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Personality and Individual Differences 40 (2006) 1039–1050

PERSONALITY AND  
INDIVIDUAL DIFFERENCES

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## Conceptual distinctions among Carver and White's (1994) BAS scales: A reward-reactivity versus trait impulsivity perspective

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Accepted 3 October 2005

Available online 20 December 2005

### Abstract

The 'BIS/BAS scales' (Carver & White, 1994) is the most widely cited inventory for assessing Gray's (1982,1991) Reinforcement Sensitivity Theory (RST) of personality. A peculiarity of this instrument is its three-factor representation of Gray's Behavioural Activation System (BAS), which mediates reactions to reward. While the BAS was initially proposed as the causal basis of Impulsivity, recent arguments suggest that Impulsivity is related to but distinct from reward-reactivity. In this paper, two studies examined Carver and White's BAS scales in terms of factor structure, and convergent/divergent validity when predicting proxies of Impulsivity and reward-reactivity. Confirmatory Factor Analysis revealed structural distinctions between the three BAS scales, and multivariate regression suggested that two of the scales (Drive and Reward-Responsiveness) reflect key concepts of the BAS, while the third (Fun-Seeking) has a broader focus, being equally related to reward-reactivity and Impulsivity.

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*Keywords:* Gray; RST; BAS; Impulsivity; BIS/BAS scales

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## 1. Introduction

Jeffrey Gray's (1982, 1991) Reinforcement Sensitivity Theory (RST) is an application of concepts from animal learning research to individual differences in human personality. Gray's major interest has been the biobehavioural delineation of a Behavioural Inhibition System (BIS), a motivational network thought to form the bases of anxiety (Gray, 1982; Gray & McNaughton, 2000). Of secondary focus to his research, but having wide influence in the field of personality, was Gray's suggestion that a parallel system to the BIS, a Behavioural Activation System (BAS, also called Behavioural Approach System, e.g., Corr, 2001), underlies variation in trait Impulsivity (e.g., Gray, 1991). The BAS is thought to mediate reactions to reward, resulting in approach of reward and the experience of positive affect. The influence of this motivationally based thesis of Impulsivity is reflected by the numerous personality models which draw upon its central concepts (e.g., Cloninger, 1987; Zuckerman, 1979).

Perhaps as a side-effect of Gray's 'bottom-up' approach to personality, psychometric assessment has proved a major difficulty for RST (Corr, 2001; Smillie, Pickering, & Jackson, submitted for publication). This has been most problematic for devising a trait measure of BAS-mediated Impulsivity (Pickering & Gray, 2001; Smillie & Jackson, 2005), which has always been poorly defined in RST (Diaz & Pickering, 1993). In fact, recent research has suggested that Impulsivity, itself a complex trait-cluster rather than a single dimension per se, may be a misnomer for the BAS-related trait (Dawe & Loxton, 2004; Pickering & Smillie, forthcoming; Quilty & Oakman, 2004; Smillie, Pickering, et al., submitted for publication). Firstly, a number of psychometric studies have shown that measures of Impulsivity tend to be aligned with Psychoticism, while purpose-built measures of BAS tend to be aligned with Extraversion (Caseras, Avila, & Torrubia, 2003; Smillie & Jackson, 2006; Zelenski & Larsen, 1999). Secondly, a significant body of neuropsychological evidence suggests that Extraversion (but not Impulsivity) is associated with BAS-related dopamine receptor effects (Depue & Collins, 1999). Supporting this view, experimental evidence demonstrates that Extraversion and purpose-built measures of BAS (but not Psychoticism or trait Impulsivity measures) are related to reward-contingent learning (Pickering, 2004; Smillie, Dalgleish, & Jackson, submitted for publication). This literature suggests a distinction between reward-reactivity and trait Impulsivity, linking the first to Extraversion and the second to Psychoticism.

One of the most successful contributions to the RST measurement process was Carver and White's (1994) BIS/BAS scales. Justifiably, the authors emphasised the uncertainty with which BAS functioning might manifest at the trait level – indeed, at this time the only attempt to develop a trait measure of the BAS had yielded disappointing results (Wilson, Gray, & Barrett, 1990). For this reason, Carver and White generated a larger number of BAS items (13) than BIS items (7) in their questionnaire, in an explicit attempt to cast a wide net for the BAS-related trait. A Principal Components Analysis indicated that the 13 items formed three correlated factors. These were named Reward-Responsiveness (RR; 5 items, e.g., *When I get something I want, I feel excited and energized*), Drive (4 items, e.g., *I go out of my way to get things I want*) and Fun-Seeking (Fun; 4 items, e.g., *I often act on the spur of the moment*).

