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Reinforcement Sensitivity Theory and emotion regulation difficulties: A multimodal investigation

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ABSTRACT

This study examined associations between BIS–FFFS, BAS dimensions, and emotion regulation (ER) assessed across self-report and behavioral domains among 101 adults. Findings revealed significant associations among the various ER assessments, as well as between ER and BIS–FFFS and BAS dimensions. As expected, BIS–FFFS was positively associated with self-reported ER difficulties, and, among women, BIS–FFFS was negatively associated with a behavioral measure of ER assessing the willingness to experience distress in order to pursue goal-directed behavior. BAS had a more complex association with ER, with certain BAS dimensions (e.g., Drive among women, Fun-Seeking) demonstrating unique positive associations with adaptive ER and other dimensions demonstrating negative associations with adaptive ER. Findings suggest the relevance of individual variations in BIS–FFFS and BAS to ER difficulties, as well as potential pathways through which sensitivity to punishment and reward may contribute to psychopathology.
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1. Introduction

Reinforcement Sensitivity Theory (RST; Corr, 2004, 2008; Gray & McNaughton, 2000) is a neurobiologically-based theory of personality that asserts that three major brain subsystems known as the Behavioral Approach System (BAS), Behavioral Inhibition System (BIS), and Fight–Flight–Freeze System (FFFS) underlie many of the individual differences observed in personality, psychopathology, and reinforcement sensitivity. The BAS is theorized to be an appetitive system underlying approach behavior in response to conditioned and unconditioned cues of reward (Corr, 2008). Individuals high on BAS are proposed to be impulsive and extraverted (Gray, 1991). In contrast, the FFFS is proposed to be a defensive avoidance system that motivates avoidance and escape behaviors in response to conditioned and unconditioned aversive stimuli. The FFFS is thought to underlie fear and panic (Gray & McNaughton, 2000). Finally, the BIS is considered to be the subsystem that resolves conflicts among competing goals (e.g., approach–avoidance conflicts) by inhibiting behavior, increasing arousal, and assessing for risk. The BIS is posited to underlie anxiety and the personality trait of Neuroticism (Corr, 2004; Gray & McNaughton, 2000).

Given that the most widely-used measures of RST (including the BIS/BAS Scales used here; Carver & White, 1994) are based on the original (and now outdated) version of RST, these self-report measures actually assess combined BIS–FFFS sensitivity within the revised RST (rRST) framework (Corr, 2004; Smillie, Pickering, & Jackson, 2006). In recognition of this, the present paper uses the term "BIS–FFFS sensitivity" throughout. That said, we recognize and value the important theoretical distinction made between BIS and FFFS within the rRST framework. Although we are also aware of attempts to distinguish BIS and FFFS sensitivity within the BIS/BAS Scales (Heym, Ferguson, & Lawrence, 2008), there is only limited support for such revisions to date. For example, Heym et al.'s (2008) proposal to subdivide Carver and White's (1994) BIS scale into a 4-item BIS and 3-item FFFS scale is based on a single factor analysis of a small sample of undergraduates. One of the only other studies to examine the factor structure and reliability of these proposed revisions (Vervoort et al., 2010) reported minimally-acceptable factor structure and low internal consistency for the 3-item FFFS scale. Similarly, we found internal consistency to be quite low (.57) for the proposed 3-item FFFS scale in our sample. Thus, based on extant research and our own data, we focused exclusively on the role of combined BIS–FFFS sensitivity in ER.

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Available evidence suggests that Carver and White's (1994) BIS scale is a reliable and valid measure of combined BIS–FFFS functioning (Corr, 2004; Smillie et al., 2006).

