutral stimuli. All other intercorrelations among accuracy scores were small and nonsignificant.

Before testing hypotheses, we considered whether age or gender might be confounders in MAFT performance. Bivariate Spearman correlations indicated no significant effects of age or gender, all *r*'s ¾.17, *p*'s >.05.

Somewhat surprisingly, bivariate correlations suggested no speed-accuracy tradeoff in MAFT performance. However, RT indices were highly correlated across all MAFT summary metrics

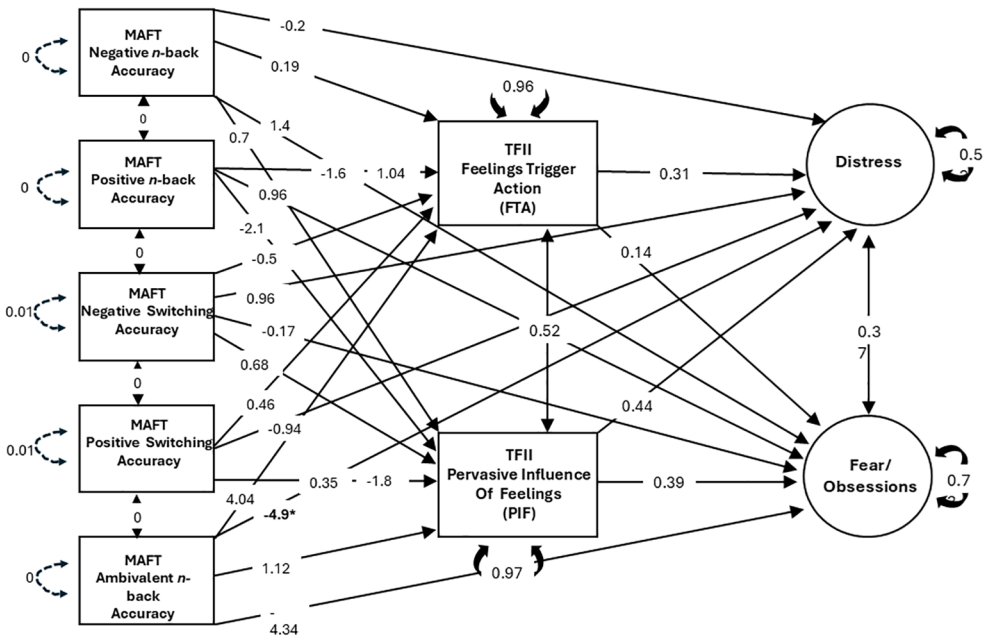

FIGURE 3
Structural equation model of affective control, ERI, and internalizing symptoms. Standardized regression coefficients shown (β). *p<.05.

TABLE 2 Descriptive statistics for key variables (N = 120).

	M (*SE*)	Range	Skewness (*SE* = 0.22)	Kurtosis (*SE* = 0.44-0.45)
Memory and Affective Flexibility Task (MAFT)				
MAFT *n*-Back Accuracy (%)				
Negative	0.88 (0.005)	0.71 – 1.00	0.63	0.74
Positive	0.88 (0.005)	0.69 – 1.00	0.88	1.69
Neutral	0.94 (0.004)	0.82 – 1.00	0.29	0.54
MAFT Switch Accuracy (%)				
Negative	0.90 (0.010)	0.25 – 1.00	-2.57	11.69
Positive	0.92 (0.007)	0.62 – 1.00	-1.39	2.39
MAFT *n*-Back Reaction Time (ms)				
Negative	1084.88 (16.85)	750.62 – 1599.55	0.67	0.04
Positive	1051.54 (15.88)	662.87 – 1635.13	0.81	1.04
Neutral	1048.21 (13.79)	660.77 – 1492.06	0.42	0.42
MAFT Switch Reaction Time (ms)				
Negative	1201.11 (15.16)	867.50 – 1887.75	0.80	1.84
Positive	1176.58 (14.42)	858.36 – 1757.75	0.69	0.98
Three-Factor Impulsivity Index (TFII)				
Feelings Trigger Action (FTA)	2.91 (0.09)	1.11 – 4.88	0.09	0.27
Pervasive Influence of Feelings (PIF)	3.53 (0.09)	1.08 – 5.00	-0.40	-0.74
Revised Inventory of Depression and Anxiety Symptoms (IDAS-II)				
Distress	125.37 (3.59)	31.58 – 266.51	0.67	1.18
Fear/Obsessions	51.06 (1.68)	14.47 – 113.67	0.86	0.59

SE, Standard Error.
Valid MAFT switching data *n* = 116, valid TFI *n* = 119, valid IDAS-II *n* = 118.

of emotional working memory and affective flexibility (Table 3; all *r*'s > 0.65), suggesting that RT scores may be more indicative of individual differences in processing or motor response speed than specific influences of task condition. Accordingly, we calculated an overall mean RT summary score across *n*-back and switch trials. Because this overall MAFT RT index was not significantly correlated with any of the MAFT accuracy indices or the TFI scores, *r*'s ¾ |.14|, *p*'s >.05. we did not consider RT further in multivariate analyses.

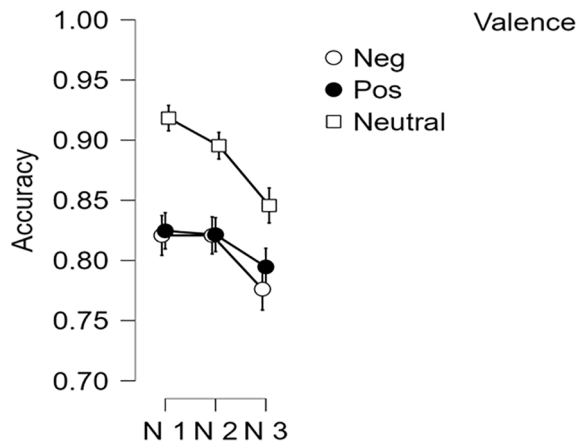

FIGURE 4
N-Back Accuracy by n-level and stimulus valence. Error bars = +/- 1 standard error.

3.2 Multivariate effects of MAFT metrics on ERI and psychopathology

We used an SEM framework to test core predictions (particularly Hypothesis 4) derived from our proposed neurocognitive model of ERI associated with internalizing psychopathology. Specifically, we constructed a structural model to examine direct effects of MAFT performance metrics on internalizing-related symptoms of Distress and Fear/Obsessions, as well as the indirect effects of these same observed behavioral indicators on psychopathology through FTA and PIF from the TFII (see Figures 1, 3).

