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Psychometric Properties of BIS/BAS Scales in a Large Sample of Offenders[Carver and White's (1994)]

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Abstract

Contemporary motivational theories of psychopathy (Lykken, 1995) employ constructs from Gray's Reinforcement Sensitivity Theory (RST; Gray, 1982), behavioral inhibition system (BIS) and behavioral activation system (BAS) functioning, to explain etiologic differences in psychopathy subtypes. Carver and White's (1994) BIS/BAS scales are the most widely used measures of these constructs, yet there is a dearth of research on how these measures perform with offenders. Using a sample of 1,515 offenders, we found evidence that five, rather than the usual four factors, underpin the BIS/BAS scales. Importantly, BIS items that tap into anxiety and fear sensitivity, respectively, split to form separate factors, yielding a structure that is more consistent with the revised (Gray & McNaughton, 2000) than with the earlier version of RST. Implications for the use of the BIS/BAS scales to study psychopathy in offenders are discussed.

Motivational Theories of Psychopathy

Since Cleckley (1941) delineated the essential features of the psychopathic personality, psychopathy has become one of the most widely researched personality disorders. The psychopathic individual's convincing façade of positive adjustment (e.g., superficial charm; good intelligence) coexists with behavioral deviance (e.g., inadequately motivated antisocial behavior; failure to follow any life plan) and is underpinned by core emotional and interpersonal deficits (e.g. lack of remorse; incapacity for love). Contemporary theorists (Lykken, 1995)

have hypothesized the existence of variants of psychopathy that are distinguishable on the basis of deficits in their neurobiological systems. Lykken hypothesized that *primary* psychopaths are born with a relatively fearless temperament that interferes with efforts to socialize these individuals. Their diminished sensitivity to the threats or punishments that caregivers may apply in trying to shape their behavior diminishes the likelihood that they will develop prosocial attitudes and tendencies. Absent extraordinary effort by their parents, these fearless youths are at risk to become psychopathic in the tradition of Cleckley.

In contrast, Lykken argued that *secondary* psychopaths manifest traits of the primary psychopath on the surface, but presumably possess normal fear sensitivity. Many of these individuals may have an adequately developed conscience, the capacity for empathy, and at least intentions toward prosocial behavior. However, their internal restraints often fail due to extraordinary appetitive drives, resulting in behavior that violates laws or other social norms.

To embed these insights in a broader theory of behavior, Lykken employed two constructs from Gray's (1982, 1987) reinforcement sensitivity theory (RST). The behavioral inhibition system (BIS) is activated by cues of potential threat, punishment, or non-reward, and its function “is to suppress behaviour that is expected to lead to punishment” (Corr, Pickering & Gray, 1995, p. 48). BIS activation is associated with *anxiety*, a transient emotion experienced while “the individual assesses the options for responding to the threatening situation” (Gray, Feldon, Rawlins, Owen & McNaughton, 1978, p. 286). In contrast, the behavioral activation system (BAS) controls sensitivity to potential rewards; its purpose is to initiate behaviour that brings the organism closer to biological reinforcers (e.g. food, sexual partners, etc.) (Corr et al., 1995). BAS activity is associated with the anticipation of pleasure, and Gray associated *impulsivity* with reward seeking behavior. Given these functions of the BIS and BAS, respectively, Lykken hypothesized that primary psychopathy results from an abnormally “weak BIS” whereas secondary psychopathy is associated with an unusually “strong BAS.”

A major revision to RST (Gray & McNaughton, 2000), however, has implications for Lykken's theory of primary psychopathy. In revised RST the function of fear sensitivity is reallocated to the fight/flight/freeze system (FFFS) and is no longer associated with BIS activation per se. In the revised theory BIS activation, including the momentary experience of anxiety, occurs primarily when the organism simultaneously senses approximately equal inputs from the FFFS (fear sensitivity) and BAS (reward opportunity recognition) and must take actions (suspend ongoing behavior; evaluate the situation) to determine the optimal response. Because fear sensitivity is unbundled from BIS functioning and can occur in the absence of anxiety, Lykken's theory of primary psychopathy arguably would be described in the revised framework as a “weak FFFS” phenomenon.

