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A closer look at Carver and White's BIS/BAS scales: Factor analysis and age group differences

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ABSTRACT

The Behavioural Inhibition and Behavioural Activation System (BIS/BAS) scales were developed by Carver and White (1994) and comprise four scales which measure individual differences in personality (Gray 1982, 1991). More recent modifications, namely the five-factor model derived from Gray and McNaughton's (2000) revised Reward Sensitivity Theory (RST) suggests that Anxiety and Fear are separable components of inhibition. This study employed exploratory and confirmatory factor analyses on the scales in order to test whether the four or five-factor model was the better fit in a sample of 994 participants aged 11–30 years. Consistent with RST, superior model fit was shown for the five-factor model with all variables correlated. Significant age effects were observed for BIS Fear and BIS Anxiety, with scores peaking in middle and late adolescence respectively. The BAS subscales showed differential effects of age group. Significantly increasing scores from early to mid and from mid to late adolescence were found for Drive, but the effect of age on Fun Seeking and Reward Responsiveness was not significant.

1. Introduction

Gray (1982, 1991) proposed the Behavioural Inhibition System (BIS) and the Behavioural Activation System (BAS) as key components of what later was termed the Reinforcement Sensitivity Theory (RST) of individual differences in personality (Pickering, Díaz, & Gray, 1995). Generally speaking, the BIS is understood to be characterised by inhibitory responses in circumstances where cues signalling aversive consequences are present whereas the BAS system is characterised by responding to cues of reward, escape, and avoidance. Greater BIS sensitivity has been suggested as reflecting greater propensity toward Anxiety disorders (Carver & White, 1994), whereas heightened reward sensitivity has been invoked to explain adolescent risk taking behaviours such as alcohol and drug use, and the development of psychopathology (Bijttebier, Beck, Claes, & Vandereycken, 2009). Individual differences in this respect are thus an area of continued importance to disentangle the mechanisms associated with elevated risk of problem behaviour during adolescence.

Carver and White (1994) developed measures of BIS/BAS systems and performed exploratory factor analysis of their scale items, using a sample of 732 college students (51.1% female). Through examination of the factor structures of their measures and as derived from the latent variables detected, they were ultimately able to break BAS down into three subscales: Fun Seeking, Drive, and Reward Responsiveness. Reward Responsiveness refers to a positive reaction to or anticipation of a reward, Drive to the relentless pursuit of desired goals, and Fun Seeking to the desire and tendency to impetuously approach a potential reward. Although the BIS/BAS scales tend to significantly correlate with one another in adult studies, patterns, and particularly strengths, of relationships differ across studies.

Research on Reinforcement Sensitivity Theory (RST) has only recently expanded from adulthood into childhood and adolescence (Colder & O'Connor, 2004; Cooper, Gomez, & Aucote, 2007; Urošević, Collins, Muetzel, Lim, & Luciana, 2012). In a cross sectional sample aged 9–23 years, Urošević et al. (2012) found overall increases in all BIS/BAS measures from early (9–12 years) to late adolescence (13–17 years) and early adulthood (18–23 years). By contrast, longitudinally, there was evidence for decline in the young adult group in Reward Responsiveness across the two year follow-up period, which the authors acknowledged may represent age-cohort effects. BIS/BAS developmental changes were associated with developmental changes in reward sensitivity related brain structures, including the orbitofrontal cortex and nucleus accumbens (Urošević et al., 2012). Consistent with previous research (Carver & White, 1994; Jorm et al., 1998), Urošević et al. also reported greater BIS scores for females, as well as greater rates of BIS sensitivity with increasing age. Sex differences in BAS sensitivities are much more varied and the question remains as to whether sex differences in BIS/BAS sensitivity are developmentally consistent or whether differences appear and disappear throughout different developmental stages.

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The Carver and White scales are a popular measure of reinforcement sensitivity, though the superiority of any single factor model of BIS/BAS has yet to be agreed upon (Demianczyk, Jenkins, Henson, & Conner, 2014; Corr, 2016). Some researchers propose that BIS/BAS scales, which were originally developed for adults, are appropriate for use in children and adults alike (Colder & O'Connor, 2004; Cooper, Gomez, et al., 2007) and there is greater accord that they are appropriate for use with adolescents (Cooper, Gomez, et al., 2007; Urošević et al., 2012). Essentially, the question does remain whether the Carver and White (1994) BIS/BAS scales are accurately measuring the constructs they were designed to and whether they are measuring the same precise construct in participants of varying demographic characteristics. Problems with the factor structure of the BIS/BAS scales have been noted (Cogswell, Alloy, van Dulmen, & Fresco, 2006; Demianczyk et al., 2014; Jorm et al., 1998), particularly in the BIS scale (see Poythress et al., 2008). Gray and McNaughton's (2000) proposal that Anxiety and Fear are separable dimensions of threat sensitivity is consistent with the finding that self-report measures of Trait Anxiety and Fear accounted for more variance than total BIS scores in a behavioural measure of threat sensitivity (Perkins, Kemp, & Corr, 2007). Finally, it has been suggested that the BIS, Drive, and Fun Seeking subscales of the Carver and White (1994) BIS/BAS scales are inadequate for measurement of moderately high to high levels of BIS/BAS sensitivity (Gomez, Cooper, & Gomez, 2005), as might be expected in adolescent populations.