As preliminary descriptive analyses before conducting SEM, we performed bivariate correlations of MAFT indices with ERI and psychopathology, provided in Table 3. As shown, we did not find significant bivariate associations of MAFT performance summary metrics with ERI or psychopathology scores.

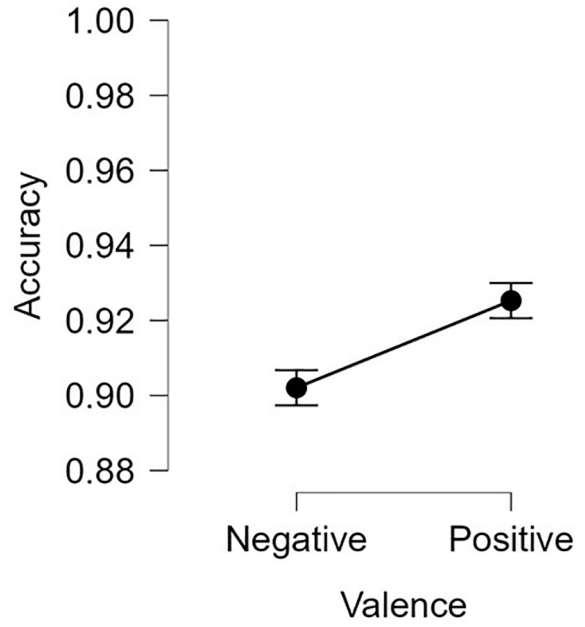

FIGURE 5
Switch accuracy by Valence. Error bars = +/- 1 standard error.

Consistent with prior work, ERI was robustly related to the IDAS-II Distress score and more modestly but significantly associated with the IDAS-II Fear/Obsessions score. The correlation with Distress was stronger for PIF than for FTA (Z = 2.22, p = 0.02), again replicating previous findings on ERI in relation to internalizing symptoms. The strength of the correlation with Fear/obsessions did not differ significantly for PIF vs. FTA (Z = 1.74, p = 0.08).

Figure 3 depicts the results of the SEM-based mediation analysis, which we used to test our theoretical model of how ERI might statistically explain hypothesized effects of affective control on internalizing psychopathology (also see Figure 1). Paths for ERI to psychopathology were significant, consistent with hypothesis 1A. Nonetheless, contrary to all other hypotheses, results did not support any links of the MAFT hot working memory or affective flexibility scores with either ERI or psychopathology. As shown in Table 4, the neutral working memory scores were the only MAFT variable that showed a significant direct effect, to IDAS-II Distress scores.

Given the limited statistical power, we conducted *post-hoc* Bayes correlations to examine the links of the MAFT variables with the ERI and psychopathology indices. No correlations yielded Bayes factors > 10.

4 Discussion

In the current study, we developed and provided preliminary validity tests for the Memory and Affective Flexibility Task (MAFT), a new behavioral assessment task designed to index key aspects of affective control. We designed the MAFT designed to provide metrics of working memory and switching performance, under both cool and hot (i.e., emotional) conditions. We employed this task to provide an integrative test of links between these two facets of cognitive control, ERI, and core dimensions of internalizing psychopathology. Our work is novel in integrating two forms of ERI, and two forms of cognitive control, both of which were assessed across trials with neutral, positive, and negative stimuli. Our reliance on an SEM model to disentangle common and unique cognitive processes embedded in the MAFT scores is a strength of our approach. We begin by considering our findings regarding the effects of ERI on psychopathology. Then, we discuss analyses specific to the MAFT and evidence in support of this new task. Finally, we turn to the integrative model findings.

As shown in bivariate correlations (Table 3) and in our SEM model (Figure 3), our results replicated and extended previous work indicating robust correlations between ERI and psychopathology. Relatively less literature has considered the Pervasive Influence of Feelings (PIF) form of ERI, which focuses on unconstrained cognitive and motivational responses to negative emotions. Consistent with prior findings (20), we found that PIF was more powerfully tied to distress-related internalizing symptoms compared to scores on the

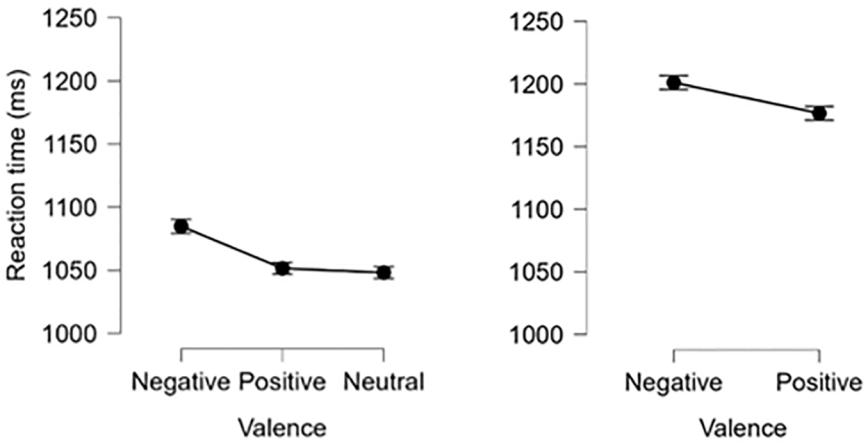

FIGURE 6
Reaction time by stimulus valence for (left) n-Back and (right) switch conditions. Error bars = +/- 1 standard error.

TABLE 3 Bivariate Spearman correlation coefficients.

