May 2013

Using Bis and Bas Sensitivity to Predict Psychopathology, Emotion Regulation and Well-Being

Walker Scott Pedersen
University of Wisconsin-Milwaukee

USING BIS AND BAS SENSITIVITY TO PREDICT PSYCHOPATHOLOGY, EMOTION REGULATION AND WELL-BEING

Walker S. Pedersen

A Thesis Submitted in

Partial Fulfillment of the

Requirements for the Degree of

Master of Science

in Psychology

at

The University of Wisconsin-Milwaukee

May 2013

ABSTRACT
USING BIS AND BAS SENSITIVITY TO PREDICT PSYCHOPATHOLOGY, EMOTION REGULATION AND WELL-BEING

by

Walker Pedersen

The University of Wisconsin – Milwaukee, 2013
Under the Supervision of Professor Christine Larson

Gray's (1982) Reinforcement Sensitivity Theory proposes that two major systems in the brain – the behavioral inhibition system and the behavioral activation system – contribute to affective states, behavior and personality. Carver and White's (1994) BIS/BAS scales attempt to measure three aspects of BAS sensitivity: Reward Responsiveness, Fun Seeking and Drive. While widely used, the validity of these scales is unclear. The current study employs structural equation modeling to test the BIS/BAS scales' ability to predict psychopathology, use of emotion regulation strategies and psychological well-being. As BAS sensitivity is thought to have a broad influence on these variables, the BAS subscales that predict these variables may be better measures of BAS sensitivity. While past researchers have looked at these relationships, none of them have done so in a single, multivariate model. Additionally, extraversion has been suggested as directly reflecting BAS sensitivity (Pickering & Smillie, 2008). A second model was also tested that includes extraversion as a predictor, along with the BAS subscales. If extraversion predicts the chosen variables better than the BAS subscales, it may imply that extraversion is a better measure of BAS sensitivity. When included in the same model, Reward Responsiveness predicted all of the outcome variables significantly, while Drive

only predicted Externalizing, and Fun Seeking did not significantly predict any of the outcome variables. This may suggest that Reward Responsiveness is a more central component of BAS sensitivity than either Drive or Fun Seeking. When extraversion was added to the model, it predicted the chosen outcome variables largely independently of Reward Responsiveness. This may imply that Extraversion and Reward Responsiveness are largely independent constructs.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

Many thanks to Dr. Christine Larson and Lauren Taubitz for all of their help.

Using BIS and BAS Sensitivity to Predict Psychopathology, Emotion Regulation and Well-Being

The behavioral inhibition system (BIS) and behavioral activation system (BAS) are primary motivational constructs proposed by Gray (1982) as key determinants of affective states and personality traits. Activation in the BIS underlies negative affect and state anxiety and is thought to mediate behaviors such as cautious appraisal of one's environment. BAS activation underlies positive affect and is thought to mediate reward-seeking behaviors. In addition, trait sensitivity of the BIS and BAS are thought to underlie personality differences. High BIS sensitivity is typically linked to maladaptive outcomes, while high BAS sensitivity is often linked to more adaptive outcomes.

Gray (1982) conceptualized BIS and BAS sensitivity as unitary constructs. While attempts to conceptualize and measure BIS sensitivity as a single trait have been relatively successful, attempts to do so for the BAS have yielded mixed results (see Caseras, Avila & Torrubia, 2003). The difficulty of characterizing BAS sensitivity as a single, unitary construct suggests either inadequacy in the survey measures used to define BAS sensitivity or that BAS sensitivity is, in fact, a multi-dimensional construct.

One of the most widely used measures of BIS and BAS sensitivity is Carver and White's Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) scales (Carver & White, 1994). Carver and White included items in this scale that captured several aspects of BAS functioning. This yielded three BAS subscales. Subsequent research has yielded mixed results about the relationships between these three subscales (Leone, Perugini, Bagozzi, Pierro & Mannetti, 2001; Ross, Millis, Bonebright & Bailley, 2002), as well as their relationship with personality traits hypothesized to be related to BAS sensitivity (Caseras et al. 2003; Heubeck, Wilkinson & Cologon, 1998; Leone & Russo, 2009).

As BAS is supposed to be a major motivational system with broad implications for personality, BAS sensitivity should predict a number of psychological outcomes. If this is the case, one avenue for better characterizing the BIS/BAS scales is to relate them to psychological outcomes, such as, psychopathology, use of emotion regulation strategies and psychological well-being. By creating a structural equation model with these variables, I hope to clarify the utility of the individual BAS subscales in predicting positive or negative outcomes. In addition, as researchers typically want to use a single measure of BAS sensitivity, examining the predictive validity of the BAS subscales may guide researchers attempting to determine which, if any, of the BAS subscales can be considered more pure measures of BAS sensitivity.

Extraversion has also been suggested as a direct reflection of BAS sensitivity (Pickering & Smillie, 2008; Smillie, Cooper, Wilt & Revelle, 2012). If this is the case, extraversion may serve as a better measure of BAS sensitivity than the BAS subscales and should be expected to predict psychopathology, use of emotion regulation strategies and psychological well-being better than the BAS subscales. In order to examine the relationship between extraversion and the BAS subscales, I will also examine the predictive validity of extraversion, when included as a predictor alongside the BAS subscales.

Reinforcement Sensitivity Theory Overview

In 1970, Gray proposed an alteration of Eysenck's (1957) theory of introversion-extraversion, forming the foundations for what ultimately became Reinforcement Sensitivity Theory (RST). Eysenck conceptualized introversion-extroversion as a continuum, with extraversion being characterized by high gregariousness and high impulsivity. According to Eysenck (1963), introversion, is caused by a greater susceptibility to conditioning to both reward and punishment. Gray believed that the key determinant of introversion is a greater susceptibility to punishment and frustrative non-reward, rather than to conditioning in general. This greater sensitivity to punishment is associated with greater anxiety, and predicts greater levels of both introversion and neuroticism. Gray based this claim on findings that individuals high in anxiety are more susceptible to conditioning, but only in circumstances that involve some form of threat (Ominsky & Kimble, 1966), as well as findings suggesting that introverts perform better at recognition and recall of threat stimuli (Eriksen, 1966).

Gray (1970) went on to tie punishment sensitivity to a specific neural system. He used the observation that anxiolytic drugs reduce the effects of punishment (Miller, 1959), but not reward, as his starting point. This provided further evidence for the link between anxiety and sensitivity to punishment, and suggested that the septo-hippocampal system, which anxiolytic drugs act on, is key to this sensitivity to punishment.

In 1982, Gray expanded on these ideas, resulting in Reinforcement Sensitivity Theory (RST). The septo-hippocampal system responsible for sensitivity to punishment was named the behavioral inhibition system (BIS). Gray proposed that this system was primarily sensitive to aversive conditioned stimuli, but also responded to novel stimuli, and innate fear stimuli, like snakes. This system was thought to give rise to an inhibition of ongoing behavior and an assessment of the current environment, especially of novel stimuli. In addition, BIS activation was thought to lead to an increase in arousal, in order to prepare an animal to react to potential threat.

Gray (1982) also proposed two other systems involved in approach and avoidance behaviors. Although involved in avoidance behaviors, the fight-flight system (FFS) was thought to be independent of the BIS. While the BIS was thought to be primarily sensitive to conditioned aversive stimuli and the experience of anxiety, the FFS was supposed to be sensitive to unconditioned punishment and non-reward, as well as the experience of panic. While BIS was thought to be involved more in cautious appraisal and cues of potential threat, the FFS was involved in the fight or flight response to immediate danger.

The behavioral approach system (BAS) was proposed to be involved in appetitive motivation and sensitivity to conditioned reward and non-punishment. As such, the BAS was supposed to be important not only in approach in response to cues of reward, but also in active avoidance. Gray believed that the BAS facilitated greater positive affect, impulsivity, and extraversion.

The workings of these three systems formed the foundation of RST (Gray, 1982). While each of these systems were involved in approach and avoidance behaviors, this initial conception of RST assumed that these systems were relatively independent of one another and gave little elaboration on how these systems may interact to produce coordinated behavior. In 2000, Gray and McNaughton proposed a revision of RST, which included some major changes to the role of the three systems, as well as further clarification on how these systems interact.

Revised Reinforcement Sensitivity Theory

Gray and McNaughton (2000) proposed changes to each of the three behavioral systems in revised reinforcement sensitivity theory (rRST). The BAS was only subjected to one major change in rRST. Rather than being sensitive only to conditioned reward and non-punishment, under rRST the BAS is sensitive to all forms of reward and non-punishment. As such, it is still assumed to mediate appetitive motivation, as well as emotions such as positive affect and optimism (Corr, 2008). The BAS is thought to be closely tied to the dopamine mediated reward system, with the nucleus accumbens playing a central role (Gray & McNaughton, 1996).

Under rRST the fight-flight system is known as the fight-flight-freeze system (FFFS), acknowledging freezing behaviors as being closely related to the fight or flight response involved in response to immediate danger. Gray and McNaughton (2000) proposed that the periaqueductal gray, medial hypothalamus and related areas make up the FFFS. These areas have been implicated in escape behaviors and are thought to underlie the experience of panic (Graeff, 1994). The main revision to the FFFS is that it is now proposed to be sensitive to all cues of punishment and non-reward, whether conditioned or unconditioned. The FFFS is still thought to mainly be involved in the emotions of panic and fear, with anxiety remaining within the domain of the BIS.

The BIS underwent the largest change in rRST. Under the revised theory, the BIS is no longer sensitive to cues of threat, or to any specific stimulus. Instead, the BIS is now seen as a system that resolves conflict arising from behavioral tendencies in the other systems. For example, when cues of threat and reward are both present in the environment, the FFFS and BAS will be activated simultaneously, reflecting the co-activation of conflicting goals. When the activation in these two systems is roughly equal, the BIS resolves the conflict, by increasing the valence of negative stimuli, until one of the goals is activated strongly enough to override the other. In addition to FFFS-BAS conflicts, the BIS is responsible for resolving conflicts between goals held within the same system (i.e. FFFS-FFFS and BAS-BAS conflicts). Because the BIS is thought to resolve conflicts by increasing the valence of negative stimuli, it is still thought to be associated with cautious assessment and anxiety.

Measuring BIS and BAS Sensitivity

While the BIS is fairly well characterized by its close relationship with anxiety, efforts to tie BAS functioning to a single personality trait have proven difficult. Extraversion, positive affectivity, novelty seeking and impulsivity have all been proposed as trait measures of BAS sensitivity (see Revelle, 1995).

Gray (1982) initially proposed impulsivity as the personality correlate of the BAS. Pickering and Smillie (2008) argue that this conceptualization of the BAS was mostly arbitrary, based primarily on the assumption that impulsivity is orthogonal with anxiety and the previously established relationship between extraversion and impulsivity (Eysenck & Eysenck, 1963). They also note that one difficulty with attempting to anchor the BAS to impulsivity is that impulsivity is a multidimensional trait, related to several personality constructs. It has been suggested that the BAS is related specifically to functional impulsivity (Smillie & Jackson, 2006). Poythress and Hall (2011) agree with this premise, arguing that the BAS is intended to be a system associated with adaptive behavior, while most conceptualizations of impulsivity are primarily maladaptive. However, impulsivity – functional or otherwise – fails to capture the full range of behaviors associated with the BAS, as seeking rewards often involves careful planning in order to achieve long term goals (Corr, 2008).

Some have argued that extraversion may arise from BAS sensitivity (Pickering & Smillie, 2008; Smillie et al., 2012). Gray (1982) initially proposed a thirty-degree rotation between extraversion and BAS sensitivity, such that BAS sensitivity was strongly correlated with, but distinct from, extraversion. However, Pickering and Smillie (2008) argue that Gray's (1982) precise positioning of extraversion in relation to BAS sensitivity was a rather hypothetical proposition, supporting his main argument against Eysenck's (1957) bottom-up approach of starting with descriptive personality traits and then looking for biological correlates for those traits. Moreover, while Gray's (1982) anchoring of BIS sensitivity to anxiety was based on a top-down approach, his anchoring of impulsivity to BAS sensitivity and his positioning of extraversion in relation to BAS sensitivity, was based on a bottom-up approach similar to Eyesenck's (Pickering & Smillie, 2008). Thus, there seems to be no substantive reason to dismiss the possibility of extraversion arising directly from BAS sensitivity.

The constructs of BAS sensitivity and extraversion show considerable overlap. Like BAS sensitivity, positive affect is a core component of extraversion (Hermes, Hagemann, Naumann & Walter, 2011; Lucas & Fujita, 2000; Watson & Clark, 2004).

Several authors have found that extraverts are more reactive to positive stimuli, implying that they are more sensitive to reward (Gomez, Cooper & Gomez, 2000; Gross, Sutton & Ketelaar, 1998; Larsen & Ketelaar, 1991). Smillie et al. (2012) found that extraverts are more sensitive to positive stimuli only when the stimulus is associated with the pursuit of reward. In support of this claim, Smillie et al. (2012) also note that past studies reporting greater sensitivity to reward for extraverts that include an element of reward pursuit have a larger effect size on average than those that do not. Furthermore, extraversion has been tied to activity in the dopamine mediated reward system, and especially the ventral striatum (Depue & Collins, 1999; Hermes et al., 2011). Thus, a strong case can be made for extraversion directly reflecting BAS sensitivity. Both are strongly tied to positive affect and reward responsiveness. Moreover, extraversion and BAS sensitivity are thought to arise from the same neural system.

While some have attempted to tie BAS sensitivity to pre-existing personality constructs, others have attempted to construct measures of BAS sensitivity, based on its proposed characteristics. The most widely used scale developed specifically to measure BIS and BAS sensitivity is Carver and White's (1994) BIS/BAS scales. Due to the difficulty in defining the BAS as a single trait, Carver and White (1994) attempted to capture several aspects of the BAS when creating these scales. This resulted in a BAS scale with three subscales: Reward Responsiveness, Drive and Fun Seeking. Reward Responsiveness concerns the amount of positive affect individuals experience in relation to rewarding stimuli or events, Drive is associated with the degree of motivation one feels to attain reward, and Fun Seeking assesses the degree to which one seeks out novel and exciting experiences.

While the BIS/BAS scales are one of the most commonly used measures of BIS and BAS functioning, the appropriateness of the BAS subscales has been questioned. Carver and White (1994) found that these subscales only correlate moderately with one another (.34-.41), and noted that this correlation is somewhat less than one might expect from three subscales measuring a single trait. Moreover, studies using confirmatory factor analysis and principal component analysis have found mixed results regarding the appropriate structure of the BAS subscales. Campbell-Sills, Liverant and Brown (2004) found evidence in support of Carver and White’s (1994) claim that the three BAS subscales make up three factors that load onto a single super-ordinate factor. Others have concluded that the BIS/BAS subscales are better conceptualized as four correlated, separate factors (Leone et al., 2001; Ross et al., 2002). As discussed by Heubeck, et al. (1998), Gray's (1982) theory implies that the personality trait arising from BAS sensitivity should be unidimensional. If so, the mixed findings about the structure of Carver and White's BAS subscales either suggests that they inadequately measure BAS sensitivity or that Gray's conceptualization of the BAS needs revision. Others have suggested that, through interaction with other brain systems, the activity of the BAS may ultimately manifest in a multidimensional cluster of traits (Wilson, Gray & Barrett, 1990). If so, the apparent multidimensional nature of the BAS subscales may be appropriate.

Those who have included related measures with the BIS/BAS scale in factor analysis have revealed further difficulties with the BAS subscales. In order to investigate the relationship between the BIS/BAS scales and measures of personality, Heubeck et al. (1998) included several measures of affective and personality traits, along with the BIS/BAS scales in a confirmatory factor analysis. They created a two factor model, with Neuroticism, Negative Affect and BIS loading onto one factor, and Extraversion, Positive Affect, Reward Responsiveness, Drive and Fun Seeking loading onto another. However, in the final solution for this model Reward Responsiveness was left out in order to improve model fit. This choice was justified by the fact that Reward Responsiveness had a positive correlation with BIS, and that this correlation was higher than with either Extraversion or Positive Affectivity (both of which, BAS sensitivity should predict). The correlation between Reward Responsiveness and BIS has been replicated by others (Leone et al., 2001; Ross et al., 2002). This may imply inadequacies in the Reward Responsiveness subscale, as BIS and BAS are traditionally assumed to be independent. Some, however, have suggested that the BAS can mediate negative emotion when received reward is smaller than expected (Carver, 2004; Pickering & Smillie, 2008). While more research is needed to determine whether this is an appropriate way to conceptualize the BAS, if this is the case, a correlation between BIS and BAS tendencies may be a result of both systems mediating negative emotion.

