

## The interaction of reinforcement sensitivity and life events in the prediction of anhedonic depression and mixed anxiety-depression symptoms

By: Natalie E. Hundt, Rosemary O. Nelson-Gray, Nathan A. Kimbrel, John T. Mitchell and Thomas R. Kwapil

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### **Abstract:**

This study examined the relationship between reinforcement sensitivity theory (RST), life stress, and internalizing symptoms. Generally, low sensitivity of the behavioral approach system (BAS) predicts depression whereas high sensitivity of the behavioral inhibition system (BIS) predicts anxiety and depression. However, few studies have examined how RST variables interact with life stress to predict these symptoms. It was hypothesized that higher BIS sensitivity would predict greater anxious arousal; lower BAS sensitivity and higher BIS sensitivity would predict greater anhedonic depression as predicted by the joint subsystems hypothesis (JSH); and low BAS, high BIS, and high life stress would interact to predict anhedonic depression symptoms whereas high BIS with high life stress would predict anxious symptoms. A sample of 285 undergraduates completed measures of RST, life stress, and internalizing symptoms. Greater BIS sensitivity predicted mixed anxiety–depression and anhedonic depressed symptoms, lower BAS predicted anhedonic depression symptoms, and life events predicted mixed anxiety–depression. Three-way interactions indicated that for high life stress, BIS predicted both types of symptoms. For low life stress, low BAS and high BIS predicted anhedonic depression whereas high BIS and high BAS predicted mixed anxiety–depression. The implications of these findings are discussed in terms of the JSH.

**Keywords:** reinforcement sensitivity theory | depression | anxiety | mixed anxiety–depression | life stress | joint subsystems hypothesis

### **Article:**

#### 1. Introduction

Reinforcement sensitivity theory (RST; Gray & McNaughton, 2000) is a biologically-based personality model consisting of three major brain systems that underlie normal mood, orienting, and appetitive functioning. These brain systems are referred to as the behavioral inhibition system (BIS), the behavioral approach system (BAS), and the fight-flight-freeze system (FFFS). The BAS is sensitive to cues of reward and relief from punishment and activates reward-seeking

behavior, feelings of elation, and desire for reward despite risk or threat to the individual (Pickering & Gray, 1999). Conversely, the BIS causes anxiety, inhibition, orienting, arousal, and passive avoidance in the face of cues to punishment and novel stimuli. Finally, the FFFS motivates avoidance and escape behaviors in response to both conditioned and unconditioned aversive stimuli, and produces the emotion of fear. Corr (2004) has suggested that BIS as previously studied actually reflects combined BIS/FFFS functioning. Therefore, the current paper refers to BIS/FFFS functioning as BIS functioning.

Extreme under- or over- sensitivity of these systems predicts psychopathology (Pickering & Gray, 1999). It is well established that high BIS is related to anxiety in adults ([Johnson et al., 2003] and [Kimbrel et al., 2007]). Many studies have also found that high BIS is related to depression (e.g. Kasch, Rottenberg, Arnow, & Gotlib, 2002).

In contrast, the literature on BAS in the prediction of internalizing psychopathology has been less consistent. Low BAS has been found to predict depression ([Depue et al., 1987] and [Meyer et al., 1999]) and has been significantly associated with persistence of depression over an 8-month interval (Campbell-Sills, Liverant, & Brown, 2004). Higher BAS in depressed patients predicts recovery from the disorder, whereas there was no relation between BIS and recovery. However, Johnson et al. (2003) found no relationship between BAS and diagnoses of depression in a longitudinal study that classified participants as meeting criteria for major depression, anxiety disorder, or both based upon DSM-IV diagnostic criteria. However, this study did not distinguish anhedonic depression from mixed anxiety–depression, which Gray (1991) hypothesized differ in terms of BAS activity. Kimbrel et al. (2007) found that low BAS predicted anhedonic depression symptoms but not mixed anxiety–depression symptoms suggesting the need to distinguish between these types of symptoms. Therefore, more research is needed to clarify the association of BAS to various types of internalizing symptoms.