	1	2	3	4	5	6	7	8	9	10	11	12	13
n-Back Accuracy (*n* = 120)													
1. Negative	–												
1. Positive	0.21*	–											
2. Neutral	0.22*	0.22*	–										
Switch Accuracy (*n* = 116)													
3. Negative	0.16	0.12	0.01	–									
4. Positive	0.32***	0.17	0.16*	0.42***	–								
n-Back Reaction Time (*n* = 120)													
5. Negative	0.01	-0.10	-0.14	0.04	0.10	–							
6. Positive	-0.04	-0.11	-0.11	0.00	0.08	0.82***	–						
7. Neutral	0.01	-0.08	-0.13	0.04	0.15	0.81***	0.87***	–					
Switch Reaction Time (*n* = 116)													
8. Negative	-0.10	-0.13	-0.20*	-0.03	-0.04	0.66***	0.66***	0.69***	–				
9. Positive	-0.16	-0.13	-0.16	-0.07	0.03	0.71***	0.68***	0.68***	0.85***	–			
Three-Factor Impulsivity Index (TFII; *n* = 119)													
10. FTA	0.07	-0.05	0.12	0.04	0.06	-0.13	-0.07	-0.08	-0.17	-0.12	–		
11. PIF	0.09	-0.12	0.02	0.12	0.04	-0.01	0.02	-0.01	0.00	-0.02	0.52***	–	
Revised Inventory of Depression and Anxiety Symptoms (IDAS-II; *n* = 118)													
12. Distress	0.02	-0.09	-0.11	0.08	-0.04	-0.04	-0.01	-0.06	-0.05	-0.05	0.44***	0.61***	–
13. Fear/Obsessions	0.03	-0.05	-0.08	-0.06	-0.11	0.04	0.00	-0.05	0.00	0.04	0.30**	0.44***	0.68***

FTA, Feelings Trigger Action; PIF, Pervasive Influence of Feelings. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Feelings Trigger Action (FTA) scale, which focuses rash speech and behavior in response to emotions. This work was also novel in considering the effects of ERI on psychopathology using the IDAS-II, a comprehensive inventory of internalizing symptoms, which allowed us to consider distress versus fear/obsessions within the same model. As expected, ERI effects generalized across both forms of internalizing symptoms, consistent with previous work highlighting the robust transdiagnostic role of ERI in various psychiatric conditions. Nonetheless, effects of ERI on fear/obsessions were relatively modest. Recent work has suggested that ERI may be more relevant for obsessive symptoms when other risk variables are present, such as intolerance of ambiguity (77). Future work might consider the contexts in which ERI is particularly related to specific forms of psychopathology.

Turning to the MAFT, several findings preliminarily supported the validity of this novel task. Most individuals were able to perform the task at above chance levels. As expected, MAFT emotional working memory performance significantly diminished as the value of *n*

TABLE 4 Parameter estimates from the SEM model.

Direct effects								
							95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
nBack neg	→	Distress	-0.024	1.233	-0.019	0.985	-2.441	2.393
nBack pos	→	Distress	1.004	1.220	0.823	0.411	-1.387	3.395
switch neg	→	Distress	0.962	0.516	1.866	0.062	-0.049	1.973
switch pos	→	Distress	-0.944	0.884	-1.068	0.285	-2.676	0.788
nBack neu	→	Distress	-4.912	1.787	-2.749	0.006	-8.415	-1.410
nBack neg	→	Fear/Obs	1.395	1.218	1.146	0.252	-0.991	3.782

(Continued)

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TABLE 4 Continued

Direct effects									
								95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
nBack pos	→	Fear/Obs	0.407	1.508	0.270	0.787	-2.549	3.364
switch neg	→	Fear/Obs	-0.165	0.697	-0.237	0.813	-1.530	1.201
switch pos	→	Fear/Obs	-1.832	1.165	-1.572	0.116	-4.115	0.452
nBack neu	→	Fear/Obs	-4.336	2.293	-1.891	0.059	-8.830	0.159

Indirect effects										
									95% Confidence Interval	
					Estimate	Std. Error	z-value	p	Lower	Upper
nBack neg	→	FTA	→	Distress	0.058	0.452	0.128	0.898	-0.829	0.945
nBack neg	→	PIF	→	Distress	0.311	0.699	0.444	0.657	-1.059	1.681
nBack pos	→	FTA	→	Distress	-0.491	0.524	-0.938	0.348	-1.517	0.535
nBack pos	→	PIF	→	Distress	-0.940	0.783	-1.200	0.230	-2.474	0.595
switch neg	→	FTA	→	Distress	-0.015	0.338	-0.044	0.965	-0.678	0.648
switch neg	→	PIF	→	Distress	0.302	0.373	0.812	0.417	-0.428	1.033
switch pos	→	FTA	→	Distress	0.143	0.405	0.353	0.724	-0.650	0.936
switch pos	→	PIF	→	Distress	0.154	0.527	0.293	0.770	-0.879	1.187
nBack neu	→	FTA	→	Distress	1.247	0.646	1.929	0.054	-0.020	2.514
nBack neu	→	PIF	→	Distress	0.493	0.829	0.595	0.552	-1.132	2.118
nBack neg	→	FTA	→	Fear/Obs	0.027	0.210	0.128	0.898	-0.386	0.439
nBack neg	→	PIF	→	Fear/Obs	0.273	0.605	0.451	0.652	-0.913	1.459
nBack pos	→	FTA	→	Fear/Obs	-0.228	0.257	-0.886	0.375	-0.733	0.276
nBack pos	→	PIF	→	Fear/Obs	-0.825	0.700	-1.179	0.238	-2.197	0.547
switch neg	→	FTA	→	Fear/Obs	-0.007	0.157	-0.044	0.965	-0.315	0.301
switch neg	→	PIF	→	Fear/Obs	0.266	0.330	0.804	0.421	-0.382	0.913
switch pos	→	FTA	→	Fear/Obs	0.066	0.188	0.353	0.724	-0.302	0.435
switch pos	→	PIF	→	Fear/Obs	0.135	0.464	0.292	0.770	-0.774	1.045
nBack neu	→	FTA	→	Fear/Obs	0.580	0.494	1.172	0.241	-0.389	1.549
nBack neu	→	PIF	→	Fear/Obs	0.433	0.744	0.582	0.560	-1.025	1.891

Total effects								
							95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
nBack neg	→	Distress	0.345	1.522	0.227	0.821	-2.638	3.328
nBack pos	→	Distress	-0.427	1.625	-0.263	0.793	-3.612	2.758
switch neg	→	Distress	1.250	0.797	1.568	0.117	-0.313	2.813
switch pos	→	Distress	-0.647	1.278	-0.506	0.613	-3.152	1.858
nBack neu	→	Distress	-3.172	2.090	-1.518	0.129	-7.269	0.925
nBack neg	→	Fear/Obs	1.695	1.351	1.255	0.210	-0.953	4.343

(Continued)