While some researchers have raised concerns about Reward Responsiveness, others have raised concerns about Fun Seeking. In a principal components analysis, Caseras et al. (2003) found that Fun Seeking loaded more strongly onto a factor representing impulsivity-thrill seeking, than a reward interest factor, which Reward Responsiveness and Drive loaded onto most strongly. Furthermore, in a confirmatory factor analysis Fun Seeking has been shown to load onto dysfunctional impulsivity more strongly that functional impulsivity, while Drive and Reward Responsiveness has shown the opposite pattern (Leone, 2009; Leone & Russo, 2009). If, as some have stated, the BAS ought to be related to functional and not dysfunctional impulsivity (Poythress & Hall, 2011; Smillie & Jackson, 2006; Smillie, Jackson & Dalgleish, 2006), this finding implies that Fun Seeking may not be an appropriate measure of BAS sensitivity.

These mixed findings about the BAS subscales have important implications for research in rRST. If the BAS subscales are independent, related constructs, it may be advisable to use scores for each separate subscale when conducting research. However, as most researchers are interested in assessing BAS sensitivity as a single construct, it would be helpful to know which of these subscales, if any, can be considered more pure or more useful measures of BAS sensitivity. Continuing research examining the structure of the BIS/BAS scale, as well as its relationship to other personality traits, will continue to increase our understanding of the BAS subscales. However, relating the BIS/BAS subscales to different types of psychological outcomes, such as psychopathology and well-being, represents another avenue for assessing the validity of these subscales. In addition, investigating which of the BIS/BAS scales consistently predict adaptive or maladaptive outcomes may yield a better understanding of the underlying components of the BAS and the best way to measure them.

Relationships Between BIS/BAS and Psychopathology, Emotion Regulation and Well-being

Psychopathology. Researchers have found evidence for two personality traits that underlie many forms of psychopathology: internalizing liability and externalizing liability (Eisenberg et al., 2001; Krueger & Markon, 2006; Krueger, McGue & Iacono, 2001). These two traits are thought to underlie the comorbidity inherent in many psychopathologies. The forms of psychopathology associated with internalizing liability include depression, anxiety, phobias, and panic disorder, as well as negative affect in general. Due to the consistency of this finding, the following section (and later, the proposed structural equation model) will be organized around these constructs.

Internalizing. BIS shows a consistent positive relationship with anxiety (Bijttebier, Beck, Claes & Vandereycken, 2009; Campbell-Sills et al., 2004; Carver & White, 1994). Studies using a BAS total score typically find little or no relationship between BAS and anxiety. However, the relatively few studies that have reported correlations between the BAS subscales and anxiety have yielded mixed results. For example, while some authors have reported no, or a very weak, relationship between any of the BAS subscales and anxiety (Campbell-Sills et al., 2004; Johnson, Turner & Iwata, 2003; Segarra et al. 2007), Jorm et al. (1999) reported a positive correlation between anxiety and Reward Responsiveness, as well as a small, but significant correlation between Fun Seeking and anxiety. In addition, Beevers and Meyer (2002) reported a positive correlation between Fun Seeking and anxiety.

Depression shows a fairly consistent positive relationship with BIS and negative relationship with BAS (Kasch, Rottenberg, Arnow & Gotlib, 2002; Kimbrel, Nelson-Gray & Mitchell, 2007; Muris, Meesters, de Kanter & Timmerman, 2005; Segarra, et al. 2007). Both Beevers and Meyer (2002) and Campbell-Sills et al. (2004) found that each of the three BAS subscales had a negative correlation with depression. Another study (Jones and Day, 2008) found that all three BAS subscales had a negative correlation with Depression, although only Reward Responsiveness was significant. Jorm et al. (1999), however, found that Reward Responsiveness had a weak positive correlation with depression. Nevertheless, the overall pattern suggests that high BAS can confer some protection from depressive symptoms.

While the positive relationship between BIS and negative affect is well established (Campbell-Sills et al., 2004; Coplan, Wilson, Frohlick, Zelenski, 2006; Erdle & Rushton, 2010; Hasler, Allen, Sbarra, Bootzin & Bernert, 2010), some studies have found a negative correlation between negative affect and BAS (Coplan, et al., 2006; Hasler, et al., 2010), while others have found no statistically significant relationship (Erdle & Rushton, 2010; Suhr & Tsanadis, 2007). A recent study found that all BAS subscales have a negative correlation with negative affect (Hasler, et al., 2010), while Heubeck, et al. (1998) found this correlation only for Drive and Fun Seeking. Taken as a whole, these findings provide mixed evidence about the role of BAS in negative affect, but suggest that high BAS sensitivity may be associated with decreased negative affect.

Externalizing. In addition to internalizing liability, externalizing liability is thought to underlie many types of psychopathology. Behaviors associated with externalizing liability include aggression, delinquency, psychopathy, substance use and hyperactivity (Bijttebier et al., 2009).

Externalizing behaviors may arise from a hyperactive BAS. A consistent link has been found between high BAS sensitivity and substance abuse (Bijttebier et al., 2009;

Voigt, et al., 2009). Lykken (1995) proposed that psychopathy was associated with BAS dominance, with a hypoactive BIS underlying primary psychopathy, and a hyperactive BAS underlying secondary psychopathy. In line with this hypothesis, Newman, MacCoon, Vaughn and Sadeh (2005) found that, relative to controls, primary psychopaths had lower BIS scores, while secondary psychopaths had higher BAS scores. Aggression (Smits & Kuppens, 2005; Yu, Branje, Keusers & Meeus, 2011) and delinquency (White et al., 1994) also have a positive relationship with BAS sensitivity.

Externalizing behaviors are linked to impulsivity (Krueger, Markon, Patrick, Benning & Kramer, 2007). Given the link between impulsivity and Fun Seeking (Smillie, et al., 2006), Fun Seeking may be expected to predict externalizing behaviors more strongly than the other BAS subscales. Some have found that Fun Seeking has a higher correlation with aggression than either Reward Responsiveness or Drive (Cooper, Gomez & Buck, 2008; Hasking, 2007), although there are exceptions to this finding (Seibert, Miller, Pryor, Reidy & Zeichner, 2010). A recent study found that Fun Seeking accounted for more variance in traits associated with psychopathy than the other BAS subscales (Sellborn & Phillips, 2012). Fun Seeking has also been implicated in substance abuse (Willem, Bijttebier, Claes & Uytterhaegen, 2012). Thus, Fun Seeking seems to play a role in externalizing behavior, possibly more so than the other BAS subscales.

Emotion Regulation – Suppression and Reappraisal. Use of emotion regulation strategies is an important outcome variable, because an individual's tendency to use different types of emotion regulation strategies has implications for social and emotional well-being (John & Gross, 2004), as well as the development of psychopathology (Aldao & Nolen-Hoeksema, 2011; Ehring, Tuschen-Caffier, Schnulle, Fischer & Gross, 2010). Expressive suppression involves suppressing the outward, physical reaction to an emotional stimulus. Overuse of this type of response-focused strategy is generally thought to be maladaptive, because it only modifies the response to a negative stimulus, without altering the negative emotional experience (John & Gross, 2004; Salkovskis & Campbell, 1994). Suppression has been linked with more internalizing disorders (Campbell-Sills, Barlow, Brown, & Hofmann, 2006; Moore, Zoellner & Mollenholt, 2008). Given these findings, it is reasonable to suspect that high BIS sensitivity, which is also related to internalizing disorders, may be related to expressive suppression. In line with this prediction, BIS has been linked to several domains of emotion regulation difficulties (Tull, Gratz, Latzman, Kimbrel & Lejuez, 2010). Conversely, as BAS may provide some protection against internalizing disorders, it may be associated with less expressive suppression. Tull et al. (2010) found that high Reward Responsiveness was associated with fewer emotion regulation difficulties; the same study, however, found that Fun Seeking predicted greater levels of emotion regulation difficulties.

Cognitive reappraisal is a form of emotion regulation, which involves reappraising the meaning of a stimulus in order to alter the intensity or valence of the emotion attached to it. For example, an individual might reframe negative criticism as an opportunity to improve. Cognitive reappraisal is generally thought to be an adaptive regulation strategy (John & Gross, 2004). Additionally cognitive reappraisal seems to be protective against internalizing disorders (Moore et al., 2008). Given this pattern of findings, BAS is likely positively associated with cognitive reappraisal, particularly Reward Responsiveness, which has been linked to fewer difficulties in emotion regulation (Tull, et al. 2010).

Psychological Well-Being. As discussed earlier, the BIS is thought to be associated with negative affect. According to Gray (1982), the trait most directly related to high BIS sensitivity is anxiety, which can be maladaptive, as in the context of anxiety disorders. On the other hand, while some have hypothesized that the BAS can play a role in negative affect (Carver, 2004; Pickering & Smillie, 2008), it is primarily related to positive affect (Carver & White, 1994; Erdle & Rushton, 2010). According to Gray (1982), high BAS is closely associated with greater extraversion, a trait that has been shown to predict subjective well-being (DeNeve & Cooper, 1998).

Relationships Between Extraversion and Psychopathology, Emotion Regulation and Well-being

Psychopathology. ***Internalizing.*** Extraversion seems to have a negative relationship with internalizing behaviors. Extraversion is associated with fewer symptoms of depression and anxiety (Hirschfeld, Klerman, Lavori & Keller 1989; Jylha & Isometsa, 2006; Rath, 1978; Trull & Sher, 1994). Some, however, have found null results. For example, Kushner, Tackett & Bagby (2012) found a relationship between extraversion and depression, but not anxiety; Jorm et al. (2000) found a relationship between extraversion and anxiety, but not depression, and Kendler, Neale, Kessler, & Heath (1993) found no significant relationship between extraversion and either anxiety or depression. Still, the overall pattern appears to be that extraversion is associated with less anxiety and depression.

The evidence for a relationship between extraversion and negative affect is mixed. Positive affect appears to have a stronger link with extraversion, while neuroticism is the strongest predictor of negative affect (Costa & McCrae, 1980; Larsen & Ketelaar, 1991). Some have, however, found that extraversion is associated with less negative affect (Albuqeurque, de Lima, Matos & Fiqueiredo, 2012; Finsch, Baranik, Liu & West, 2012; Nemanick & Munz, 1997; Verduyn & Brans, 2012), while others have found no relationship (Gutierrez, Jimenez, Hernandez & Puente, 2005; Howell & Rodzon, 2011). Despite the inconsistent findings for extraversion and negative affect, in general, extraversion appears to have a negative relationship with internalizing behaviors.

Externalizing. While some have found a positive relationship between extraversion and externalizing behaviors, such as substance abuse (Krueger & Tackett, 2003) and delinquent behaviors (John, Caspi, Robins & Moffitt, 1994), others have found no relationship (Anderson, Tapert, Moadab & Crowley, 2007; Seibert et al., 2010). A meta-analysis (Miller & Lynam, 2001) found no relationship between anti-social behaviors and extraversion for studies based on the Five Factor Model (Costa & McCrae, 1992) of personality, and a positive relationship for studies using Eysenck's three factor model of Psychoticism, Extraversion, Neuroticism (Eysenck & Eysenck, 1970).

DeYoung, Peterson, Seguin & Tremblay (2008) argue that only certain components of extraversion – those dealing with assertiveness and dominance – are associated with externalizing behaviors, while components like warmth and gregariousness are not. This may explain the mixed findings, as the components of extraversion that are unrelated to externalizing behavior may mask those that are related (Deyoung et al., 2008). A recent study provided evidence for this hypothesis, finding that the excitement seeking facet of extraversion was positively associated with antisocial behavior, and the assertiveness facet of extraversion was associated with aggression, while the facets of warmth and positive emotions were negatively associated with antisocial behaviors and aggression, respectively (Jones, Miller & Lynam, 2011).

Emotion Regulation – Suppression and Reappraisal. Some studies have found that extraversion is associated with more effective emotion regulation. Ng and Diener (2009) found that extraverts were more effective at both maintaining positive emotion and down-regulating negative emotion. Nelis et al. (2011) found that participants who completed emotion competence training showed higher levels of positive affect and extraversion. These findings suggest that extraversion may be associated with more effective and adaptive strategies. In line with this, studies have found that extraversion is positively associated with cognitive reappraisal and negatively associated with suppression (Gross & John, 2003; Wang, Shi & Li, 2009).

Psychological Well-Being. Since extraversion predicts greater positive affect and fewer symptoms of depression and anxiety, a link between extraversion and well-being seems to be a reasonable expectation. Indeed, multiple researchers have found a positive relationship between extraversion and well-being (Albuqeurque et al. 2012; Gutierrez et al., 2005; McCrae & Costa, 1991). A meta-analysis has confirmed this relationship (DeNeve & Cooper, 1998).

The Current Study

While several studies have looked at the relationship between the BIS/BAS scales and differing types of psychopathology, most of these used a total BAS score, and do not report results for the individual BAS subscales, and thus, are not helpful in making distinctions among them. In addition, most of the studies that do report results for the BAS subscales only report zero-order correlations. Including BIS and the three BAS subscales in a single model may shed further light on which of the BAS subscales account for the most unique variance in measures of psychopathology and other measures of psychological well-being and emotional functioning. The current study uses structural equation modeling to investigate the relationships between the BIS/BAS subscales and measures of internalizing behaviors, externalizing behaviors, psychological well-being and emotion regulation strategies. Relating the BIS/BAS subscales to these measures of psychological functioning may yield insight into the predictive power of these subscales. This may help future researchers to determine which BIS/BAS subscales are the best predictors of specific psychopathologies, and which, if any, are good predictors of positive and negative outcomes more generally. It may also inform our understanding of the key components of the BAS. Additionally, as extraversion has been suggested as a direct measure of BAS sensitivity, testing whether extraversion predicts the chosen psychological outcome variables, over and above what is predicted by the BAS subscales, may yield insight into how to best measure and conceptualize BAS sensitivity.

Past research indicates a consistent, positive relationship between BIS and internalizing behaviors, including anxiety (Campbell-Sills et al., 2004; Carver & White, 1994), depression (Kasch et al., 2002; Kimbrel et al., 2007) and negative affect

(Campbell-Sills et al., 2004; Erdle & Rushton, 2010; Hasler et al., 2010). I expected this same relationship in the current study. Given the tendency for BAS sensitivity to correlate negatively with both depression (Kasch et al., 2002; Segarra, et al. 2007) and negative affect (Hasler, et al., 2010), BAS sensitivity was expected to have a negative relationship with internalizing. However, the past findings seem to offer no clear indication of which of the BAS subscales are likely to exhibit this negative relationship.

As discussed above, high BAS sensitivity seems to play a significant role in multiple forms of externalizing behaviors (Bijttebier et al., 2009). Given the link between impulsivity and externalizing (Krueger et al., 2007), it was predicted that, while other BAS subscales may be related to externalizing, Fun Seeking would be the biggest predictor. Past research linking Fun Seeking to substance abuse (Willem, et al. 2012) and psychopathy (Sellborn & Phillips, 2012) provide support for this prediction.

Based on the link between BIS and internalizing behaviors (Bijttebier, et al. 2009), as well as emotion regulation difficulties (Tull, et al. 2010), BIS was expected to have a positive relationship with suppression, which has also been linked to internalizing behaviors (Campbell-Sills et al., 2006; Moore et al., 2008) and is generally considered maladaptive when over-used (John & Gross, 2004; Salkovskis & Campbell, 1994). Based on past findings that Reward Responsiveness predicts fewer emotion regulation difficulties (Tull, et al. 2010), Reward Responsiveness was expected to be negatively associated with expressive suppression, and positively associated with cognitive reappraisal. Fun Seeking, on the other hand, was expected to have a positive relationship with expressive suppression and a negative relationship with cognitive reappraisal, as Fun

Seeking has been linked to emotion regulation difficulties (Tull, et al. 2010). While the literature offers little indication of which emotion regulation strategies Drive is associated with, Carver and White's (1994) conception of Drive implies an ability to pursue reward. As the pursuit of reward often entails prevailing through hardships, Drive was expected to be associated with adaptive regulation strategies (i.e. greater cognitive reappraisal, less expressive suppression), which may enable long-term pursuit of reward.

Given the close relationship between BIS sensitivity and both negative affect (Campbell-Sills et al., 2004; Hasler, et al. 2010) and anxiety (Bijttebier et al., 2009), BIS sensitivity was expected to be negatively associated with well-being. Since BAS predicts positive affect (Carver & White, 1994; Erdle & Rushton, 2010) and extraversion (Carver & White, 1994; Caseras et al., 2003) BAS sensitivity was expected to be positively associated with well-being. However, since Fun Seeking is associated with dysfunctional impulsivity (Leone, 2009; Leone & Russo, 2009), it was expected that this subscale may predict well-being less well than either Reward Responsiveness, or Drive.

As researchers have suggested that extraversion arises directly from BAS sensitivity (Pickering & Smillie, 2008; Smillie et al., 2012), a second structural equation model was also tested in which the four BIS/BAS subscales and extraversion are used to predict internalizing behaviors, externalizing behaviors, cognitive reappraisal, expressive suppression and psychological well-being.

