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Manuscript Draft

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Abstract: Recent revisions of Gray's Reinforcement Sensitivity Theory (RST) have important implications for self-report measures of approach and avoidance behaviours and how Gray's model relates to other personality models. In this paper, we examine the revised RST by comparing Carver and White's (1994) original one-factor solution of the BIS scale with two alternative two-factor solutions separating BIS-Anxiety and FFFS-Fear. We also examine the relationships between Eysenck's PEN and revised RST factors. Two hundred and twelve participants completed Carver and White's BIS/BAS scales and Eysenck's Personality Questionnaire-Revised. Confirmatory factor analyses of the original BIS scale showed that the hypothesized two-factor model of BIS-Anxiety and FFFS-Fear was the best fit to these data. Associations between the revised RST and Eysenck's PEN were examined using path analysis. In line with theoretical predictions, Psychoticism was related to revised BIS-Anxiety and BAS, Neuroticism to revised BIS-Anxiety and FFFS-

Fear, and Extraversion to BAS and FFFS-Fear. Distinctions between BAS subscales and their associations to BIS, N and P were made in terms of past, present and future focus. Possible explanations for mixed findings in the literature and implications for future research are discussed.

Revisions to: **Ms. Ref. No.: PAID-D-08-00106**
A re-evaluation of the relationship between Eysenck's PEN and Gray's revised RST:
Psychoticism in the here and now - BIS in the yesterday and tomorrow!

Dear Editor,

Thank you for organizing the review process and for you email of April 9th 2008 giving us the opportunity to revise and resubmit the Manuscript. We would like to thank the three reviewers for the time and effort they put into their reviews. Their comments were very useful and allowed us to clarify the focus of the paper and strengthen the analyses. Detailed answers to the reviewers' comments are presented below. We have addressed all of the reviewers' concerns.

First of all, we would like to thank you for your personal comments and reference for the recently released Corr & McNaughton chapter in Corr (2008). We have incorporated their invaluable discussion into our manuscript. For instance, you had pointed out that the first suggestion for the split of the BIS scale into specific anxiety and fear items was made by Corr & McNaughton (2008) and we have highlighted this in the paper (page 4, paragraph 3; page 5, paragraph 2).

Moreover, a number of the reviewers' changes called for additional information and we have tried to make all of these changes while keeping the manuscript within the 5000 word limit for *Personality and Individual Differences*. For example, we have now included one additional model for the confirmatory factor analysis and the appropriate figures showing the two CFA models (e.g. page 9 and 10, Figure 2) as well as a descriptive table for the RST and PEN variables (page 11, Table 2). Throughout the text we have also clarified some arguments.

Word count: 4908

Reviewer 1

General Comment:
'In this study the authors examine associations among Eysenck's PEN and indices relevant to Gray's RST, using Carver and White's (1994) BIS/BAS scales to index RST constructs. Noting important theoretical distinctions between Gray's early (1987) and revised (Gray & McNaughton, 2000) theory (e.g., the reallocation of sensitivity to conditioned fear stimuli from the BIS to FFFS), the authors inspect the C&W BIS scale items and, on rational grounds, identify items more related to "fear" than to "anxiety" and demonstrate, using CFA, statistical support for separate BIS-anxiety and FFFS-fear scales. Associations among these scales generally conform to hypotheses and provide a useful contribution to the literature on relations between PEN and RST constructs.

The manuscript is well-written, well-organized, and concise. Hypotheses are clearly stated, methods and analyses clearly described, and results are presented in a

straightforward manner. Recognizing that there is some pressure on authors to limit introductory material in light of word or page limits for manuscripts, the few concerns I had about this manuscript relate mainly to issues in their literature review.'

Response:

We thank the reviewer for the positive comments about the paper and for the extremely helpful and detailed comments on the MS. We agree with all of the points made by the reviewer and have addressed each as detailed below.

Issue 1:

'On p.3 the authors note, regarding the literature on relations between E and BIS, that "the negative relationship . is not always found", citing a single reference. Of course, even a single instance supports the descriptor "not always," but this characterization hardly describes what the bulk of the literature with which I am familiar seems to show. See, e.g., the following correlations and associated references:

-.14 Carver & White (1994), Study 2
-.19 Jorm et al. (1999)
-.20 Caseras et al. (2003)
-.16 Heubeck et al. (1998)
-.14 Franken et al. (2005)
-.12 Muller & Wytykowska (2005), Study 4
-.11 Chi et al. (2005)

Unless the authors have a number of other exceptional findings with which I am not familiar, wouldn't ". is usually found" (citing the above) be a fairer characterization of the literature than the one they have chosen?'

Response 1:

We agree with this comment and have changed the wording on page 3 (paragraph 3) highlighting that the negative link between E and BIS is usually found, but is typically weaker. We refer to the recent review chapter by Torrubia, Avila and Caseras (2008) who quoted most of the references indicated above by the reviewer and came to the same conclusions.

Issue 2:

'Also on p. 3, the authors note that evidence for a positive relationship between N and BAS has not been consistently demonstrated. Again, in much of the literature with which I am familiar, except for an occasional positive relationship between N and Reward Responsivity, correlations between N and BAS (Total score or subscales) have pretty consistently been very low (i.e., < .10) and sometimes on the order of "0" if not negative. See, e.g.,

Jorm et al. (1999) except for RR = .25

Caseras et al. (2003)
McHoskey et al. (1998) Study 1   (BAS-T = .00)
Franken et al. (2005), except RR = .13
Smillie et al. (2006) Study 2
Muller & Wytykowska (2005) Study 4, (BAS-T = .05)
Chi et al. (2005), except RR = .24
Jackson & Smillie (2004), except RR = .14
Zelenski & Larsen (1999), except RR = .25
Gremore et al. (2005), (BAS-T = .16)
Smolewska et al (2006)

So again, the author's characterization of what the bulk of the literature shows seems to understate, if not misstate, the state of affairs.'