Carver and White (1994) validated their scales using a psychometric study in which relationships with other personality measures were assessed. They also conducted two experiments in which the scales were correlated with self-reports of happiness and nervousness after receiving

reward and punishment. While all three scales appeared promising measures of the BAS, they did not always show convergent validity. Firstly, RR, Drive and Fun varied greatly in their concurrent relationships with several other personality measures. Secondly, after controlling for initial happiness ratings, only RR and Drive were significant predictors of self-reported happiness following experimentally manipulated reward. Various divergences among the three scales have emerged in subsequent research, when predicting a wide range of psychometric, behavioural and physiological variables (e.g., Carver, 2004; Carver, Meyer, & Antoni, 2000; Jorm et al., 1999; Reuter, Schmitz, Corr, & Hennig, 2005; Wingrove & Bond, 1998). Some explanation of these divergences seems critical for proper interpretation of research which has employed the BIS/BAS scales.

Do Carver and White's three BAS scales relate to a common construct? A number of studies using Confirmatory Factor Analysis have concluded that RR, Fun and Drive reflect distinct but related constructs (e.g., Heubeck, Wilkinson, & Cologon, 1998; Leone, Perugini, Bagozzi, Pierro, & Mannetti, 2001; Ross, Millis, Bonebright, & Bailley, 2002). Nevertheless, this does not negate the possibility that all three are manifestations of reward-reactivity, mediated by the BAS. There seems to be no a priori basis for arguing that psychometric manifestations of the BAS *must* be unidimensional. That Carver and White's BAS scales are subtly different from each other does not imply that they correspond to separate causal influences (nor that summing them to make a total scale is wrong). On the other hand, however, the fact that RR, Drive and Fun frequently diverge in their relationships with behavioural and psychometric criteria could indicate that the distinctions between them are meaningful and deserving of attention. In any case, it is not possible to resolve this issue only by examining the structure of the BIS/BAS scales. Rather, it is necessary to identify the conceptual nature of any distinctions among these three putative measures of BAS.

Recent research has begun to shed light on this problem. Zelenski and Larsen (1999) compared measures based upon the theories of Eysenck and Gray, and also Cloninger (1987), using Principal Components Analysis. One factor was labelled 'BAS', being comprised of RR and Drive, along with three potential markers of reward-reactivity (Extraversion, Reward-Expectancy and Persistence). While the Fun scale also had a moderate loading on this factor, it was primarily associated with Psychoticism, Novelty-Seeking, and Impulsiveness, which together comprised a factor the authors labelled 'Impulsivity'. Near identical findings were presented by Caseras et al. (2003), using very similar personality scales: Fun loaded on an 'Impulsivity' factor, while Drive and RR loaded on a 'BAS' factor. More recently, Knyazev, Slobodskaya, and Wilson (2004) demonstrated that Drive and RR are associated mostly with Extraversion, while Fun is more strongly related to Psychoticism and Impulsivity.

Results from these studies are interesting for two reasons. Firstly, they complement Carver and White's (1994) experimental validation of their questionnaire, in which Drive and RR, but not Fun, predicted reactions to reward. Secondly, they suggest that the distinction between trait Impulsivity and reward-reactivity proposed in the recent literature could serve as an organising framework for conceptual differences among Carver and White's (1994) BAS scales. Specifically, it seems that RR and Drive might be conceived of more or less exclusively as measures of the BAS (aligned with Extraversion), while Fun may reflect Impulsivity (aligned with Psychoticism). Inspection of scale items encourages this view: While the RR and Drive items plainly concern reactions to or motivation by reward, some items for the Fun scale are typical of most Impulsiveness

scales but have no obvious links to key concepts relating to the BAS (such as the sample item presented earlier; *I often act on the spur of the moment*).