TABLE 4 Continued

Total effects								
							95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
nBack pos	→	Fear/Obs	-0.646	1.757	-0.368	0.713	-4.090	2.798
switch neg	→	Fear/Obs	0.094	0.649	0.144	0.885	-1.179	1.367
switch pos	→	Fear/Obs	-1.630	1.276	-1.277	0.202	-4.131	0.872
nBack neu	→	Fear/Obs	-3.323	2.329	-1.426	0.154	-7.889	1.243
Total indirect effects								
							95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
nBack neg	→	Distress	0.369	0.978	0.377	0.706	-1.548	2.285
nBack pos	→	Distress	-1.431	1.145	-1.249	0.212	-3.676	0.814
switch neg	→	Distress	0.288	0.640	0.449	0.653	-0.967	1.542
switch pos	→	Distress	0.297	0.836	0.355	0.722	-1.342	1.937
nBack neu	→	Distress	1.740	1.218	1.429	0.153	-0.646	4.127
nBack neg	→	Fear/Obs	0.300	0.718	0.418	0.676	-1.107	1.706
nBack pos	→	Fear/Obs	-1.053	0.838	-1.257	0.209	-2.696	0.589
switch neg	→	Fear/Obs	0.259	0.445	0.582	0.561	-0.613	1.130
switch pos	→	Fear/Obs	0.202	0.599	0.337	0.736	-0.971	1.375
nBack neu	→	Fear/Obs	1.013	0.938	1.079	0.280	-0.826	2.852

Robust standard errors, robust confidence intervals, ML estimator.
Fear/Obs, Fear/Obsessions. MAFT scores are accuracy scores. Neg, Negative; Neu, Neutral; Pos, Positive; FTA, Feelings Trigger Action; PIF, Pervasive Influence of Feelings.
→ denotes the effect on.

increased, suggesting strong parallels with previous research using similar *n*-back designs (63, 78). Our task was constructed to allow direct comparison between the effects of positive and negative stimuli on working memory performance – a key addition to the literature. Although many previous studies have examined the effect of negative stimuli on working memory performance, we are aware of only two investigations that have conjointly considered negative and positive stimuli on working memory, and those yielded inconsistent effects; Levens and Phelps (79) found that positive and negative stimuli both were related to enhanced accuracy in a recency probes task, whereas Rączy and Orzechowski (80) found that positively valenced words, but not negatively valenced words, interfered with accuracy on an two-back task. We observed lower accuracy in working memory performance on the *n*-back in the context of both positive and negative trials as compared to neutral trials. Our detection of interference during negative trials might reflect our use of emotional pictures, as contrasted with the work by Rączy and Orzechowski (80). Our findings for non-specific interference from emotionally arousing stimuli of either valence further align with previous research on the susceptibility of working memory to acute stress (50).

Regarding affective flexibility, accuracy on the switch trials was modestly correlated with accuracy on the working memory trials, indicating that the two trial types might capture partially separable processes. Of concern, though, accuracy scores for the negative switch trials were highly leptokurtic, suggesting that as constructed, the MAFT did not effectively elicit sufficient variability in switching performance. Future versions could potentially benefit from manipulating difficulty levels, perhaps by adapting task demands to require more rapid responses. In considering the relatively high-performance levels, it is worth noting that participants may have been able to accurately respond by considering their affective state, rather than attending carefully to the stimulus and task demands; future versions of the task might include conditions in which a participant is asked to respond to specific features embedded within affective images. Computational methods to extract specific processes tied to task performance are also recommended.

Although researchers have varied in their use of accuracy versus speed as indices of flexibility, our task design allowed us to examine RT across *n*-back and switch trial conditions. With this novel information, the performance profile we observed calls into question whether RT can be interpreted as a valid index of affective flexibility. Response speed was highly correlated across *n*-back and switch trials, with all RT index correlations >.65. This profile suggests that it is more likely that RT indices on MAFT switch trials are indicative of processing and/or motoric speed than they are specific to flexibility. These findings highlight an unexpected benefit of considering working memory and flexibility within the same task. As has been indicated in some prior work

across cognitive tasks [e.g., (54)], negatively valenced stimuli led to a slowing of RTs on both working memory and switching trials. This is consistent with the idea that negative information could lead to a slowed, more cautious approach that may be nonspecific to working memory or switching demands.

Taken together, our analyses of task conditions suggest partial success in achieving our aim of creating a novel affective control task. That is, we found evidence that MAFT *n*-back trial performance tracked as expected with the level of working memory load, and we observed interference effects of emotion stimuli on working memory task performance. We also saw appropriate separation between *n*-back and switch trial scores. Armed with this information, we used MAFT accuracy indices to test our hypotheses concerning ERI and psychopathology.

Contrary to prediction, bivariate correlations showed no significant effect of MAFT performance on indices of ERI or psychopathology, and our multivariate SEM model provided no evidence that the hot working memory or affective flexibility scores were related directly or indirectly to ERI or to psychopathology scores (see Figure 3). Although few studies are available, it is worth noting that our findings are conceptually consistent with those of a previous study, which showed that working memory in the context of a stress manipulation was unrelated to ERI (81).

In contrast to the null effects for affective control in the our SEM model, we observed a direct effect of cool working memory dysfunction (i.e., lower accuracy on *n*-back trials with neutral images) on the IDAS-II Distress score. This is consistent with a large body of previous work that those who struggle with cool cognitive control facets may be at higher risk for internalizing syndromes (22). We extend this body of research by showing that the indirect effect of cool working memory on Distress through ERI was not significant, suggesting that cool working memory and ERI show separable effects on Distress. This is consistent with recent models highlighting that working memory and ERI may have unique genetic pathways toward psychopathology (82).

In sum, the current study provides three findings that contribute to the understanding of ERI, cognition, and psychopathology. First, we replicated and extended previous work linking ERI to internalizing psychopathology. Second, our multivariate model provided support for the importance of cool working memory for internalizing symptoms. Third, our findings indicated that ERI and cool working memory may exert separable effects on psychopathology.