The most widely used personality trait measures of BIS and BAS functioning are Carver and Whites's (1994) BIS/BAS scales. These measures have been used in recent studies with offenders (e.g., Newman, MacCoon, Vaughn & Sadeh, 2005; Uzieblo, Verschuere, & Crombez, 2007) to explore relationships with indices of psychopathy. But for these few studies, however, the BIS/BAS scales have been used primarily with undergraduate samples; there has been little investigation of the psychometric properties of these scales with offenders, and no previous study has examined the factor structure of the BIS/BAS scales using an offender sample. Thus, in the present study, using a large sample of offenders, we examined the factor structure and internal consistency of the BIS/BAS scales. We also examined intercorrelations among the BIS and BAS scales, as well as their associations with measures of theoretically relevant constructs, including anxiety, impulsivity, and harmavoidance.

Method

Participants

Participants were English-speaking adult offenders aged 21 and older who were enrolled in a multi-site study of antisocial personality disorder. They were either serving prison sentences or participating in court-ordered, community-based substance use treatment programs in Florida, Oregon, Utah, Nevada and Texas. Potential participants were excluded if they scored under 70 on an IQ screen or were currently receiving psychotropic medication for active symptoms of psychosis.

Of 1,741 participants recruited into the larger study, 1,515 were included in the present analyses. Cases were excluded due to attrition (e.g., voluntary withdrawal), missing data, failure on the IQ screen ($n = 6$), or potentially invalid protocols ($n = 36$, see below). In the final sample 84% were male, 66% were Caucasian, and 52% were recruited from the prison sites. The mean age of the sample was 30.5 ($SD = 6.5$). The mean score on the IQ screen (Quick Test; Ammons & Ammons, 1962) was 94.83 ($SD = 9.62$). By self-report, the educational background of the sample included 30.5% with no high school diploma or GED, 23.1% who completed a GED course, 19.2% who completed high school, 23.9% who attended some college, and 3.3% who completed college.

Measures

***BIS/BAS Scales* (Carver & White, 1994)—**The BIS/BAS scales were developed using undergraduate students. Items are completed using a 4-point scale (from 1, *disagree strongly* to 4, *agree strongly*). Factor analysis revealed a single 7-item scale designed to assess BIS features, and three scales, Reward Responsivity (RR; 5 items), Drive (DR; 4 items) and Fun Seeking (FUN; 4-items) that assess different aspects of BAS functioning. Cronbach's α for the BIS, RR, DR, and FUN scales in the derivation sample were .74, .73, .76, and .66, respectively.

***Personality Assessment Inventory* (PAI; Morey, 1991)—**The PAI is a 344-item, self-report inventory that assesses multiple clinical (e.g., Depression) and interpersonal (e.g., Dominance) constructs. The PAI has displayed satisfactory psychometric properties across student, community, clinical, and correctional samples. Following Edens and Ruiz (2005), T-scores > 79 on either of two validity scales, Infrequency (INF) or Inconsistency (ICN), were used to exclude 36 cases as possibly invalid due to careless or random responding. High scores on INF indicate frequent endorsement of items that are rarely endorsed, whereas ICN is an index of inconsistent responding to pairs of items that have similar content and correlate moderately highly. The Anxiety (ANX) scale items assess the cognitive, affective, and physiological features common to the experience of anxiety. ANX was used as a criterion measure because anxiety is associated with BIS activation in RST. In this sample, $\alpha = .91$ for the ANX scale.

***Barratt's Impulsivity Scale – Version* 11 (BIS-11; Barratt, 1994)—**The BIS-11 is a 30-item self-report measure whose items assess attentional deficits, motor restlessness, and non-planning features of impulsivity. The BIS-11 has been used in previous studies of the BIS/BAS scales (Miller, Joseph, & Tudway, 2004) and was included as a criterion measure because of the association in RST theory of impulsivity with BAS activation. Alpha in the present sample was .86.

***Harmavoidance*_(HA; Tellegen, 1982)—**The HA scale is a 28-item, forced-choice, self-report measure of trait fearfulness. Each item juxtaposes a risky or potentially fear-inducing activity with another that is less so but equally unpleasant. A high HA score indicates a preference for avoiding potentially harmful situations, whereas a low score suggests that the

individual has a more fearless temperament. The HA scale was included as a criterion validity measure because of Lykken's (1995) “weak BIS” (i.e., low fear) hypothesis regarding primary psychopathy. Internal consistency reliability in the present sample was $\alpha = .86$.