Past research has demonstrated that extraversion is associated with these variables in much the same way that the BAS subscales are. Given its tendency to correlate negatively with depression and anxiety (Hirschfeld et al., 1989; Rath, 1978; Jylha &

Isometsa, 2006; Trull & Sher, 1994), extraversion was expected to predict fewer internalizing behaviors. Although the literature on extraversion and externalizing behaviors is mixed, those that have not gotten null findings have shown extraversion predicting more externalizing behaviors (John et al., 1994; Krueger & Tackett, 2003). Like the BAS subscales, extraversion has shown a positive relationship with cognitive reappraisal and a negative relationship with expressive suppression (Gross & John, 2003; Wang et al., 2009). Similarly, past literature shows a clear link between extraversion and psychological well-being (see DeNeve & Cooper, 1998).

While past research has shown that extraversion predicts psychopathology, use of emotion regulation strategies and well-being and that these relationships tend to be in the same direction as the BAS subscales, little is known about the degree to which the predictive utility of extraversion overlaps with that of the BAS subscales. Including extraversion, along with the BIS/BAS subscales, as a predictor of the chosen psychological outcome variables was expected to have one of several possible results. The BAS subscales and extraversion could both be significant predictors of the outcome variables. Although this would not have provided evidence for whether the BAS subscales or extraversion is a better measure of BAS sensitivity, it would suggest that extraversion and the BAS subscales are independent constructs. Alternatively, the BAS subscales may have no longer been significant predictors after extraversion was added to the model. This would demonstrate overlap between extraversion and the BAS subscales, and may suggest that extraversion is a better measure of BAS sensitivity, because it would be predicting outcomes which ought to be associated with BAS sensitivity better than the BAS subscales. This finding would strengthen the argument of conceptualizing extraversion as a direct reflection of BAS sensitivity.

Method

Participants

Analysis was conducted on a previously collected data set, consisting of survey data from 497 undergraduate students. It should be noted that the most complex model to be tested includes 76 parameter estimates. Thus, the design does fall short of the common recommendation that there be at least ten participants per parameter estimated. While this suggests caution is needed in interpreting fit indices for our more complex models, Jackson (2003) found that absolute sample size has a larger impact on the reliability of estimates than does the ratio of subjects to parameters.

Surveys were administered online. The majority of participants were female (83.9%) and had a mean age of 19.2 years. Participants were predominantly Caucasian (85.8%).

Measures

BIS/BAS. Carver and White's (1994) BIS/BAS scales serve as the exogenous variables within the models created. Total scores for the four subscales, BIS, Reward Responsiveness, Drive and Fun Seeking each serve as observed variables.

Extraversion. A total score from the Extraversion subscale on the Mini-International Personality Item Pool (Mini-IPIP; Donnellan, Oswald, Baird & Lucas, 2006) serves as the Extraversion variable, which is an observed variable. The Mini-IPIP is based on the Five Factor Model (Costa & McCrae, 1992), with each of the five subscales being made up of four questions and has good internal consistency (α=.77; Donnellan et al., 2006).

Internalizing. The latent variable Internalizing (INT) is made up of summed scores from the trait version of the State-Trait Anxiety Inventory, form X-2 (STAI-T; Spielberger, Gorsuch & Lushene, 1970), the Beck Depression Inventory – Second Edition (BDI; Beck, Steer & Brown, 1996), and the Negative Affect subscale of the Positive and Negative Affect Schedule – General (PANAS; Watson, Clark & Tellegen, 1988) serving as indicators.

A total score from the STAI-T was used as the Anxiety indicator. The STAI-T is a commonly used measure of trait anxiety and is made up of twenty items related to feelings of anxiety or calmness. Participants state how often they generally have the feeling listed in each item. Spielberger et al. (1970) found that the STAI-T has high internal consistency (α=.89, for undergraduates).

The Depression indicator consists of a total score from the BDI. The BDI consists of 21 items relating to symptoms of depression. The BDI was updated in 1996 to reflect the DSM-IV criteria for depression. This version of the BDI (i.e. the BDI-II) has high internal consistency (α=.92) and test-retest reliability (r=.93), which suggests that it is not sensitive to short-term variation in mood (Beck, 1996).

The Negative Affect indicator for INT was created from a total score of the Negative Affect subscale of the PANAS. The PANAS is made of 20 items, each listing a different affective state. Ten of these states are positive and ten are negative. Participants rate the degree to which they generally experience the affective state listed.

The reliability for the Negative Affect subscale of the PANAS is high (α=.89) and the test-retest reliability is considered adequate (r = .71; Watson, et al., 1988).

Externalizing. As with INT, several measures of externalizing behaviors were included in a single latent variable, Externalizing (EXT). EXT has three indicator variables: Physical Aggression, Verbal Aggression and Delinquent Behavior. The Physical Aggression and Verbal Aggression indicators were made from total scores for the Physical Aggression and Verbal Aggression subscales of the Aggression Questionnaire (Buss & Perry, 1992). The Aggression Questionnaire has 29 items and includes subscales for Anger and Hostility, in addition to the Physical and Verbal Aggression scales. The Physical Aggression and Verbal Aggression subscales have adequate internal consistency (α=.85 and α=.72, respectively; Buss & Perry, 1992). The Anger and Hostility subscales were not included in the EXT variable, as many of the items on these subscales involve holding anger in, rather than expressing anger, and thus, would not serve as good indicators of externalizing behavior.

The Delinquent Behavior indicator of EXT was made up of a total score on the Delinquent Behavior Index (Farrington & West, 1971) which contains 36 items, each of which states a delinquent behavior. For each behavior participants are asked to report whether they have participated in that behavior never, once, or more than once. This scale has demonstrated good internal consistency (α=.78; Farrington & West, 1971).

Emotion Regulation – Suppression and Reappraisal. Measures of the use of two common emotion regulation strategies were included in the model: Expressive Suppression and Cognitive Reappraisal. These serve as separate observed variables, made up of total scores for the Expressive Suppression and Cognitive Reappraisal subscales of the Emotion Regulation Questionnaire (Gross & John, 2003). This scale is made of 10 items and is designed to measure the degree to which individuals rely on expressive suppression and cognitive reappraisal to regulate their emotions. Data from multiple samples showed an average internal consistency of α=.79 for reappraisal and α=.73 for suppression (Gross & John, 2003).

Psychological Well-Being. Well-Being is the final exogenous variable in the models. The Ryff Scales of Psychological Well-Being (PWB) will be used to measure this variable (Ryff, 1989). The PWB is made up of six subscales, each designed to measure a different aspect of psychological well-being. This scale has good internal consistency, with Chronbach's alpha ranging from .86 to .93 for the individual subscales (Ryff, 1989). Past research suggests that the six subscales of the PWB do not tend to load onto a single construct, due to partial overlap between the subscales (Springer & Hauser, 2006). Because of this, a single total score across all six subscales of the PWB, was used to form a single observed variable. This approach is in line with recommendations for dealing with the PWB given by Springer, Hauser and Freese (2006), who have stated that researchers using this scale "should be far more confident in their ability to reliably assess relationships between variables and global well-being than in its specific dimensions…" (p. 1130).

The Model

In order to further investigate the predictive validity of the BIS/BAS scales, a structural equation model that uses the four BIS/BAS subscales as exogenous, observed variables, to predict measures of psychopathology, emotion regulation and psychological well-being (see Figure 1) was created. The measures of psychopathology included two latent variables, INT and EXT. INT is made up of three indicators: Anxiety, Depression

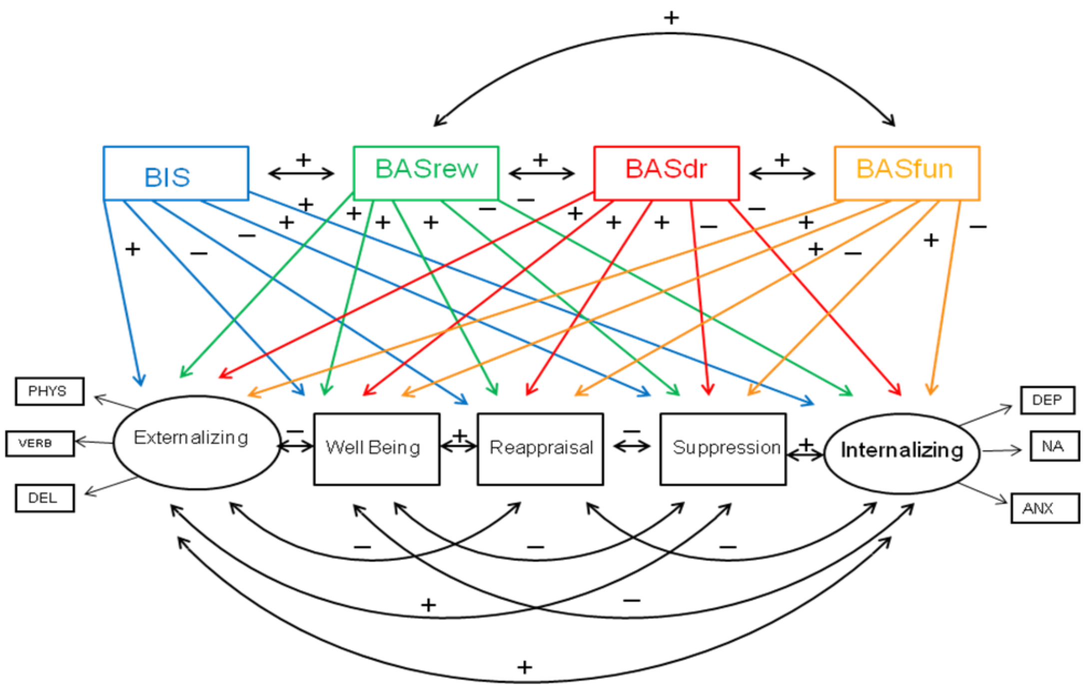


Figure 1.Diagram of model to be tested, with BIS and BAS subscales as predictors. Arrows indicate freely estimated paths. A "+" indicates a predicted positive relationship, while a "-" indicates a predicted negative relationship. BIS = Behavioral Inhibition Scale, BASrew= Reward Responsiveness, BASdr = Drive, BASfun = Fun Seeking. PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

and Negative Affect. EXT is also made up of three indicators: Physical Aggression, Verbal Aggression and Delinquent Behaviors. The emotion regulation variables are Expressive Suppression and Cognitive Reappraisal, both of which serve as observed variables. Finally, Well-Being serves as a single observed variable.

As discussed previously, the BAS subscales are generally thought of as interrelated (Carver & White, 1994). In addition, a consistent positive relationship between BIS and Reward Responsiveness has been found (Heubeck et al., 1998; Leone et al., 2001; Ross et al., 2002). Due to this, the paths between each of the BAS subscales, as well as the path between BIS and Reward Responsiveness were freely estimated. Because emotion regulation strategies have been shown to have an influence on a variety of internalizing and externalizing behaviors (Aldao & Nolen-Hoeksema, 2011; Ehring et al., 2010), as well as well-being more generally (Garnefski, Kraaij & van Etten, 2005; Hsieh, 2011; Lougheed & Hollenstein, 2012; Saxena, Dubey & Pandey, 2011; Singh & Mishra, 2011; Watson, 2008), paths from both Cognitive Reappraisal and Expressive Suppression to EXT, INT and Well-Being were also added. These paths are bidirectional, because it was expected that externalizing and internalizing behaviors, as well as general well-being, each affect frequency and type of emotion regulation. The paths between Cognitive Reappraisal (which is generally thought to be adaptive; John & Gross, 2004; Salkovskis & Campbell, 1994) and both EXT and INT were expected to be negative, while the path between Cognitive Reappraisal and Well-Being was expected to be positive. Conversely, it was predicted that paths between Expressive Suppression (overuse of which is maladaptive; John & Gross, 2004) and both EXT and INT would be positive, while the path between Expressive Suppression and Well-Being would be negative.

A negative relationship between Cognitive Reappraisal and Expressive Suppression was also expected, since individuals who use Cognitive Reappraisal more should, as a result, rely on Expressive Suppression less, and vice versa. Because EXT and INT represent psychological disturbances, I expected these variables to have a bidirectional negative relationship with Well-Being. In addition, a positive correlation between internalizing behaviors and externalizing behaviors has been found in past literature (Gilliom & Shaw, 2004; Lilienfeld, 2003). I, therefore, included bidirectional paths between INT and EXT, which I expected to be positive.

The primary goal of this study was to better understand the ability of the individual BIS/BAS subscales to predict internalizing behaviors, externalizing behaviors, psychological well-being and use of the emotion regulation strategies of cognitive reappraisal and expressive suppression. While past research led me to make some tentative predictions about relationships between individual BIS/BAS subscales and my chosen outcome variables, as these variables have never been evaluated together in one sample, the nature of the study remains fairly exploratory. In order to examine the degree to which 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, so that their parameters could be evaluated. Paths with non-significant parameter estimates ($p>.05$) were subsequently removed from the model. Parameter estimates and fit indices were then obtained for the resulting trimmed model.

Several alternative models were also created and compared to the main model. In order to assess how leaving each of the BAS subscales out of the model affects its fit and ability to predict the five outcome variables, models using only BIS and every possible pair of the three BAS subscales were created. Similarly, in order to assess how well each

BAS subscale predicts the outcome variables in the absence of the other two BAS subscales, models using only BIS and each individual BAS subscale as predictors were also created. Because researchers often use a BAS total score made from the three BAS subscales summed, a model using BIS and a BAS total score as predictors was created as well. Comparing this model to the main model, which uses the individual BAS subscales as predictors, was intended to determine whether using a BAS total score would result in a model with less ability to predict the outcome variables. To assess the predictive validity of extraversion in relation to the BIS/BAS scales, a final model was tested that was identical to the first, but with Extraversion added as a predictor. These models were assessed using the same criteria as the first model. For each of the alternative models, non-significant paths were trimmed and parameter estimates and fit indices were obtained for the resulting model.

Because of the unequal distribution of males and females in sample, the effect of including the small number of males in the sample on the outcome of the main model was tested. In order to examine this, the model was analyzed a second time using only female participants and those paths and parameter estimates that changed as a result were noted.

Data Preparation

Missing data accounted for 3.1% of observations. Mean imputation was used when a subject is missing no more than 25% of the items on a given subscale. When a subject was missing more than 25% of the items on a given subscale, the score for that subscale was counted as missing. The full information maximum likelihood method was used to handle these missing values (Muthen & Muthen, 2010).

To ensure that the findings were not driven by a few extreme observations, scores that were more than three standard deviations from their mean were recoded to the value of the nearest observation not considered an outlier (Kline, 2011). The data set was also screened for multivariate outliers, by computing the Mahalanobis distance and its associated p-value for each subject. A Bonferonni-corrected alpha level of .05, yielding a cutoff of p=.0001, for individual Mahalanobis distance scores was used. One subject qualified as a multivariate outlier based on this criterion and was excluded from analysis.

Three variables had univariate skewness with an absolute value greater than 1, including Depression (1.07), Negative Affect (1.07) and Delinquency (1.14). Additionally, Delinquency had an absolute value greater than one for kurtosis (1.14). In order to minimize the effect of non-normality on estimation I used maximum likelihood with robust standard errors, as implemented by MPLUS, to estimate parameters and fit indices.

The initial covariance matrix was ill scaled due the each of the BAS subscales having variances less than one-tenth than the largest variance. To remedy this each of the BAS subscales were rescaled by multiplying each observation by 3. The resulting covariance matrix is reproduced in Appendix A.

Evaluating Model Fit

As recommended by Kline (2011) multiple fit indices were used to evaluate model fit, including the chi-square statistic, normalized chi-square, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI) and Standardized Root Mean Residual (SRMR). A chi-square statistic associated with a p-value of greater than

.05 is typically considered an indication of good fit. However, this statistic is often not used as the primary indicator of good fit, due to its sensitivity to sample size. A normalized chi-square statistic below 2, RMSEA values below .05, CFI values above .95 and SRMR values below .08 are typically considered indications of good fit. In addition, normalized chi-square below 3, RMSEA values below .08, CFI values above .9 and SRMR values below .1 are considered indications of adequate fit. Models having one fit index indicating inadequate fit were interpreted as having some evidence of inadequate fit; those with more than one fit index indicating inadequate fit were considered to have poor fit.

Two fit indices for the comparison of non-nested models were used to compare models against one another, the Akaike information criterion (AIC) and Bayesian information criterion (BIC), with preference going to models with lower scores on the indices. Additionally, as the study is particularly interested in the predictive ability of each model, as a function of which predictors are included, special attention was paid to changes in the disturbances (residual variances) of the endogenous variables, with preference being given to models that were able to account for more variability in these variables.

After estimating each model, non-significant paths were trimmed away. This procedure was carried out for the main model tested, as well as each alternative model. At each step of this process, the path with the highest p-value was removed and the fit indices for the resulting model were consulted. A chi-squared difference score was computed for each step, in order to verify that the path just trimmed did not result in a significant reduction of model fit at the .05 level.