The objective of this paper is to examine conceptual differences among Drive, Fun, and RR from a reward-reactivity versus trait Impulsivity perspective. It is hypothesised that RR and Drive are more closely related to the BAS, while Fun is related to the broader trait-cluster of Impulsivity. Study 1 examines the structure of the three BAS scales using Confirmatory Factor Analysis. It is predicted that a model representing Drive and RR as two facets of a BAS superfactor, with Fun represented as a second correlated factor, will show superior fit to a single-factor representation. In study 2, multivariate regression is used to explore the conceptual nature of structural differences among RR, Drive and Fun. Specifically, the three scales are compared in terms of their relationships with two composite variables constructed to represent reward-reactivity and trait Impulsivity. This builds upon secondary observations in the literature regarding differences among Carver and White's (1994) BAS scales, and attempts to identify how they might be effectively used in future tests of RST.

## 2. Study 1

### 2.1. Method

#### 2.1.1. Participants and questionnaire

The BIS/BAS scales were administered to 543 volunteers (35% male; mean age = 22.74, SD = 9.24) at the University of Queensland. Of these, 364 were first-year psychology students participating in exchange for course credit; 63 were third-year psychology students who completed questionnaires as part of the practical requirements for a course in applied psychological measurement; and 116 were members of the community who had responded to advertisements.

#### 2.1.2. Statistical analyses

Numerous representations of all four BIS/BAS scales (RR, Fun, Drive and BIS) have already been tested in the literature. In contrast, the present study will include only the three BAS scales in the analyses. This is to eliminate potential influences of the BIS scale on the structure of the three BAS scales. For instance, it is possible that a four-factor correlated model has always provided the best fit to Carver and White's scales due to the significant correlation usually, albeit unexpectedly, found between BIS and RR (e.g., Jorm et al., 1999). For the Confirmatory Factor Analysis, two models will be fitted: one in which all items are loaded onto a single BAS factor, and one which represents Drive and RR as facets of a BAS superfactor, with Fun represented as a separate but related factor.

### 2.2. Results

#### 2.2.1. Preliminary statistics

Descriptive statistics presented in Table 1 are consistent with previous research. The scales demonstrate predictable intercorrelations, and modest reliability.

Table 1  
Descriptive statistics for the BAS scales

	RR	Fun	Means	SD	Alpha
RR	–	–	17.45	1.81	0.66
Fun	0.33**	–	12.26	2.13	0.69
Drive	0.36**	0.45**	10.85	2.29	0.75

N = 543.

\*\* p < .001.

2.2.2. Confirmatory factor analysis

Two confirmatory factor models were fitted using AMOS (Arbuckle, 2003). Parameter estimation was based upon the covariance matrix, using the AMOS asymptotically distribution free method of estimation to account for observed violations of multivariate normality. For the single-factor model all RR, Drive, and Fun items were specified as indicators of a single latent variable (Fig. 1). As might be anticipated from previous studies, this model was rejected outright due to unacceptable fit,  $\chi^2_{(65)} = 338.58, p < .001$ ; adjusted GFI = 0.87; CFI = 0.70; RMSEA = 0.11. (It is worth noting, however, that the unweighted alpha coefficient computed for a BAS-total scale is .81, suggesting high internal consistency among all BAS items.) The second model conceived of Drive and RR as related facets of a BAS superfactor, while representing Fun as a separate but related construct (Fig. 2). Model fit was superior to the single-factor model, and modestly acceptable by most conventions,  $\chi^2_{(62)} = 225.21, p < .001$ ; adjusted GFI = 0.94; CFI = 0.91;

