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The Approach System as a Component of Personality

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Over the past several decades, a large body of work has examined the idea that a broad general-purpose system manages motivation, affect, cognition, and behavior in response to cues of incentive and reward. This system has been referred to as the approach system, behavioral activation system (BAS), behavioral engagement system, or behavioral facilitation system (e.g., Depue & Iacono 1989, Fowles 1988, Gray 1990). Personality, neural, animal conditioning, and psychopharmacology models all differentiate one system that acts to foster the approach of incentive cues from another system that acts to avoid threats.

The biological basis of the BAS has been characterized as involving dopaminergic circuits that project from the ventral tegmental area to the ventral striatum (including the nucleus accumbens bilateral putamen, and caudate), and into prefrontal regions such as the medial orbitofrontal cortex, ventromedial prefrontal cortex and anterior cingulate cortex (Whitton, Treadway, & Pizzagalli, 2015). In particular, research suggests that reward anticipation activates the NAcc (Knutson & Greer, 2008) and that activation of this region is particularly related to willingness to work to obtain reward (Treadway et al., 2009).

We have found it useful to differentiate among inputs to, outputs of, and sensitivity of the BAS (see Johnson, Edge, Holmes, & Carver, 2008). Allergies provide a helpful metaphor for these distinctions: a personal allergy (sensitivity) to pollen (the input) guides the degree of symptoms (output) that a person might develop when exposed to pollen. In the case of BAS, inputs are cues of potential reward, ranging from laboratory stimuli to broader life events that suggest potential for goal attainment. The neurobiological pathways implicated in this system guide differential levels of individual sensitivity to those inputs. BAS outputs include interest in incentives, motor activity, energy, confidence, and pleasure in rewards. Hence a person with a strong trait-like tendency toward high BAS activity would be expected to show more energy, activation, eagerness, and confidence when given an opportunity to pursue potential rewards than a person with a tendency toward low BAS activity. As noted above, most discussions of BAS treat it as a general-purpose system. However, some have also posited that the human approach system is specialized somewhat in the direction of social incentives in particular. Thus, it has been argued that sociability and exploration are also indicators of engagement of this system (Depue & Iacono 1989).

In the following sections, we review measures of BAS sensitivity and their psychometric qualities, we consider gender differences, stability and developmental shifts in BAS sensitivity across the life course, validation of BAS self-report measures against biological and behavioral indices. We briefly discuss genetic contributions to BAS. We then consider BAS sensitivity shapes outcomes related to normative variation in goal regulation, affect, close relationships and to several psychopathologies. We conclude with a brief discussion of future directions.

Self-report Measures Pertaining to BAS

Several research groups have developed self-report measures of BAS reactivity. Some of the most well-validated and widely used measures include the Behavioral Inhibition Scale /Behavioral Activation Scale (BIS/BAS; Carver & White, 1994), the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia et al., 2001), the Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995) and the Temporal Experience of Pleasure Scale (TEPS; Gard et al., 2006). Both the BIS/BAS and the SPSRQ focus on a range of responses to rewards, while the SHAPS and TEPS focus more closely on the experience of pleasure in the presence or anticipation of rewards.

BIS/BAS

Before the development of the BIS/BAS scales (Carver & White, 1994), theories about BAS had been tested mainly using animal models. Carver and White developed the BIS/BAS to measure self-reported sensitivity to threats and rewards in humans. The BAS-relevant items were based in part on Gray's earlier theory of the appetitive motivation system, postulated to underlie movement toward goals and generate positive emotion in response to reward-related cues or incentives. The BAS-related items reflect emotional responses to obtaining reward, active pursuit of goals, and the tendency to seek out rewarding and novel experiences, all of which are properties that Gray had attributed to BAS function. Although not originally intended to form separate scales, the BAS-related items consistently separate into distinct (albeit correlated) BAS subscales in factor analyses (Table 1).

Table 1.

Descriptions and reliability statistics of 4 measures of the sensitivity of the BAS

Measure	**Subscales**	**Description**	**Internal reliability**
BIS/BAS (Carver & White, 1994)	Drive (4 items)	Sustained pursuit of goals	α = .76
	Reward Responsiveness (5 items)	Positive affect, energy, and motivation in response to obtaining or anticipating reward	α = .73
	Fun-seeking (4 items)	Tendency to approach new experiences that may lead to reward without regard to negative consequences; desire for novel rewards	α = .66
SPSRQ (Torrubia et al., 2001)	Sensitivity to Reward (SR) (24 items)	Tendency to approach reward in specific contexts, and to react to reward cues	α = .78 (males) α = .75 (females)
SHAPS[a]	14 items	Inability to experience pleasure	α = .91