1.1. RST and emotion regulation difficulties

Individual variations in BIS–FFFS and BAS sensitivity have been theorized to underlie a wide range of psychopathology, including anxiety, mood, substance, eating, and personality disorders (Fowles, 2001; Gray, 1991; Kimbrel, 2008; Kimbrel, Cobb, Mitchell, Hundt, & Nelson-Gray, 2008), and many of these predictions have been substantiated by empirical data (Bijttebier, Beck, Claes, & Vandereycken, 2009; Hundt, Kimbrel, Mitchell, & Nelson-Gray, 2008; Kimbrel et al., 2008; Kimbrel, Mitchell, & Nelson-Gray, 2010). Yet, the mechanisms through which BIS–FFFS and BAS operate to increase the risk for psychopathology remain unclear (Bijtterbier et al., 2009). One mechanism that may be particularly relevant is emotion regulation (ER). As defined here, ER refers to adaptive ways of responding to emotions (regardless of their intensity/reactivity), including accepting responses, the ability to control behaviors in the face of emotional distress, and the functional use of emotions as information (Gratz & Roemer, 2004). Thus, ER can be distinguished from a temperamental emotional vulnerability, as ER involves the way in which individuals respond to their emotions (rather than the quality of these emotions). ER difficulties have been implicated in the pathogenesis of many forms of psychopathology (Gratz & Tull, 2010) and are thought to underlie the association between personality and psychopathology (Linehan, 1993).

As for the association between BIS–FFFS, BAS, and ER difficulties, theoretical literature suggests that variations in reinforcement sensitivity may have implications for the development of ER (Depue & Iacono, 1989), affecting the ways in which individuals respond to or regulate their emotions. Although no studies have examined associations between BIS–FFFS, BAS, and ER difficulties as defined here, research has demonstrated that these subsystems are associated with specific behaviors thought to stem from ER difficulties. For example, Randles, Flett, Nash, McGregor, and Hewitt (2010) found that BIS–FFFS sensitivity was significantly positively associated with rumination. Hundt et al. (2008) found that BIS–FFFS sensitivity was negatively associated with drug use, whereas BAS was positively associated with drug and alcohol use (consistent with findings of Voight et al. (2009)). Kimbrel et al. (2008) also found that BIS–FFFS was positively associated with bulimic symptoms. Further, research suggests that the relationship between BIS–FFFS and personality disorders may depend on self-regulation (a broader construct including ER) capacity (Claes, Vertommen, Smits, & Bijttebier, 2009).

1.2. Study objectives and hypotheses

In an attempt to further establish the role of ER in RST, the present study examined associations between BIS–FFFS, BAS, and ER using a multi-method approach. Specifically, in order to obtain a more comprehensive understanding of the relationships between BIS–FFFS, BAS, and ER, we assessed ER across subjective (i.e., self-reported ER difficulties) and behavioral (i.e., the willingness to experience emotional distress and ability to engage in goal-directed behavior in the context of distress) indices.

Given that those high in BIS–FFFS sensitivity are likely to engage in avoidance and withdrawal behaviors (which can have paradoxical, emotion-dysregulating effects; Salters-Pedneault, Tull, & Roemer, 2004), we expected that BIS–FFFS sensitivity would be positively associated with self-reported ER difficulties and negatively associated with behavioral indices of ER. Additional support for this hypothesis comes from findings that the emotions of anxiety and fear (which correspond to BIS and FFFS sensitivity, respectively) have been associated with numerous ER difficulties (Gratz & Tull, 2010) and the tendency to rely on avoidance as an ER strategy (Salters-Pedneault et al., 2004). Further, BIS–FFFS sensitivity is associated with the Neuroticism facet of Vulnerability, suggesting that people high in BIS–FFFS may be more likely to exhibit poor coping skills when experiencing stress (Mitchell et al., 2007).

BAS-related hypotheses were less straightforward. BAS sensitivity has been found to be associated with personality constructs that map onto particular ER difficulties examined here (e.g., difficulties engaging in goal-directed behavior and controlling impulsive behaviors when distressed). Specifically, BAS was found to be negatively associated with the Conscientious facet of Deliberation (suggesting that high BAS individuals may act without considering future consequences) and positively associated with the Neuroticism facets of Impulsivity and Anger Hostility (Mitchell et al., 2007). Thus, one might expect that BAS would be positively associated with these ER difficulties. However, recent evidence that BAS dimensions may be differentially associated with functional and dysfunctional forms of impulsivity (Leone & Russo, 2009) suggest that the BAS dimensions may have differential associations with ER as well. Specifically, given that the Fun-Seeking dimension of BAS is most strongly associated with dysfunctional impulsivity (Leone & Russo, 2009) and may be characterized by a consummatory urge to persist in appetitive behavior with minimal regard for the outcome (Corr, 2008), we hypothesized that this BAS dimension would be positively associated with ER difficulties, particularly difficulties engaging in goal-directed behaviors and controlling impulsive behaviors when distressed (the ER difficulties most closely associated with dimensions of impulsivity; i.e., lack of perseverance and negative urgency, respectively; Whiteside & Lynam, 2001). In contrast, we expected BAS–Drive to evidence negative associations with ER difficulties, as this BAS dimension is characterized by the persistent pursuit of goals and is most strongly associated with functional impulsivity (Leone & Russo, 2009). We also expected that the Reward-Responsiveness component of BAS would have negative associations with ER difficulties, as this component is primarily characterized by positive emotions and energy in response to rewards rather than impulsivity *per se*.