Nonetheless, our findings provided little support for the hot cognition parameters from the MAFT, and we acknowledge that even the effect for cool working memory was relatively modest. Although consistent with previous work attempting to link self-rated and behavioral task performance metrics of conceptually related constructs (83, 84), several limitations specific to the MAFT suggest the need for caution in interpreting results from this novel task. As described, few people obtained low negative switch accuracy scores, and RT scores were strongly tied to individual differences, and less to task-specific demands. Given all effects for hot cognitive indices in relation to psychopathology and impulsivity were null, there is some question of whether the task adequately activated emotion. The MAFT relies on a very common approach in hot cognition research of using brief presentations of valenced stimuli. Any emotion elicitation effects of such brief stimulus presentations may be minor, and aside from subtle reaction time changes, we have no evidence to verify that an emotion powerful enough to interfere with processing was evoked. The addition of psychophysiology indices could help validate the extent of emotion arousal induced by the valenced stimuli. Overall, the reliability and validity of the novel MAFT task remain largely unestablished.

Other limitations are less specifically tied to the MAFT. Our cross-sectional design constrains our ability to comment on the direction of effects. We relied on self-rated measures of symptom severity, and it will be important to consider how findings generalize to diagnostic indicators. Our sample was limited to undergraduate students, although here it is worth noting that undergraduate students now demonstrate a prevalence of diagnosable psychological disorders that is comparable to the prevalence observed in the general population (85). Most of our sample was female, and there is a need to assess generalizability of effects across genders. Given higher rates of impulsivity in clinical and male groups, these sample issues may have limited ability to detect behavioral indicators of impulsivity. Perhaps most critically, our sample size of 120 is quite small given that some suggest sample sizes of 250 for testing SEM path models. Our small sample may have hindered the ability to detect meaningful effects and may limit the replicability of effects. Regarding replicability, though, we would note that not only were the bivariate and multivariate effects for most MAFT parameters on ERI and psychopathology null, but effect sizes were small as well. Bayes correlations also did not support meaningful effects of MAFT indices with psychopathology or impulsivity. Nonetheless, findings from the study should be interpreted with caution until replicated in a larger sample.

Overall, given the relatively limited evidence to support the MAFT affective control indices, future research would do well to test how parameters on the MAFT correspond to those obtained using traditional, stand-alone working memory and switching tasks. Such work would ideally include testing a large sample and considering the effects of clinical disorders.

Despite the limitations, current findings are consistent with the large body of work on cognitive remediation for psychopathology and provide particular support for interventions focused on working memory. Here, we raise one caveat though. The relatively small effect sizes of the cognitive tasks on the clinical outcomes suggest the need to consider comprehensive interventions that pair cognitive remediation with other clinical approaches (86, 87). We hope that ongoing work will integrate basic research into transdiagnostic clinical intervention approaches.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Committee for Protection of Human Subjects (CPHS), University of California,

Berkeley. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

KA: Conceptualization, Funding acquisition, Methodology, Supervision, Writing – original draft, Writing – review & editing. ME: Conceptualization, Writing – original draft, Writing – review & editing. ER: Conceptualization, Writing – review & editing. NR: Project administration, Writing – original draft. ÅH: Conceptualization, Funding acquisition, Writing – review & editing. SJ: Conceptualization, Funding acquisition, Methodology, Resources, Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Assessment of cognitive function in bipolar disorder with passive smartphone keystroke metadata: a BiAffect digital phenotyping study

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Background: Cognitive dysfunction in bipolar disorder persists in the euthymic state and has been shown to be associated with a number of negative sequelae including treatment resistance and increased risk of relapse. There has been recent attention on digital phenotyping and passive sensing through smart, connected devices to probe cognition in real-world settings. BiAffect is a custom-built smartphone keyboard that captures keystroke metadata ('how you type, not what you type'). In previous studies, our group has demonstrated that BiAffect-derived keystroke metadata is associated with cognitive domains like processing speed. For the present study, we hypothesized that typing metadata would be significantly associated with executive function and planning.

Methods: 18 participants with bipolar disorder and 12 healthy comparison participants from the Prechter Longitudinal Study of Bipolar Disorder at the University of Michigan were provided a mobile phone with a customized keyboard that passively collected keystroke metadata. Participants also completed a neuropsychological battery including the Tower of London task. Irregularities in typing and times to make a move on the Tower of London task were compared using sample and Shannon entropy, respectively.

Results: Participants with bipolar disorder had significant increases in entropy in typing (p = .005, d = -1.28) and entropy of Tower of London move times (p = .029, d = -.84). Furthermore, typing entropy was significantly associated with irregularity in Tower of London moves in participants (r = .59, p = .006), as well as variability of clinician-rated depressive symptoms and self-rated impulsive actions and feelings.

Conclusions: This pilot study demonstrates that passive, unobtrusive smartphone keystroke metadata can be used to probe cognitive function and dysfunction in bipolar disorder, revealing multi-scalar behavioral features accessible through digital assays

KEYWORDS

digital biomarkers, bipolar disorder, executive function, smartphone, digital phenotyping

Introduction

Cognitive dysfunction in bipolar disorder has been shown to be present even in the euthymic state (1). Cognitive dysfunction in bipolar disorder has been associated with poor treatment response, increased risk of relapse (2), and comorbid substance abuse (3). In bipolar depressive disorders, patients demonstrate executive function deficits such as impaired response inhibition and difficulties with set-shifting. These cognitive deficits are often associated with illness course and poor treatment response. In addition, the further implications of cognitive dysfunction have been demonstrated in first episode bipolar patients where better performance on frontal/executive tasks was significantly correlated with faster time to recovery (4) and work status (5).

The literature on cognitive dysfunction demonstrates that not only can these deficits occur during an acute episode and impact treatment response but can also occur during euthymic states and predict symptom recurrence and relapse. Furthermore, these deficits broadly have a negative impact of emotion regulation across the spectrum of mood disorders, as well as in patients with bipolar disorder (6–8). Additionally, targeting cognitive dysfunction can augment current treatment modalities and prevent future mood episodes (9). Because of this, monitoring cognitive performance in patients with mood disorders has tremendous clinical implications. However, traditional cognitive assessment can be expensive, time-consuming, and temporally inexact, thus limiting its use and widespread implementation. These limitations demonstrate the need for passive, unobtrusive, objective assessment of cognitive function in the context of mood disorders. There has been recent attention on digital phenotyping and passive sensing through smart, connected devices to probe cognition in real-world settings. Our passive sensing, BiAffect, is a custom-built smartphone keyboard that captures keystroke metadata ('how you type, not what you type') (10). In previous studies, our group has demonstrated that BiAffect-derived keystroke metadata is associated with mood symptom severity and can be used prospectively to predict changes in mood in patients with bipolar disorder (11). For the present study, we hypothesized that typing metadata would be significantly associated with executive function measured with traditional cognitive testing in participants with bipolar disorder.