Procedure

Trained research assistants (RAs) enrolled participants and collected data using procedures approved by the Institutional Review Boards of two U.S. universities. Participants were told that their responses would be kept confidential and that participating in the study (or not) would not affect their length of sentence at the institution. The research protocol was administered one-to-one in quiet, private rooms, and participants were not debriefed regarding protocol results. Participants completed the self-report measures alone if they had either completed 10 grades of mainstream education or obtained a GED, *and* could fluidly read aloud the first few items of the PAI. Those who did not meet these criteria were tested for reading comprehension (Johns, 1997). Self-report items were read aloud to individuals who could not read at a 9^{th} grade level. Except at one facility that did not allow payment for research participation, individuals were paid $20 at the completion of the protocol.

Results

Factor Structure of the BIS/BAS Scales

Using a randomly selected half of the sample ($n = 758$), we performed an exploratory principal axis factor analysis (EFA) of the BIS and BAS items. A variety of criteria (e.g., Cattell's scree test, Thurston's criteria, the percentage of variance accounted for by each factor and each solution, the size of the communalities, factor representation, and interpretability) suggested a five-factor solution that explained 62% of the items' shared variance (eigenvalues = 5.3, 2.6, 2.0, 1.5, and 1.1). Because some of the components were moderately correlated ($r > .32$), an oblique rotation (direct oblimin, with Delta=0), was performed. This rotation appeared adequate, based on Thurstone's (1964) criteria.

This five-factor solution was similar to the Carver and White (1994) structure except that the BIS scale separated into two factors. Similar to findings by Johnson, Turner, and Iwata (2003), two items that explicitly mention “fear” split off from the remaining BIS items that appear to tap “anxiety” to form a separate factor (couplet). We labeled these factors BIS-F and BIS-A, respectively. Despite the problems typically inherent in a two-item factor (i.e., instability), we retained this five-factor solution because it made strong conceptual sense in light of revised RST (Gray & McNaughton, 2000) and reflected the bifurcated item content of the larger BIS scale.

Next, we completed confirmatory factor analyses (CFA) on the second half of the sample ($n = 757$) to test the fit of the structure that emerged from our own EFA as well as 2-factor and 4-factor (both correlated and uncorrelated) models that have been reported among non-offender samples. We assessed quality of fit using multiple indexes, as each index has limitations (Kline, 1998; MacCallum & Austin, 2000) and there is no consensus criterion for evaluating model fit. For example, Hu and Bentler (1999) proposed a two-index “rule of thumb” criterion for maximum likelihood estimation that combines a relative fit index (e.g., CFI, TLI >.95) with the SRMR (<.08) or RMSEA (<.06). However, Chen, Curran, Bollen, Kirby, and Paxton (2008) recently found little empirical support for the use of <.06 – or any other cut point – as a universal cutoff value for RMSEA. Moreover, such known problems with fit indices as “lack of strong correspondence between alternative fit indices for a decision based on one to be consistent with a decision based on another” (McDonald & Ho, 2002, p. 72) militate against imposition of a hard standard. Thus, different aspects of fit were evaluated, including absolute fit (χ^2), fit adjusted for model parsimony (Non-Normed Fit Index, or NNFI), and fit relative to

a null model (Comparative Fit Index, or CFI, and root mean square error of approximation, or RMSEA). Following convention, the criterion for adequate fit was defined as CFI and NNFI ≥ .90 or .95 and RMSEA < .08 or .06, (Byrne, 1994; Hu & Bentler, 1999, respectively). Our focus here is on the relative fit of models. All CFA models were fit within Amos 5.01 (Arbuckle, 2003), using maximum likelihood estimation techniques. Parallel analyses using Mplus version 4.2 (Muthen & Muthen, 1998-2007) with weighted least squares mean and variance (WLSMV) adjusted to account for potentially non-normally distributed BIS/BAS items produced highly similar fit indices (e.g., CFI= .92, .93; RMSEA=.06, .08, respectively, for Model 1) and virtually identical estimated factor loadings. We report the results of the more widely applied and interpretable maximum likelihood estimation technique.

Results of the CFA are shown in Table 1. Model 1 is the EFA-based, five-factor model in which the BAS factors are correlated with each other, BIS-F and BIS-A are correlated, but the BAS and BIS factors are constrained to be uncorrelated with each other. Model 2 relaxes this final constraint and permits the BIS and BAS factors to be correlated. Analogous models for the traditional four-factor and two-factor (BIS and BAS modeled as unidimensional) structures are represented as models 3-6, respectively.