Corr's joint subsystems hypothesis (JSH; 2002) provides a theoretical perspective on BAS functioning in depression. The JSH states that neither BIS nor BAS should be examined separately because they are functionally interdependent and that each has antagonistic effects upon the action of the other system. Thus, low approach would exacerbate the effect of high avoidance in producing depression symptoms. The JSH does not necessarily require an interaction, but rather two main effects would be sufficient to support this hypothesis (Corr, 2002). Few studies have examined the JSH in relation to internalizing symptoms, and therefore more investigation is necessary.

Finally, RST states that an individual is predisposed to certain levels of BIS and BAS sensitivity by genetic and biological factors but that environmental contingencies and learning modify these predispositions throughout development. For example, Fowles (1994) has hypothesized that individuals with high BIS may be overly sensitive to aversive stimuli. Thus, it may be the case that high BIS individuals are more likely to develop anxiety or depression after experiencing stressful life events. Negative life events predict depression, anxiety, and overall psychopathology in both cross-sectional and longitudinal studies ([Paykel, 2003] and [Tennant, 2002]); but few studies have examined the interaction of personality and life stress in predicting internalizing symptoms. The few to do so suggest that personality and life stress may interact to produce greater depressive symptoms. For example, Kendler, Kuhn, and Prescott (2004) found both main effects of neuroticism and stressful life events and also an interaction of these two variables in the prediction of later depression onset. However, others (e.g. Rijdsdijk et al., 2001) found no evidence for an interaction between neuroticism and life events in predicting

depression, suggesting that more studies are needed to clarify the association between personality, life events, and psychopathology.

The current study is, to the authors' knowledge, one of the first to look at the interaction of life stress, RST personality variables, and symptoms of depression and anxiety. As depression and anxiety are assumed to represent a continuum from normal to psychopathology, this study examined symptoms in a college student population. It was hypothesized that (a) higher BIS sensitivity would predict greater anxious arousal; (b) consistent with the JSH, lower BAS sensitivity and higher BIS sensitivity would predict greater anhedonic depression; (c) low BAS and high BIS would predict anhedonic depression symptoms when life stress was high whereas high BIS would predict anxious symptoms when life stress was high.

## 2. Method

### 2.1. Participants

Three hundred and seventeen introductory psychology students at the University of North Carolina at Greensboro participated. The sample (mean age = 20.3; SD = 4.4) was predominantly Caucasian (68%) and female (66%), which was consistent with the university demographics. Data from 32 participants were excluded for missing responses or high scores on the Infrequency Scale (Chapman & Chapman, 1986), resulting in a final sample of 285 participants.

### 2.2. Measures

#### 2.2.1. Mood and anxiety symptom questionnaire – short form

The MASQ short form (Watson & Clark, 1991) is a 62-item Likert-scale self-report measure based upon Watson and Clark's tripartite model of anxiety and depression that postulates these disorders share a general distress feature, but each has distinct components. The Anxious Arousal scale measures anxiety components such as somatic tension and physiological hyperarousal. The Anhedonic Depression scale measures loss of interest or pleasure in activities, low energy, and withdrawal. Two General Distress scales, a General Distress Depression scale and a General Distress Anxiety scale, measure negative emotions common to both anxiety and depression. As these scales were highly correlated, they were collapsed to form an overall General Distress scale with an internal consistency of .94. The MASQ has good internal consistency and validity ([Keogh and Reidy, 2000] and [Reidy and Keogh, 1997]). However, some concerns with the factor structure and item loadings have been raised (Keogh & Reidy, 2000).

#### 2.2.2. Behavioral inhibition system/behavioral activation system scales

The BIS/BAS Scales (Carver & White, 1994) include 20 items that measure emotional responding in situations that may evoke anxiety or impulsivity. Although there is a single BIS scale, three related scales assess BAS: Drive, Reward Responsiveness, and Fun Seeking. Confirmatory factor analyses show that these scales load on a general BAS factor but the Reward Responsiveness scale also correlates positively with BIS ( $r = 0.2$  to  $r = 0.3$ , [Campbell-Sills et al., 2004] and [Leone et al., 2001]). The BIS/BAS Scales have moderate internal consistency and good convergent and discriminant validity (Campbell-Sills et al., 2004).

### 2.2.3. Sensitivity to punishment/sensitivity to reward questionnaire

The SPSRQ (Torrubia, Avila, Moltó, & Caseras, 2001) contains two 24-item scales to measure Sensitivity to Reward (SR) and Sensitivity to Punishment (SP). The scales showed good internal consistency (Torrubia et al., 2001), construct validity ([Avila and Parcet, 2000] and [Avila and Parcet, 2001]) and correlate with other measures of anxiety and impulsivity (Torrubia et al., 2001).

