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BAS Reward Responsiveness: A unique predictor of positive psychological functioning

Lauren E. Taubitz, **Walker S. Pedersen**, and **Christine L. Larson***

University of Wisconsin – Milwaukee, United States

Abstract

Previous research on Reinforcement Sensitivity Theory has well-characterized the Behavioral Inhibition System in terms of its behavioral and emotional manifestations, but the Behavioral Approach System (BAS) is less well-defined, particularly regarding the prominence of reward sensitivity versus impulsivity. Furthermore, few researchers evaluate both systems in one model. We evaluated the relationship between Carver and White's (1994) BIS/BAS Scales and areas of psychological functioning including internalizing, externalizing, affect regulation, and well-being. 497 undergraduates completed a battery of self-report measures. Two structural equation models indicate that the Reward Responsiveness subscale uniquely predicts adaptive functioning across all domains. Reward Responsiveness may be a more pure measure of BAS than other BAS traits and may be important for resilience from maladaptive psychological functioning.

Keywords

BIS/BAS; Reward sensitivity; Internalizing; Externalizing; Resilience

1. Introduction

Much effort has been devoted to integrating research on the neurobiology of appetitive and aversive motivation with the study of emotion, personality, and psychopathology. The Behavioral Inhibition and Behavioral Approach Systems (BIS and BAS respectively; Carver & White, 1994; Corr, 2008; Gray, 1982; Gray & McNaughton, 2000) have been central to this line of research. While the BIS has been well-characterized, (Bijttebier, Beck, Claes, & Vandereycken, 2009; Caseras, Ávila, & Torrubia, 2003), the BAS is less well-understood (Caseras et al., 2003; Leone, 2009; Leone & Russo, 2009; Smillie, Jackson, & Dalgleish, 2006). Moreover, little work has examined how the BIS and BAS uniquely relate to psychopathology or affect regulation within one model (Caseras et al., 2003; Leone, 2009; Leone & Russo, 2009; Smillie et al., 2006; cf. Gomez & Gomez, 2005). Thus, the purpose of this study was to examine unique BAS contributions in predicting behavior and affect, including internalizing, externalizing, emotion regulation, and well-being while simultaneously considering overlap with the BIS.

*Corresponding author at: University of Wisconsin – Milwaukee, Department of Psychology, 2441 E. Hartford Ave., Milwaukee, WI 53211, United States. Tel.: +1 414 229 4996; fax: +1 414 229 5219. larsoncl@uwm.edu (C.L. Larson).

1.1. Reinforcement Sensitivity Theory (RST)

Gray's (1982) Reinforcement Sensitivity Theory proposes that the BIS and BAS are two major neurobiological systems that contribute to affect, behavior and personality. In the most recent revision of RST (rRST; Corr, 2008; Gray & McNaughton, 2000), the BAS is conceptualized as a mediator of approach behavior for appetitive stimuli (Gray & McNaughton, 2000) and is thought to facilitate goal-directed activity and positive emotions. In rRST, the Fight–Flight–Freeze System (FFFS) facilitates avoidance of aversive stimuli, and the BIS resolves goal conflicts between systems (e.g., BAS–FFFS). Although rRST distinguishes between the FFFS and the BIS, most self-report measures do not (in keeping with original RST). Accordingly, this investigation does not distinguish the FFFS from the BIS.

The BIS exhibits excellent construct validity. It consistently predicts negative affect, neuroticism, and anxiety (Bijttebier et al., 2009; Campbell-Sills, Liverant, & Brown, 2004; Carver & White, 1994), supporting Gray's hypotheses about the relationship between this system and punishment sensitivity. In contrast, the relationship between the BAS and theoretically related constructs is murkier. Self-reported BAS has been associated with manifold constructs, including Reward Responsiveness, extraversion, impulsivity (either functional or dysfunctional), and both positive and negative approach-related affective states (e.g., happiness and anger, respectively; Carver, 2004; Carver & White, 1994; Caseras et al., 2003; Franken & Muris, 2005; Leone & Russo, 2009). Thus, while the BIS has been unitarily related to negative affect and anxiety, the BAS has been associated with numerous related, but distinct, constructs. It is not clear which chiefly characterizes the BAS, particularly regarding the role of Reward Responsiveness and impulsivity.