Finally, given evidence of gender differences in BIS–FFFS and BAS (Heym et al., 2008) and ER (Gratz & Roemer, 2004), as well as findings that gender moderates the association between ER and maladaptive outcomes (Gratz et al., in press), we examined if associations between BIS–FFFS, BAS, and ER differ as a function of gender.

2. Methods

2.1. Participants

Participants were 101 adults (63.4% female) from the community ranging from 18 to 60 years of age (*mean* = 24.38 ± 10.01). With regard to their racial/ethnic background, 50.5% of participants identified as White, 24.8% as Black/African–American, 10.0% as Asian/Asian–American, and 14.9% as another racial/ethnic background.

2.2. Measures

The *BIS/BAS Scales* (Carver & White, 1994) is a widely-used 20-item self-report measure of the sensitivity of the RST subsystems. The BIS/BAS Scales have been found to demonstrate good reliability and convergent and discriminant validity (Carver & White, 1994). Scores are obtained for four subscales: one BIS–FFFS sensitivity and three BAS sensitivity (i.e., Reward-Responsiveness, Drive, and

Fun-Seeking) subscales. Internal consistency for all scales was adequate (αs ranging from .69 to .76).

The *Difficulties in Emotion Regulation Scale* (DERS; Gratz & Roemer, 2004) is a 36-item measure that assesses individuals' typical levels of emotion dysregulation across six domains: nonacceptance of negative emotions, difficulties engaging in goal-directed behaviors when distressed, difficulties controlling impulsive behaviors when distressed, limited access to effective ER strategies, lack of emotional awareness, and lack of emotional clarity. The DERS has been found to have high internal consistency, good test–retest reliability, and adequate construct and predictive validity (Gratz & Roemer, 2004; Gratz & Tull, 2010). Internal consistency in the current sample was adequate (αs = .87 for the total score and .60–.91 for the subscales).

This study also utilized a behavioral measure of two ER dimensions: the willingness to experience emotional distress in order to pursue goal-directed behavior and the ability to engage in goal-directed behavior when distressed (Gratz, Rosenthal, Tull, Lejuez, & Gunderson, 2006). Specifically, following exposure to several minutes of an empirically-supported laboratory stressor shown to induce emotional distress (PASAT-C; Lejuez, Kahler, & Brown, 2003), participants were given the opportunity to terminate this task at any time (a measure of the willingness to experience distress). However, participants were under the impression that: (a) their performance on this task would determine the amount of time they would receive to work on a subsequent task (completion of anagrams), and (b) their performance on the subsequent task would determine the amount of their reimbursement. Thus, latency in seconds to task termination was used as a measure of the willingness to experience distress in order to pursue goal-directed behavior (Willingness). Of note, this behavioral measure of ER is optimal for the goals of the present study, as it presents participants with opportunities for both reward (greater reimbursement) and punishment (emotional distress). As such, this task was expected to activate the BIS considering its proposed role as a conflict resolution system (Gray & McNaughton, 2000).

After this task, all participants received standardized negative feedback that their performance was below average and, therefore, they would receive only 8 min (out of 20) to solve the anagrams. This ensured that all participants were experiencing some distress before the anagrams. Participants were then given 48 solvable anagrams. The number solved correctly in 8 min was used as an index of the ability to engage in goal-directed behavior when distressed (Goal-directed Behavior).

To control for differences in the level of distress induced by the PASAT-C and negative feedback, participants completed the 10-item Negative Affect (NA) subscale of the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) following exposure to several minutes of the laboratory stressor (immediately prior to receiving the option to terminate the task), and following the negative feedback (immediately prior to the anagrams task). These variables were used as covariates in analyses using Willingness and Goal-directed Behavior as outcomes, respectively. Internal consistency for both NA scales was excellent (αs = .83 and .87).