Results

Main Model

Most fit indices for the initial estimation of the main model, which included BIS, Reward Responsiveness, Drive and Fun Seeking as predictors of EXT, Well Being, Reappraisal, Suppression and INT suggested adequate fit, except for normalized χ^2, which was above the cutoff for adequate fit ($\chi^2(38)=125.77$, $p<.01$; $\chi^2/df = 3.31$; RMSEA = .069; CFI = .95; SRMR = .049). However, this model contained several non-significant paths, which were removed. Each step of this process and the resulting change in fit can be seen in Appendix B. As Fun Seeking was no longer a significant predictor of any of the outcome variables after trimming non-significant paths, this variable was removed from the model. The final result (Figure 2), was a model with adequate fit ($\chi^2(42) = 107.62$, $p<.01$, $\chi^2/df = 2.56$, RMSEA = .057, CFI = .96, SRMR = .051; fit indices for this and all subsequent models can be seen in Appendix C). I will subsequently refer to this trimmed model as the main model. The general improvement in the fit of this model, as opposed to the first, likely reflects the reduced complexity of the model after removing Fun Seeking as a variable, as many fit indices tend to favor models with fewer variables.

The main model included Reward Responsiveness positively predicting Well

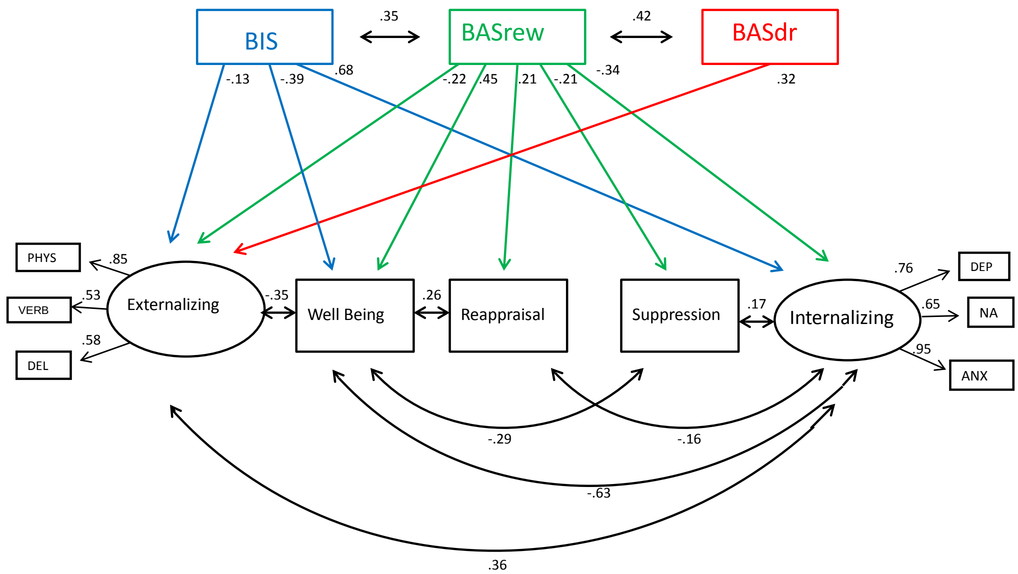


Figure 2. Main model with standardized path coefficients. BIS = Behavioral Inhibition Scale, BASrew= Reward Responsiveness, BASdr = Drive, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

Being (β = .45, b = .431, p<.01) and Reappraisal (β = .21, b = .210, p<.01), and negatively predicting EXT (β = -.22, b = -.197, p<.01), Suppression (β = -.21, b = -.169, p<.01) and INT (β = -.34, b = -.513, p<.01), and BIS negatively related to EXT (β = -.13, b = -.209, p=.019) and Well Being (β = -.39, b = -.643, p<.01), while positively predicting INT (β = .68, b = 1.821, p<.01), with Drive only significantly predicting EXT (β = .32, b = .256, p<.01). Neither Cognitive Reappraisal nor Expressive Suppression were related to EXT. Additionally, the path between Cognitive Reappraisal and Expressive Suppression was not significant. The disturbances for this and all subsequent models can be seen in Table 1.

Models Using BIS and Alternative Combinations of Two BAS Subscales

As the main model included BIS and two BAS subscales (Reward Responsiveness and Drive) as predictors, we next compared this model with models using the other possible combinations of two BAS subscales as predictors. This included

Table 1

Residual Variances for Each Model Created

Model	EXT	Well Being	Reappraisal	Suppression	INT
Main Model- BIS, Reward and Drive	.872	.767	.955	.955	.577
BIS, Reward and Fun	.937	.777	.953	.953	.591
BIS, Drive and Fun	.882	.914	.985	.985	.659
Reward and BIS as only predictors	.958	.779	.957	.955	.584
Fun and BIS as only predictors	.95	.914	.985	.985	.659
Drive and BIS as only predictors	.899	.914	-	.984	.657
Main Model – Female Subjects Only	.888	.786	.936	.964	.587
BIS with the three BAS subscales summed	.948	.905	.985	.985	.647
BIS, Reward, Drive, Fun and Extraversion	.877	.722	.944	.928	.576

Note. EXT = Externalizing, INT = Internalizing, BIS = Behavioral Inhibition Scale, Reward = Reward Responsiveness, Fun = Fun Seeking.

a model with BIS, Fun Seeking and Drive as predictors, as well as one with BIS, Reward Responsiveness and Fun Seeking as predictors. Non-significant paths were removed from these models (See Appendices D & E). The resulting models can be seen in Appendices F and G. The fit indices for both of these models suggest adequate fit ($\chi^2(42) = 132.36$, $\chi^2/df = 3.15$, RMSEA = .067, CFI = .94, SRMR = .05, for the model with BIS, Drive and Fun Seeking; $\chi^2(41) = 124.46$, $\chi^2/df = 3.05$, RMSEA = .065, CFI = .95, SRMR = .057, for the model with BIS, Reward Responsiveness and Fun Seeking) with the exception of normalized chi square, which missed the cutoff for adequate fit for both models. As seen in Appendix C, the AIC and BIC for the main model were lower for those of either of these alternative models. Additionally, the main model resulted in lower residual variances (disturbances) for EXT, Well Being and INT than in either of these alternative models.

Models Using BIS and a Single BAS Subscale as Predictors

Models using only BIS and a single subscale of BAS as predictors were also created. This included three models with different pairs of predictors, one with BIS and Reward Responsiveness (Appendix H), one with BIS and Drive (Appendix I) and one with BIS and Fun Seeking (Figure J). The non-significant paths that were removed from these models can be seen in Appendices K, L and M.

For the most part, these models each demonstrated adequate fit, with the exception of the model with BIS and Fun Seeking having a normalized chi-square above 3. The AIC and BIC for the model using BIS and Reward Responsiveness as predictors (AIC = 32308, BIC = 32492) was lower than those for either the model using BIS and Drive (AIC = 32509, BIC = 32694) or the model using BIS and Fun Seeking (AIC = 32508, BIC = 32697). Each of these models had lower AIC and BIC than the main model (AIC = 35372, BIC = 35573), which may be due, in part, to these models having fewer variables and, thus, being less complex. The main model, however, accounted for more variance in the endogenous variables than any of these smaller models. However, residual variances for Well Being, Reappraisal, Suppression, and INT were very similar for the main model and that using only BIS and Reward Responsiveness. The main model, however, accounts for more variance in EXT than the model with only BIS and Reward Responsiveness. This is due both to the inclusion of Drive to the main model, which is a significant predictor of EXT ($\beta = .32$, $b = .265$, $p<.01$), as well as, Reward Responsiveness being a being a significant negative predictor ($\beta = -.22$, $b = -.197$, $p<.01$) in the main model, but not in the model with only BIS and Reward Responsiveness as predictors.

Model Using BIS and a BAS Total Score as Predictors

A model using BIS and a single BAS variable made up of the three BAS subscales summed as predictors was also tested (Appendix N). While this BAS total model had the lowest AIC (31434) and BIC (31626) scores, it accounted for less variance in each of the five outcome variables than the main model (see Table 1). For example, although the BAS total variable in this model predicts EXT ($\beta = .12$, $b = .315$, $p=.035$), it did not account for as much variance in EXT as when Reward Responsiveness ($\beta = -.22$, $b = -.197$, $p<.01$) and Drive ($\beta = .32$, $b = .265$, $p<.01$) were included as separate predictors in the main model.

Main Model with Extraversion Added as a Predictor

Next, the effect of adding Extraversion as a predictor to our main model was tested (Figure 3). In the initial iteration of this model, paths from Extraversion to each of the outcome variables were freely estimated. The path between Extraversion and EXT, however, was not significant (β = .012, b = .018, p=.824), and was trimmed away ($\Delta\chi^2(1)$ = -.129, p = .719). The resulting model had good to adequate fit ($\chi^2(48)$ = 128.14, p<.01, χ^2/df = 2.67, RMSEA = .059, CFI = .952, SRMR = .054) and a higher AIC (37909) and BIC (38143) than the main model. In this model, Extraversion was a significant predictor of Well Being (β = .24, b = .366, p<.01), Reappraisal (β = .1, b = .158, p = .037), Suppression (β = -.16, b = -.205, p<.01) and INT (β = -.09, b = -.212, p = .024). Path estimates from the other predictor variables to the outcome variables changed only

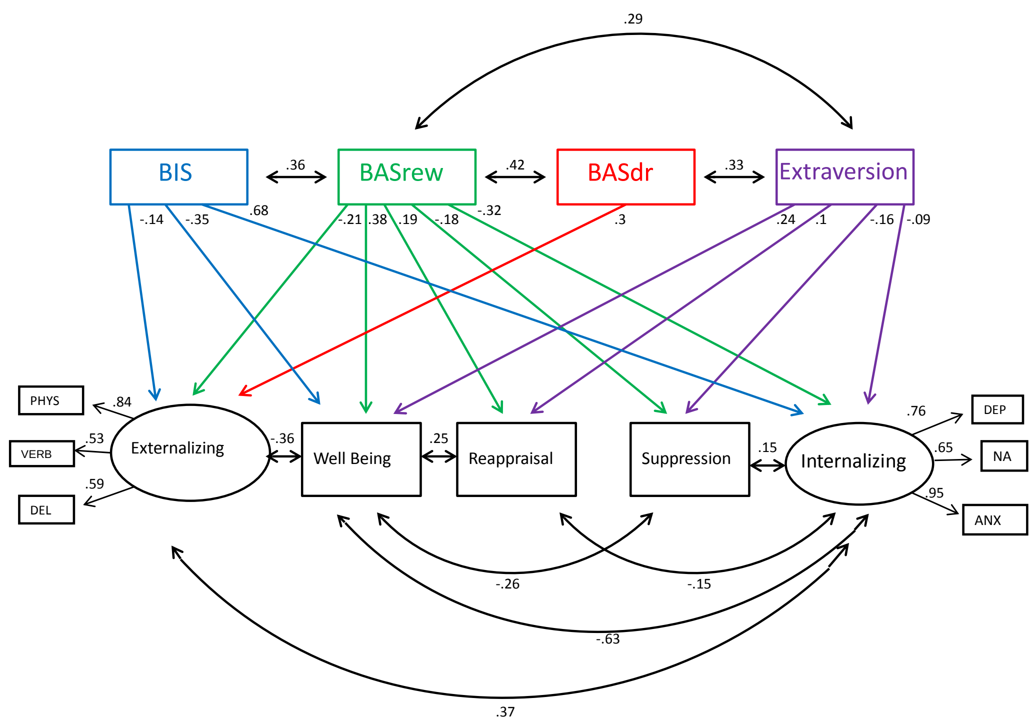


Figure 3. Model using BIS and Reward Responsiveness, Drive and Extraversion as predictors with standardized path coefficients. BIS = Behavioral Inhibition Scale, BASrew = Reward Responsiveness, BASdr = Drive, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

modestly with the inclusion of Extraversion, with the biggest change being the path from Reward Responsiveness to Well Being, which had a standardized path coefficient of .45 in the main model and of .38 when Extraversion was included.

Outcome of Main Model When Males Are Excluded

In order to assess whether the inclusion of the small number of male participants in data analysis had a substantial impact on the results of the model, the original model using BIS, Reward Responsiveness, Fun Seeking and Drive was fit to the data using only female participants. Non-significant paths that were removed can be seen in Appendix O. The resulting model (Appendix P) demonstrated adequate fit ($\chi^2(51) = 134.74$, $\chi^2/df = 2.64$, RSMEA = .063, CFI = 9.36, SRMR = .059) but does include some differences from the model that resulted from including both male and female participants (Figure 2). The path from Fun Seeking to Reappraisal, which was trimmed away when male subjects were included in the analysis ($\beta = .071$, $b = .067$, $p = .08$), was kept when male subjects were excluded ($\beta = .129$, $b = .118$, $p = .003$). Consequently, Fun Seeking was removed from the model when males were included, because it was not a significant predictor of any of the outcome variables, but was retained when males were excluded. Additionally, the path from BIS to EXT was significant when males were included ($\beta = -.132$, $b = -.209$, $p = .019$), but was trimmed from the model when males were excluded in analysis ($\beta = -.046$, $b = -.071$, $p = .443$). Excluding males from analysis also resulted in a significant path between EXT and Reappraisal ($\beta = -.142$, $b = -3.834$, $p = .012$), while this path was trimmed away when males were included ($\beta = -.096$, $b = -2.882$, $p = .053$).

Discussion

After removing non-significant paths, our main model demonstrated adequate fit on all fit indices. While this model had a higher AIC and BIC than several of the other models tested (specifically each of those using fewer variables), it accounted for more variance in the chosen outcome variables than any other model, except for the model with Extraversion added as a predictor. The surviving paths in the main model suggest that Reward Responsiveness is the best predictor of the chosen outcome variables. In fact, four of the five outcome variables (Well Being, Reappraisal, Suppression and Internalizing) were significantly predicted by Reward Responsiveness to the exclusion of the other two BAS subscales. In this model, Drive only predicts Externalizing, while Fun Seeking does not significantly predict any of the outcome variables.

The BAS is thought to be a major neural system guiding and organizing many types of behaviors. If this is the case, BAS sensitivity should have broad implications for several personality traits, as well as, several psychological outcome variables. Based on this logic, a scale that is intended to measure BAS sensitivity should predict a range of psychological outcome variables. Given that the BAS subscales appear – to some degree – to measure different constructs, it seems reasonable to ask whether one of these subscales can be considered a more central component or more pure measure of BAS sensitivity. As Reward Responsiveness significantly predicted all five of our chosen outcome variables, and did so to the exclusion of both Drive and Fun Seeking on four of these five variables, this suggests that Reward Responsiveness may be a more pure measure of BAS than the other two BAS subscales. While certainly not demonstrating this conclusively, the finding that Reward Responsiveness supersedes the other two BAS subscales on several psychological outcome variables does suggest that Reward Responsiveness may warrant particular consideration as an effective measure of BAS sensitivity.

One striking observation is the tendency for Reward Responsiveness to predict positive outcomes on each of the chosen outcome variables. As expected, Reward Responsiveness predicts less INT, as well as greater Well Being. In terms of emotion regulation, Reward Responsiveness predicts more cognitive reappraisal, which is thought to be a more effective regulation strategy, and less expressive suppression, overuse of which is generally thought to be unhealthy. Additionally, in contrast to my prediction, Reward Responsiveness predicted less EXT. Given this pattern, Reward Responsiveness is distinct from the other BAS subscales chosen in that it appears to predict outcomes generally associated with better mental health for each of the outcome variables chosen. Furthermore, for those variables that Drive and Fun Seeking predict positive outcomes, Reward Responsiveness does so better, to the extent that these relationships become non-significant when Reward Responsiveness is included in the model. This suggests the Reward Responsiveness may play a key role in the aspects of BAS sensitivity that make it a generally adaptive trait.

The negative relationship between Reward Responsiveness and EXT was an unexpected result, given the general link between BAS sensitivity and externalizing behaviors (Bijttebier et al., 2009), and specifically past research linking high BAS sensitivity with the indicators used to define Externalizing in the present study, delinquency (White et al., 1994) and aggression (Smits & Kuppens, 2005; Yu, Branje, Keusers & Meeus, 2011). It should be noted, however, that many of these studies looked only at the relationship between externalizing behaviors and BAS as a whole, rather than the facets of BAS as defined by Carver and White's scale. The different relationship between the BAS subscales and Externalizing (positive for Drive and Fun Seeking, negative for Reward Responsiveness), suggests that BAS sensitivity, as operationalized by the BIS/BAS scales, is multi-dimensional. This supports past findings that the BAS subscales may best be thought of as largely independent, related constructs (Leone et al., 2001; Ross et al., 2002). Further, this finding suggests that researchers investigating the link between BAS sensitivity and externalizing behaviors would benefit from using individual BAS subscale scores, rather than a single BAS total score.