1.2. Carver and White's (1994) BIS/BAS Scales

The most widely used self-report measure of BIS/BAS functioning is Carver and White's (1994) BIS/BAS Scales. In their original article, Carver and White (1994) noted a lack of consensus on how BAS activity would manifest behaviorally. Because of this, they included items reflecting a range of behaviors that could be BAS-mediated. This resulted in the formation of three BAS subscales: Reward Responsiveness, Drive, and Fun Seeking. The Reward Responsiveness subscale reflects the degree to which one experiences positive responses to rewards. Drive measures how persistent one is in pursuing desired goals, and Fun-Seeking measures how much one desires new rewards and seeks out rewards on the spur of the moment.

Research utilizing exploratory and confirmatory factor analysis suggests that the three BAS subscales reflect distinct constructs, particularly with regard to impulsivity and reward responsivity (Caseras et al., 2003; Leone, 2009; Leone & Russo, 2009; Smillie et al., 2006; cf. Campbell-Sills et al., 2004). Several researchers have found that the Reward Responsiveness and Drive subscales better reflect reward sensitivity, while Fun Seeking is more related to impulsivity (Caseras et al., 2003; Leone, 2009; Smillie et al., 2006). Thus, it appears that the BIS/BAS Scales reflect the greater confusion within the literature on the roles of impulsivity and Reward Responsiveness in the BAS.

1.3. Impulsivity

The definition and role of impulsivity in the BAS are important to consider due to the consistent relationship between impulsivity and maladaptive outcomes. Across the lifespan, high impulsivity has been related to externalizing behavior problems and delinquency (Eisenberg et al., 2009; Giovanelli, Hoerger, Johnson, & Gruber, 2013; White et al., 1994). While nearly all traditional definitions of impulsivity have a maladaptive connotation (e.g., pursuing short-term gains while ignoring long term consequences), the function of the BAS in RST is purportedly adaptive. Corr (2008) describes how dysfunctional impulsivity is not related to successful BAS functioning (p. 21). Rather, he defines successful BAS function as pursuing rewards by identifying reinforcers, and creating and executing plans to acquire them. He defines BAS impulsivity as the consummatory actions that occur after executing the plan necessary for goal pursuit. Thus, although commonly represented in self-report measures of the BAS (Leone, 2009; Leone & Russo, 2009; Smillie et al., 2006), the dysfunctional nature of conventionally-defined impulsivity is inconsistent with the intended function of the BAS in RST (Corr, 2008).

1.4. Reward Responsiveness

The Reward Responsiveness construct, on the other hand, is more consistent with Corr's (2008) definition of impulsivity. Reward Responsiveness can be defined as one's ability to experience pleasure in the anticipation and presence of reward-related stimuli. It may also involve approach motivation for ideas or activities that provide a sense of pleasure. Studies relating Carver and White's (1994) BIS/BAS Scales to behavior provide evidence that Reward Responsiveness may be adaptive while Fun Seeking (more related to dysfunctional impulsivity) and, to some extent, Drive, is associated with maladaptive behavior. For example, Franken and Muris (2006) found that Fun Seeking, but not Reward Responsiveness, was associated with increased substance abuse. On the contrary, Reward Responsiveness, but not Drive or Fun Seeking, was related to better decision-making on the Iowa Gambling Task (Franken & Muris, 2005). These Reward Responsiveness findings support Corr's (2008) definition of BAS impulsivity as adaptive.

1.5. The present study

Given that successful BAS functioning is theorized to be adaptive (Corr, 2008), it is important that self-report measures of the BAS relate to adaptive functioning. Researchers have taken a multivariate approach to examining the BAS subscales in relation to impulsivity (Leone, 2009; Leone & Russo, 2009; Smillie et al., 2006) and reward sensitivity (Smillie et al., 2006), but no one has considered BIS/BAS relationships with other important behavioral and personality features in one model. As constructs that are thought to have broad, organizing influences on personality, BIS and BAS should have major influences on emotional and mental health, and the BAS subscales that best predict broad measures of emotional and mental health are likely those that are most central to the BAS construct. Additionally, it is necessary to consider both BIS and BAS functioning in the same model to capture the variance accounted for by the interplay between these constructs (e.g., joint subsystems hypothesis; Corr, 2002; Gray & McNaughton, 2000) and to account for a positive relationship between BIS and Reward Responsiveness that is sometimes found

(Leone, Perugini, Bagozzi, Pierro, & Mannetti, 2001; Ross, Millis, Bonebright, & Bailley, 2002).