2.3. Procedure

This study received approval by the university's Institutional Review Board. Participants were recruited from the Washington DC area using advertisements posted throughout the community and on-line. Individuals interested in participating were instructed to contact research personnel to schedule a study session.

Upon arrival to the laboratory, participants were given information about the study and asked to provide written informed consent. Next, they completed a questionnaire packet containing the measures described above. Following completion of the questionnaires, participants were seated in front of a computer screen and instructed to sit quietly for 5 min (to ensure that they acclimated to the room and reached a baseline level of arousal prior to the presentation of the laboratory task). Participants then received standardized instructions for completing the laboratory task. Once participants understood the instructions, the experimenter left the room for the remainder of the study, but was able to observe the participants from an adjacent room. An intercom allowed the experimenter and participants to communicate as needed. After the laboratory task and anagrams, participants were fully debriefed and reimbursed $25.

2.4. Analysis plan

Bivariate correlations were conducted to examine associations between BIS–FFFS, BAS dimensions, and ER. Next, hierarchical multiple regression analyses were conducted to examine unique relations between BIS–FFFS, BAS dimensions, and ER, controlling for gender (and, for our behavioral measures of Willingness and Goal-directed Behavior, NA experienced in response to the PASAT-C and negative feedback, respectively). The moderating role of gender was examined by including gender by BIS–FFFS and BAS dimension interactions in the final step of the models.

3. Results

3.1. Zero-order associations between BIS–FFFS, BAS dimensions, and ER

Consistent with expectations, BIS–FFFS was significantly positively correlated with all self-reported ER difficulties (except lack of emotional awareness). However, despite presenting participants with conflicting reward and punishment contingencies, BIS–FFFS was not significantly correlated with the behavioral measure of Willingness. Similarly, Goal-directed Behavior was not significantly correlated with BIS–FFFS or most BAS dimensions. The only exception was BAS–Fun-Seeking, which was positively associated with Goal-directed Behavior. BAS–Fun-Seeking also demonstrated a significant positive correlation with lack of emotional clarity. No other BAS–ER correlations were significant, contrary to hypotheses (Table 1). Further, despite evidence of gender differences in BIS (with women showing higher BIS sensitivity; see Table 1), results did not change when controlling for gender.[1]

3.2. BIS–FFFS and BAS dimensions predicting self-reported ER difficulties

As hypothesized (see Table 2), BIS–FFFS was uniquely positively associated with overall self-reported ER difficulties, as was BAS–Fun-Seeking. Further, BAS–Reward-Responsiveness was uniquely negatively associated with overall ER difficulties. Gender did not moderate the associations between BIS–FFFS or BAS dimensions and overall self-reported ER difficulties. Although our focus was on overall self-reported ER difficulties, we explored associations between BIS–FFFS and BAS dimensions and specific self-reported ER difficulties. These analyses produced similar findings. Specifically, with the exception of lack of emotional awareness, BIS–FFFS remained a significant predictor of all ER difficulties (βs > .28, ps < .01). BAS–Fun-Seeking failed to emerge as a significant unique predictor of most specific dimensions of self-reported ER difficulties, with the exception of a positive unique association with lack

[1] We also assessed heart rate variability (HRV), a marker of ER capacity (Thayer & Lane, 2000), during the PASAT-C's most difficult level. BIS–FFFS and BAS were not associated (alone or through gender interactions) with HRV (all ps > .10). Thus, analyses are not presented.