Table 1 reveals that only our EFA-derived, five-factor models achieved adequate fit (using liberal thresholds, but not the Hu and Bentler, 1999 hard criterion) across most indices. Although the four-factor models also achieved fair fit according to the RMSEA, they fell below the (liberal) threshold of adequate fit on both the CFI and NNFI. The two-factor models both manifested poor fit. A test of the significance of the difference in fit between the two five-factor models indicated that the model with correlated factors (Model 2) fit significantly better than the model that constrained factors to be uncorrelated (Model 2; χ^2 difference = 101.59, $df = 6$, $p < .001$). This best fitting model is shown in Figure 1.

Correlations among the BIS and BAS Scales

Table 1 presents correlations among the BIS and BAS scales. BIS-F and BIS-A are positively correlated but they exhibit different associations with the BAS scales. Whereas BIS-F is unrelated to RR and has small, negative associations with DR and FUN, BIS-A has small to moderate positive associations with all BAS measures. Correlations among the BAS scales ranged from .32 to .45.

Associations with Criterion Measures

Anxiety is associated in RST with BIS functioning, and correlations between the ANX scale with the BIS-F ($r = .28$, $p < .01$) and BIS-A ($r = .41$, $p < .01$) factors were consistent with this expectation. The magnitude of these two correlations differed (t (1511) = −4.31, $p < .001$), indicating a significantly stronger association for ANX with BIS-A (Steiger, 1980). Harmavoidance (HA) was weakly but significantly associated with BIS-F ($r = .14$, $p < .01$) but not with BIS-A ($r = .04$, ns). The magnitude of these correlations differed significantly (t (1510) = 3.25, $p < .002$).

Finally, as expected impulsivity measured using the BIS-11 was significantly associated with the BAS Fun ($r = .38$, $p < .01$) and Drive ($r = .14$, $p < .01$). However, BIS-11 scores were unrelated to the BAS Reward Responsiveness scale ($r = .03$, ns) and, unexpectedly, were correlated positively with both BIS-A ($r = .25$, p < .01) and BIS-F ($r = .16$, p < .01) scores.

Discussion

Our results suggest a number of ways in which the BIS/BAS scales work differently with offenders than with non-offenders. However, although we interpret our findings with respect

to offender versus non-offender status, we note that some differences may also be related to gender (or other sociodemographic factors). In prior studies with community and undergraduate samples, the substantial majority of participants have been women (Poythress, Edens, Landfield, Lilienfeld, Skeem, & Douglas, 2008), whereas women represent only about 16% of our offender sample. Thus, some of the differences observed could be related to gender.

First, the four-factor structure published by Carver and White (1994), which has received some support in subsequent student and community samples (e.g., Ross, Millis, Bonebright, & Bailley, 2002; Sava & Sperneac, 2006), did not replicate in this sample. Rather, we found that a five-factor structure fits the BIS/BAS scales better. The same three BAS scales (RR, DR, FUN) were identified in this sample as in prior research; however, the BIS scale was found to be underpinned by two factors, one comprising five items that appear to tap mainly anxiety (BIS-A) and one comprising two items whose content relates to fearfulness (BIS-F).

Although the BIS-A and BIS-F scales are modestly correlated (r = .24), their separation make conceptual sense. At the personality trait level, fear and anxiety are usually viewed as separate constructs that, depending on the fear measure employed, are uncorrelated (Schmitt & Newman, 1999) or only minimally correlated (Perkins, Kemp & Corr, 2007; White & Depue, 1999). Further, somewhat different neurological systems are thought to underlie the experiences of fear and anxiety (Gray & McNaughton, 2000).

A thoughtful reviewer noted that the two items that comprise the BIS-F scale are both reverse scored and suggested the possibility that BIS-F may be a spurious, method-related factor (see Marsh, 1996). Although we cannot definitively rule out method influences, the pattern of correlations for BIS-F and BIS-A with external measures provides some support for our substantive interpretation of these factors. Harmavoidance was uniquely associated with BIS-F, as would be expected, and although both BIS factors were positively correlated with anxiety, the correlation was significantly higher for BIS-A than for BIS-F. In our view, this coherent pattern of associations with external measures militates against concluding that BIS-F is merely a method factor.

In this sample the correlations among BAS scales (r's range .32 to .45) were similar to those typically obtained in undergraduate (Carver & White, 1994, r's range .34 to .41) and community (Johnson et al., 2003, r's range .37 to .51) samples. Because the BIS scale separated into two factors in the present sample, direct comparisons with prior studies are difficult. Typically, the unitary BIS scale has been positively correlated with RR but unrelated to DR and FUN (see, e.g., Carver & White, 1994; Ross et al., 2002). In the present sample BIS-F had weak relations with all BAS scales, whereas BIS-A had small to moderate positive correlations (rs ranging from .17 to .30) with all BAS scales.