The purpose of this study was to use structural equation modeling (SEM) to investigate how Carver and White's (1994) BIS/BAS Scales are related to adaptive and maladaptive functioning regarding internalizing, externalizing, well-being, and emotion regulation strategies. These dependent variables were chosen to capture broad categories of psychological functioning. Most psychopathology can be categorized by internalizing or externalizing behaviors. By grouping several measures into latent variables of internalizing and externalizing, respectively, we hoped to investigate which BAS subscales best predict psychopathology-relevant behaviors. Similarly, well-being was included because it broadly measures positive emotional function. Measures of emotion regulation strategies were also included as they also have broad implications on emotion and psychopathology. We reasoned that the BAS subscales that best predict these broad measures of psychological functioning are likely central aspects of the BAS.

2. Method

2.1. Participants

Participants included 497 undergraduates recruited from psychology courses who completed a battery of self-report measures online for course credit. The majority of participants were female (83.9%),[1] young adult (mean age = 19.2 years), and Caucasian (85.8%).

2.2. Measures

Carver and White's (1994) BIS/BAS Scales served as the exogenous variables within the SEM models created. BIS, Reward Responsiveness, Drive and Fun Seeking subscale scores each serve as observed variables. BIS, Reward Responsiveness, and Drive all have good reliability (α = 0.74, α = 0.73, and α = 0.76, respectively). BIS includes items like "I worry about making mistakes". Reward Responsiveness includes items such as, "When good things happen to me, it affects me strongly." Drive includes items like "I go out of my way to get things I want". Fun Seeking has fair reliability (α = 0.66) and includes items such as, "I crave excitement and new experiences."

The latent variable internalizing (INT) comprises summed scores from the following indicators: total scores from the State-Trait Anxiety Inventory, Trait version (STAI-T; Spielberger, Gorsuch, & Lushene, 1970), the Beck Depression Inventory, 2nd ed. (BDI-II; Beck, Steer, & Brown, 1996), and the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) Negative Affect subscale.

The latent variable externalizing (EXT) includes three indicator variables of externalizing behaviors. The Physical and Verbal Aggression indicators were total scores from the Physical Aggression and Verbal Aggression subscales of the Aggression Questionnaire

[1]Major conclusions of the model were the same when male participants were removed. However, the path from Fun Seeking to Reappraisal was significant (β = 0.13, b = 0.12, p = 0.003), so Fun Seeking was retained in the model. The paths from BIS to EXT (β = −0.13, b = −0.21, p = 0.019) and between EXT and Reappraisal were also significant (β = −0.14, b = −3.83, p = 0.012).

(Buss & Perry, 1992). The third indicator was the Delinquent Behavior Index (Farrington & West, 1971) total score.

Measures of two common emotion regulation strategies were included in the model: Expressive Suppression and Cognitive Reappraisal. These served as separate observed variables made up of the Expressive Suppression and Cognitive Reappraisal subscale scores from the Emotion Regulation Questionnaire (Gross & John, 2003).

The final exogenous variable, Well-Being, was measured using the Ryff Scales of Psychological Well-Being (PWB; Ryff, 1989). Because past researchers have indicated overlap between its six subscales (Springer & Hauser, 2006), a single total score across all six subscales of the PWB was used to form a single observed variable.