In order to compare typing metadata to traditional cognitive testing, we employed a dynamical systems approach to time-series derived from typing metadata and cognitive performance by utilizing sample entropy analysis (12, 13). Sample entropy analysis has been successfully applied to analyzing time series data from several clinical domains, including but not limited to bipolar disorder to predict changes in mood self-report (4), motor activity (7), as well as motor activity in depression (8), and a range of the other physiological disorders such as heart disease (5). In taking this dynamical systems approach, we were also interested in examining how typing dynamics relates to variability of depressive symptoms and impulsivity, as our previous study demonstrated that instability of mood ratings were associated with worsening depressive symptoms (11).

For the present study, we hypothesized that if irregularity of move times on the Tower of London task is reflective of poor planning or impulsivity, participants with bipolar disorder will demonstrate higher levels of entropy in move times compared to healthy comparison participants. Furthermore, we hypothesized that higher entropy of move times on the Tower of London task would be associated with higher levels of entropy in typing dynamics for participants with bipolar disorder (Figure 1).

Materials and methods

Participant recruitment

18 participants with bipolar disorder (12 with bipolar I, 6 with bipolar II) and 12 healthy comparison participants from the Prechter Longitudinal Study of Bipolar Disorder at the University of Michigan (14) completed informed consent in accordance with the Declaration of Helsinki and were provided a mobile phone with the BiAffect app. Information regarding data collection from this cohort have been described in more detail in previous publications (10, 11, 15).

Cognitive assessment

Participants completed a custom made cognitive task on the smartphone modeled after the Tower of London task (16), a test developed to measure planning and problem solving. In the custom smartphone task, participants were to replicate the top configuration of colored, stacked balls by making the bottom

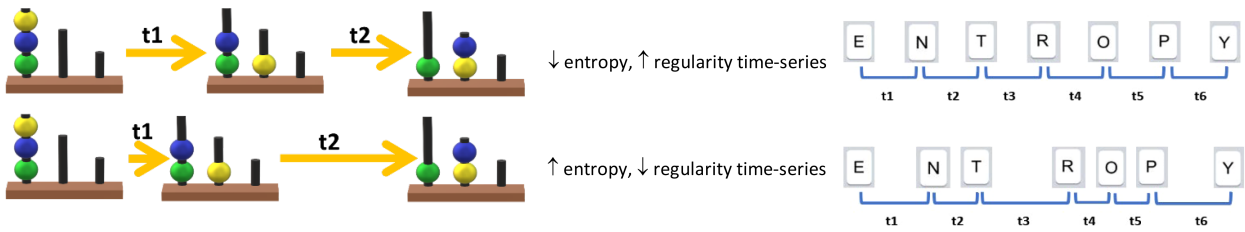

FIGURE 1
Description of entropy values. T1, T2,...Tn refers to the move time intervals on either of the Tower of London task (left) or interkey delays from keyboard dynamics (right). Higher entropy values are indicative of more irregularity of move times.

pegboard look the same (Figure 2). The top pegboard was predetermined (includes multiple versions) and the bottom pegboard is manipulated by the participant. The bottom configuration of balls are touch-sensitive so that the participant can move/drag one ball from one peg and drop/place onto another peg. The pegs vary in height so that the tallest peg on the left can hold up to three balls, the middle can hold up to two balls, and the short peg can only hold one ball. For each trial, there is a preset configuration for the bottom configuration for all moves. There are set rules for moving the balls: 1) can only move one ball at a time; 2) cannot put more balls on a pole than can fit; 3) cannot move a bottom ball without moving the ball on top first. Participants are recorded on how long it takes them to complete the bottom configuration to match the top and the number of moves they make (total time to complete configuration, the time it takes move by move, and number of moves it takes to match the top configuration. The minimum number of moves for each problem was preset at 5 and 6, defined to be a "moderate" difficulty level, each one to be given randomly in the morning ecological momentary assessment (EMA) session and in the evening EMA session. For example, they were given a 5- and a 6-move problem in the morning. We administered two problems so that the task could remain brief (as opposed to up to 30 moves of increasing difficulty, ranging from 10 moves to 32 moves on variant versions of the Tower of London) and include moderate difficulty problems to obtain a range of move times and errors. A total of 11 unique configurations of 5-move problems and 11 unique configurations of 6-move problems were randomly assigned so that no configuration was repeated until all versions were completed, thus minimizing any learning effects. Thus, participants completed a total of 22 problems across all sessions.

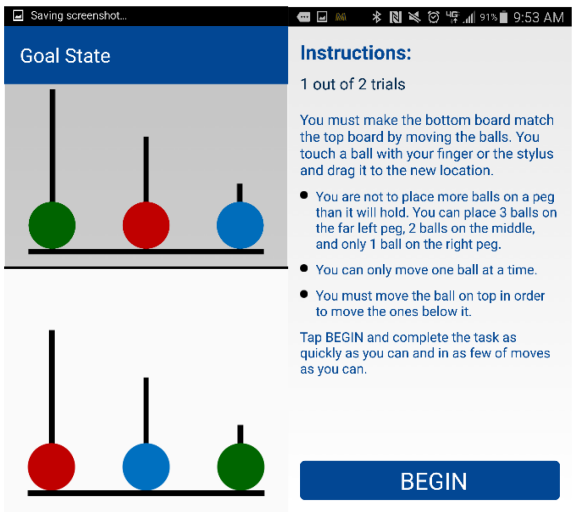

FIGURE 2
Tower of London task. Instructions that were given before starting the task "You must make the bottom board match the top board by moving the balls. You touch a ball with your finger and drag it to the new location. You are not to place more balls on a peg than it will hold; You can place 3 balls on the far-left peg, 2 balls on the middle, and only 1 ball on the right peg. You can only move one ball at a time. You must move the ball on top in order to move the ones below it. Tap BEGIN and complete the task as quickly as you can and in as few of moves as you can." If participants did not finish the task within 2 minutes, they received this prompt "That was a good try. Let's go to the next one.".