Given that Carver and White's BIS scale was constructed on the basis of earlier RST theory (Gray, 1982), we did not anticipate that their BIS scale would separate in to separate *fear* and *anxiety* components, especially given the scale's weak coverage of fear sensitivity (Poythress et al., 2008). Nevertheless, our obtained pattern of associations arguably makes sense in revised RST, in which the BIS is not directly responsive to threat cues (nor associated directly with the fear emotion). As discussed earlier, in revised RST sensitivity to cues of threat or punishment and the concomitant experience of fear are ascribed to the FFFS. In this regard FFFS functions independently of (i.e., orthogonal to) BAS. Thus, the small to negligible associations between BIS-F and the BAS scales in the present data would be consistent with expectations from the revised theory. Further, in the revised theory BIS receives input from both FFFS and BAS and becomes active when signals from these opposing systems indicate an approach-avoidance conflict. The tension experienced in conjunction with BIS activation is anxiety, and it is present when fear (FFFS signal) and potential pleasure (BAS signal) input

is simultaneously received. This, too, would appear to be consistent with the present data, which reveal associations of approximately equal magnitude for BIS-A with BIS-F (r = .24) and with the BAS scales (rs ranging from .17 to .30).

Gray (1982) associated impulsivity with BAS activity, and in prior studies with undergraduate and community samples positive associations with measures of impulsivity have been reported for all three BAS scales, although most prominently the FUN scale (see, e.g., Zelenski & Larsen, 1999; Caseras, Avila, & Torrubia, 2003). In the present study a slightly different pattern of associations was obtained. FUN (r = .38) and DR (r = .14) correlated positively with impulsivity, although RR was not significantly related to impulsivity.

Somewhat unexpectedly, in this study BIS-F was significantly associated with impulsivity (r = .16), whereas in prior studies with undergraduates, the total BIS scale and measures of impulsivity have been uncorrelated (Chi, Park, Lim, Park, et al., 2005, r = .00) or negatively correlated (Zelenski & Larsen, 1999, r = −.24; Caseras et al., 2003, r = −.14). However, Gremore, Chapman and Farmer (2005) reported a modest correlation (.18) among female offenders. One possible explanation for the association between the BIS-11 with BIS-F is that the relationship is mediated by negative affectivity. Whiteside and Lynam (2001) identified a sense of *urgency* as a facet of impulsivity, reflecting a tendency to act precipitously despite potential long-term harmful consequences because of the perceived need to act to alleviate negative emotions. Although we did not measure urgency directly, we addressed this issue indirectly with supplemental regression analyses. When impulsivity was regressed onto BIS-F, BIS-F explained 2.6% of the variance in BIS-11 scores, F (1, 1507) = 41.48, p < .001. However, when ANX was included as a predictor at the second step of the regression, BIS-F was no longer a significant predictor (β = .016, t = .688, p = .492). Thus, in this sample negative affectivity appears to mediate the association between impulsivity and BIS-F. This finding provides one potential explanation for the different associations for BIS with impulsivity across samples; BIS and impulsivity have not been positively associated in student and community samples, perhaps because these groups are less prone to high levels of negative affectivity and/or because the dysfunctional impulsivity found in offenders contributes to their anxiety by generating life stressors.

Summary and conclusions

The present findings suggest that Carver and White's BIS/BAS scales work somewhat differently with offenders than with non-offenders. The main difference appears to be in the structure and functioning of the BIS scale, which constitutes a unitary scale with student and community samples but divides into separate facets relating to fear sensitivity and anxiety in offenders. The separate assessment of fear sensitivity and anxiety is consistent with revised RST (Gray & McNaughton, 2000), which allocates these functions to different systems. In our view, it is unlikely that the separate BIS-F and BIS-A factors that emerged in this study will prove to be adequate indices of FFFS and BIS functioning. Fear sensitivity is a complex construct that is not adequately captured – substantively or psychometrically – by the two items that comprise the BIS-F scale identified in this study. Further, there is ample evidence to suggest that the five residual BIS-A items provide inadequate coverage of the array of functions ascribed to the behavioral inhibition system in RST (Poythress et al., 2008) and instead assess mainly constructs in the negative emotionality spectrum. Thus, although we encourage further investigations of the reliability and validity of the current BIS/BAS scales with offenders, we urge the development of new measures that more adequately capture fear sensitivity and the functions of BIS as defined in revised RST.