### 2.2.4. Recent life change questionnaire

The RLCQ (Miller & Rahe, 1997) is a 74-item self-report inventory that assesses stressful, neutral, and positive life changes overall and in five domains: work, health, home/family, financial, and personal/social. Respondents indicate if the event occurred in the past 2 years and if so, when. The RLCQ does not allow an examination of whether the events are dependent or independent of a participant's behavior. Events were weighted by severity based upon the 1995 rescaling, and overall Life Change scores were standardized. The RLCQ has good reliability and predictive validity (Miller & Rahe, 1997). As most recent life events were expected to have the most impact upon symptoms, only events in the past 6 months were included in analyses.

### 2.2.5. Infrequency scale for personality measures

The Infrequency Scale (Chapman & Chapman, 1986) is a 13-item scale that contains items that are unlikely to be true and indicates a random response style. Participants who endorsed three or more items on the Infrequency Scale were excluded from the analysis. The measure has been widely used (e.g. Lewandowski et al., 2006).

### 2.2.6. Procedure

Participants signed a consent form and completed study measures in random order online in a university computer lab monitored by a research assistant. After completion, participants were debriefed and received course credit.

## 3. Results

Internal consistency and bivariate correlations among study variables are presented in Table 1. All scales had acceptable to good internal consistency (see Table 1). Anxious Arousal, General Distress, and the total negative life events score had a skewed distribution and were log transformed. To combine the two RST measures and produce composite variables for BIS and BAS, a principal components analysis (PCA) was conducted with Promax oblique rotations to allow factors to correlate. A PCA with the six BIS and BAS scales produced two factors with eigenvalues over one, together explaining 63% of the variance. The factors clearly appeared to represent a BIS factor with loadings ranging from .83 to .85 and a BAS factor with loadings ranging from .72 to .78, upon which each of the BIS and BAS scales loaded appropriately. Cross loadings were minimal and the two factors correlated .02. BIS and BAS factor scores were used in subsequent analyses.<sup>1</sup>

Table 1. Cronbach's alpha and Pearson correlations of MASQ subscales with BIS/BAS and SPSRQ subscales

	Anxious arousal	Anhedonic depression	General distress	BIS	BAS RR	BAS drive	BAS fun	SP	SR
Mean	27.43	58.31	47.39	12.84	12.25	7.15	8.66	11.67	12.46
SD	9.70	14.23	16.20	2.28	2.12	2.29	2.09	5.50	4.54
Anxious arousal	.89	.33**	.75**	.15*	-.10	.02	-.05	.26**	.09
Anhedonic depression		.91	.54**	.21**	-.31**	-.15*	-.17**	.43**	-.10
General Distress			.94	.31**	-.09	-.03	.01	.39**	.08
BIS				.76	.19**	.07	.13*	.43**	.09
BAS RR					.73	.39**	.50**	-.05	.33**
BAS drive						.78	.42**	-.17**	.49**
BAS fun							.74	-.12	.40**
SP								.85	.02
SR									.79

Note: \* $p < .05$ ; \*\* $p < .01$ . Cronbach's alpha presented on the diagonal. SP = Sensitivity to punishment; SR = Sensitivity to reward.

A previous factor analysis of the MASQ (Keogh & Reidy, 2000) indicated problematic cross-loadings of items, particularly those on the Anhedonic Depression scale. Thus, a PCA was run with the 62 items rather than the scales from this measure. Although 11 factors with eigenvalues over one resulted, a scree plot suggested that two factors accounting for 43% of the variance fit the data best. The first factor, accounting for 30% of the variance, was composed mostly of items from the Anxious Arousal and General Distress scales. Items included statements such as “Was unable to relax,” “Heart was racing or pounding,” and “Was disappointed in myself.” Eight items from the Anhedonic Depression scale loaded more highly on this factor than on the second factor. These included items such as “Felt withdrawn,” “Felt unattractive” and “Felt really bored.” Thus, it appears that this component is somewhat heterogeneous, tapping both anxious symptoms and negative affect, or mixed anxiety–depression. The second component, accounting for 13% of the variance, appeared to specifically tap anhedonic depression and was comprised entirely of items from the Anhedonic Depression scale and the General Distress: Depression scale. Items from this factor included classic signs of depression such as “Felt sad,” “Looked forward to things with enjoyment” (reverse scored),” and “Seemed to move quickly and easily” (reverse scored). The correlation between the two factors was .32, and the factor loadings are similar to those found by Keogh and Reidy (2000) with the exception that they forced a three-factor solution, separating the current mixed anxiety–depression factor into two.<sup>2</sup> Factor scores for mixed anxiety–depression and anhedonic depression were used as criterion variables in regressions.