BiAffect and ecological momentary assessment

Participants used BiAffect-equipped Android smartphones and completed a 17-day baseline EMA period during which they were prompted, once daily, to rate their mood, energy, rapidity of thinking, and impulsive feelings and actions using a visual analog scale of 0 to 100 (17, 18). Three participants had less than 17 days collected (11, 15 and 16 days collected). Simultaneously, BiAffect unobtrusively collected typing kinematics metadata as participants interacted with their phones as usual, allowing us to extract average typing speed (measured using time since last key or interkey delay) within each day in their natural environments. Participants also completed a baseline clinician-rated Hamilton Rating Scale for Depression (HAM-D) (19) at study entry. Variability of EMA and HAM-D measures were obtained using the standard deviation.

Entropy analysis

To calculate entropy for the Tower of London task, Shannon entropy (20) was calculated on move times as a function of trial order across all sessions. Shannon entropy is a measure of uncertainty or randomness in a complex system. Shannon entropy was selected due to Tower of London move times being measured on the order of seconds and the length of the total time-series. For calculation of entropy from typing data, sample entropy

(21) was calculated based on the interkey delay as a function of keypress order across all keypresses with interkey delays less than 96 seconds (which represents delays between letters, words, sentences, and conversations).

Statistical analysis

t-tests were used to analyze group differences for continuous variables and the chi-square test was used for categorial variables. Pearson's correlations were used to analyze the association of typing entropy and Tower of London entropy, as well as typing entropy and self-rated EMA measures.

Results

Participant characteristics

Clinical, demographic and Tower of London performance data are summarized in Table 1. This cohort was derived from the larger Prechter Longitudinal Study which was 85% Caucasian with bipolar disorder onset at the average age of 17 years (14). There was no significant difference in age, sex, education, or IQ (all p >.05). On the Tower of London task, participants with bipolar disorder took longer to complete the task and had more total moves but these differences were not statistically significant (p = .16 and p = .21, respectively) after controlling for age and education.

TABLE 1 Clinical, cognitive, and demographic participant characteristics.

	Control (n =12)	Bipolar (n=18)	
Age [range]	44.9 (9.0) [30 – 61]	47.4 (10.6) [31 – 63]	t (40) = 1.1 p = .28
Sex (M/F)	4/8	6/12	$\chi 2$ = 0.1 P = .92
Education (years)	16 (1.3)	15.8 (1.9)	t(40) = .70 p = .49
WAIS-IQ	108.8 (11.4)	108.5 (7.4)	t(29) = -.05 p = .97
Mean HAM-D	0.7 (0.9)	10.7 (5.4)	t(29) = 6.5 p <.001
TOL duration (seconds)	15.7 (9.0)	18.6 (11.3)	t(2242) = -4.5 p <.001
Total TOL legal moves	7.9 (3.3)	8.4 (3.9)	t(2242) = -2.9 p <.001

All data are represented as means (standard deviations). HAM-D, Hamilton Rating Scale for Depression; TOL, Tower of London.

Entropy analysis

Participants with bipolar disorder had significant increases in entropy of interkey delay times (typing entropy) (p = .005, d = -1.28) and entropy of Tower of London move times (p = .029, d = -.84) (Figure 3). Typing entropy was significantly correlated with Tower of London entropy (Figure 4, r = .59, p = .006), variability in depressive symptoms as measured by the HAM-D (r = .57, p = .009), and variability in self-rated impulsive actions (r = .52, p =.04) and feelings (r = .59, p = .02). There were no significant associations of typing entropy with the average values of EMA ratings of mood, energy, impulsive actions/feelings or racing thoughts. There was a significant association of Tower of London entropy with variability of self-rated impulsive actions (r = .43, p = .03) but no significant associations with variability of impulsive feelings or average levels of impulsive feelings or actions.

Discussion

In this study, we used an innovative approach leveraging entropy to measure poor planning and impulsivity actively (Tower of London) and passively (typing), associated with cognitive dysfunction in the context of bipolar disorder. We found that Tower of London move time entropy was significantly higher in participants with bipolar disorder compared to controls and this was also reflected in significantly higher multiscale entropy in typing speed in participants with bipolar participants. Typing entropy was also positively associated with variability in depressive symptoms and self-rated impulsivity. While our application of entropy measures to cognitive performance metrics (like move times), our findings are consistent with previous studies that have linked lower entropy in motoric behavior to better planning. Interestingly in a review of research on skilled climbing expertise, the authors found that higher entropy was associated with higher climb times and reduced experience and skill with climbing (22). Similarly, it has been shown that higher entropy on a motor preservation task was associated with worse cognitive performance in adolescents with high-risk for psychosis (23).

With regards to the relationship between typing entropy and variability of mood, Stange et al. demonstrated that instability of typing speed and instability of mood both predicted future elevations of depressive symptoms in this same cohort (11). This highlights the potential of these instability metrics being used prospectively to prevent future mood episodes.

Implications for emotion regulation

We demonstrated that typing entropy was associated with the instability of self-reported impulsivity and mood symptoms. This is reflective of the relationship between impulsivity and emotion dysregulation seen not only in bipolar disorder but transdiagnostically as well. In a study of participants with borderline personality disorder, it was shown that greater levels of emotional dysregulation were associated with higher entropy of choice patterns on a strategic decision-making task (24). Additionally, in alignment with this paper's findings, a population-based study by Wen and colleagues demonstrated passive detection of impulsivity using the entropy of the smartphone activities (call logs, battery charging and screen status) (25). They found that motor impulsivity was positively correlated with entropy of the screen checking suggestive of poor planning. Of note,