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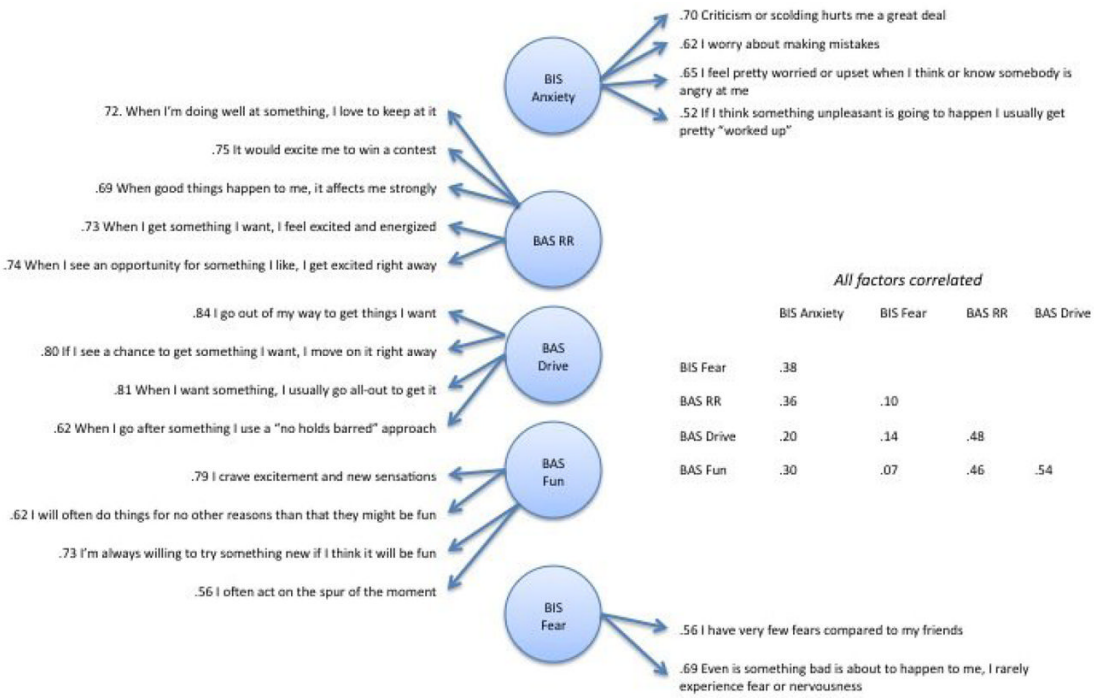

Figure 1.
Factor structure of the BIS/BAS scales

Table 1

Results of Confirmatory Factor Analyses

Model	χ^2	df	NNFI	RMSEA	CFI
1. EFA 5-factor model, BIS and BAS uncorrelated	685.79	166	.87	.06	.90
2. EFA 5-factor model, BIS and BAS correlated	583.79	160	.89	.06	.92
3. Carver & White 4-factor model, BIS and BAS uncorrelated	782.33	167	.86	.07	.89
4. Carver & White 4-factor model, BIS and BAS correlated	709.26	164	.87	.07	.89
5. Two factors (BIS, BAS) uncorrelated	2065.94	170	.62	.12	.64
6. Two factors (BIS, BAS) correlated	2014.04	169	.63	.12	.65

Note. EFA = exploratory factor analysis. BIS = Behavioral Inhibition Scales; BAS = Behavioral Activation System scales. NNFI= Non-Normed Fit Index; RMSEA = root mean square error of approximation. CFI = Comparative Fit Index.

Table 2

BIS/BAS Scale Correlations

	BIS-A	BAS-RR	BAS-DR	BAS-FUN
BIS-F	.24**	.05	−.12**	−.05*
BIS-A		.30**	.17**	.22**
BAS-RR			.41**	.32**
BAS-DR				.45**

Note.

BIS-F = Behavioral Inhibition – Fear scale; BIS-A = Behavioral Inhibition – Anxiety scale; BAS-RR = Behavioral Activation System – Reward Responsiveness scale; BAS-DR = Behavioral Activation System – Drive scale; BAS-FUN = Behavioral Activation System – Fun Seeking scale.

* $p < .05$.

** $p < .01$.