2.3. The model

To investigate the predictive validity of the BIS/BAS Scales, we created an SEM model using the four BIS/BAS subscales to predict measures of psychopathology, emotion regulation, and well-being. Because the BAS subscales are theoretically interrelated (Carver & White, 1994), and a positive BIS-Reward Responsiveness relationship has been observed (Leone et al., 2001; Ross et al., 2002), paths between each of the BAS subscales and the path between BIS and Reward Responsiveness were freely estimated. Because emotion regulation strategies influence psychopathology and general well-being (Aldao & Nolen-Hoeksema, 2012; Lougheed & Hollenstein, 2012; Singh & Mishra, 2011), paths from both Cognitive Reappraisal and Expressive Suppression to EXT, INT and Well-Being were added in addition to a bidirectional path between Cognitive Reappraisal and Expression Suppression. A bidirectional path between INT and EXT was added because internalizing and externalizing behaviors are often correlated (Lilienfeld, 2003). A bidirectional path between internalizing and well-being was included, because while internalizing tends to negatively affect well-being, experiences that negatively affect well-being can also trigger internalizing symptoms (e.g., childhood pain; Shelby et al., 2013).

To examine whether the BIS/BAS subscales predict the chosen outcome variables, paths from each of the BIS/BAS subscales to INT, EXT, Well-being, Cognitive Reappraisal and Expressive Suppression were included in the model and their parameters were evaluated. Paths with non-significant parameter estimates ($p > 0.05$) were subsequently removed from the model, and parameter estimates and fit indices were obtained.

2.4. Data preparation

When a subject was missing ≤25% of the items on a given subscale, mean imputation was used to handle missing values (3.1% of all individual items were missing). Otherwise, the summed score for that subscale was counted as missing. Full information maximum likelihood (FIML) was used to handle missing subscale values. Scores >3 S.D. from their mean were recoded as the value of the nearest non-outlying observation. One subject was classified as a multivariate outlier (Mahalanobis distance with $p < 0.0001$) and was excluded from analysis.

Maximum likelihood with robust standard errors was used to estimate parameters and fit indices using MPLUS (Muthen & Muthen, 2010) software. The initial covariance matrix was ill-scaled because each of the BAS subscales had variances less than one-tenth of the largest variance. To remedy this, each of the BAS subscales was rescaled by multiplying each observation by three.

2.5. Evaluating model fit

Good model fit is indicated by normalized chi-square (χ^2) < 2, Root Mean Square Error of Approximation (RMSEA) < 0.05, Comparative Fit Index (CFI) > 0.95, and Standardized Root Mean Residual (SRMR) < 0.08. Adequate model fit is indicated by normalized χ^2 < 3, RMSEA < 0.08, CFI > 0.90, and SRMR < 0.1. After estimation, non-significant paths were trimmed. At each step, the path with the highest chi-square was removed and fit indices were reviewed. A χ^2 difference score was computed for each step to verify that the trimmed path did not result in a significant reduction of model fit ($p < 0.05$).

3. Results

3.1. Main model

The initial model included BIS (m = 21.5, SD = 3.44), Reward Responsiveness (m = 53.01, SD = 6.02), Drive (m = 33.67, SD = 6.55) and Fun Seeking (m = 36.6, SD = 6.36) as predictors of EXT, Well Being (m = 39.25, SD = 5.85), Reappraisal (m = 27.22, SD = 5.98), Suppression (m = 13.83, SD = 4.79) and INT. EXT had Physical Aggression (m = 16.97, SD = 6.48), Verbal Aggression (m = 11.96, SD = 3.67), and Delinquent Behavior (m = 9.74, SD = 7.53) as indicators, while INT had Trait Anxiety (m = 41.35, SD = 9.76), Depression (m = 9.68, SD = 7.42), and Negative Affectivity (m = 17.78, SD = 6.33) as indicators. Descriptive statistics reflect the scaling factor applied to the BAS subscales.

Fit indices for the initial model suggested adequate fit, except for normalized chi-square (χ^2 (38) = 125.77, p <0.01; χ^2/df = 3.31; RMSEA = 0.069; CFI = 0.95; SRMR = 0.049); however, this model contained several non-significant paths. These were removed to create the final model. Fun Seeking was removed since it did not significantly predict any outcome variables. The resulting model (see Fig. 1) exhibited adequate fit (χ^2 (42) = 107.62, p < 0.01; χ^2/df = 2.56; RMSEA = 0.06; CFI = 0.96; SRMR = 0.05). Standardized structural coefficients for this model can be seen in Fig. 1.