(Snaith et al., 1995)		across normatively enjoyable situations	
TEPS (Gard et al., 2006)	Anticipatory Pleasure (10 items)	Tendency to experience pleasure during anticipation of reward	α = .74
	Consummatory Pleasure (8 items)	Tendency to experience “in-the-moment” pleasure	α = .71

Non-BAS-relevant subscales are not included

Reliability statistics reported in Franken et al., 2007

Large scale studies have replicated this factor structure in the English version (Jorm et al., 1999; Johnson et al., 2003) and in a Spanish version (Segarra et al, 2014). Campbell-Sills et al (2004) found support for the 4-factor structure (3 BAS scales, 1 BIS scale), with the exception of a single item that failed to load on the Reward Responsiveness scale. Their findings also supported a higher order factor of overall BAS, in addition to the 3 subscales. Findings of one study of 562 undergraduates did not find support either of these factor structures (Cogswell et al., 2006). Overall, though, the bulk of the evidence supports the 4-factor structure of the BIS/BAS scales, providing evidence for multifaceted, and distinguishable, manifestations of approach motivation in personality.

SPSRQ

Whereas the Carver and White scale’s items focus on general rewards, Torrubia and colleagues (2001) developed the SR scale within the SPSRQ to measure sensitivity to a variety of specific rewards, such as money, sex, and social power, as well as impulsivity in the context of rewards. They designed the SR scale to capture a single dimension of approach motivation (rather than separable subscales), which they expected would relate to both extraversion and neuroticism. Each item is phrased in the form of a yes-no question. Many items on the SR scale are socially relevant, encompassing hypersexuality, attention-seeking, and social dominance. This contrasts with the BAS items, which focus more generally on experiences of reward or good experiences.

In addition to this difference, many SR items connote some degree of social deviance or general negativity: for example, “Do you like displaying your physical abilities even though this may involve danger?” As a result, a “yes” response to these items concedes some level of negative consequence of approach behavior. While it was not assumed that individuals would necessarily have equal sensitivities to different types of reward, Torrubia and colleagues expected that differences would generalize across types of reward; as a result, items are summed to provide one total score. Although some subsequent studies have reported satisfactory internal consistency of the SR scale (e.g., Caseras et al., 2003; Mitchell et al., 2007), other studies have not found strong support for the original 2-factor model differentiating reward versus punishment sensitivity (e.g., O’Connor et al., 2004; Cogswell et al., 2006).

SHAPS

The SHAPS was devised to be brief measure of anhedonia (the inverse of reward sensitivity) that could be used across cultural and clinical populations. To this end, researchers asked 55 individuals ages 15-80 recruited from the community to list five situations that they found pleasurable and thought would be applicable to broad groups of people (Snaith et al., 1995). These depictions were then reworded to form scale items. The final scale includes 14 items that loaded on a single factor, answered using a dichotomous “agree” or “disagree” format (higher scores indicate greater anhedonia). A validation study of the SHAPS in a non-clinical population generated high internal consistency values and replicated the single factor structure (Franken et al., 2007).

The TEPS

The TEPS was developed based on biological and behavioral evidence that responses to reward anticipation versus consumption can be distinguished. Animal researchers have been able to distinguish key neurotransmitters involved in consummatory pleasure versus anticipatory pleasure, also termed “liking” and “wanting” (Berridge et al., 2009). Dopamine plays a key role in goal-oriented anticipatory pleasure, as well as reward learning, whereas opioid mechanisms appear more crucial in consummatory pleasure. Accordingly, the TEPS provides one subscale for anticipatory pleasure and a separate subscale for consummatory pleasure.

Both TEPS scales cover responses to specific and general pleasurable stimuli across all five sensory modalities (Gard et al., 2006). Similar to the rationale for providing a summed total for the SR scale, scores on the TEPS are summed to provide one anticipation score and one consumption score across sensory modalities. A two-factor structure of anticipation versus consumption scores was identified across five separate university samples (Gard et al., 2006).

Convergent and Discriminant Validity of Approach Motivation

The self-report measures described here show expected correlations with each other. The Carver and White BAS scales are moderately intercorrelated (Carver & White, 1994; Jorm et al., 1999; Johnson et al., 2003). Moreover, the TEPS Anticipatory Pleasure and Consummatory Pleasure scales and the SR subscale of the SPSRQ have all shown significant correlations with all BAS subscales (Gard et al., 2006; Cogswell et al., 2006). The SHAPS also displays the expected inverse relationships with BAS subscales (Franken et al., 2007).