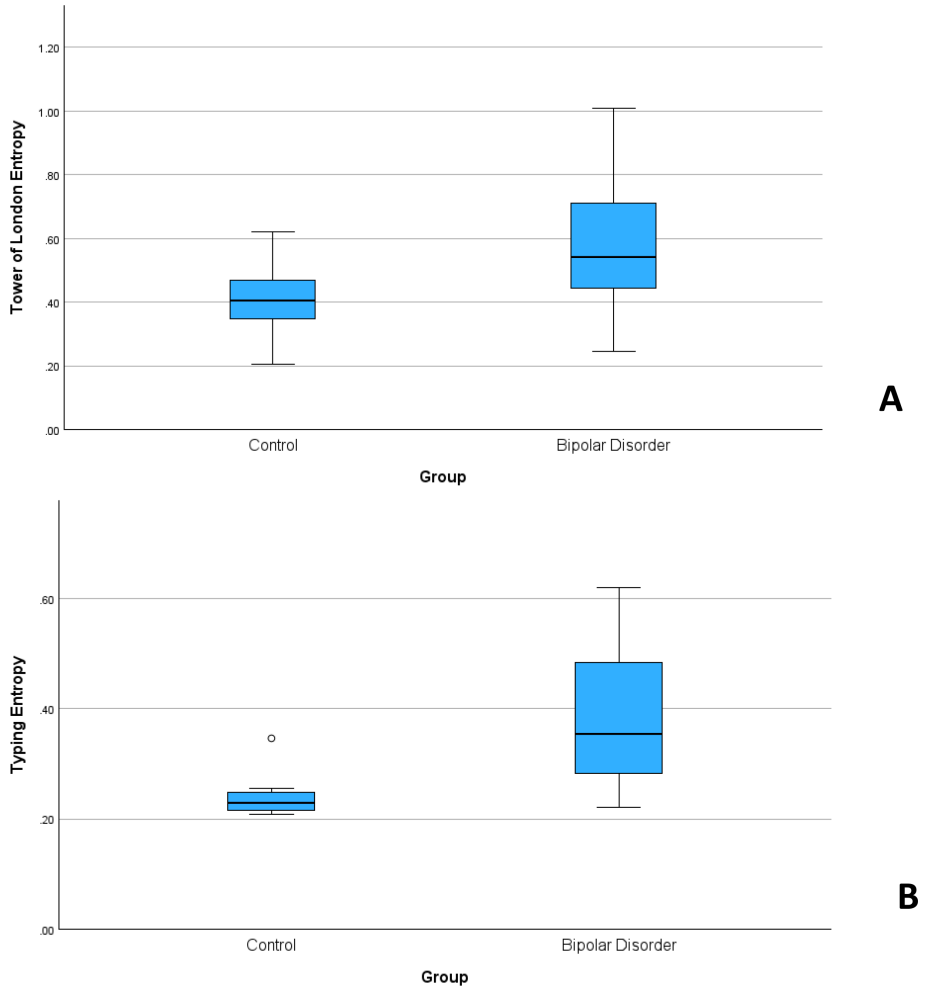

FIGURE 3
Participants with bipolar disorder had significantly higher levels of entropy as measured from typing **(A)** as well as the performance on the Tower of London task **(B)**.

impulsivity is one of the core emotion regulation deficits demonstrated in bipolar disorder (26). With regards to mood symptoms and emotion regulation, it has been shown that variability of cognitive performance was associated with negative affect (27).

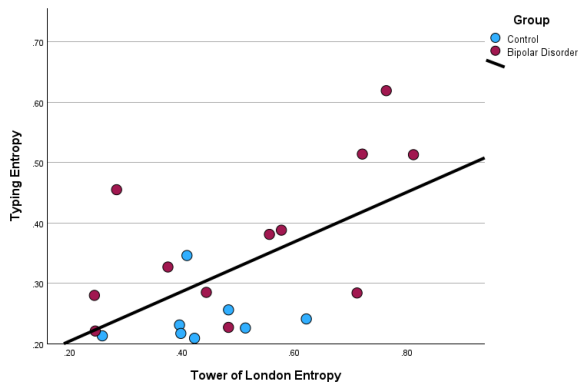

FIGURE 4
Typing entropy was positively associated with Tower of London entropy.

Limitations

Our study was limited by a small sample size and a short study duration. Additionally, the small sample precluded analysis of potential confounders like digital literacy, medication usage and familiarity with the use of smartphone. Another limitation is inherent to mobile cognitive assessments, namely the lack of standardization and control of the testing environment. These potential confounders are being addressed in our ongoing BiAffect studies where we are collecting this important contextual information (ClinicalTrials.Gov NCT04358900).

Conclusions

In summary, our pilot study demonstrates that passive, unobtrusive smartphone keystroke metadata can be used to probe cognitive function and dysfunction in bipolar disorder, revealing multi-scalar behavioral features accessible through digital assays. Future work is needed in larger samples to validate these findings

and to determine whether this type of passive digital biomarker data can be used as an early warning sign to enable just-in-time adaptive interventions and prevent future mood episodes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Illinois at Chicago Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

OA: Conceptualization, Writing – original draft, Writing – review & editing. JB: Formal analysis, Writing – review & editing. AD: Conceptualization, Data curation, Formal analysis, Software, Writing – review & editing. JZ: Writing – review & editing. JS: Writing – review & editing. JD: Writing – review & editing. FH: Data curation, Writing – review & editing. SL: Conceptualization, Writing – review & editing. PN: Writing – review & editing. KR: Data curation, Writing – review & editing. MM: Funding acquisition, Writing – review & editing. AL: Conceptualization, Funding acquisition, Writing – review & editing.

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Conflict of interest

Authors OA and AL are the co-founders of KeyWise AI.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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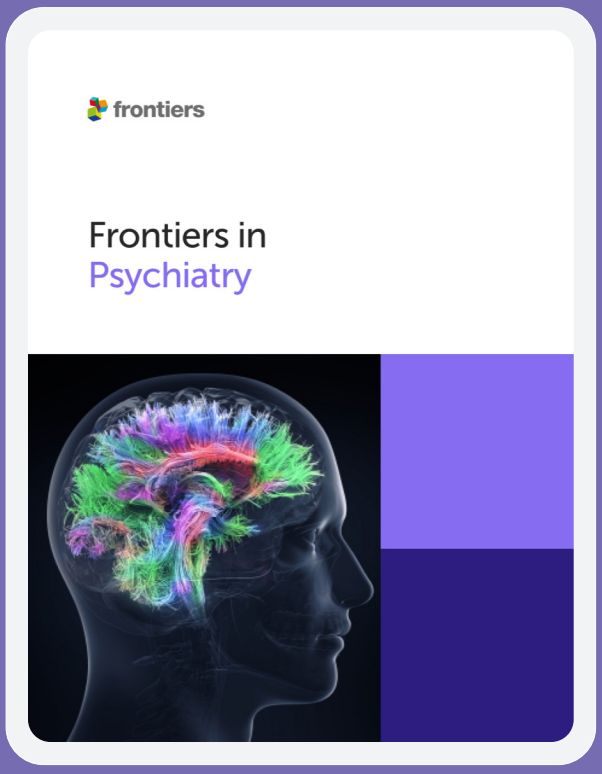

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