A hierarchical regression was run to predict the mixed anxiety–depression symptom factor with the predictors entered in the order displayed in Table 2 and Table 3. In addition, a regression was conducted with anhedonic depression symptoms partialled out. This produced nearly identical results and therefore was not included. The overall model was significant at  $F(277) = 44.88, p < .01$ . The BIS factor and stressful life events were significant predictors.

When all five categories of life events were entered into the regression simultaneously instead of the total score, only events related to home and family significantly predicted outcome. Next, although BAS by itself was not a predictor, the two-way interaction of BIS and BAS was significant over and above the main effects. In addition, the three way interaction of BIS, BAS, and life events was significant and accounted for 1% of the variance. The three-way interaction was explored according to Aiken and West's (1991) methodology with the SPSS syntax files provided in O'Connor (1998). This graphs the personality predictor variables at 2.5 standard deviations above and below the mean separately for low and high life events. Symptoms, in standard deviations from the mean, are presented on the *x*-axis. In addition, the simple slopes of the interaction lines were calculated and presented on the relevant figures, along with the resulting *t* test *p*-values indicating whether the slopes are significantly different from zero. These results indicated that for low life events (Fig. 1), the effect of high BIS was greater when combined with high BAS. For high life events (Fig. 2), it also appears that the effect of high BIS was greater when combined with high BAS although the effect of BAS appears small. Taken together, and consistent with the main effect of high BIS, BIS does appear to predict more mixed anxiety–depression symptoms. However, these results suggest that when combined with low BAS and low stressful life events, BIS does not predict these symptoms. In addition, although there was no main effect of high BAS on anxious symptoms, when combined with high BIS it does have a small effect. Finally, stressful life events predicted more mixed anxiety–depression symptoms only when combined with high BIS, suggesting that BIS might be related to difficulties coping with stress.

Table 2. Hierarchical regression predicting mixed anxiety–depression symptoms

	Predictors	Beta	<i>R</i> <sup>2</sup> change	<i>p</i> -value
Step 1	Age	−.08	.01	.19
	Gender	.01		.88
	Ethnicity	−.00		.98
Step 2	BIS factor	.36	.18	.00
	BAS factor	−.05		.35
	Life events	.20		.00
Step 3	BIS × BAS	.12	.01	.05
	Events × BAS	−.03		.63
	Events × BIS	.00		.99
Step 4	BIS × BAS × Events	−.13	.01	.03

Note: BIS = Behavioral inhibition system factor; BAS = Behavioral approach system factor.

Table 3. Hierarchical regression predicting anhedonic depression symptoms

	Predictors	Beta	<i>R</i> <sup>2</sup> change	<i>p</i> -value
Step 1	Age	.04	.00	.51
	Gender	−.03		.59

	Predictors	Beta	R <sup>2</sup> change	p-value
	Ethnicity	.04		.59
Step 2	BIS factor	.34	.19	.00
	BAS factor	-.26		.00
	Life events	.10		.08
Step 3	BIS × BAS	.02	.00	.51
	Events × BAS	.03		.64
	Events × BIS	.02		.78
Step 4	BIS × BAS × Events	.13	.01	.03

Note: BIS = Behavioral inhibition system factor; BAS = Behavioral approach system factor.