Researchers have also considered convergent and divergent validity with other personality traits, most commonly measures of extraversion, neuroticism, and affective temperament. Extraversion is particularly relevant, as most models today emphasize pursuit of incentives as being a central mechanism driving extraversion (Carver & Scheier, 2012). Consistent with such models, a series of studies provides evidence that reward sensitivity is highly related to extraversion (Lucas et al., 2000). In Carver and White’s original validation of the BIS/BAS, all three BAS subscales were significantly associated with extraversion, with Fun-seeking showing the strongest relationship (Carver & White, 1994). Similarly, the SR subscale and TEPS Anticipatory and Consummatory Pleasure scales correlate positively with extraversion measures (Gard et al., 2006; Segarra et al., 2014; Torrubia et al., 2001).

One might expect that positive affectivity would also correlate with measures of BAS sensitivity, though not be entirely overlapping with them, as measures of BAS sensitivity focus on affective responses to cues of reward, whereas measures of positive affectivity per se are less focused on the role of context. Consistent with this, BAS scales have shown significant but modest relationships with positive affectivity measures (Carver & White, 1994). The SHAPS has also shown expected inverse relationships with measures of positive affect (Franken et al., 2007).

Findings on whether the various BAS-relevant scales relate to negative affectivity are mixed, and tend to differ by measure. As noted above, across measures, most factor analyses have found that responses to threat and punishment are separable from responses to incentives. Consistent with this separability, BAS Drive, BAS Fun-Seeking, SHAPS, TEPS Consummatory Pleasure scores have been found not to relate significantly to negative affectivity (Franken et al., 2007; Franken & Muris, 2006; Gard et al., 2006; Johnson et al., 2003). An exception to this pattern is the SRSPQ, in which both SR and SP have been found to relate to neuroticism (Torrubia et al., 2001; Mitchell et al., 2007). Indeed, Torrubia and colleagues (2001) argued that both SR and SP should confer a general heightened sensitivity in line with Gray's original impulsivity-anxiety dimensions.

Moderate positive correlations have been observed of the BAS Reward Responsiveness scale and the TEPS Anticipatory Pleasure Scale with the BIS scale (Franken & Muris, 2006; Gard et al., 2006; Johnson et al., 2003). These associations are consistent with the idea that there is a more general reactivity to environmental cues, or an overall affective reactivity, which would lead to higher scores on both BAS and BIS measures. However, these associations between BIS and BAS are never very strong. If a general reactivity is responsible for it, that overall reactivity clearly does not overwhelm the separate sensitivities.

Some researchers have proposed that a strong reactivity to nonreward would be expected if a person has a strong motivation to achieve rewards (e.g., Carver, 2004; Corr, 2001). To address this possibility directly, Wright, Lam & Brown (2009) developed a 5-item Frustrative Nonreward subscale to append to the BIS/BAS. This scale correlates with both the BIS scale and Reward Responsiveness, but not the other two BAS subscales. This finding is consistent with the idea that those who are most responsive to reward also experience stronger negative emotions when reward-related goals are thwarted, but the negative emotions appear specific to emotional responses to reward and its absence.

Age and Gender Differences in Approach Motivation

Several studies have reported gender differences in responses on these self-report scales. Women scored higher than men on Reward Responsiveness (Carver & White, 1994; Jorm et al., 1999), and in one study, scored lower on Drive (Jorm et al., 1999). In contrast, men reported greater sensitivity to reward, on average, than women on the SPSRQ, perhaps reflecting the greater focus on impulsivity of the SR subscale (Torrubia et al., 2001).

Considerable evidence suggests important changes in reward sensitivity across the lifespan, with a peak of reward sensitivity during adolescence (Somerville, Jones, & Casey, 2010). Cross-sectional findings indicate that adolescents, as compared with children and adults, have stronger responsivity to rewards, including monetary incentives (Hardin, Schroth, Pine, & Ernst, 2007; Jazbec et al., 2006) and positive feedback (Cauffman et al., 2010), whether measured by positive affective displays (Ernst et al., 2005) or neural responsivity (Van Leijenhorst et al., 2010). A recent longitudinal study found an increase in reward sensitivity coinciding with early to late adolescence, with a stabilization in the early 20s corresponding with decreases in volume in the left nucleus accumbens (Urošević, Collins, Muetzel, Lin, & Luciana, 2012). At the other end of the age spectrum, investigators have found lower BAS scores in older adults, suggesting that BAS may weaken over time (Jorm et al., 1999); this is consistent with reports that dopaminergic function decreases later in life (Li et al., 2010).

Beyond these normative developmental patterns, reward sensitivity has shown stability over time. Studies using the BAS scale have shown exceptional test-retest reliability over two years (Brown, 2007; Carver & White, 1994).