In this model, Reward Responsiveness was negatively associated with EXT (β = −0.22, b = −0.20, p <0.01), INT (β = −0.34, b = −0.51, p <0.01), and suppression (β = −0.21, b = −0.17, p < 0.01), and positively associated with Well-Being (β = 0.45, b = 0.43, p < 0.01) and Reappraisal (β = 0.21, b = 0.21, p < 0.01). BIS was positively associated with INT (β = 0.68, b = 1.82, p < 0.01) and negatively associated with EXT (β = −0.13, b = −0.21, p = 0.02) and Well-Being (β = −0.39, b = −0.64, p < 0.01). Drive was positively associated with EXT (β = 0.32, b = 0.26, p < 0.01) but was unrelated to any other outcome variable.

3.2. The bifactor model

Our main model (Fig. 1) suggests that Reward Responsiveness may have a different relationship with the outcome variables than the other BAS subscales. This seems particularly true of externalizing, which was negatively associated with Reward Responsiveness but positively associated with Drive. To further investigate this, we created a bifactor model in which the three BAS subscales form a single BAS latent variable that is used (along with BIS) to predict our endogenous variables. In this model, Reward Responsiveness was allowed to predict the outcome variables directly in addition to predicting them indirectly through the BAS latent variable. This model was designed to investigate the unique predictive power of Reward Responsiveness after accounting for variance that it shares with the other BAS subscales.

Most fit indices for this model suggested adequate to good fit both before (χ^2 (43) = 131.74, $p < 0.01$; χ^2/df = 3.06; RMSEA = 0.07; CFI = 0.95; SRMR = 0.05) and after trimming nonsignificant paths (χ^2 (51) = 139.31, p <0.01; χ^2/df=2.73; RMSEA = 0.06; CFI = 0.95; SRMR = 0.05). In this model (see Fig. 2), greater BIS predicted greater INT ($b = 1.82$, $p < 0.01$, $\beta = 0.68$) and lower Well-Being ($b = -0.65$, $p < 0.01$, $\beta = -0.38$). The BAS latent variable was positively associated with EXT ($b = 0.74$, $p < 0.01$, $\beta = 0.62$). The direct paths from Reward Responsiveness to the endogenous variables showed that Reward Responsiveness is negatively associated with EXT ($b = -0.45$, $p < 0.01$, $\beta = -0.52$), INT ($b = -0.51$, $p < 0.01$, $\beta = -0.34$) and Suppression ($b = -0.17$, $p < 0.01$, $\beta = -0.22$), and positively associated with Well Being ($b = 0.43$, $p < 0.01$, $\beta = 0.46$) and Reappraisal ($b = 0.21$, $p < 0.01$, $\beta = 0.22$).

4. Discussion

We sought to clarify the relationship between the BAS and a broad range of psychological and emotional functioning using Carver and White's (1994) BIS/BAS Scales. The most striking finding from our analyses is that the Reward Responsiveness subscale uniquely predicted adaptive functioning across all domains tested: decreased internalizing, externalizing, and decreased use of suppression, increased use of Reappraisal, and increased well-being. Consequently, Reward Responsiveness may be the best indicator of successful BAS functioning.

4.1. Main model versus bifactor model

The findings from our main model extend previous work on the BIS/BAS Scales (Carver & White, 1994) by modeling the BIS and BAS subscales simultaneously and by predicting multiple measures of psychological functioning. The bifactor model confirmed that these associations between Reward Responsiveness and the dependent variables remain even after partialing out latent BAS variance. The primary difference between the main and bifactor models is the relationship between the BAS scales and externalizing. In the main model, Drive predicted externalizing to a moderate degree ($\beta = 0.32$) while the latent BAS variable in the bifactor model was more strongly associated with externalizing ($\beta = 0.62$). Similarly, Reward Responsiveness was more strongly associated with decreased externalizing in the bifactor model ($\beta = -0.52$) than the main model ($\beta = -0.22$). Thus, there is a common thread

across the BAS subscales that confers risk for externalizing, but there is something unique about Reward Responsiveness that promotes resiliency from externalizing.