Comparing the main model to the model in which only BIS and Reward Responsiveness were used as predictors adds another level of complexity to the relationship between EXT and Reward Responsiveness. When only BIS and Reward Responsiveness are used as predictors, Reward Responsiveness shows no relationship with EXT. It is only when Drive is added as a predictor that Reward Responsiveness becomes a significant negative predictor of EXT. Thus, it appears that certain aspects of Reward Responsiveness are protective against externalizing behavior, but that these are only evident once Drive is used as a covariate. This negative relationship between Reward Responsiveness and EXT is also present when using Fun Seeking as a covariate. Thus, it may be that in general high BAS sensitivity does confer risk for externalizing behaviors, but that high Reward Responsiveness is actually protective against externalizing behaviors once the risk conferred by general high BAS sensitivity is controlled for. This apparent ambivalent relationship between high BAS sensitivity and externalizing behaviors is in line with Corr's (2008) argument that the BAS is multidimensional in nature. The BAS is thought to mediate consummatory behaviors when reward is immediately available. This aspect of the BAS seems conceptually related to impulsivity, which may partially account for the link between high BAS sensitivity and externalizing behaviors. On the other hand, the BAS is also thought to mediate long-term goal seeking and planning, which may confer protection against externalizing behaviors, once the facets of BAS related to impulsivity have been controlled for.

While Drive only predicts EXT in the main model, when Reward Responsiveness is left out of the model, it does significantly predict higher levels of Well Being, as well as lower levels of Suppression and INT. The fact that these paths drop out of the model when Reward Responsiveness is added suggests that the variance accounted for in these three variables by Drive largely overlaps with the variance accounted for by Reward Responsiveness, and that Reward Responsiveness is ultimately a better predictor of these three outcomes, as evidenced by the higher path coefficients from Reward Responsiveness when it is used to predict these variables as opposed to Drive.

Although Fun Seeking was removed from the main model because it was not significantly predicting any of the outcome variables, we can glean some information about Fun Seeking by looking at what it predicts when it is used as a predictor in the absence of the other two BAS subscales. In this model, Fun Seeking has a positive relationship with EXT. This was expected given the general link between BAS sensitivity and externalizing behaviors, as well as the ties that Fun Seeking has with impulsivity, which is also related to externalizing behaviors. When Fun Seeking and Drive were included in the same model, however, the path between EXT and Fun Seeking fell away. This suggests that the variance accounted for by these two constructs is largely overlapping, but that Drive supersedes Fun Seeking as a predictor of EXT. This finding runs counter to my prediction the Fun Seeking would be the biggest predictor of EXT and is surprising given past research that suggests that Fun Seeking has a stronger relationship with externalizing behaviors than either Drive or Reward Responsiveness.

Nearly every model tested showed BIS predicting INT positively, as well as Well Being and EXT negatively. Given close relationship BIS has with depression (Kasch, et al. 2002; Kimbrel, et al. 2007; Muris, et al. 2005; Segarra, et al. 2007), anxiety (Bijttebier, et al. 2009; Campbell-Sills et al., 2004; Carver & White, 1994) and negative affect (Campbell-Sills et al., 2004; Coplan, et al. 2006; Erdle & Rushton, 2010; Hasler, et al. 2010), the strong link between BIS and INT, as well as the negative relationship between BIS and Well Being, were expected. While past research has linked low BIS with some externalizing behaviors, most studies have found that low BIS tends to predict hyperactivity and substance abuse, more so than behaviors like aggression and delinquency (Hundt, Kimbrel, Mitchell & Nelson-Gray, 2008; Johnson, et al. 2003; Seibert, et al. 2010), which served as indicators of the EXT variable in the current study. Therefore, while there is some intuitive appeal to the possibility that the cautious behavior that attends high BIS may provide some protection against behaviors like aggression and delinquency, the lack of this finding in other studies suggests that this interpretation should be made cautiously.

As many studies have used a single BAS total score, rather than reporting findings for individual subscales, investigating the effect that this practice may have on results is an important issue. Comparing the main model against the model using a BAS total score may be instructive in this regard. Although the AIC and BIC scores favor the BAS total score model over the main model, the BAS total score model accounts for less variance in each of the outcome variables than the main model. In fact, with the exception of EXT, parameter estimates for these models suggest that researchers would do better predicting each of the chosen outcome variables by using Reward Responsiveness alone than by using a BAS total score. The addition of Drive as a covariate, as in the main model, causes Reward Responsiveness to be a stronger predictor of Externalizing than the BAS total score as well. Based on this, researchers attempting to predict psychological outcomes should consider using and report results for each of the BAS subscales, rather than using a total score. Further, the fact that the BAS subscales predict the chosen outcome variables differently suggests that the BAS subscales, to some degree, measure different constructs. Thus, researchers will likely add greater precision to their study by using the BAS subscales individually, regardless of whether they are dealing with the specific variables used in the current study.

Another goal of this study was to investigate the relationship between Extraversion and the BAS subscales by examining how they interact when used to predict the same outcome variables in a single model. Some have suggested that extraversion is a direct personality correlate of BAS sensitivity. If this is the case, one might expect extraversion to predict the same psychological outcome variables as the BAS subscales, but to a greater degree. While extraversion did significantly predict Well Being, Reappraisal, Suppression and INT when added to the main model, it did so largely independently of Reward Responsiveness, suggesting that it was able to account for unique variance in these outcome variables. While doing little to settle which of these measures may be a more pure measure of BAS sensitivity, this does suggest that Reward Responsiveness, and Extraversion, as measured by the Mini IPIP are largely independent constructs. While this initially may seem to imply that extraversion is not as strong a candidate for a direct correlate of BAS sensitivity as initially thought, this outcome may largely reflect the way that extraversion was measured in the current study. Depue and Collins (1999) have suggested that BAS sensitivity is related to a specific facet of extraversion, known as agentic extraversion. In the current study, we used the Mini IPIP to measure extraversion, which does not allow extraversion to be separated out into individual facets. This represents a major limitation, because the use of extraversion as a whole, rather than the facet of agentic extraversion, may have masked some of the predictive ability of this variable. Future research should look at the degree to which the predictive ability of agentic extraversion compares to that of the BAS subscales, in order to get a clearer picture of the relationship between these variables.

Another potential limitation of this study is the uneven distribution of males and females in the sample. As males made up only 16% of the sample, I investigated how the inclusion of these males may have affected the overall outcome of the main model.

Excluding males from the sample did result in some substantive changes to the model, including Fun Seeking significantly predicting Reappraisal, the removal of the path from BIS to Externalizing and a significant path from Externalizing to Reappraisal being retained. While this hints at potential gender differences in the relationships represented by these paths, it is not possible to assess whether this is the case, given the small number of males in our sample. Because of this, it is impossible to know how our models may have been affected by having a sample with an equal number of males and females. Future research is needed to look at whether the relationships between the BIS/BAS scales and psychological outcome variables may be influenced by gender.

Another limitation to this study is that no behavioral or neural measures of BAS sensitivity were employed. While the ability of Reward Responsiveness to predict several psychological outcome variables better than the other BAS subscales suggests that it may be a good candidate as a more central component of BAS sensitivity, the current study did not employ any means of directly linking Reward Responsiveness to other measures of BAS sensitivity.

There are several behavioral and neural measures that have been suggested as measures of BAS sensitivity. For example, Pickering and Smillie (2008) have noted that certain types of category learning tasks are mediated by dopaminergic pathways that are thought to form the basis of the BAS, suggesting that performance on these tasks may provide a behavioral measure of BAS sensitivity. It has also been suggested that the P300 and anterior P2 components of the ERP during reward prediction may also be sensitive to dopaminergic activation associated with reward (Martin & Potts 2004;

Pickering & Smillie, 2008). Others have used fMRI to index activity in areas related to reward processing – such as the orbitofrontal cortex and nucleus accumbens – during tasks that involve reward and non-reward conditions (Cohen, Young, Baek, Kessler & Ranganath, 2005). Thus, there are several paradigms available for researchers attempting to index BAS sensitivity. The major difficulty is determining which measure or measures provide the most accurate way to assess BAS sensitivity. Future researchers should attempt to incorporate several types of measures of BAS sensitivity, along with measures of personality traits and psychological outcome variables, into single datasets. This will allow researchers to verify the usefulness of each measure by identifying those measures that have high agreement with other tasks designed to measure BAS sensitivity, while also predicting the personality traits and psychological outcome variables thought to be associated with the BAS.

Despite the challenges associated with measuring BAS sensitivity, rRST remains a promising theory. The sustained interest in this theory since Gray (1982) proposed it demonstrates its continued relevance. Arguably the most important feature of rRST is its potential to tie personality and behavior to specific neural systems. In order to capitalize on this potential, reliable and valid measures of BIS and BAS sensitivity need to be available at each level of analysis. Thus, continuing to develop and refine self-report, behavioral and neural measures of BIS and BAS sensitivity remains an important challenge. This is especially true of BAS sensitivity, as developing a valid self-report measure of it has proven more difficult than BIS sensitivity.

The results of the current study suggest that Carver and White's (1994) BAS subscales are significant predictors of several psychological outcome variables thought to be associated with BAS sensitivity. The current study, however, also suggests that there are important differences in the individual BAS subscales, such as their relationship to externalizing behaviors. Furthermore, Reward Responsiveness appears to be a stronger predictor of several outcome variables, largely displacing the other two BAS subscales when included in the same model. While being far from conclusive, these results may suggest that Reward Responsiveness is a better measure of BAS sensitivity than either Fun Seeking of Drive. In conjunction with other studies that have suggested that the BAS subscales are largely independent constructs (Leone et al., 2001; Ross et al., 2002), these results suggest that researchers using the BIS/BAS scales should consider analyzing results for the BAS subscales individually, rather than using a total score.

In addition, as there is no current gold standard for measuring BAS sensitivity, researchers should include multiple measures in their study procedures, incorporating multiple types of measures (i.e. self-report, behavioral and neural) into a single study when possible. Doing so will allow researchers to better understand the relationships between individual measures of BAS sensitivity, as well as their relationship to personality traits and psychological outcome variables that are thought to be associated with the BAS. The end goal of this process should be the valid and reliable measurement of BAS sensitivity on multiple levels of analysis. As the potential of rRST lies in its ability to tie personality and behavior to neural systems, finding valid self-report, behavioral and neural measures of BAS sensitivity that agree with one another is arguably the most important challenge in rRST research.

References

Albuquerque, I., Lima, M., Matos, M., & Figueiredo, C. (2012). Personality and subjective well-being: What hides behind global analyses? *Social Indicators Research, 105*(3), 447-460. doi: 10.1007/s11205-010-9780-7

Aldao, A., & Nolen-Hoeksema, S. (2012). When are adaptive strategies most predictive of psychopathology? *Journal of Abnormal Psychology, 121*(1), 276-281. doi: 10.1037/a0023598

Anderson, K. G., Tapert, S. F., Moadab, I., Crowley, T. J., & Brown, S. A. (2007). Personality risk profile for conduct disorder and substance use disorders in youth. *Addictive Behaviors, 32*(10), 2377-2382. doi: 10.1016/j.addbeh.2007.02.006

Beck, A.T., Steer, R.A., & Brown, G.K. (1996). *Manual for the Beck Depression Inventory-II*. San Antonio, TX: Psychological Corporation

Beevers, C. G., & Meyer, B. (2002). Lack of positive experiences and positive expectancies mediate the relationship between BAS responsiveness and depression. *Cognition and Emotion, 16*(4), 549-564. doi: 10.1080/02699930143000365

Bijttebier, P., Beck, I., Claes, L., & Vandereycken, W. (2009). Gray's reinforcement sensitivity theory as a framework for research on personality–psychopathology associations. *Clinical Psychology Review, 29*(5), 421-430. doi: 10.1016/j.cpr.2009.04.002

Buss, A. H., & Perry, M. P. (1992). The aggression questionnaire. *Journal of Personality and Social Psychology, 63*, 452-459.

Campbell-Sills, L., Barlow, D. H., Brown, T. A., & Hofmann, S. G. (2006). Acceptability and suppression of negative emotion in anxiety and mood disorders. *Emotion, 6*(4), 587-595. doi: 10.1037/1528-3542.6.4.587

Campbell-Sills, L., Liverant, G. I., & Brown, T. A. (2004). Psychometric evaluation of the behavioral Inhibition/Behavioral activation scales in a large sample of outpatients with anxiety and mood disorders. *Psychological Assessment, 16*(3), 244-254. doi: 10.1037/1040-3590.16.3.244

Carver, C. S. (2004). Negative Affects Deriving From the Behavioral Approach System. *Emotion*, *4*(1), 3-22. doi:10.1037/1528-3542.4.1.3

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67*(2), 319-333. doi: 10.1037/0022-3514.67.2.319

Caseras, X., Ávila, C., & Torrubia, R. (2003). The measurement of individual differences in behavioural inhibition and behavioural activation systems: A comparison of personality scales. *Personality and Individual Differences, 34*(6), 999-1013. doi: 10.1016/S0191-8869(02)00084-3

Cooper, A., Gomez, R., & Buck, E. (2008). The relationships between the BIS and BAS, anger and responses to anger. *Personality and Individual Differences, 44*(2), 403-413. doi: 10.1016/j.paid.2007.09.005

Coplan, R. J., Wilson, J., Frohlick, S. L., & Zelenski, J. (2006). A person-oriented analysis of behavioral inhibition and behavioral activation in children. *Personality and Individual Differences, 41*(5), 917-927. doi: 10.1016/j.paid.2006.02.019

Corr, P. J. (2008). Reinforcement sensitivity theory (RST): Introduction. In P. J. Corr (Ed.), *The reinforcement sensitivity theory of personality* (pp. 1-43). New York, NY US: Cambridge University Press. doi: 10.1017/CBO9780511819384.002

Costa, P. T., & McCrae, R. R. (1980). Influence of extraversion and neuroticism on subjective well-being: Happy and unhappy people. *Journal of Personality and Social Psychology, 38*(4), 668-678. doi: 10.1037/0022-3514.38.4.668

Costa, P. T., & McCrae, R. R. (1992). Four ways five factors are basic. *Personality and Individual Differences, 13*(6), 653-665. doi: 10.1016/0191-8869(92)90236-I

DeNeve, K. M., & Cooper, H. (1998). The happy personality: A meta-analysis of 137 personality traits and subjective well-being. *Psychological Bulletin, 124*(2), 197-229. doi: 10.1037/0033-2909.124.2.197

Depue, R. A., & Collins, P. F. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences, 22*(3), 491-569. doi: 10.1017/S0140525X99002046

DeYoung, C. G., Peterson, J. B., Séguin, J. R., & Tremblay, R. E. (2008). Externalizing behavior and the higher order factors of the big five. *Journal of Abnormal Psychology, 117*(4), 947-953. doi: 10.1037/a0013742

Donnellan, M. B., Oswald, F. L., Baird, B. M., & Lucas, R. E. (2006). The mini-IPIP scales: Tiny-yet-effective measures of the big five factors of personality. *Psychological Assessment, 18*(2), 192-203. doi: 10.1037/1040-3590.18.2.192

Ehring, T., Tuschen-Caffier, B., Schnülle, J., Fischer, S., & Gross, J. J. (2010). Emotion regulation and vulnerability to depression: Spontaneous versus instructed use of emotion suppression and reappraisal. *Emotion, 10*(4), 563-572. doi: 10.1037/a0019010

Eisenberg, N., Cumberlanc, A., Spinard, T. L., Fabes, R. A., Shepard, S. A., Reiser, M.,…Guthrie, I. K. (2001). The relations of regulation and emotionality to children's externalizing and internalizing problem behavior. *Child Development, 72*(4), 1112-34.

Erdle, S., & Rushton, J. P. (2010). The general factor of personality, BIS–BAS, expectancies of reward and punishment, self-esteem, and positive and negative affect. *Personality and Individual Differences, 48*(6), 762-766. doi: 10.1016/j.paid.2010.01.025

Eriksen, C. W. (1966). Cognitive responses to internally cued anxiety. In C. Spielberger (Ed.), *Anxiety and Behavior*. New York: Academic Press.

Eysenck, H. J. (1957). *The dynamics of anxiety and hysteria; an experimental application of modern learning theory to psychiatry*. Oxford England: Frederick A. Praeger.

Eysenck, S. B., & Eysenck, H. J. (1963). On the dual nature of extraversion. *British Journal of Social & Clinical Psychology, 2*(1), 46-55. doi: 10.1111/j.2044-8260.1963.tb00375.x

Eysenck, S. G., & Eysenck, H. J. (1970). Crime and personality: An empirical study of the three-factor theory. *British Journal of Criminology, 10*(3), 225-239.

Farrington, D. P., & West, D. J. (1971). A comparison between early delinquents and young aggressives. *British Journal of Criminology, 11,* 341–358.