There is some question about whether these scales adequately capture BIS/BAS levels in children. In a sample of 284 children ages 8-12, factor analysis did not support the 4-factor structure described above (Muris et al., 2005). Rather, BIS and BAS items appeared to form two orthogonal dimensions, each with satisfactory internal consistency (.81). There was also an unexpectedly strong relationship between BIS and overall BAS, suggesting that items may not generalize well to this younger group.

A more recent project examined samples of children, adolescents, young adults, and later adults (approximately age 36) and determined that Fun-seeking did not differentiate well from the other BAS factors and a few other items had suboptimal psychometric properties across the age groups (Pagliaccio et al., 2016). Using a trimmed model in which Fun-seeking and the suboptimal items were omitted yielded evidence of consistent factors across age groups. Consistent with earlier results, BAS scores tended to be highest in young adulthood and lower in childhood and later adulthood, exhibiting a nonlinear relationship across development.

Biological and Behavioral Correlates of Self-Report Measures

The self-report scales discussed here have all been linked to behavioral, physiological, and neural responses to appetitive stimuli. With respect to overt behavior, research has linked TEPS Anticipatory Pleasure and BAS scores with willingness to exert greater effort to obtain reward when the probability of obtaining reward was relatively low (Geaney et al., 2015). This suggests that these personality traits may help predict motivation in contexts where those with low reward sensitivity would not feel that the benefits of potential rewards outweigh the costs.

Much research examining physiological correlates of behavioral activation has focused on frontal cortical asymmetry (Harmon-Jones et al., 2010). Relative left frontal activity has been associated with approach motivation as measured by the BIS/BAS scales (Amodio et al., 2008; Sutton & Davidson, 1997), but some studies have not found this relationship (Pizzagalli et al., 2003; Gable et al., 2015). Results from a recent meta-analysis taking into account unpublished dissertations suggest that midline posterior versus frontal theta activity may be a more robust marker of BAS activity than relative left frontal alpha activity (Wacker et al., 2010).

Neuroimaging studies have found correspondence between BOLD response to potential rewards in areas of the reward circuit and self-reported levels of approach motivation. As one example, in an fMRI study in which participants were presented with images of types of food as they lay in the scanner, self-reported BAS Drive scores predicted greater neural activation in the frontostriatal-amygdala-midbrain network in response to appetizing food images (Beaver et al., 2006). Greater Anticipatory Pleasure (TEPS), but not Consummatory Pleasure, has been found to correspond with a stronger connection between key regions in the neural reward circuit during anticipation of monetary reward (Li et al., 2015).

Heritability and Genetic Polymorphisms Relevant to BAS Research

In a two-wave longitudinal twin study, researchers estimated that genetics accounted for 28-35% of the variability in BAS scores (Takahashi et al., 2007). Participants were retested on the BIS/BAS scales an average of 2.25 years after the first administration, and stability in BAS scores appeared to be driven predominantly by genetic factors (heritability estimates above .5), whereas non-shared environmental factors contributed to both the stability and change in BAS scores over time (Takahashi et al., 2007).

Many recent studies of the neurological basis of reward sensitivity suggest links to specific genetic polymorphisms (Bogdan & Pizzagalli, 2009). In a recent article, Ogden and colleagues (2004) integrated findings of a pharmacogenomic study of mice with recent human studies of related phenomena and concluded that reward sensitivity is most affected by pathways involving dopamine- and by cAMP-regulated phosphoprotein, DARPP-32, a major target for dopamine in the striatum.

Most neuroimaging studies in humans that consider genetic influences on neural responses to reward have identified significant effects of genes relevant to dopamine function, including D2, D3, and D4 receptors and dopamine transporter (DAT). Research on neural responses to reward have found significant differences in the following genes associated with dopamine: ANKK1, related to dopamine synthesis (Felsted, Ren, Chouinard-Decorte, & Small, 2010), 141C Ins/Del polymorphism related to D2 receptors (Forbes et al., 2009), DRD4 (Marco-Pallarés et al., 2009), and DAT1 (Dreher, Kohn, Kolachana, Weinberger, & Berman, 2009). Individuals carrying the 9-repeat allele of the DAT1 polymorphism have been shown to take more risks in pursuit of rewards during decision-making tasks (Zhong et al., 2009) and to have increased striatal activity in response to reward cues (Zhong, Chark, Ebstein, & Chew, 2012)

Beyond the studies of genes that are directly linked to dopaminergic function, studies of genes with indirect links to dopaminergic functioning also appear related to neural responses to rewards, including the Catechol-O-methyltransferase (COMT) and brain-derived neurotrophic factor (BDNF) genes. The COMT gene facilitates the production of COMT, an enzyme involved in catalyzing dopamine and other catecholamines (Chen et al., 2004). The BDNF gene has neurobiological effects on the mesolimbic dopamine pathway, among other effects (Berton et al., 2006; Guillin et al., 2001). Both COMT and BDNF have been linked to the strength of neural response to reward (Dreher et al., 2009; Marco-Pallarés et al., 2009).