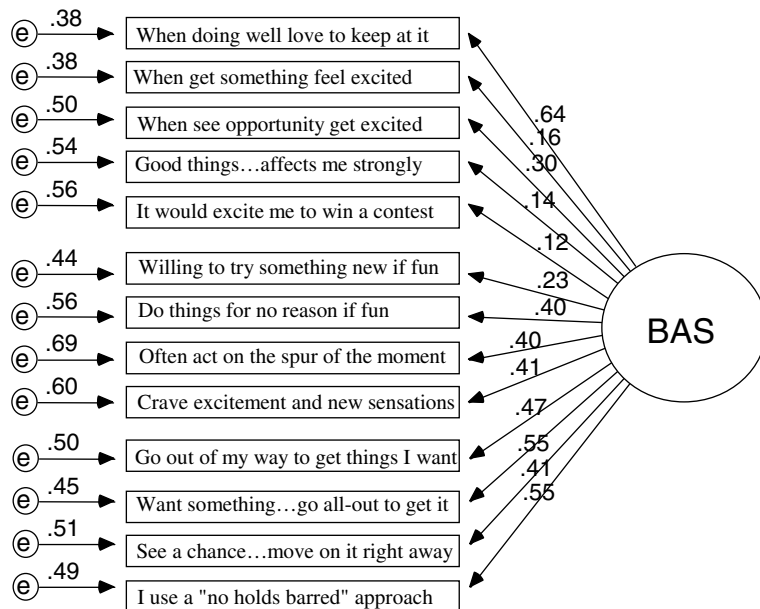


Fig. 1. Confirmatory factor analysis of the BAS scales assuming a single latent factor ( $\chi^2_{(65)} = 338.58, p < .001$ ; Adjusted GFI = 0.87; CFI = 0.70; RMSEA = 0.11).

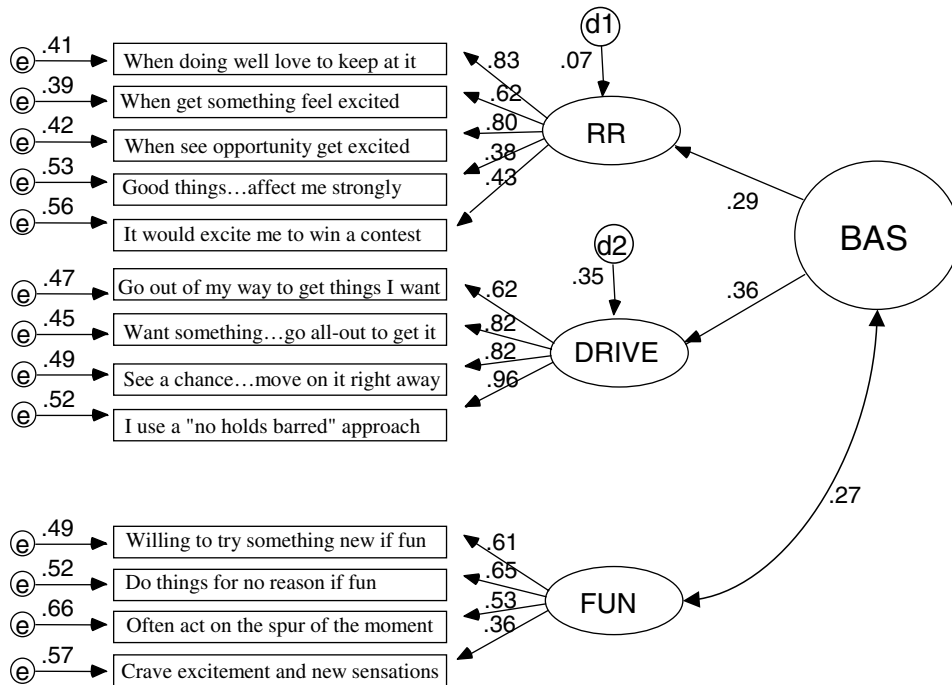


Fig. 2. Confirmatory factor analysis representing RR and Drive as facets of a common latent factor (BAS), distinct from Fun ( $\chi^2_{(62)} = 225.21, p < .001$ ; Adjusted GFI = 0.94; CFI = 0.91; RMSEA = 0.04).

RMSEA = 0.04. Overall, this study is in agreement with earlier evidence (e.g., Ross et al., 2002) that the three BAS scales reflect related but distinct constructs.

### 3. Study 2

#### 3.1. Method

##### 3.1.1. Participants

One-hundred-and-seventy-seven first-year psychology students from the University of Queensland participated in this study in exchange for course credit (age,  $M = 19.5$ ,  $SD = 4.1$ ; 30% male).

##### 3.1.2. Questionnaires

All participants completed the BIS/BAS scales, the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001), the Eysenck Personality Profiler (EPP; Eysenck, Barrett, Wilson, & Jackson, 1992), and the Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1975). In addition, participants completed the Positive and Negative Affect Scales (PANAS; Watson, Clarke, & Tellegen, 1988). The PANAS has a number of question formats, and this study used the format which asks participants to indicate the extent to which they feel a particular way *In General*.