Garnefski, N., Kraaij, V., & van Etten, M. (2005). Specificity of relations between adolescents' cognitive emotion regulation strategies and internalizing and externalizing psychopathology. *Journal of Adolescence, 28*(5), 619-631. doi: 10.1016/j.adolescence.2004.12.009

Gilliom, M., & Shaw, D. S. (2004). Codevelopment of externalizing and internalizing problems in early childhood. *Development and Psychopathology, 16*(2), 313-333. doi: 10.1017/S0954579404044530

Gomez, R., Cooper, A., & Gomez, A. (2000). Susceptibility to positive and negative mood states: Test of Eysenck's, Gray's and Newman's theories. *Personality and Individual Differences*, *29*(2), 351-366. doi: 10.1016/S0191-8869(99)00198-1

Graeff, F. G. (1994). Neuroanatomy and neurotransmitter regulation of defensive behaviors and related emotions in mammals. *Brazilian Journal of Medical & Biological Research, 27*, 811-829.

Gray, J. A. (1982). *The Neuropsychology of Anxiety*. Oxford: Oxford University Press.

Gray, J. A., & McNaughton, N. (1996). The neuropsychology of anxiety: Reprise. In D. A. Hope (Ed.), *Nebraska Symposium on Motivation, 1995: Perspectives on anxiety, panic, and fear*. (pp. 61-134). Lincoln, NE: University of Nebraska Press.

Gray, J. A., & McNaughton, N. (2000). *The neuropsychology of anxiety, second edition*. New York: Oxford Press Inc.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*(2), 348-362. doi: 10.1037/0022-3514.85.2.348

Gross, J. J., Sutton, S. K., & Ketelaar, T. (1998). Relations between affect and personality: Support for the affect-level and affective reactivity views. *Personality and Social Psychology Bulletin, 24*(3), 279-288. doi: 10.1177/0146167298243005

Gutiérrez, J. L. G., Jiménez, B. M., Hernández, E. G., & Puente, C. P. (2005). Personality and subjective well-being: Big five correlates and demographic variables. *Personality and Individual Differences, 38*(7), 1561-1569. doi: 10.1016/j.paid.2004.09.015

Hasking, P. A. (2007). Reinforcement sensitivity, coping, and delinquent behaviour in adolescents. *Journal of Adolescence, 30*(5), 739-749. doi: 10.1016/j.adolescence.2006.11.006

Hasler, B. P., Allen, J. J. B., Sbarra, D. A., Bootzin, R. R., & Bernert, R. A. (2010). Morningness–eveningness and depression: Preliminary evidence for the role of the behavioral activation system and positive affect. *Psychiatry Research, 176*(2–3), 166-173. doi: 10.1016/j.psychres.2009.06.006

Hermes, M., Hagemann, D., Naumann, E., & Walter, C. (2011). Extraversion and its positive emotional core—Further evidence from neuroscience. *Emotion, 11*(2), 367-378. doi: 10.1037/a0021550

Heubeck, B. G., Wilkinson, R. B., & Cologon, J. (1998). A second look at carver and white's (1994) BIS/BAS scales. *Personality and Individual Differences, 25*(4), 785-800. doi: 10.1016/S0191-8869(98)00124-X

Hirschfeld, R. M., Klerman, G. L., Lavori, P., & Keller, M. B. (1989). Premorbid personality assessments of first onset of major depression. *Archives of General*

Psychiatry, 46(4), 345-350. doi: 10.1001/archpsyc.1989.01810040051008

Howell, R. T., & Rodzon, K. S. (2011). An exploration of personality–affect relations in daily life: Determining the support for the affect-level and affect-reactivity views. *Personality and Individual Differences, 51*(7), 797-801. doi: 10.1016/j.paid.2011.06.020

Hsieh, M. (2011). The relations among emotion regulation strategies, self-concept, and adolescents' problem behaviors. *Dissertation Abstracts International Section A: Humanities and Social Sciences, 71*(7-A).

Hundt, N. E., Kimbrel, N. A., Mitchell, J. T., & Nelson-Gray, R. O. (2008). High BAS, but not low BIS, predicts externalizing symptoms in adults. *Personality and Individual Differences, 44*(3), 565-575. doi: 10.1016/j.paid.2007.09.018

John, O. P., Caspi, A., Robins, R. W., & Moffitt, T. E. (1994). The 'little five': Exploring the nomological network of the five-factor model of personality in adolescent boys. *Child Development, 65*(1), 160-178. doi: 10.2307/1131373

John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation: Personality processes, individual differences, and life span development. *Journal of Personality, 72*(6), 1301-1333. doi: 10.1111/j.1467-6494.2004.00298.x

Johnson, S. L., Turner, R. J., & Iwata, N. (2003). BIS/BAS levels and psychiatric disorder: An epidemiological study. *Journal of Psychopathology and Behavioral Assessment, 25*(1), 25-36. doi: 10.1023/A:1022247919288

Jones, S. E., Miller, J. D., & Lynam, D. R. (2011). Personality, antisocial behavior, and aggression: A meta-analytic review. *Journal of Criminal Justice, 39*(4), 329-337.

doi: 10.1016/j.jcrimjus.2011.03.004

Jones, S., & Day, C. (2008). Self appraisal and behavioural activation in the prediction of hypomanic personality and depressive symptoms. *Personality and Individual Differences, 45*(7), 643-648. doi: 10.1016/j.paid.2008.07.008

Jorm, A. F., Christensen, H., Henderson, A. S., Jacomb, P. A., Korten, A. E., & Rodgers, B. (1999). Using the BIS/BAS scales to measure behavioural inhibition and behavioural activation: Factor structure, validity and norms in a large community sample. *Personality and Individual Differences, 26*(1), 49-58. doi: 10.1016/S0191-8869(98)00143-3

Jorm, A. F., Christensen, H., Henderson, A. S., Jacomb, P. A., Korten, A. E., & Rodgers, B. (2000). Predicting anxiety and depression from personality: Is there a synergistic effect of neuroticism and extraversion? *Journal of Abnormal Psychology*, *109*(1), 145-149. doi: 10.1037/0021-843X.109.1.145

Jylhä, P., & Isometsä, E. (2006). The relationship of neuroticism and extraversion to symptoms of anxiety and depression in the general population. *Depression and Anxiety*, *23*(5), 281-289. doi: 10.1002/da.20167

Kasch, K. L., Rottenberg, J., Arnow, B. A., & Gotlib, I. H. (2002). Behavioral activation and inhibition systems and the severity and course of depression. *Journal of Abnormal Psychology, 111*(4), 589-597. doi: 10.1037/0021-843X.111.4.589

Kendler, K. S., Neale, M. C., Kessler, R. C., & Heath, A. C. (1993). A longitudinal twin study of personality and major depression in women. *Archives of General Psychiatry*, *50*(11), 853-862. doi: 10.1001/archpsyc.1993.01820230023002

Kimbrel, N. A., Nelson-Gray, R., & Mitchell, J. T. (2007). Reinforcement sensitivity and maternal style as predictors of psychopathology. *Personality and Individual Differences, 42*(6), 1139-1149. doi: 10.1016/j.paid.2006.06.028

Kline, R. B., (2011). *Principles and practice of structural equation modeling, third edition*. New York, NY: Guilford Press.

Krueger, R. F., & Markon, K. E. (2006). Reinterpreting comorbidity: A model-based approach to understanding and classifying psychopathology. *Annual Review of Clinical Psychology, 2*, 111-133. doi: 10.1146/annurev.clinpsy.2.022305.095213

Krueger, R. F., Markon, K. E., Patrick, C. J., Benning, S. D., & Kramer, M. D. (2007). Linking antisocial behavior, substance use, and personality: An integrative quantitative model of the adult externalizing spectrum. *Journal of Abnormal Psychology, 116*(4), 645-666. doi: 10.1037/0021-843X.116.4.645

Krueger, R. F., McGue, M., & Iacono, W. G. (2001). The higher-order structure of common DSM mental disorders: Internalization, externalization, and their connections to personality. *Personality and Individual Differences, 30*(7), 1245-1259. doi: 10.1016/S0191-8869(00)00106-9

Krueger, R. F., & Tackett, J. L. (2003). Personality and psychopathology: Working toward the bigger picture. *Journal of Personality Disorders, 17*(2), 109-128. doi: 10.1521/pedi.17.2.109.23986

Kushner, S. C., Tackett, J. L., & Bagby, R. M. (2012). The structure of internalizing disorders in middle childhood and evidence for personality correlates. *Journal of Psychopathology and Behavioral Assessment, 34*(1), 22-34. doi: 10.1007/s10862-

011-9263-4

Larsen, R. J., & Ketelaar, T. (1991). Personality and susceptibility to positive and negative emotional states. *Journal of Personality and Social Psychology, 61*(1), 132-140. doi: 10.1037/0022-3514.61.1.132

Leone, L. (2009). Testing conceptual distinctions among carver and white's (1994) BAS scales: A comment and extension on Smillie, Jackson, and Dalgleish (2006). *Personality and Individual Differences,46*(1), 54-59. doi: 10.1016/j.paid.2008.09.004

Leone, L., Perugini, M., Bagozzi, R. P., Pierro, A., & Mannetti, L. (2001). Construct validity and generalizability of the Carver-White Behavioural Inhibition System/Behavioural Activation System scales. *European Journal of Personality, 15*(5), 373-390. doi: 10.1002/per.415

Leone, L., & Russo, P. M. (2009). Components of the behavioral activation system and functional impulsivity: A test of discriminant hypotheses. *Journal of Research in Personality, 43*(6), 1101-1104. doi: 10.1016/j.jrp.2009.08.004

Lilienfeld, S. O. (2003). Comorbidity between and within childhood externalizing and internalizing disorders: Reflections and directions. *Journal of Abnormal Child Psychology, 31*(3), 285-291. doi: 10.1023/A:1023229529866

Lougheed, J. P., & Hollenstein, T. (2012). A limited repertoire of emotion regulation strategies is associated with internalizing problems in adolescence. *Social Development, 21*(4), 704-721. doi: 10.1111/j.1467-9507.2012.00663.x

Lucas, R. E., & Fujita, F. (2000). Factors influencing the relation between extraversion and pleasant affect. *Journal of Personality and Social Psychology*, *79*(6), 1039-1056. doi: 10.1037/0022-3514.79.6.1039

Lykken, D. T. (1995). *The antisocial personalities*. Hillsdale, NJ England: Lawrence Erlbaum Associates, Inc.

Martin, L. E., & Potts, G. F. (2004). Reward sensitivity in impulsivity. *NeuroReport: For Rapid Communication of Neuroscience Research*, *15*(9), 1519-1522. doi: 10.1097/01.wnr.0000132920.12990.b9

McCrae, R. R., & Costa, P. T. (1991). Adding liebe und arbeit: The full five-factor model and well-being. *Personality and Social Psychology Bulletin, 17*(2), 227-232. doi: 10.1177/014616729101700217

Miller, J. D., & Lynam, D. (2001). Structural models of personality and their relation to antisocial behavior: A meta-analytic review. *Criminology*, *39*(4), 765-798. doi: 10.1111/j.1745-9125.2001.tb00940.x

Miller, N. E. (1959). Liberalization of basic S-R concepts: Extensions to conflict behavior, motivation and social learning. In S. Kock (Ed.), *Psychology: A Study of Science*, *Study 1, Vol. 2* (pp. 196-292). McGraw-Hill, New York.

Moore, S. A., Zoellner, L. A., & Mollenholt, N. (2008). Are expressive suppression and cognitive reappraisal associated with stress-related symptoms? *Behaviour Research and Therapy, 46*(9), 993-1000. doi: 10.1016/j.brat.2008.05.001

Muthen, L.K. and Muthen, B.O. (2010). *Mplus User's Guide, Sixth Edition*. Los Angeles, CA: Muthen & Muthen.

Muris, P., Meesters, C., de Kanter, E., & Timmerman, P. E. (2005). Behavioural

Inhibition and Behavioural Activation System scales for children: Relationships with Eysenck's personality traits and psychopathological symptoms. *Personality and Individual Differences, 38*(4), 831-841. doi: 10.1016/j.paid.2004.06.007

Nelis, D., Kotsou, I., Quoidbach, J., Hansenne, M., Weytens, F., Dupuis, P., & Mikolajczak, M. (2011). Increasing emotional competence improves psychological and physical well-being, social relationships, and employability. *Emotion, 11*(2), 354-366. doi: 10.1037/a0021554

Nemanick, R. C. J., & Munz, D. C. (1997). Extraversion and neuroticism, trait mood, and state affect: A hierarchical relationship? *Journal of Social Behavior & Personality, 12*(4), 1079-1092.

Newman, J. P., MacCoon, D. G., Vaughn, L. J., & Sadeh, N. (2005). Validating a distinction between primary and secondary psychopathy with measures of gray's BIS and BAS constructs. *Journal of Abnormal Psychology, 114*(2), 319-323. doi: 10.1037/0021-843X.114.2.319

Ng, W., & Diener, E. (2009). Personality differences in emotions: Does emotion regulation play a role? *Journal of Individual Differences, 30*(2), 100-106. doi: 10.1027/1614-0001.30.2.100

Ominsky, M., & Kimble, G. A. (1966). Anxiety and eyelid conditioning. *Journal of Experimental Psychology, 71*(3), 471-472. doi: 10.1037/h0022981

Pickering, A. D., & Smillie, L. D. (2008). The behavioural activation system: Challenges and opportunities. In P. J. Corr (Ed.), *The reinforcement sensitivity theory of personality* (pp. 120-154). New York, NY US: Cambridge University Press. doi:

10.1017/CBO9780511819384.005

Poythress, N. G., & Hall, J. R. (2011). Psychopathy and impulsivity reconsidered. *Aggression and Violent Behavior, 16*(2), 120-134. doi: 10.1016/j.avb.2011.02.003

Rath, S. (1978). Some personality correlates along anxiety, extraversion and neuroticism dimensions. *Asian Journal of Psychology & Education, 3*(3), 46-51.

Revelle, W. (1995). Personality processes. *Annual Review of Psychology, 46*, 295-328. doi: 10.1146/annurev.ps.46.020195.001455

Ross, S. R., Millis, S. R., Bonebright, T. L., & Bailley, S. E. (2002). Confirmatory factor analysis of the behavioral inhibition and activation scales. *Personality and Individual Differences, 33*(6), 861-865. doi: 10.1016/S0191-8869(01)00196-9

Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology, 57*(6), 1069-1081. doi: 10.1037/0022-3514.57.6.1069

Salkovskis, P. M., & Campbell, P. (1994). Thought suppression induces intrusion in naturally occurring negative intrusive thoughts. *Behaviour Research and Therapy*, 32(1), 1-8. doi: 10.1016/0005-7967(94)90077-9

Saxena, P., Dubey, A., & Pandey, R. (2011). Role of emotion regulation difficulties in predicting mental health and well-being. *Journal of Projective Psychology & Mental Health, 18*(2), 147-155.

Segarra, P., Ross, S. R., Pastor, M. C., Montañés, S., Poy, R., & Moltó, J. (2007). MMPI-2 predictors of Gray's two-factor reinforcement sensitivity theory. *Personality and*

Individual Differences, 43(3), 437-448. doi: 10.1016/j.paid.2006.12.013

Seibert, L. A., Miller, J. D., Pryor, L. R., Reidy, D. E., & Zeichner, A. (2010). Personality and laboratory-based aggression: Comparing the predictive power of the five-factor model, BIS/BAS, and impulsivity across context. *Journal of Research in Personality, 44*(1), 13-21. doi: 10.1016/j.jrp.2009.09.003

Sellbom, M., & Phillips, T. R. (2012). An examination of the triarchic conceptualization of psychopathy in incarcerated and nonincarcerated samples. *Journal of Abnormal Psychology,* doi: 10.1037/a0029306

Singh, S., & Mishra, R. C. (2011). Emotion regulation strategies and their implications for well-being. *Social Science International, 27*(2), 179-198.

Smillie, L. D., Cooper, A. J., Wilt, J., & Revelle, W. (2012). Do extraverts get more bang for the buck? Refining the affective-reactivity hypothesis of extraversion. *Journal of Personality and Social Psychology, 103*(2), 306-326. doi: 10.1037/a0028372

Smillie, L. D., & Jackson, C. J. (2006). Functional impulsivity and reinforcement sensitivity theory. *Journal of Personality, 74*(1), 47-83. doi: 10.1111/j.1467-6494.2005.00369.x

Smillie, L. D., Jackson, C. J., & Dalgleish, L. I. (2006). Conceptual distinctions among Carver and White's (1994) BAS scales: A reward-reactivity versus trait impulsivity perspective. *Personality and Individual Differences, 40*(5), 1039-1050. doi: 10.1016/j.paid.2005.10.012

Smits, D. J. M., & Kuppens, P. (2005). The relations between anger, coping with anger, and aggression, and the BIS/BAS system. *Personality and Individual Differences,* *39*(4), 783-793. doi: 10.1016/j.paid.2005.02.023

Spielberger, C., Gorsuch, R. and Lushene, R. (1970) *Manual for the State–Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologist Press.