Additional neuroimaging studies have linked reward sensitivity to activity in opioid receptors, which appear relevant for wanting and liking rewards and have been implicated in drug addiction (Cui et al., 2014; Kawahara et al., 2013). The opioid receptor mu-1 gene (OPRM1) guides the function of mu opioid receptors and has been linked to neural responses to reward, including greater neural activation and connectivity in reward-related circuitry (Ray et al., 2014).

Research attempting to link self-report BAS scales to genetic polymorphisms in humans has had mixed results. Consistent with the neuroimaging studies just described, much of this work has studied genes associated with dopaminergic functioning. Individuals who carry at least one A1 allele of the ANKK1 have been found to report lower BAS Drive (Felsted et al., 2012) and higher BAS Reward responsiveness (Davis et., 2008; Lee et al., 2007). The g allele of DRD3 was associated with the BAS Drive scale in one sample but not in a second sample (Henderson et al., 2000). Null findings have been found for DAT1 (Henderson et al., 2000), DRD2 markers of the 141 Ins/Del gene (Davis et al., 2008), C957T mutation related to D2 receptor (Davis et al., 2008), and COMT (Henderson et al., 2000). In two studies comparing BAS scores with a composite of multiple serotonergic polymorphisms, one found a significant association among persons exposed to early adversity (Pearson, McGeary, & Beevers, 2014), whereas another did not (Johnson, Carver, Joormann, & Cuccaro, 2016). On the other hand, the latter found that OPRM1 interacted with early adversity to predict BAS Reward Responsiveness.

BAS Outcomes

Individual differences in sensitivity of the BAS have been linked to a broad range of outcome domains, including goal setting and appraisal, affective responses to goal progress (or lack thereof), and interpersonal relationships. In this section, we examine evidence that individual differences in BAS levels contribute to outcomes in each of these domains.

Goal Setting and Appraisal

It has long been suggested that individual differences in BAS ought to differentially shape goal setting tendencies, such that people high in BAS sensitivity would tend to set relatively more goals to pursue rewards than those lower in BAS sensitivity (Elliot & Thrash, 2002). Consistent with theory, high BAS scores have been found to relate to tendencies to set more approach-oriented goals (i.e., goals involving moving toward something) as opposed to avoidance-oriented goals (i.e., goals involving moving away from something; e.g., Jones, Shams, & Liversidge, 2007). For example, persons who are high in approach sensitivity as measured by the BAS are more likely to endorse goals that focus on the development of competence and mastery as opposed to the avoidance of incompetence (Elliot & Thrash, 2002). One particularly illustrative finding is that high BAS scores have been found to relate to increased willingness to set and pursue extremely ambitious life goals, such as earning millions of dollars or appearing regularly on TV (Alloy et al., 2012; Johnson & Carver, 2006).

BAS sensitivity has also been linked to individual differences in goal-relevant values and appraisals. High BAS scores are associated with holding more approach-oriented values, such as performance, achievement, and perfectionism (Alloy et al., 2009) and to tendencies to favor self-serving appraisals of successful task performance that may promote confidence in one's ability to succeed (e.g., a tendency to attribute success to one's own internal qualities rather than to chance; Meyer et al., 2010).

Affective Responses

Another class of BAS output is affect. In his initial theory, Gray (1994) suggested that the affective outcomes of activity in the behavioral approach and inhibition systems were grouped by valence. More specifically, he held that the BAS was responsible for generating all positively valenced affects such as hope, excitement, and elation, in support of goal pursuit and attainment, and only positively valenced affects. Consistent with this notion, BAS scores have been shown to predict situational positive affect in response to cues that a reward is available (Carver & White, 1994; Heponiemi et al., 2003), as well as positive emotional responses immediately after receiving rewards (De Pascalis et al. 2010; Germans & Kring 2000).

There are conceptual complications, however, with respect to certain other affects. Gray consistently held that frustrative nonreward engages the BIS, rather than the BAS, consistent with the view that negative valence always is attributable to BIS activity. This view is not held universally. Carver and Scheier (1998) have argued that the affective outputs of the behavioral approach and threat systems are instead products of self-regulatory feedback loops that monitor the rate of progress (or lack thereof) toward one's goals and away from threats. In this view, feelings facilitate effort regulation by signaling whether one is progressing toward one's goal at a sufficiently rapid pace. Accordingly, when the perceived rate of goal-related progress falls below a criterion value that defines acceptable or anticipated progress, negative affect arises that signals a need to increase one's efforts. Positive affect arises when perceived progress exceeds the criterion value, signaling that one's efforts can potentially be relaxed (Carver, 2003).