Research examining the factor structure of these scales, drawing age comparisons between early adolescents and adults is sparse at best, though Cooper, Gomez, et al. (2007), who supported the comparability of the BIS/BAS scales for adolescents and adults, came notably close with a sample of adolescents aged 12–16 and adults aged 21–40. In this study, we will assess the goodness of fit of the Carver and White (1994) model, and then explore the age and sex effects on each of the subscales.

2. Method

2.1. Participants

The sample was composed of 994 males and females (58.4% female), aged 11–30 years. Data was then split into four developmental categories: early adolescence (age 11–13, $n = 431$, 53.1% female), mid-adolescence (age 14–16, $n = 363$, 54.8% female), late adolescence (age 17–22, $n = 120$, 76.7% female) and adulthood (age 23–30, $n = 80$, 76.3% female).

2.2. Measures

2.2.1. The BIS/BAS scales (Carver & White, 1994)

These scales include 20 items: seven items measure Behavioural Inhibition, four items measure Drive, four items measure Fun Seeking and five items measure Reward Responsiveness.

2.3. Procedures

Participants were recruited from an opportunity sample of school and university students in Northern Ireland. An electronic survey was administered via Survey Gizmo which contained items from the BIS/BAS scales utilised here, as well as participant information, consent, and additional measures collected as part of an ongoing developmental study. Parental consent (for adolescents) and participant consent were gained prior to participation in the survey and all responses were anonymous. Ethical approval was granted by the Local University Research Ethics Committee.

2.4. Statistical approach

2.4.1. Preliminary analyses

Data was analysed using IBM SPSS Statistics for Windows Version 21. Internal consistency, skewness, and kurtosis were first inspected to verify the overall normality and suitability of the data. Exploratory factor analyses (EFAs) were performed using IBM SPSS and, for confirmatory factor analyses (CFAs), IBM SPSS Amos Version 20 (Arbuckle, 2012) was used to further assess model fit. EFAs were performed with principal axis factoring extraction and oblique rotation; chosen to be consistent with the procedure employed by Carver and White (1994). Two-way MANOVA was then conducted with sex and age as between-subject factors and BIS/BAS measures (mean scale item scores) as dependent variables.

2.4.2. Model comparisons

Several measures of goodness of fit were utilised in the CFAs of the BIS/BAS models, the first of which being the chi-squared value. Here, a non-significant chi-squared value would be indicative that the proposed model appropriately fits – i.e. is supported by – the data. However, as large sample sizes often cause chi-squared tests to be significant, the chi-squared value is divided by the degrees of freedom in order to determine how suitable the model is; a quotient of 3 or less is considered generally indicative of good model fit (Carmines & McIver, 1981). The Root Mean Square Error of Approximation (RMSEA; Steiger, 1990) was calculated to concur with these results and to further assess whether each item for each scale belongs where it is and the scales interrelate as proposed. RMSEA values of ≤.06 are indicative of desirable model fit, with of ≤.08 being indicative of reasonable fit between the model structure as per the BIS/BAS design, and the model proposed by the observed data (Byrne, 2013; Hu & Bentler, 1999). The Comparative Fit Index (CFI; Bentler, 1990) and the Tucker–Lewis Index (TLI; Tucker & Lewis, 1973) values were also calculated to further assess and verify model fit. CFI and TLI values of ≥.90 signify acceptable model fit, with values of ≥.95 being indicative of good fit (Hu & Bentler, 1999). Finally, the Expected Cross Validation Index (ECVI) values were calculated along with 90% confidence intervals. These values offer a comparative evaluation of multiple models, with lower values being indicative of relatively superior fit (Browne & Cudeck, 1993).

In following similar factor analytic research on the BIS/BAS scales, efforts were made to make alterations to the BIS/BAS scales, such that indices of model fit could be compared in order to identify the superior model design for the scales for different demographics. The two modification comparisons, drawn from previous research on these scales and further suggested by the results of exploratory principal axis factor analysis, included assigning the reverse-coded items to their own second BIS variable, labelled BIS-F as the items represent Fear. The remaining five items, representing Anxiety, are labelled BIS-A. This five-factor model is tested whilst then constraining the two BIS variables to be uncorrelated to the three BAS variables for one model and having the five variables correlated in the other model.

3. Results

Cronbach's alpha values for BIS ($\alpha = .72$), Drive ($\alpha = .80$), Fun-Seeking ($\alpha = .71$), and Reward Responsiveness ($\alpha = .80$) were within an acceptable range and were even slightly higher than Carver and White's original range of .66 to .74 (Carver & White, 1994). The two reverse-coded items in the BIS scale were shown as problematic in terms of their effect on the Cronbach's alpha value of this scale and this held for all groups when the data was split by sex and age.

3.1. Factor analysis

EFAs revealed that each item loaded most strongly to its intended scale, for both sexes and throughout the age span discussed here, with