4.2. Internalizing

Our findings support a large body of research relating the BIS with internalizing constructs such as anxiety, depression, and general negative affect (Bijttebier et al., 2009; Campbell-Sills et al., 2004; Carver & White, 1994). Our data extend these findings by demonstrating that the relationship between the BIS and internalizing cannot be accounted for by overlap with any BAS constructs.

More importantly, our findings highlight the unique role of Reward Responsiveness in promoting resilience from internalizing. These Reward Responsiveness findings are consistent with experience sampling studies demonstrating causality between reward and decreased internalizing (Geschwind et al., 2010; Zautra, Johnson, & Davis, 2005). For example, Geschwind et al. (2010) found that more daily reward experiences are associated with decreased future negative affect in the aftermath of stressful life events. These findings support the idea that Reward Responsiveness may be uniquely protective against internalizing.

4.3. Externalizing

Both the main and bifactor models highlight an important distinction between the BAS subscales and externalizing. Unlike previous research associating a hyperactive BAS with externalizing behaviors (Bijttebier et al., 2009; Franken & Muris, 2006; White et al., 1994), our findings indicate that Reward Responsiveness is actually protective against externalizing while Drive (in the main model) and, in particular, the latent BAS variable (in the bifactor model) are associated with increased externalizing.

More broadly, Reward Responsiveness may be protective against dysfunctional impulsive behavior such as pursuing short-term rewards while ignoring long-term negative consequences. Our models suggest that Reward Responsiveness better reflects the adaptive definition of impulsivity proposed by Corr (2008), while Drive and the latent BAS variable may reflect more dysfunctional impulsivity, supporting findings by Leone (2009) and Leone and Russo (2009). The opposing relationships between the BAS subscales and externalizing (positive for Drive and the latent BAS variable; negative for Reward Responsiveness), is consistent with previous research indicating that BAS sensitivity is multi-dimensional (Leone et al., 2001; Ross et al., 2002; Smillie et al., 2006) and that researchers should not rely on a single BAS total score.

4.4. Psychological well-being and emotion regulation

We found a unique positive relationship between Reward Responsiveness, but not other BAS variables, and psychological well-being and adaptive patterns of emotion regulation. Replicating Tull, Gratz, Latzman, Kimbrel, & Lejuez (2010), our data indicate that Reward Responsiveness is specifically associated with less use of Suppression and greater use of Reappraisal – a pattern of emotion regulation that has been previously associated with greater well-being and less psychopathology (Aldao & Nolen-Hoeksema, 2012; Gross &

John, 2003). The emotion regulation and well-being findings further highlight the consistent pattern of increased Reward Responsiveness and better psychological function across broad domains of functioning.

4.5. Limitations

There are several notable limitations to our study. First, this study relies solely on self-report data and thus provides a somewhat limited measure of how the BIS and BAS are operationalized. Self-report scales could be more affected by subject demographic characteristics than a behavioral measure would be. Given that this sample is comprised solely of undergraduates and is largely white, young adult, and female, it is unknown how these results would differ if a more diverse sample was used. Occasionally gender differences have been found in self-reported BIS and BAS scores (e.g., Study 1 in Carver & White, 1994). However, when male participants were removed from our sample, the major conclusions were the same.[1]

5. Conclusion

The BAS is thought to be a neural system guiding and organizing appetitive responses that have broad implications for personality and psychopathology. Our main model (Fig. 1) and previous research (Leone, 2009; Leone & Russo, 2009; Smillie et al., 2006) suggest that the BAS subscales measure related but different constructs. In addition, given that Reward Responsiveness protected against externalizing symptoms while Drive and the latent BAS factor predicted more externalizing symptoms, Reward Responsiveness is uniquely consistent with Corr's (2008) conception of BAS impulsivity as adaptive. These findings combined suggest that Reward Responsiveness may be a more pure measure of BAS than Drive or Fun Seeking.