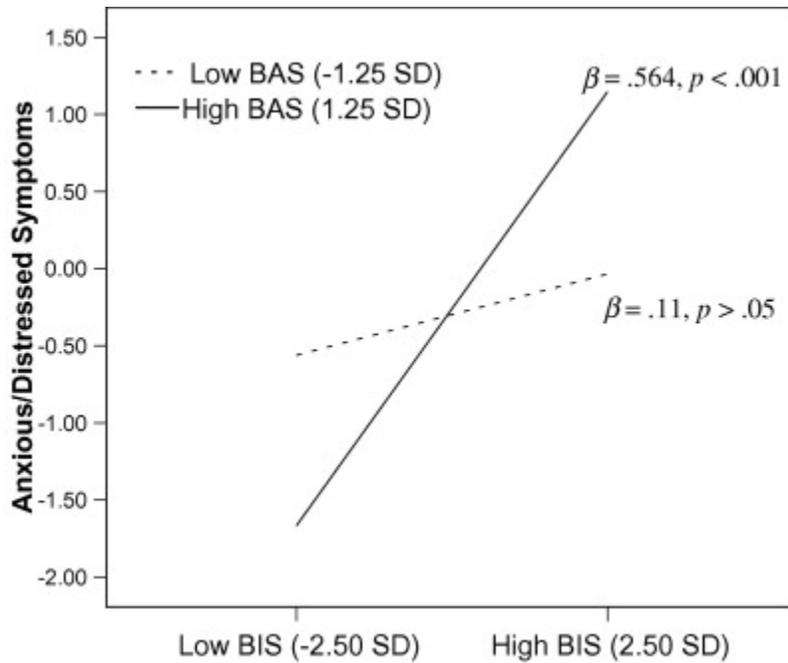


Fig. 1. Three-way interaction: Mixed anxiety–depression symptoms at low levels (1 SD below mean) of stressful life events. Note: SD = standard deviation.

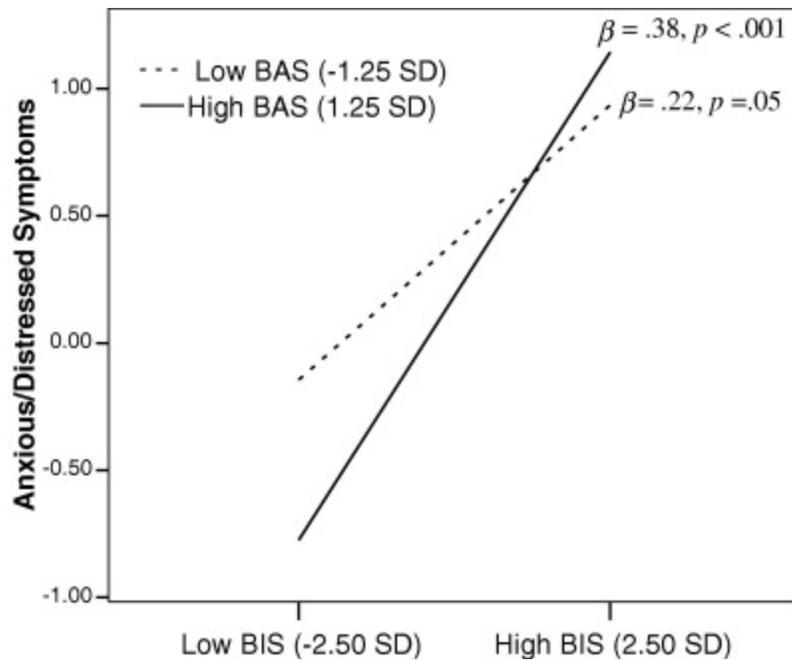


Fig. 2. Three-way interaction: Mixed anxiety–depression symptoms at high levels (1 SD above from mean) of stressful life events. Note: SD = standard deviation.

Next, a hierarchical regression predicting the anhedonic depression factor was conducted (Table 3), and a regression conducted with mixed anxiety–depression symptoms partialled out produced nearly identical results. Results showed main effects for BIS and BAS such that high BIS and low BAS predicted more symptoms. The main effect of life events only approached significance. Although no two-way interactions were significant, the three way interaction of  $BIS \times BAS \times Life\ Events$  was significant. Further analyses of this interaction indicated that under low life stress (Fig. 3), the effect of high BIS was increased when combined with low BAS. This is consistent with the main effects discussed earlier. For high levels of life events (Fig. 4), the effect of high BIS was increased when combined with low BAS. Low BIS and high BAS appeared to predict low levels of anhedonic depression symptoms, whereas all other personality styles predicted higher levels. This suggests that high stress is associated with anhedonic depression symptoms when combined with high BIS.