### 3.1.3. *Statistical analyses*

Focal hypotheses were tested using Multivariate Multiple Linear Regression (MMLR). This is a variation of canonical correlation, which in turn can be thought of as an extension of standard multiple linear regression. In standard regression, a composite of predictor variables is regressed onto a single criterion variable. In canonical correlation, a composite of predictor variables is regressed onto a composite of criterion variables. It is then possible to find additional pairs of composite variables. In the MMLR to be conducted in this study, the precise constitution of the composite criteria is able to be specified a priori (see Cohen, Cohen, Aiken, & West, 2003, for discussion of multivariate regression).

Two composite variables were constructed to test hypotheses for this study. A composite of EPQ Extraversion, SPSRQ Sensitivity to Reward, and PANAS Positive Affect was constructed to represent reward-reactivity ('BAS'). According to recent research, Extraversion is the most likely candidate for the BAS-related trait (Depue & Collins, 1999; Pickering, 2004). Positive emotionality is also of fundamental importance to current understanding of the BAS (Depue & Collins, 1999; Gray, 1991). Finally, Sensitivity to Reward has shown reasonable validity to date as a measure of reward-reactivity (e.g., Smillie & Jackson, 2005). To provide a representation of trait Impulsivity ('IMP'), a composite was formed using EPQ Psychoticism, along with Risk-Taking, Impulsiveness and Sensation-Seeking, which are subscales of EPP Psychoticism. This model reflects the view that the Impulsivity tends to be most strongly associated with Psychoticism. Importantly, all of these measures have been found *not* to predict reward-contingent learning in a series of recent experiments (Pickering, 2004; Smillie, Dalgleish, et al., submitted for publication; Smillie, Pickering, et al., submitted for publication) suggesting their distinctiveness from BAS-reactivity. Carver and White's BAS scales were regressed on these two linear composites simultaneously, thus taking into account the large proportion of variance they share. It was expected that RR and Drive would primarily relate to the BAS composite, while Fun would primarily relate to the IMP composite. Regression parameters and covariances in this model were estimated using AMOS.

## 3.2. *Results*

### 3.2.1. *Preliminary statistics*

Correlations between Drive, RR and Fun and other personality measures are presented in Table 2. Alpha coefficients are also provided, and any pair-wise correlation involving a scale with an alpha coefficient less than .70 was corrected for attenuation. Of the three BAS scales, Fun correlates most strongly with Impulsivity measures, however, it also has the strongest relationship with EPQ Extraversion.

### 3.2.2. *Multivariate multiple linear regression model*

Fig. 3 depicts the MMLR model with parameters estimated using AMOS. It can firstly be seen that the composite models of BAS and IMP are strongly and significantly related to their constituent variables. This suggests that the variables selected as indicators for the two latent constructs are appropriate. A lower loading of Positive Affect on BAS is the one exception, which may reflect the more distal relationship of mood to Gray's biological systems. In support of the focal hypothesis, it is clear that RR is a significant predictor of BAS ( $r = .28, p < .001$ ) and a non-significant predictor of IMP ( $r = -.09, ns$ ); Drive is a significant predictor of BAS ( $r = .30, p < .001$ ) and a

Table 2  
Correlations between the BIS/BAS scales and other personality measures

	Alpha	Drive	Fun	RR
Alpha		0.74	0.71	0.68
Sensitivity to Reward	0.83	0.39**	0.48**	0.42**
Sensitivity to Punishment	0.88	-0.23*	-0.25**	0.04
Extraversion	0.92	0.36**	0.66**	0.32**
Neuroticism	0.93	0.04	-0.02	0.02
Psychoticism	0.86	0.17	0.21*	-0.25**
Positive Mood	0.94	0.09	0.08	0.32**
Negative Mood	0.91	-0.09	-0.18*	0.09
Impulsiveness	0.75	0.27**	0.60**	0.23*
Risk-Taking	0.67	0.24*	0.45**	0.05
Sensation-Seeking	0.81	0.29**	0.50**	0.18*

N = 177.

\* p < .05.

\*\* p < .01.