Springer, K. W., & Hauser, R. M. (2006). An assessment of the construct validity of Ryff's Scales of Psychological Well-Being: Method, mode, and measurement effects. *Social Science Research, 35*(4), 1080-1102. doi: 10.1016/j.ssresearch.2005.07.004

Springer, K. W., Hauser, R. M., & Freese, J. (2006). Bad news indeed for Ryff's six-factor model of well-being. *Social Science Research, 35*(4), 1120-1131. doi: 10.1016/j.ssresearch.2006.01.003

Suhr, J. A., & Tsanadis, J. (2007). Affect and personality correlates of the Iowa gambling task. *Personality and Individual Differences, 43*(1), 27-36. doi: 10.1016/j.paid.2006.11.004

Tull, M. T., Gratz, K. L., Latzman, R. D., Kimbrel, N. A., & Lejuez, C. W. (2010). Reinforcement sensitivity theory and emotion regulation difficulties: A multimodal investigation. *Personality and Individual Differences, 49*(8), 989-994. doi: 10.1016/j.paid.2010.08.010

Trull, T. J., & Sher, K. J. (1994). Relationship between the Five-Factor Model of personality and axis I disorders in a nonclinical sample. *Journal of Abnormal Psychology, 103*(2), 350-360. doi: 10.1037/0021-843X.103.2.350

Verduyn, P., & Brans, K. (2012). The relationship between extraversion, neuroticism and aspects of trait affect. *Personality and Individual Differences, 52*(6), 664-669. doi: 10.1016/j.paid.2011.12.017

Voigt, D. C., Dillard, J. P., Braddock, K. H., Anderson, J. W., Sopory, P., & Stephenson, M. T. (2009). BIS/BAS scales and their relationship to risky health behaviours. *Personality and Individual Differences, 47*(2), 89-93. doi: 10.1016/j.paid.2009.02.003

Wang, L., Shi, Z., & Li, H. (2009). Neuroticism, extraversion, emotion regulation, negative affect and positive affect: The mediating roles of reappraisal and suppression. *Social Behavior and Personality, 37*(2), 193-194. doi: 10.2224/sbp.2009.37.2.193

Watson, D., & Clark, L. A. (1997). Extraversion and its positive emotional core. In R. Hogan, J. A. Johnson & S. R. Briggs (Eds.), Handbook of personality psychology (pp. 767-793). San Diego, CA: Academic Press. doi: 10.1016/B978-012134645-4/50030-5

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063-1070. doi: 10.1037/0022-3514.54.6.1063

Watson, E. B. (2008). Emotion regulation in affluent adolescents: Investigating the relationship between regulation and functioning. *Dissertation Abstracts International: Section B: The Sciences and Engineering, 68*(9-B).

White, J. L., Moffitt, T. E., Caspi, A., Bartusch, D. J., Needles, D. J., & Stouthamer-Loeber, M. (1994). Measuring impulsivity and examining its relationship to delinquency. *Journal of Abnormal Psychology, 103*(2), 192-205. doi: 10.1037/0021-843X.103.2.192

Willem, L., Bijttebier, P., Claes, L., & Uytterhaegen, A. (2012). Temperament and problematic alcohol use in adolescence: An examination of drinking motives as mediators. *Journal of Psychopathology and Behavioral Assessment, 34*(2), 282-292. doi: 10.1007/s10862-012-9279-4

Wilson, G. D., Gray, J. A., & Barrett, P. T. (1990). A factor analysis of the Gray-Wilson personality questionnaire. *Personality and Individual Differences, 11*(10), 1037-1045. doi: 10.1016/0191-8869(90)90131-A

Yu, R., Branje, S. J. T., Keusers, L., & Meeus, W. H. J. (2011). Psychometric characteristics of Carver and White's BIS/BAS scales in Dutch adolescents and their mothers. *Journal of Personality Assessment, 93*(5), 500-507. doi: 10.1080/00223891.2011.595745

Appendix A

Covariance Matrix with Variances on Diagonal.

	Anxiety	DEP	NA	WB	PA	VA	DEL	REAP	SUPP	BIS	Reward	DRIVE	Fun
Anxiety	95.075												
DEP	52.696	54.967											
NA	37.809	23.963	39.937										
WB	-37.589	-24.379	-17.333	34.162									
PA	8.894	7.398	7.293	-10.857	41.9								
VA	1.377	1.161	2.189	-0.459	11.168	13.428							
DEL	8.421	8.906	7.294	-9.339	24.366	6.204	56.654						
REAP	-11.29	-7.001	-4.107	11.6	-4.233	0.342	-3.833	35.672					
SUPP	7.49	7.124	2.406	-9.36	3.836	-2.156	4.277	-0.929	22.899				
BIS	18.743	9.125	8.344	-5.014	-3.489	-1.531	-4.798	0.031	-0.836	11.83			
Reward	-5.242	-6.284	-1.986	11.071	-4.942	0.729	-4.429	7.596	-6.103	7.019	36.2		
Drive	-6.359	-3.338	-1.918	5.673	7.642	6.926	6.611	2.112	-3.926	-0.379	16.433	42.802	
Fun	-11.654	-4.484	-4.722	6.578	3.083	3.503	10.11	4.573	-3.694	-3.163	13.133	16.986	40.42

Note. Variance and covariances reflect those obtained after Reward Responsiveness, Drive and Fun Seeking were scaled, by multiplying each value in those subscales by 3. DEP = Depression, NA = Negative Affect, WB = Well-Being, PA = Physical Aggression, VA = Verbal Aggression, DEL = Delinquency, REAP = Reappraisal, SUPP = Suppression, BIS = Behavioral Inhibition Scale, Reward = Reward Responsiveness, Fun = Fun Seeking.

Appendix B

Paths Removed from Main Model with Corresponding Parameter Estimates and χ^2 Difference Tests

Step	Path Removed	β	b, p-value	χ^2	df	χ^2/df	$\Delta\chi^2$, p-value
Original				125.77	38	3.310	
1	BIS to Suppression	.005	.008, .917	125.631	39	3.221	-0.139, .709
2	Reappraisal With Suppression	.015	.395, .769	125.331	40	3.133	-0.3, 584
3	Fun Seeking to Internalizing	.018	.026, .704	125.071	41	3.051	-0.26, .610
4	Fun Seeking to Well Being	-.019	-.018, .625	125.041	42	2.977	-0.03, .862
5	Drive to Suppression	-.027	-.019, .632	124.969	43	2.906	-0.072, .788
6	Fun Seeking to Suppression	-.064	-.048, .190	126.556	44	2.876	1.587, .208
7	BIS to Reappraisal	-.073	-.127, .184	128.131	45	2.847	1.575, .209
8	Drive to Reappraisal	-.069	-.063, .193	129.816	46	2.822	1.685, .194
9	Drive to Well Being	-.051	-.045, .229	131.303	47	2.794	1.487, .223
10	Drive to Internalizing	.032	.045, .336	132.306	48	2.756	1.003, .317
11	Fun Seeking to Externalizing	.086	.073, .113	134.763	49	2.750	2.457, .117
12	Fun Seeking to Reappraisal, Fun Seeking Removed from Model	.071	.067, .080	100.424	40	2.511	-34.339, <.01
13	Externalizing with Reappraisal	-.096	-2.882, .053	103.843	41	2.533	3.419, .0644
14	Externalizing with Suppression	.110	2.655, .055	107.620	42	2.562	3.777, .052

Note. β = standardized path coefficient for path removed; b, p-value = non-standardized path coefficient for path removed, with associate p-value; χ^2 = chi-squared statistic associated with model after removal of path; df = degrees of freedom after removal of path; χ^2/df = normalized chi-square after removal of path; $\Delta\chi^2$, p-value = chi-square difference test for path removed, with associated p-value, BIS = Behavioral Inhibition Scale.

Appendix C

Fit Indices for Each Model Created After Removal of Non-Significant Paths

Model Predictors	χ^2	df	χ^2 p-value	χ^2/df	RMSEA	CFI	SRMR	AIC	BIC
BIS, Reward and Drive (Main Model)	107.620	42	p<.01	2.562	.057	.96	.051	35372.33	35573.17
BIS, Reward and Fun	124.463	41	p<.01	3.036	.065	.948	.057	35385.02	35590.05
BIS, Drive and Fun	132.357	42	p<.01	3.151	.067	.942	.050	35593.32	35794.15
Reward and BIS	88.028	33	p<.01	2.67	.059	.965	.049	32308.65	32492.75
Fun and BIS	115.021	32	p<.01	3.59	.073	.945	.048	32508.37	32696.66
Drive and BIS	95.543	33	p<.01	2.90	.063	.959	.044	32509.93	32694.03
BIS, Reward and Drive (Main Model – Female Subjects Only)	134.743	51	p<.01	2.64	.063	.936	.059	32299.74	32512.47
BIS with the three BAS subscales summed	105.234	31	p<.01	3.395	.07	.951	.044	31434.47	31626.94
BIS, Reward, Drive, Fun and Extraversion	128.141	48	p<.01	2.67	.059	.952	.054	37909.26	38143.57

Note. χ^2 = chi-square statistic, df = degrees of freedom, χ^2 p-value = p-value associate with chi-square statistic, RMSEA = Root Mean Square Error of Approximation, CFI = Comparative Fit Index, SRMR = Standardized Root Mean Square Residual, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, BIS = Behavioral Inhibition Scale, Reward = Reward

Appendix D

Paths Removed from Model Using BIS, Fun Seeking and Drive as Predictors with Corresponding Parameter Estimates and χ^2 Difference Tests

Step	Path Removed	β	b, p-value	χ^2	df	χ^2/df	$\Delta\chi^2$, p-value
Original				125.192	34	3.682	
1	Drive to Reappraisal	.005	.004, .924	125.120	35	3.575	-0.072, .788
2	Suppression to Reappraisal	-.017	-.463, .739	124.739	36	3.465	-0.381, .537
3	BIS to Reappraisal	.019	.034, .687	124.699	37	3.37	-0.04, .841
4	Fun Seeking to Externalizing	.028	.024, .640	124.730	38	3.282	0.031, .860
5	Drive to Internalizing	-.054	-.076, .188	126.586	39	3.246	1.856, .173
6	Drive to Suppression	-.053	-.073, .160	128.365	40	3.209	1.779, .182
7	Drive to Well Being	.048	.043, .161	130.270	41	3.177	1.905, .167
8	BIS to Suppression	-.070	-.097, .139	132.357	42	3.151	2.087, .149

Note. β = standardized path coefficient for path removed; b, p-value = non-standardized path coefficient for path removed, with associate p-value; χ^2 = chi-squared statistic associated with model after removal of path; df = degrees of freedom after removal of path; χ^2/df = normalized chi-square after removal of path; $\Delta\chi^2$, p-value = chi-square difference test for path removed, with associated p-value, BIS = Behavioral Inhibition Scale.

Appendix E

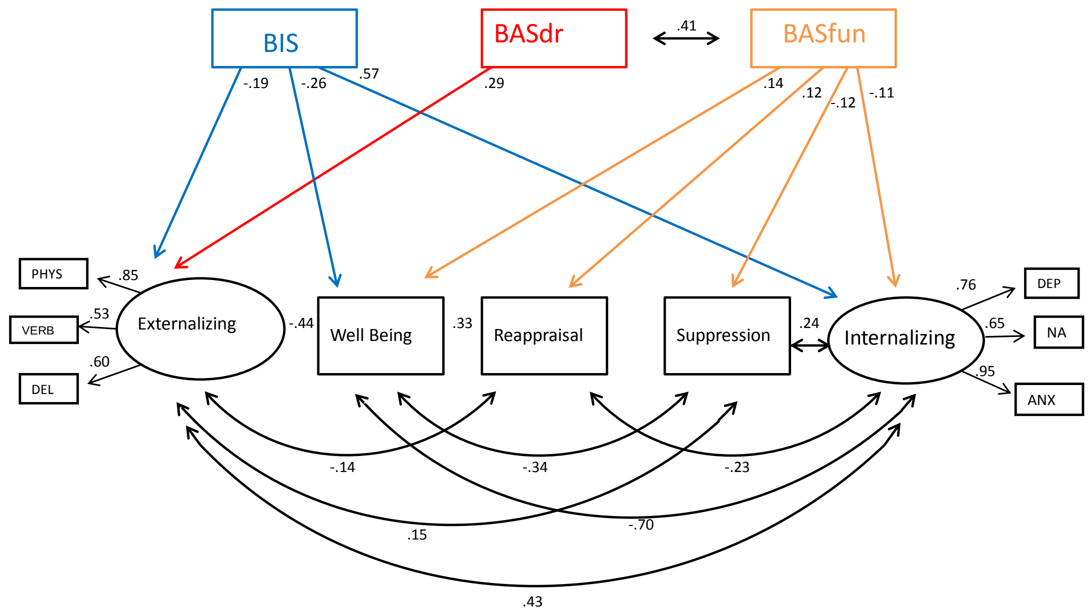
Paths Removed from Model Using BIS, Reward and Fun Seeking as Predictors with Corresponding Parameter Estimates and χ^2 Difference Tests

Step	Path Removed	β	b, p-value	χ^2	df	χ^2/df	$\Delta\chi^2$, p-value
Original				115.263	33	3.493	
1	BIS to Suppression	.008	.012, .872	115.144	34	3.387	-0.119, .73
2	Reappraisal to Suppression	.016	.441, .742	114.879	35	3.282	-0.265, 607
3	Fun Seeking to Reappraisal	.034	.032, .453	116.01	36	3.22	1.131, .288
4	Fun Seeking to Internalizing	.039	.056, .387	116.358	37	3.145	0.348, .555
5	Fun Seeking to Well Being	-.03	-.027, .426	116.774	38	3.073	0.416, .519
6	Fun Seeking to Suppression	-.073	-.055, .126	119.011	39	3.052	2.237, .135
7	Externalizing with Suppression	.106	2.661, .071	122.170	40	3.054	3.159, .076
8	BIS to Reappraisal	-.079	-.138, .119	124.463	41	3.036	2.293, .130

Note. β = standardized path coefficient for path removed; b, p-value = non-standardized path coefficient for path removed, with associate p-value; χ^2 = chi-squared statistic associated with model after removal of path; df = degrees of freedom after removal of path; χ^2/df = normalized chi-square after removal of path; $\Delta\chi^2$, p-value = chi-square difference test for path removed, with associated p-value, BIS = Behavioral Inhibition Scale.

Appendix F

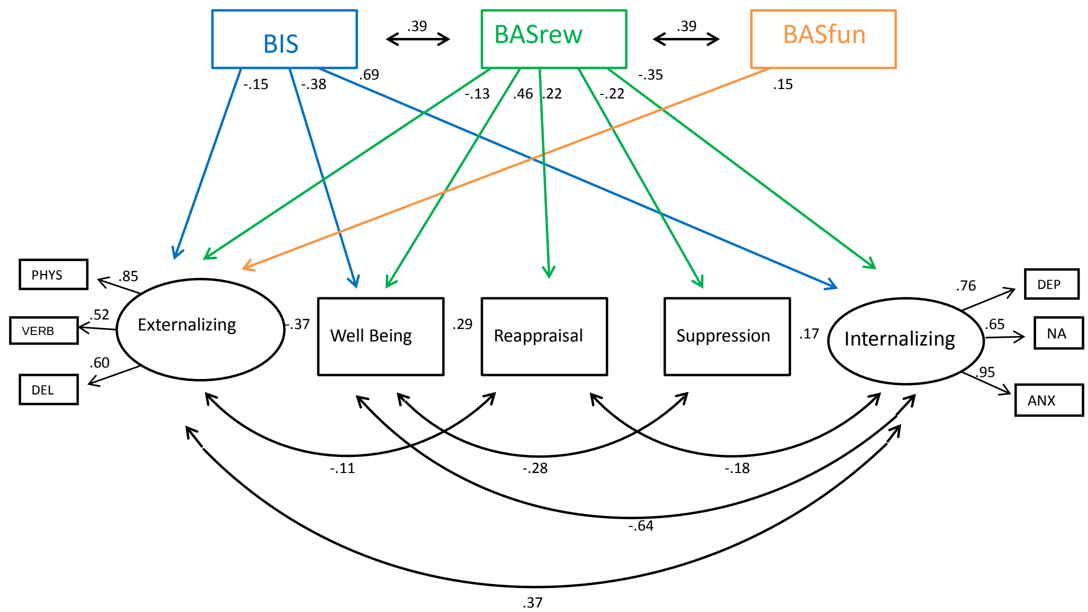
Model using BIS, Drive and Fun Seeking as predictors with standardized path coefficients.



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.