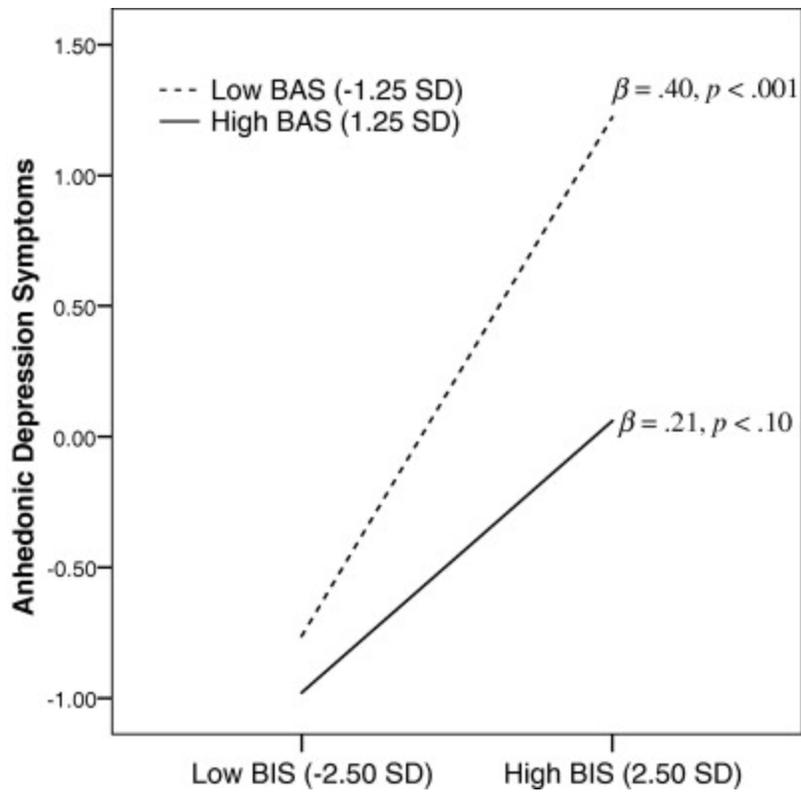


Fig. 3. Three-way interaction: Anhedonic depression symptoms at low levels (1 SD below mean) of stressful life events. Note: SD = standard deviation.

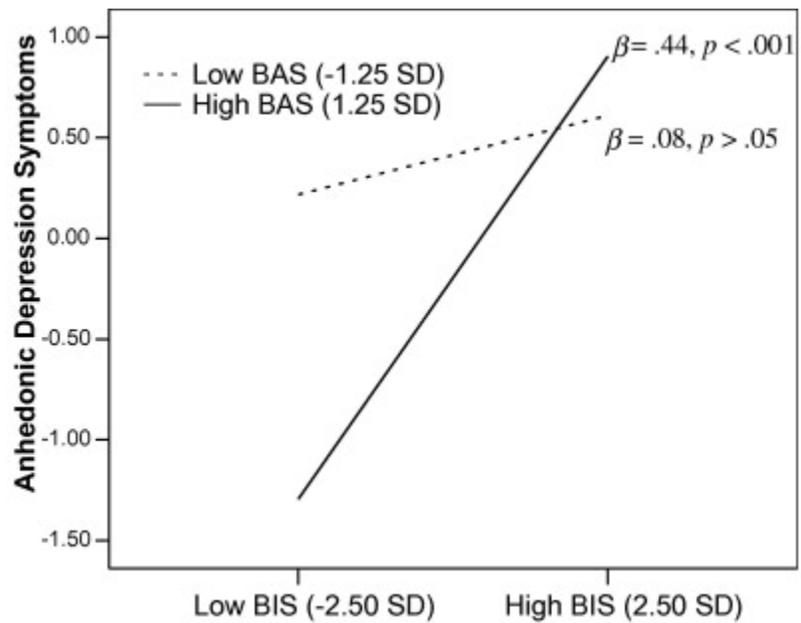


Fig. 4. Three-way interaction: Anhedonic depression symptoms at high levels (1 SD above mean) of stressful life events. Note: SD = standard deviation.