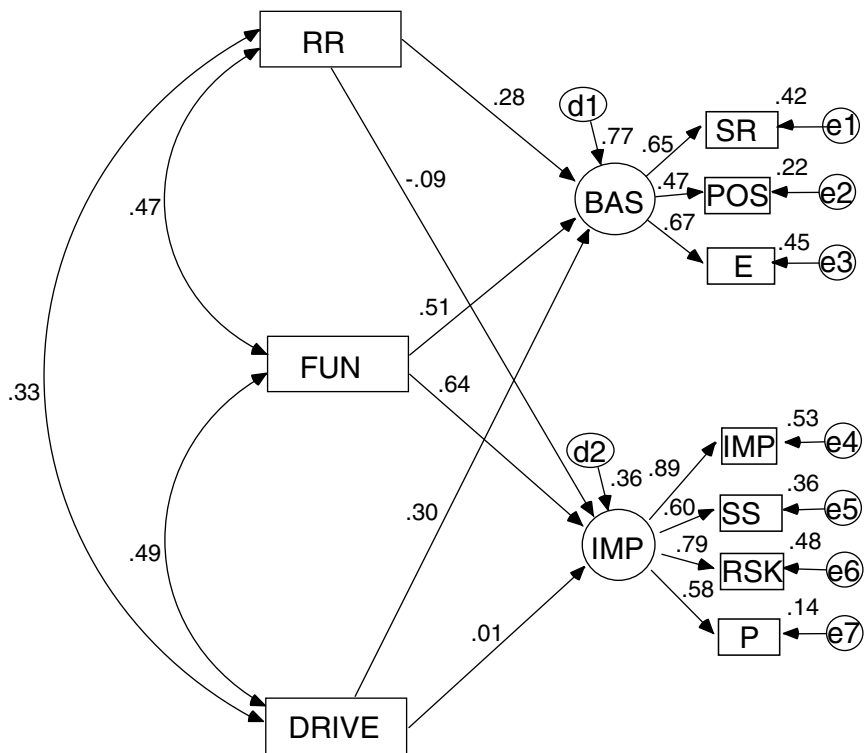


Fig. 3. MMLR exploring conceptual divergences among the three BAS scales. RR and Drive are only related to BAS composite, while Fun is equally related to BAS and IMP composites. All regression coefficients greater than .16 are significant at  $p < .05$ . SR = Sensitivity to Reward; POS = Positive Affect; E = EPQ Extraversion; IMP = EPP Impulsiveness; SS = EPP Sensation-Seeking; RSK = EPP Risk-Taking; P = EPQ Psychoticism.

non-significant predictor of IMP ( $r = .01$ , ns); and Fun is a strong and significant predictor of both IMP ( $r = .64$ ,  $p < .001$ ) and BAS ( $r = .51$ ,  $p < .001$ ). Curiously, both Drive and RR are notably weaker predictors overall than Fun. This may be explained by their high correlations with Fun, potentially indicating that their effects are partially mediated by this scale. Overall, results suggest that Drive and RR exclusively reflect concepts relating to the BAS, while Fun also relates to trait Impulsivity.

#### 4. Discussion

This paper contributes to the understanding of conceptual differences among Carver and White's (1994) BIS/BAS scales, the most widely used purpose-built measure of RST. Many studies have shown divergences among Carver and White's three BAS scales, leaving no doubt that the scales are subtly different, but offering little suggestion as to what those differences may reflect. According to the present findings, one of the ways in which the three BAS scales may differ from each other is in terms of the reward-reactivity versus trait Impulsivity distinction proposed in the recent literature (e.g., Dawe & Loxton, 2004; Quilty & Oakman, 2004; Smillie & Jackson, 2006). Specifically, results show that Drive and RR predict a composite of psychometric measures which have all been shown in recent experimental investigations to reflect reward-reactivity. Furthermore, they did not predict a composite of Impulsivity measures which have been shown *not* to predict experimental reactions to reward. Fun was related to both composite variables, suggesting it may reflect reward-reactivity and trait Impulsivity. This may suggest that RR and Drive provide purer measurement of concepts relating to the BAS than Fun does. On the other hand, Fun may provide a useful measure of traits which draw conceptually upon BAS *and* Impulsivity (e.g., Sensation-Seeking, Zuckerman, 1979), but a less-than-ideal measure for RST research.