This model holds that the specific emotional outputs (rather than valence per se) differ between the approach versus the threat system (Carver & Scheier, 1998). Thus, the positive affect generated by better-than-expected goal-related progress takes the form of eagerness and joy when doing well at approaching goals, but takes the form of relief and contentment when doing well at avoiding threats (Carver, 2003).

Responses to lack of expected progress toward approach goals are negative in valence, taking one of two forms. The form depends on the degree to which a goal appears ultimately attainable versus lost (see Carver, 2004). Progress somewhat below the criterion yields frustration and anger. If the approach goal seems unattainable, the affective response is more likely to be sadness, dejection, and despondency (see Carver & Harmon-Jones, 2009).

Research findings are consistent with the idea that high BAS sensitivity can result in negative emotions when goal pursuit goes poorly. In one such study involving frustrative nonreward, participants were led to believe that they could earn extra credit if they performed sufficiently well at a task, but were subsequently given feedback indicating that they had failed to do so (Carver, 2004). Individual differences in BAS sensitivity (specifically the fun-seeking subscale), but not BIS sensitivity, were significantly associated with participants' ratings of sadness and frustration after failing to earn the reward. Conceptually similar results have also been reported by Van den Berg, Franken, and Muris (2011).

In addition to predicting situational negative affect, BAS sensitivity has also been shown to positively relate to trait anger (Harmon-Jones, 2003) and proneness to guilt (Sheikh & Janoff-Bulman, 2010), both of which have been conceptualized as approach-oriented emotions (see Amodio et al., 2007 and Carver & Harmon-Jones, 2009). Collectively, these findings support the idea that individual differences in BAS produce different affective states as a function of progress or lack of progress toward goals.

This means that the picture of a person with a highly sensitive BAS is considerably more complex than simply positive affect and effort engagement. The picture also depends on the context in which the person is presently operating. A person with a sensitive BAS who is presently facing obstacles and difficulty may be vulnerable to frustration and anger or even sadness and dejection (though not fear) depending on the degree of difficulty, which must be figured into the prediction of his or her behavior.

Close Relationships

Researchers have suggested that close relationships can be construed in terms of motivational tendencies to approach relationship-related rewards (e.g., intimacy) and avoid relationship-related punishments (Gable, 2006; for a broader perspective, see Fitzsimons, Finkel, & vanDellen, 2015). Within this framework, an individual with underactive approach motivation might tend to be seen as cold or distant by others and to be disinterested in engaging in affiliative behaviors. On the other hand, overactive approach motivation might result in behaviors deemed to be overly intrusive or abrasive. Empirical findings support the notion that BAS sensitivity is linked to meaningful relationship outcomes, such as closer friendships (Berry, Willingham, & Thayer, 2000), greater satisfaction with family and friendship relationships (Gutierrez, Garriz, Peri, Vall, & Torrubia, 2016), secure adult attachment (Carver, 1997), and the tendency to respond actively to potential threats to romantic relationships (Meyer, Olivier, & Roth, 2005). Less information is available regarding potential negative effects of high BAS.

A question that was alluded to at the beginning of the chapter is whether BAS sensitivity is best conceptualized exclusively as a domain-general tendency to approach rewards, or whether there is a distinct or partially distinct subsystem involved in responding specifically to social reward cues. A series of studies conducted by Laurenceau and colleagues (2010) supported the incremental validity of relationship incentive sensitivity (a relationship-specific analogue of BAS) in predicting couples' perceptions of relationship quality and situational positive affect when couples were instructed to have a conversation focused on their positive feelings for one another. These findings further support the utility of thinking about the BAS in understanding functional outcomes in the domain of close relationships, and also suggest that it may be important to understand and measure domain-specific facets of BAS, such as relationship incentive sensitivity, in order to more effectively predict outcomes within specific domains of functioning.

Psychopathology

The BAS has been linked repeatedly to a range of psychopathologies, including both internalizing and externalizing outcomes. Across both cross-sectional and prospective studies, underactivity of the BAS has been consistently identified as a correlate of and risk factor for internalizing syndromes, including major depressive disorder (MDD), generalized anxiety disorder, and obsessive compulsive disorder (e.g., Brown, 2007; Kasch et al., 2002; Kim, Kang, & Kim, 2009). The relationship between MDD and blunted approach motivation has received particular attention. This is unsurprising, given that hallmarks of an underactive approach system might include apathy and amotivation, low positive affect, passivity, and low energy, all of which are characteristic symptoms of major depressive episodes.