Appendix G

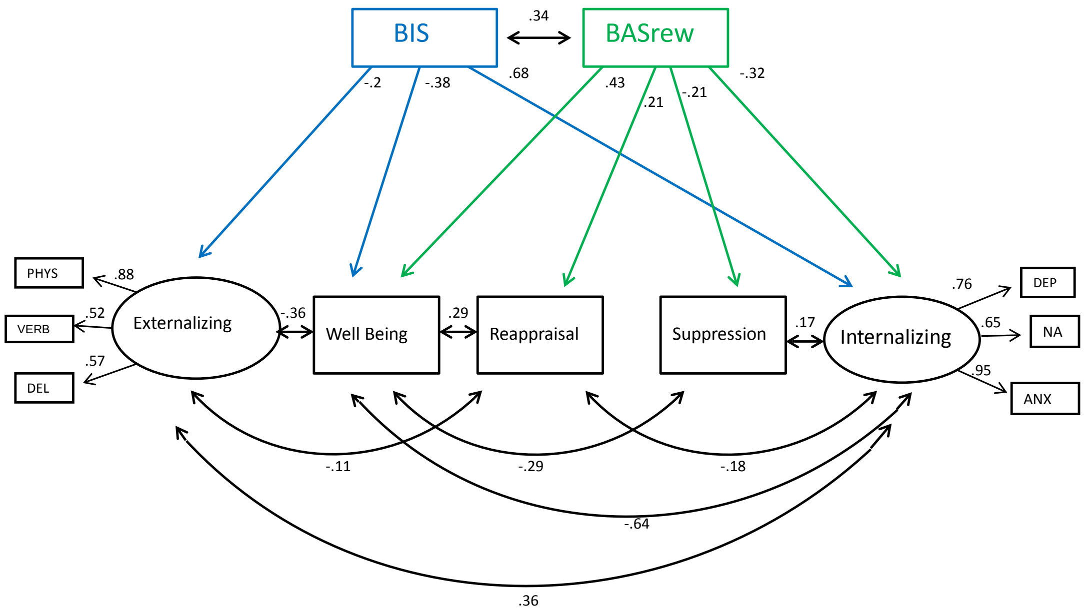
Model using BIS, Drive and Reward Responsiveness as predictors with standardized path coefficients.



BIS = Behavioral Inhibition Scale, BASrew= Reward Responsiveness, BASfun = Fun Seeking, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

Appendix H.

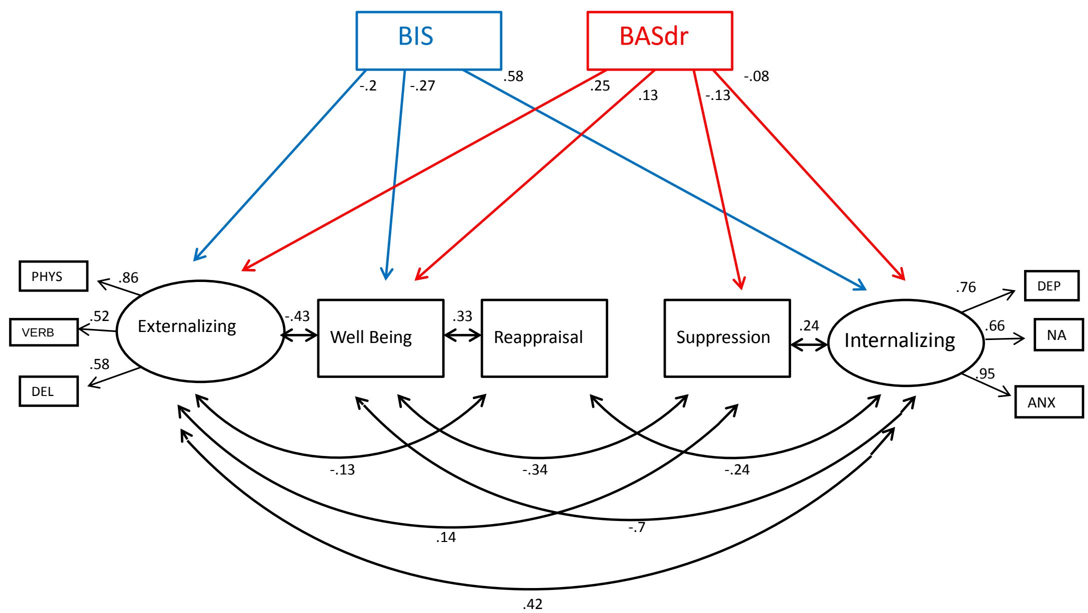
Model using BIS and Reward as predictors with standardized path coefficients.



BASrew= Reward Responsiveness, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

Appendix I

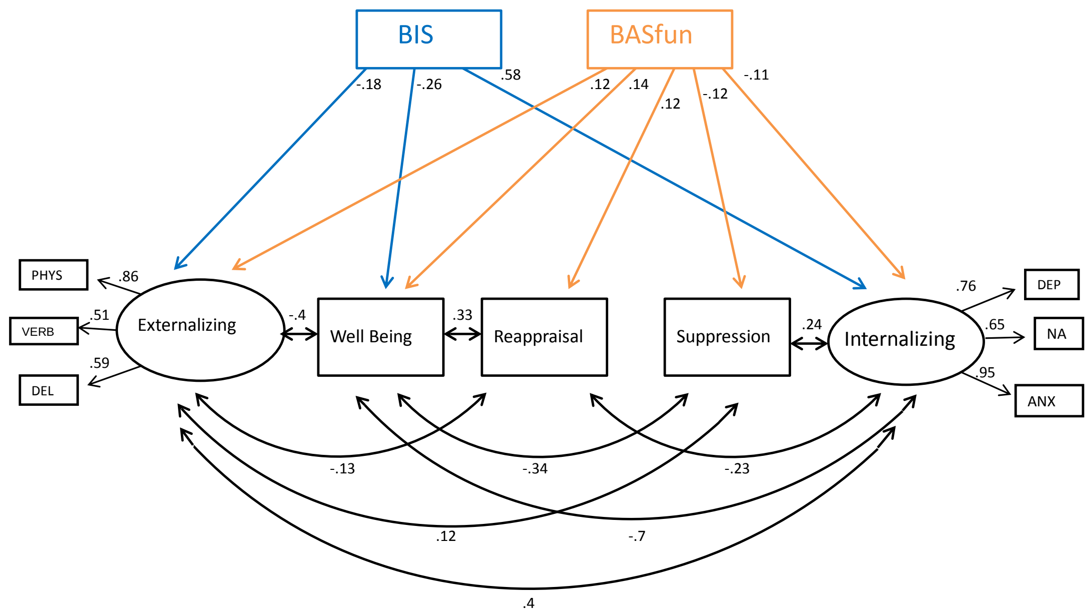
Model using BIS and Drive as predictors with standardized path coefficients.



BIS = Behavioral Inhibition Scale, BASdr = Drive, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

Appendix J

Model using BIS and Fun Seeking as predictors with standardized path coefficients.



BIS = Behavioral Inhibition Scale, BASdr = Drive, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

Appendix K

Paths Removed from Model Using BIS and Reward as Predictors with Corresponding Parameter Estimates and χ^2 Difference Tests

Step	Path Removed	β	b, p-value	χ^2	df	χ^2/df	$\Delta\chi^2$, p-value
Original				81.132	28	2.898	
1	Reappraisal with Suppression	.015	.400, .766	80.927	29	2.791	-0.205, .651
2	BIS to Suppression	.024	.033, .625	81.152	30	2.705	0.225, .6352
3	Reward to Externalizing	-.072	-.070, .192	82.758	31	2.67	1.606, .205
4	BIS to Reappraisal	-.077	-.134, .128	84.964	32	2.655	2.206, .137
5	Externalizing with Suppression	.100	2.652, .080	88.028	33	2.668	3.064, .08

Note. β = standardized path coefficient for path removed; b, p-value = non-standardized path coefficient for path removed, with associate p-value; χ^2 = chi-squared statistic associated with model after removal of path; df = degrees of freedom after removal of path; χ^2/df = normalized chi-square after removal of path; $\Delta\chi^2$, p-value = chi-square difference test for path removed, with associated p-value, BIS = Behavioral Inhibition Scale.

Appendix L

Paths Removed from Model Using BIS and Drive as Predictors with Corresponding Parameter Estimates and χ^2 Difference Tests

Step	Path Removed	β	b, p-value	χ^2	df	χ^2/df	$\Delta\chi^2$, p-value
Original				93.593	29	3.227	
1	BIS to Reappraisal	.002	.004, .959	93.47	30	3.116	-0.123, .726
2	Reappraisal with Suppression	-.026	-.731, .601	94.528	31	3.049	1.058, .304
3	Drive to Reappraisal	.054	.049, .267	94.431	32	2.951	-0.097, .755
4	BIS to Suppression	-.053	-.074, .263	95.543	33	2.895	1.112, .292

Note. β = standardized path coefficient for path removed; b, p-value = non-standardized path coefficient for path removed, with associate p-value; χ^2 = chi-squared statistic associated with model after removal of path; df = degrees of freedom after removal of path; χ^2/df = normalized chi-square after removal of path; $\Delta\chi^2$, p-value = chi-square difference test for path removed, with associated p-value, BIS = Behavioral Inhibition Scale.

Appendix M

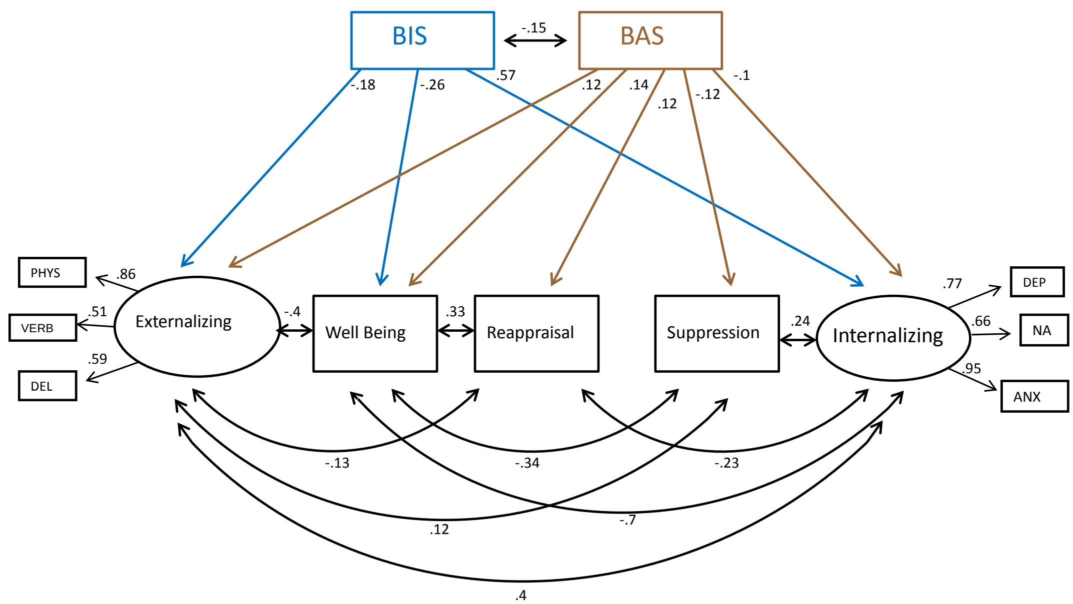
Paths Removed from Model Using BIS and Fun Seeking as Predictors with Corresponding Parameter Estimates and χ^2 Difference Tests

Step	Path Removed	β	b, p-value	χ^2	df	χ^2/df	$\Delta\chi^2$, p-value
Original				113.506	29	3.914	
1	Reappraisal with Suppression	-.017	-.473, .734	113.056	30	3.769	-0.45, .502
2	BIS to Reappraisal	.019	.034, .687	112.981	31	3.645	-0.075, .784
3	BIS to Suppression	-.070	-.097, .139	115.021	32	3.594	2.04, .153

Note. β = standardized path coefficient for path removed; b, p-value = non-standardized path coefficient for path removed, with associate p-value; χ^2 = chi-squared statistic associated with model after removal of path; df = degrees of freedom after removal of path; χ^2/df = normalized chi-square after removal of path; $\Delta\chi^2$, p-value = chi-square difference test for path removed, with associated p-value, BIS = Behavioral Inhibition Scale.

Appendix N

Model using BIS and BAS total score as predictors with standardized path coefficients.



BIS = Behavioral Inhibition Scale, BAS = BAS Total Score, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.

Appendix O

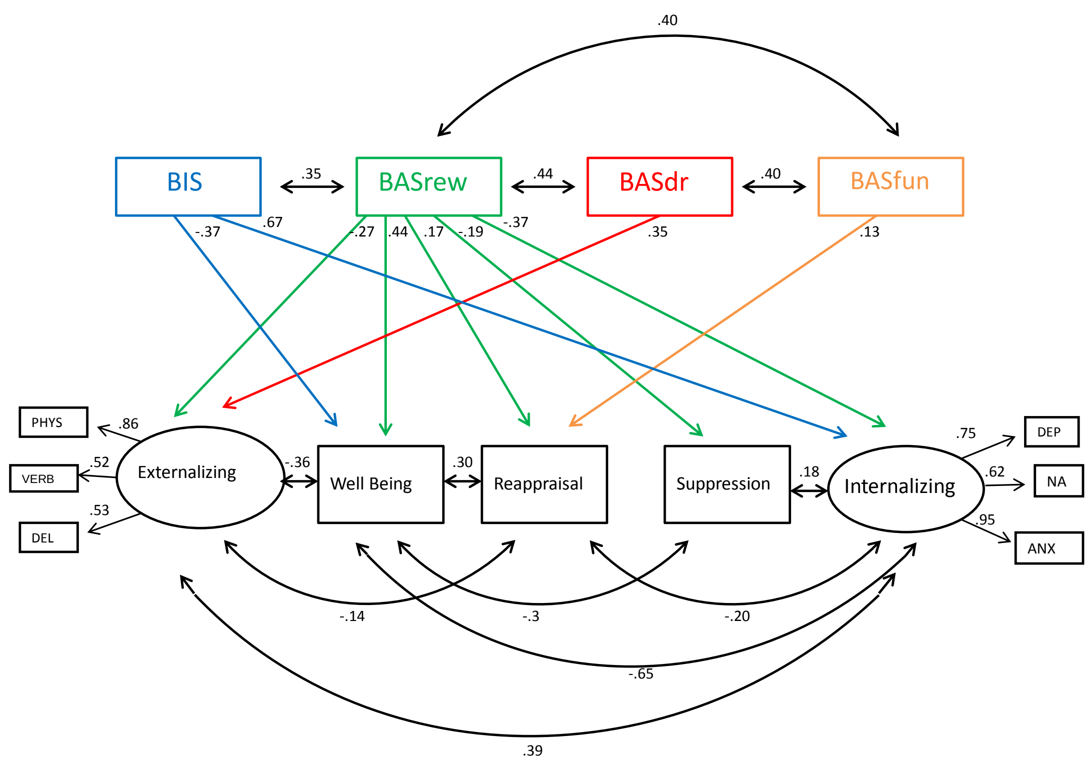
Paths Removed from Main Model Analyzed with Male Subject Excluded with Corresponding Parameter Estimates and χ^2 Difference Tests

Step	Path Removed	β	b, p-value	χ^2	df	χ^2/df	$\Delta\chi^2$, p-value
Original				122.947	38	3.235	
1	Fun Seeking to Suppression	-.012	-.009, .842	122.623	39	3.144	-0.324, .569
2	Reappraisal with Suppression	-.014	-.376, .781	122.605	40	3.065	-0.018, .893
3	Drive to Suppression	-.018	-.013, .765	122.4	41	2.985	-0.205, 651
4	BIS to Suppression	.025	.035, .618	123.019	42	2.929	0.619, .431
5	Fun Seeking to Well Being	-.03	-.027, .554	123.241	43	2.866	0.222, .638
6	Fun Seeking on Internalizing	.015	.021, .730	122.754	44	2.79	-0.487, .485
7	BIS to Externalizing	-.046	-.071, .443	123.360	45	2.741	0.606, .436
8	Drive to Internalizing	.048	.067, .306	124.401	46	2.704	1.041, .308
9	Drive to Reappraisal	-.057	-.051, .304	125.589	47	2.672	1.188, .276
10	Drive to Well Being	-.032	-.028, .376	126.626	48	2.638	1.037, .309
11	Supression With Externalizing	.085	1.862, .19	128.119	49	2.615	1.493, .222
12	BIS to Reappraisal	-.100	-.178, .087	131.016	50	2.62	2.897, .089
13	Fun Seeking to Externalizing	-.178	.116, .060	134.743	51	2.642	3.727, .054

Note. β = standardized path coefficient for path removed; b, p-value = non-standardized path coefficient for path removed, with associate p-value; χ^2 = chi-squared statistic associated with model after removal of path; df = degrees of freedom after removal of path; χ^2/df = normalized chi-square after removal of path; $\Delta\chi^2$, p-value = chi-square difference test for path removed, with associated p-value, BIS = Behavioral Inhibition Scale.

Appendix P

Results for main model when males are excluded with standardized path coefficients.



BIS = Behavioral Inhibition Scale, BASrew = Reward Responsiveness, BASdr = Drive, BASfun = Fun Seeking, PHYS = Physical Aggression, VERB = Verbal Aggression, DEL = Delinquent Behavior, DEP = Depression, NA = Negative Affect, ANX = Anxiety.