It is important to emphasise that results from this research, like those of previous studies, do not enable firm conclusions. On the one hand, Fun does diverge from Drive and RR in the manner explained above, and a single-factor BAS model shows unacceptably low fit in Confirmatory Factor Analysis. On the other hand, the Cronbach's alpha for a BAS-total scale is .81, suggesting reasonable internal consistency and therefore high communality among the items. Furthermore, study 2 shows that all three scales have strong bivariate correlations with Extraversion, an arguably critical correlate of the BAS (Pickering, 2004), and are significant independent predictors of a proxy 'BAS' variable. This indicates that, while Fun may have a broader focus, it may not be *unrelated* to the BAS, and therefore may not contaminate a BAS-total scale. Indeed, many studies (including our own) have shown sensible relationships between the total scale and a range of BAS-related criteria (e.g., Gomez & Gomez, 2002; Reuter et al., 2005; Smillie, Dalgleish, et al., submitted for publication; Smillie & Jackson, 2006).

In examining divergences among Carver and White's measures of BAS, one advantage of this paper was its provision of a double-dissociation test. That is to say, there was the opportunity for each of the three scales to predict a BAS construct, *and or* an Impulsivity construct. A single-dissociation test (e.g., the provision of BAS-related criteria only) would not have revealed a conceptual distinction among Carver and White's BAS scales. A related strength of this research is the use of the MMLR analysis. Many studies in the literature examining convergent and divergent validity employ only zero-order correlations (e.g., Carver & White, 1994; Jorm et al., 1999), which

do not take into account correlated predictors. Ordinary Linear Regression does take this into account, but does not permit prediction of multiple criteria. The analysis conducted in study 2 overcomes both problems by enabling the simultaneous prediction of multiple criterion variables by multiple predictor variables. Future personality research concerned with the validation of psychometric instruments may benefit from the use of this strategy.

The growing consensus of a distinction between reward-reactivity and trait Impulsivity provides a useful framework with which to evaluate RST questionnaires, and inform research regarding their appropriate use. An interesting question which fell beyond the scope of the present research concerns the relationship between BAS-reactivity and trait Impulsivity. The boundaries between these concepts are becoming more clearly defined, but perhaps this makes an explanation for their frequent overlap all the more necessary. One possibility is that the biological substrates of the BAS are shared with those underlying trait Impulsivity, as suggested by disagreement in the literature as to whether dopaminergic activity is primarily related to Extraversion or Psychoticism (Pickering, 2004). Alternatively, it is possible that Impulsivity and reward-reactivity have a common biology but are mediated by separate cognitive mechanisms. This interpretation might argue that our 'BAS' and 'IMP' concepts are *both* theoretically related to Gray's reward system. Their distinctiveness would then be explained in terms of other psychological constructs in personality. (The mediation of Gray's biological systems by traits based in cognition is explored by Cloninger (1987).)

Related to this last point, a noteworthy caveat to this paper concerns the validity of the composite variables created in study 2. Our artificial 'BAS' proxy does not necessarily constitute an accurate representation of Gray's reward system, and indeed it was a key premise of this research that the BAS is a concept shrouded in uncertainty. Instead, our composite provides a psychometric marker to which one would expect reward-reactivity to relate. The composite was composed of a previously validated measure of BAS, along with measures of Extraversion and positive emotionality, which have been identified as the key personality and affect dimensions associated with reward-reactivity (e.g., Depue & Collins, 1999). Regarding our 'Impulsivity' composite, it is significant that the scales used for this have recently been shown *not* to relate to BAS-mediated learning (Pickering, 2004; Smillie, Dalgleish, et al., submitted for publication; Smillie, Pickering, et al., submitted for publication). As such, our BAS composite formed a sensible and empirically justified representation of BAS-reactivity, while our Impulsivity composite was likely to be relatively distinct from BAS influences. Nevertheless, as external validity for these composites was not demonstrated in the present research, our conclusions must be tentative. Converging experimental research would strengthen the present findings. In particular, measures of Impulsivity and reward-reactivity should be doubly dissociated in experiments which provide behavioural indices of BAS and Impulsivity.

In closing, this paper suggests that one of the ways in which Carver and White's (1994) BAS scales differ from each other is in terms of the distinction between reward-reactivity and trait Impulsivity. Two of the scales (Drive and RR) appear to be related only to reward-reactivity while a third (Fun) appears also to reflect trait Impulsivity. This builds upon secondary observations noting discrepancies among the scales in previous research, and has clear theoretical and practical significance. The theoretical implication of these findings concerns the apparent usefulness of distinguishing between the trait concepts of Impulsivity and reward-reactivity. The practical implication of these findings concerns appropriate use of the BIS/BAS scales in RST research.

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