At the opposite end of the approach motivation spectrum, overactive approach motivation has been linked to problems of risk-taking and impulsivity (e.g., Braddock et al., 2011); anger and aggression (e.g., Harmon-Jones, 2003); antisocial behavior and psychopathy (e.g., Morgan et al, 2014; Pujara et al., 2014); and substance use (e.g., Hamilton, Sinha, & Potenza, 2012). These findings suggest that BAS hyperactivity may be relevant to understanding a wide range of externalizing behaviors and syndromes, a notion for which there is considerable support overall (e.g., Bjork et al., 2010; see Johnson, Turner, & Iwata, 2003).

Hypersensitivity of the BAS has also emerged as a leading candidate etiological model for the bipolar spectrum disorders and mania. These disorders are characterized by intensely elevated or irritable mood, increased goal-pursuit, and impulsive pursuit of rewarding activities, among other symptoms (see Johnson et al., 2012 for a review). In the sections that follow, we discuss evidence that low levels of approach motivation are associated with depression and that high levels of approach motivation are associated with externalizing syndromes and mania.

Underactive Approach Motivation and Depression

Multiple lines of research, including neurophysiology, behavior, and self-report, converge on the conclusion that hypoactivity of the approach system is implicated in the etiology of depression. Low approach motivation may be especially related to of the transdiagnostic clinical feature of anhedonia (see Treadway et al., 2012, for discussion).

At the neural level of analysis, MDD has been consistently linked to blunted reactivity to reward in striatal regions that are thought to subserve the approach system (see Whitton, Treadway, & Pizzagalli, 2015 for review). Of note, striatal hypoactivation in response to rewards has been observed not only in those diagnosed with MDD, but also in children of depressed parents (e.g., Gotlib et al., 2010) and at-risk adolescents (Olino et al., 2014), and has also been found to predict increases in depressive symptoms over a two-year timespan in adolescence (Morgan et al., 2013), suggesting that this blunting of the approach system is not simply a second order consequence of depressive experiences. Parallel evidence has emerged from EEG studies that have shown that depressed individuals and those with a history of depression exhibit lower activation in left anterior cortical areas than non-depressed persons, cortical regions which have also been implicated in approach system sensitivity, as described earlier (see Harmon-Jones et al., 2013 for review).

At the behavioral level, depressed individuals demonstrate lower responsiveness to rewards and less willingness to work for rewards than other people. For example, Pizzagalli and colleagues (2005) found that individuals with elevated depressive symptoms failed to show the expected response bias toward one of two stimuli that was more frequently paired with a reward, and this deficit in reward learning predicted higher anhedonic symptoms one month later. Individuals with MDD, including those experiencing first episode depression and individuals with high trait anhedonia, are less willing to engage in effort to obtain rewards and are more likely to disengage from demanding reward tasks than non-depressed individuals (Brinkmann & Gendolla, 2008; Treadway et al., 2012; Yang et al., 2016).

At the self-report level of analysis, low BAS scores have been linked to depression cross-sectionally and shown to predict a more severe course of depression over time (e.g., Campbell-Sills, Liverant, & Brown, 2004; Kasch et al., 2002). Consistent with these findings, persons with depression also report less positive emotional responsiveness in response to anticipatory reward cues (McFarland & Klein, 2009) and are less likely to set and plan for specific approach-oriented goals (Dickson & MacLeod, 2004). Overall, these findings provide strong support for the notion that underactive approach motivation, measured across multiple levels of analysis, is a central facet of vulnerability to depression and anhedonia.

Overactive Approach Motivation and Externalizing Syndromes

There are a number of pathways though which high BAS sensitivity might be a risk factor for psychopathology. For example, individuals who have overactive approach systems might be predisposed to unrestrained and overenthusiastic pursuit of rewards that are intrinsically problematic, such as illegal drug use resulting in substance use disorders; that causes individuals to behave in ways that are regarded as abrasive or intrusive by others, as in the case of unabashedly seeking social dominance (e.g., as is commonly observed in psychopathy); under conditions that are suboptimal for goal attainment; or that interferes with completion of less rewarding tasks that are important for long-term adaptation. In particular, multiple theorists have suggested that high levels of BAS sensitivity are central to understanding the spectrum of externalizing disorders (see Fowles, 2001 and Newman & Wallace, 1993).

There is considerable evidence supporting the notion that high BAS sensitivity is implicated in a range of externalizing behaviors and syndromes. For example, Hundt and colleagues (2008) found that high BAS was cross-sectionally associated with symptoms of drug and alcohol abuse, psychopathy, and hyperactive-implulsive ADHD symptoms in an undergraduate sample. These findings converge conceptually with Honomichl and Donnellan's (2012) prospective finding that surgency, a dimension of temperament that taps into appetitive motivations and bears a strong conceptual resemblance to BAS, assessed at 54 months of age predicted externalizing behaviors assessed at 15 years.