A continuing challenge for Reinforcement Sensitivity Theory research is to provide a clearer definition of the BAS and how it relates to psychopathology and other major areas of psychological functioning. Our results suggest that future researchers should evaluate the BIS and BAS subscales as unique predictors of personality and psychopathology to identify BIS/BAS relationships with behavior and their contributions to risk and resilience.

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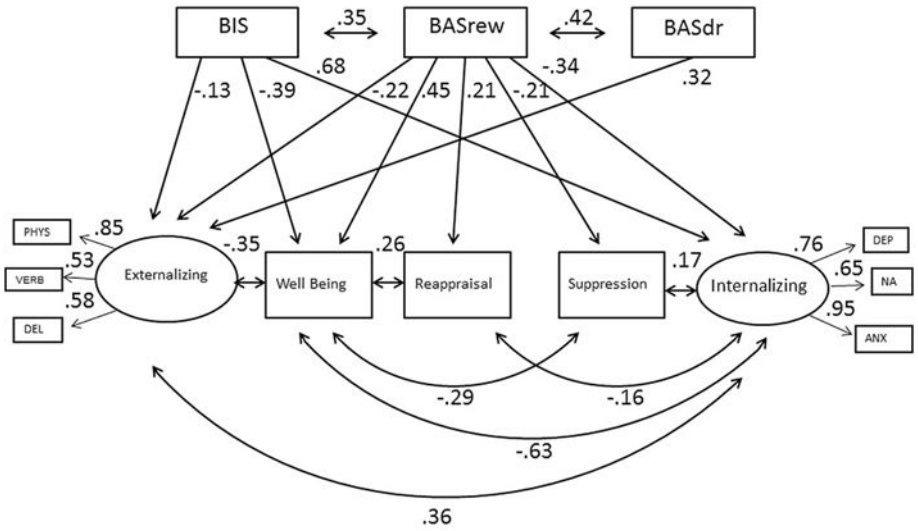

Fig. 1.

Main model with standardized path coefficients. BIS = Behavioral Inhibition Scale, BASrew = Reward Responsiveness, BASdr = Drive, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

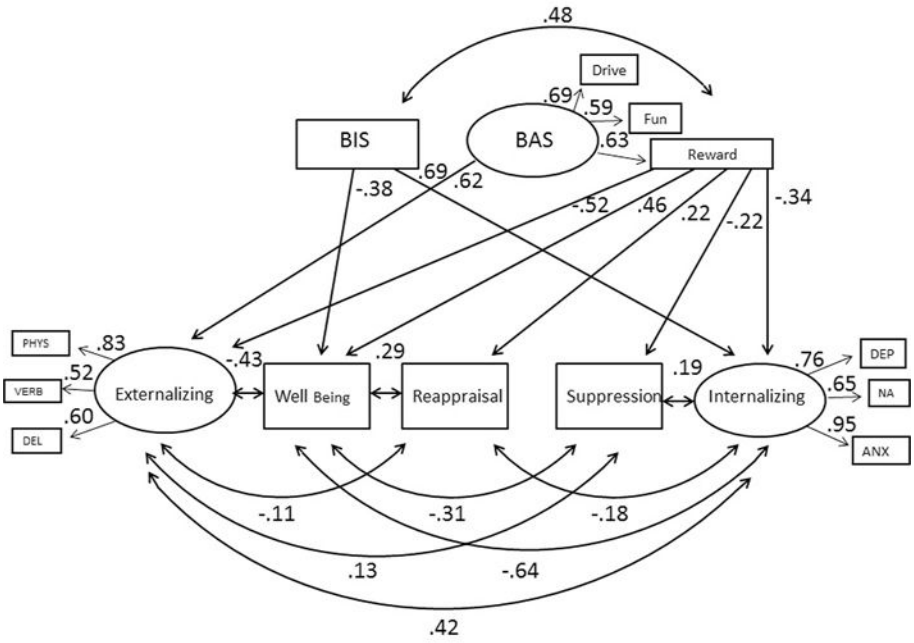

Fig. 2.

Bifactor model with standardized path coefficients. BIS = Behavioral Inhibition Scale, BAS = Behavioral Approach Scale, Reward = BAS Reward Responsiveness, Drive = BAS Drive, Fun = BAS Fun Seeking, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.