## 4. Discussion

The current study assessed the relationship between RST personality traits, stressful life events, and internalizing symptoms. Results indicate that BIS, BAS, and stressful life events interact to produce internalizing symptoms, although the pattern of predictors differs across anxious and depressive symptoms. Overall, these findings suggest that life events are important variables to consider in conjunction with specific personality styles; however, life events may not predict internalizing symptoms when combined with low BIS. The current study also provides some support for the JSH. Specifically, it appears that low BAS exacerbates the effects of high BIS on anhedonic depressive symptoms.

With respect to RST and internalizing psychopathology, the current study replicated previous findings indicating that high BIS is associated with both anxiety and depression, which is consistent with a number of previous studies (e.g. [Johnson et al., 2003] and [Kimbrel et al., 2007]). For anhedonic depression symptoms, low BAS was also a significant predictor. This is consistent with the previous literature ([Depue et al., 1987], [Kimbrel et al., 2007] and [Meyer et al., 1999]) and suggests that low reward-seeking behavior may predict depression, perhaps because these individuals experience fewer rewarding events in everyday life. In addition, higher BIS predicted greater anhedonic depression, which is also consistent with previous studies ([Kasch et al., 2002] and [Meyer et al., 1999]) and suggests that an anxious and overvigilant personality style may also lead to depression, perhaps by route of the BIS's attentional bias towards threatening information.

The pattern of interactions found between RST personality traits and life events indicates that high BIS is especially likely to predict internalizing psychopathology when combined with high life stress. Interestingly though, high BIS predicted anhedonic depression symptoms in the absence of stress when combined with low BAS, and high BIS predicted mixed anxiety–depression symptoms in the absence of stress when combined with high BAS. Thus, it appears that certain personality styles—particularly those characterized by high BIS sensitivity—predict anxiety and depression even in the absence of objectively stressful life events. In contrast, BAS sensitivity primarily appears to be important only when combined with high BIS.

Regarding the JSH, as expected, the main effects for both high BIS and low BAS were predictive of anhedonic depression. The interaction between BIS, BAS, and life events described above also suggests that low BAS exacerbates the effects of high BIS on internalizing symptomatology under conditions of low stress. In contrast, very different results were found for mixed anxiety–depression symptoms. Specifically, the current study found that high BIS *and* high BAS predicted mixed anxiety–depression symptoms in the absence of stressful life events. One explanation for this finding is that individuals that are high on both BIS and BAS may frequently find themselves in approach–avoidance conflicts which may, in turn, lead to high levels of distress. For example, individuals with this type of personality style might experience substantial conflict (e.g. high levels of both excitement and anxiety) when facing novel social experiences. As a result, these individuals might remain continually conflicted about these situations due to the potential threats and rewards present. This conflict, in turn, might manifest itself in the form of consistently high levels of general distress (i.e. mixed anxiety and depression symptoms).

### 4.1. Limitations and strengths

The current study had several limitations that should be addressed in future research. First, the sample consisted entirely of college students, which limits generalizability. Second, the measure of internalizing psychopathology did not result in three clear factors as expected, and the measure's validity may have been lowered somewhat by not using the scales as designed. Third, the study relied upon self-report measures exclusively, which leaves open the possibility of error due to shared method variance.

The current study also had several strengths. First, it is one of the first studies to examine the interaction between RST personality variables and life events. Second, the use of a non-clinical sample allowed examination of the relationship between personality, life stress, and internalizing symptomatology while avoiding the confounds associated with clinical samples. Finally, the large sample size allowed for the testing of smaller effects, such as the interactions between RST variables and life stress.

#### 4.2. Future directions

Future work could examine how BIS and BAS sensitivity interact with life events to predict psychopathology using prospective designs. Future studies might also assess whether particular types of life events are more likely to interact with either high BIS or low BAS. For example, Coyne and Whiffen (1995) have reviewed evidence that suggests that negative social events may be particularly important for sociotropic individuals. Finally, future research could aim to identify factors that might mediate the association between RST personality traits and psychopathology. For example, Jackson and Francis (2004) have proposed that cognitions and attitudes may mediate the relationship between RST personality traits and behavior.

#### 5. Conclusion

In conclusion, the results from the current study indicate that both personality and life events are important variables to consider in relation to internalizing symptomatology. In addition, some support was found for the JSH. These results suggest that future research in this area is warranted.

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1 Results of regressions with the anxious arousal and anhedonic depression scales from the MASQ as criterion variables are available from the first author upon request.

2 Factor structure and item loadings available from the first author upon request.