Table 1
Intercorrelations among ER measures, BIS–FFFS, BAS dimensions, and covariates.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	DERS-total															
2	DERS-nonacceptance	**.68**														
3	DERS-Goal-directed behavior difficulties	**.72**	**.32**													
4	DERS-Impulse control difficulties	**.73**	**.24**	**.54**												
5	DERS-Lack of access to strategies	**.84**	**.52**	**.66**	**.62**											
6	DERS-Lack of awareness	**.30**	.10	−.09	.07	−.03										
7	DERS-Lack of clarity	**.69**	**.39**	**.33**	**.43**	**.38**	**.41**									
8	Pasat-C Willingness	−.09	−**.20**	−.08	−.03	−.09	−.00	.08								
9	Goal-directed behavior (anagrams)	.09	.15	.03	.03	.00	.14	.01	.07							
10	BIS–FFFS	**.53**	**.44**	**.48**	**.29**	**.51**	−.02	**.34**	−.03	.04						
11	BAS–Drive	−.10	−.13	.01	.12	−.16	−.16	−.05	−.07	.09	−.01					
12	BAS-reward	−.10	−.03	−.03	.00	−.18	−.07	−.06	−.09	.07	.12	**.59**				
13	BAS–Fun-Seeking	.07	.03	.08	.12	−.06	−.04	**.24**	−.05	**.27**	−.07	**.39**	**.41**			
14	Gender	.14	.07	.16	**.23**	.04	−.03	.10	−.02	.01	**.26**	.08	.14	−.07		
15	PASAT- C NA	**.33**	.18	**.32**	**.32**	**.33**	−.10	**.23**	−.04	−.08	**.32**	−.07	−.10	−.08	.17	
16	Pre-Anagrams NA	**.38**	**.21**	**.33**	**.30**	**.41**	−.07	**.26**	−.07	−.05	**.32**	−.07	−.05	.05	.12	**.83**

Note: Significant correlations (p <.05) in boldface.

Table 2
Unique Associations between BIS–FFFS, BAS Dimensions, and ER.

	Self-reported ER		Behavioral measures of ER			
	Overall ER difficulties		Willingness		Goal-directed behavior	
	β	t	β	t	β	t
Step 1[a]						
Gender	.14	1.38	−.01	−.12	.01	.11
NA[b]			−.03	−.33	−.05	−.49
Step 2						
BIS–FFFS	.57	6.56**	−.01	−.06	.10	.89
BAS–Drive	−.04	−.42	−.03	−.21	.01	.07
BAS–Fun-Seeking	.23	2.48*	−.02	−.16	.31	2.78**
BAS-reward	−.25	−2.29*	−.07	−.49	−.09	−.68
Step 3						
BIS–FFFS × gender	.06	.50	−.30	−2.05*	−.12	−.78
Drive × gender	.01	.03	.47	2.38*	.08	.42
Fun-Seeking × gender	.19	1.44	−.14	−.87	−.14	−.91
Reward × gender	−.08	−.45	−.08	−.35	.06	.26

[a] Only variables unique to each step are presented.
[b] For Willingness, NA refers to NA during the PASAT-C. For Goal-directed Behavior, NA refers to pre-anagrams NA.
* p < .05.
** p < .01.

of emotional clarity (β = .38, p < .001). Likewise, BAS–Reward-Responsiveness was uniquely associated with only lack of emotional clarity (β = −.24, p < .05) and lack of access to effective ER strategies (β = −.25, p < .05), demonstrating significant negative associations with each.

3.3. BIS–FFFS and BAS dimensions predicting behavioral measures of ER

Whereas BIS–FFFS and BAS dimensions were not uniquely associated with Willingness, BAS–Fun-Seeking was uniquely positively associated with Goal-directed Behavior (counter to expectations; Table 2). As for the moderating role of gender in these associations, inclusion of the interaction terms in the final step of the model accounted for a significant amount of additional variance in Willingness (ΔR^2 = .11, F[4,90] = 2.93, p < .05). However, only the interactions of gender with BIS–FFFS and BAS–Drive emerged as significant. To examine the nature of these interactions, the slopes of the final equations were computed at data points corresponding to high and low levels of the predictor variables (±1.0 *SD*; Aiken & West, 1991). Whereas neither BIS–FFFS nor BAS–Drive was associated with Willingness among men, both were associated with Willingness among women. Specifically, BIS–FFFS was negatively associated with Willingness and BAS–Drive was positively associated with Willingness. Gender did not emerge as a moderator in the analysis for Goal-directed Behavior.

4. Discussion

This study is the first to examine relations between BIS–FFFS, BAS dimensions, and various ER dimensions assessed through self-report and behavioral methods. Consistent with hypotheses, BIS–FFFS was positively associated with multiple dimensions of self-reported ER difficulties and uniquely associated with overall self-reported ER difficulties (controlling for gender and BAS dimensions). These findings suggest that avoidance motivations arising from the emotional states of fear and anxiety may underlie maladaptive responses to emotions, consistent with extant research on ER difficulties and anxiety disorders (Gratz & Tull, 2010).