Consistent with the self-report findings, hypersensitivity of the mesolimbic dopaminergic reward system has been implicated in a range of externalizing syndromes (Baskin-Sommers & Foti, 2015). Of note, heightened activation of the nucleus accumbens during reward anticipation has been shown to correlate with externalizing symptoms and alcohol dependence (Bjork et al., 2010), psychopathy (Pujara et al., 2014), and cannabis use (Nestor, Hester, & Garavan, 2010).

Overactive Approach Motivation and Mania

In its initial incarnation, the BAS hypersensitivity model of bipolar disorder emerged from the observation that the core symptoms of mania overlap considerably with the outputs of the BAS, such as increased activity and heightened high arousal positive affect (Depue & Iacono, 1989). Direct tests of the relationship between self-reported BAS sensitivity and mania have generally supported this model. Of import, BAS sensitivity is prospectively related to initial onset of bipolar spectrum disorders (Alloy et al., 2012) and to the course and severity of manic symptoms over time (Alloy et al., 2008; Meyer et al., 2001).

These findings converge with evidence that willingness to set ambitious goals has itself been found to predict the onset of bipolar disorder in at-risk individuals (Alloy et al., 2012) and a more severe course of mania over time among those diagnosed with bipolar I disorder (Johnson, Carver, & Gotlib, 2012; Tharp et al., 2016). Among persons with bipolar disorder, goal attainment is often followed by unusually persistent elevations in positive affect (Farmer et al., 2006), large increases in energy and effort (Fulford et al., 2010), and higher levels of manic symptoms (Johnson et al., 2000; Johnson et al., 2008).

These self-report findings are complemented by behavioral and neurophysiological evidence of increased willingness to expend effort for reward (e.g., Harmon-Jones et al., 2008; Hayden et al., 2008) and elevated activity in the ventral striatum in response to reward (e.g., Pechkam & Johnson, 2015; see Nusslock, Young, & Damme, 2014 for a review). Taken together, self-report and biobehavioral findings provide compelling support for the notion that hypersensitivity of BAS is involved in the etiology of mania and bipolar disorder, although it has recently been suggested that the BAS hypersensitivity model may be overly broad in that only certain facets of the BAS are dysregulated in bipolar disorder (see Johnson et al., 2012).

Unanswered Questions and Future Directions

This chapter has focused on the idea that there is a domain-general system organized around approach incentives, as well as some of the implications that might follow from the incorporation of such a system in personality. Given that focus, much else has been left aside. Clearly more is involved in personality than approach of incentives. For the most part, we have disregarded another very obvious category of motivation—the desire to avoid or escape from threats—and the emotions, actions, and other outputs that follow from that category of motivation. There is also a growing body of work that suggests that even those two broad systems do not sufficiently capture the complexity of human self-regulation. In particular, many have suggested the existence of a system of self-control, which comes into play when the potential arises for conflict between short-term and longer-term desires, for example.

In Gray's (1982) original conception of the BAS in humans, he gave the trait variable that was linked to BAS function the label impulsivity. In retrospect, that may have not been the best choice of label. At first glance, impulsivity does seem to be tied to intense desires for particular outcomes. But impulsivity is a concept with a great deal of complexity, and many influences may lie behind a given impulsive action (e.g., Eysenck, 1987; Johnson, Carver & Joormann, 2008; Parker & Bagby, 1997; Torrubia, Ávila, Moltó, & Caseras, 2001). By attaching the term impulsivity to BAS sensitivity, Gray was in effect positing that impulsivity follows purely from wanting an incentive. However, impulsive action sometimes depends on a lack of threat sensitivity. Impulsive action (and its absence) also often depends on the system that manages self-control. If that system is very responsive, impulsivity (of any sort) is less likely.

One important direction for future work will be to determine more precisely the roles that are played by approach sensitivity and a function of self-control in creating greater versus lesser impulsivity (Carver, Johnson, & Joormann, 2008). That is, cognitive control may help override tendencies toward either extremely blunted BAS or toward extremely reactive BAS. This would imply that a person who tends to have either a passive disengagement (in the case of low BAS sensitivity) or an overly reactive tendency to seek rewards (in the case of high BAS sensitivity) is likely to experience less difficulty if he or she is able to engage cognitive control to regulate affect, cognition, and behavior. Relatively few studies to date have considered how variations in these two dimensions may combine to predict outcomes. We see this as a particularly promising direction for future research.

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