As for BAS dimensions, consistent with expectations and the conceptualization of BAS–Reward-Responsiveness, this BAS dimension was uniquely negatively associated with self-reported ER difficulties. Further, BAS–Fun-Seeking was uniquely positively associated with overall self-reported ER difficulties and lack of

emotional clarity. These findings are in-line with past evidence that BAS–Fun-Seeking is associated with maladaptive ER strategies (e.g., substance use; Voight et al., 2009) and exhibits the strongest association (relative to other BAS dimensions) with dysfunctional impulsivity (Leone & Russo, 2009). Findings of an association between BAS–Fun-Seeking and lack of emotional clarity in particular suggest that high levels of arousal stemming from the pursuit of intense, rewarding activities may interfere with the detection of discrete emotional states.

Fewer findings emerged for our behavioral indices of ER. Unexpectedly, BIS–FFFS did not emerge as a unique predictor of Willingness, despite the conflicting nature of the task. However, among women, BIS–FFFS was negatively (and BAS–Drive positively) uniquely associated with Willingness. The fact that these associations emerged only for women suggests that this behavioral measure of ER may not function in the same manner for men as it does for women. For example, although persistence on this task is interpreted as the willingness to experience distress in order to pursue goal-directed behavior, there may be gender differences in the relevance and salience of this goal. Further, it is important to consider that women exhibited higher levels of BIS–FFFS sensitivity than men. Consequently, women may have been more likely to evaluate or perceive the laboratory task as conflicting with regard to reward and punishment, resulting in greater BIS engagement. In addition, the significant unique relationship between BAS–Drive and Willingness may provide some insight into one way in which the BIS resolved this conflict (i.e., by engaging BAS–Drive). Indeed, this finding is consistent with the conceptualization of BAS–Drive as involving the persistent pursuit of goals and previous research showing that this BAS dimension in particular is a strong predictor of functional outcomes (Leone & Russo, 2009).

Finally, BAS–Fun-Seeking was unexpectedly found to be positively associated with our behavioral ER measure of Goal-directed Behavior. Although contrary to past findings of an association between BAS–Fun-Seeking and dysfunctional impulsivity, Leone and Russo (2009) argue that BAS–Fun-Seeking may be associated with functional impulsivity when the reward is proximal (as it was in our anagrams task). In such cases, the consummatory component of BAS–Fun-Seeking (Corr, 2008) motivates behavior aimed at obtaining that reward (in this case, successful completion of anagrams). It warrants mention that we did not find a similar association between BAS–Fun-Seeking and our self-report measure of difficulties engaging in goal-directed behaviors when distressed, as well as other self-reported ER dimensions where we expected a relationship (e.g., difficulties controlling impulsive behaviors when distressed). The fact that the items that compose our self-report assessment of ER do not specify the proximity of a reward may explain why we failed to find such associations.

Although interesting, the results of this study must be evaluated in light of its limitations. Given that this study used correlational data and a cross-sectional design, the temporal order of the relationships examined may differ from our predictions, highlighting the need for prospective studies of the interrelations of BIS–FFFS, BAS, and ER. Additionally, although findings revealed gender differences in the associations examined, this study involved a small sample of men, limiting both the generalizability of the results and our power to detect differences. Findings must be replicated with larger mixed-gender samples. Finally, as stated previously, current research on the rRST is limited by the lack of self-report measures that adequately distinguish between BIS and FFFS sensitivity. Consequently, it is difficult to determine the unique roles of BIS and FFFS in our findings. Future studies would greatly benefit from the development of psychometrically-sound measures that accurately map onto the subsystems described in rRST.

Limitations notwithstanding, findings highlight the relevance of BIS–FFFS and BAS dimensions to ER, providing preliminary evidence that these subsystems are differentially associated with ER difficulties. This study represents an important first step in understanding pathways between BIS–FFFS, BAS, and ER difficulties. Additional research in this area may facilitate the identification of ER difficulties as a mechanism underlying BIS–FFFS, BAS, and psychopathology. In particular, research should examine the associations between BIS–FFFS, BAS, and specific forms of psychopathology previously shown to be strongly associated with ER difficulties, such as borderline personality pathology and posttraumatic stress disorder (Gratz & Tull, 2010).

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