Response 2:
The manuscript stated: '…evidence for the positive relationship between N and BIS has been consistently demonstrated but not for BAS', which was indeed in line with the reviewer's comment (i.e. low relationship between N and BAS). However, to make this more explicit, the phrase 'but not for BAS' has been excluded and instead the following phrase added with some additional references: '…however, correlations between N and BAS have been low, except for some subscales (e.g. Zelenski & Larsen, 1999; Jackson & Smillie, 2004).' (page 3, paragraph 3). This is in line with the reviewer's argument as well as the before mentioned review chapter by Torrubia et al. (2008) who point out the same issue.
However, with regards to the subscale Reward Responsiveness and its links to N - this has not been explicitly highlighted here on page 3, as the Carver and White subscales are introduced later in the paper. However, the occasional positive correlation between N and BAS-RR has been explicitly highlighted on page 6 (paragraph 2) and further discussed in the discussion (page 13 and 14, first paragraphs).

Issue 3:
'On p. 5 the authors cite a single source, Heubeck et al. (1998), in support of the assertion that the BIS/BAS scales have been "well validated" in the literature. In fact the Heubeck paper is very tepid and cautious in its appraisal of the BIS/BAS scales, raising a number of questions about the construct validity of these scales and, particularly in the case of BIS, concerns about the lack of adequate coverage of functions attributed to BIS in early RST. Along with Heubeck, a number of other investigators (Jorm et al., 1999; Brenner et al., 2005) criticize BIS as mainly assessing constructs in the negative emotionality spectrum. Thus, as presented the authors assertion of "well validated" seems an overly sanguine characterization of the literature regarding these measures.'

Response 3:
Appropriate changes have been detailed – the phrase 'well validated' has been changed to 'extensively used' (page 5, paragraph 2), which we feel is more appropriate, and the Cogswell et al (2006) and Johnson et al (2003) studies as well as Corr and

McNaughton review (2008) have been discussed in more detail with regards to criticisms on the factor structure of BIS rather than the Heubeck study, which did not add to this argument (page 5, paragraph 2).

Issue 4:
      'On p. 5 the authors make the case for parsing the C&W BIS scale into separate scales. This would be a good place to at least mention that in one prior study (Johnson et al., 2003) the two more obvious "fear" items loaded together to form a separate factor/ couplet from the remaining 5 BIS items. It may be worth exploring the fit of this alternative structure for BIS as well.

Response 4:
      This comment was particularly useful - the Johnson et al. reference has been incorporated into the MS and incorporated as a second alternative model in the CFA, separating only the two fear items they highlight into the FFFS-Fear in contrast to the three item FFFS factor we propose (e.g. page 5 paragraph 2, continue to page 6 top and Table 1; and page 10; Figure 2).

Issue 5:
      'The authors are careful to note (1) the preliminary nature of their findings and need for replication, (2) that the parsed BIS scales "cover only a limited range of relevant behavior," and (3) the need for general revision of scales in light of revised RST. I agree with these cautions but, in light of the tendency of investigators to continue, now 8 years after Gray & McNaughton (2000) to continue testing the earlier theory, I think I would be inclined to make the cautions somewhat more forcefully.'

Response 5:
      The limitations of this study and findings (e.g. need for replication, limited range, greater sample size) have been highlighted more explicitly in the discussion by stating that any conclusions should be drawn with those limitations in mind (page 14, paragraph 2 and 3) and further weight has been put on the importance to incorporate the revised RST in future research in the final paragraph (page 14).

Reviewer 2:

General Comment:
      'This paper addresses two major issues: 1) revisions of Carver and White's scale to fit the revised RST (particularly the distinctions between the BIS and FFFS), and 2) the relationship of Gray's revised dimensions to Eysenck's dimensions. A new psychometrically sound, theory-based scale is desperately needed in the field, and as such this paper represents a step in that direction, although certainly more revision to the scale is necessary. I think this paper's most substantial contribution to the literature would be the revised BIS scale that separates BIS-Anxiety and FFFS. The relationship of Gray's dimensions to Eysenck's dimensions has been examined in some depth previously,

but in this paper they provide some data on convergent and divergent validity for the new BIS-Anxiety and FFFS scales. This is a clear, well-written paper that I think would provide a beneficial addition to the existing RST literature. However, I recommend that some issues be addressed before it is suitable for publication in PAID.'

Response:
We thank the reviewer for their supportive comment. We agree with the points raised and have addressed each comment as detailed below.

Introduction:

Issue 1:
I might suggest a new title; the meaning of the part after the colon is not immediately clear until one reads the paper

Response 1:
We agree with the reviewer and changed the title to make it more focused and relevant for the literature.

Issue 2:
Good explanation of Gray's theory, with a minor change. On page 3, the authors correctly point out that the BIS is activated by approach-avoidance conflicts (which come from reward and punishment contingencies). Please also note that approach-approach conflicts or avoidance-avoidance conflicts can activate the BIS as well.

Response 2:
We thank the referee for the positive comment and have added that approach-approach and avoidance- avoidance conflicts can also activate BIS (page 3, paragraph 2).

Results:
Issue 3:
Did you use any kind of principle components analysis or exploratory factor analysis to decide which original BIS items would be moved to the new BIS scale? If not, how do we know that your current FFFS scale and BIS scale are the best possible ones that can be made from Carver & White's BIS scale? I am unclear why certain items ended up on the FFFS scale versus the BIS scale. For example, the item "Criticism or scolding hurts me quite a bit" does not appear to me to tap "conflict and uncertainty," which you state to be a main theme of BIS-Anxiety. Rather, it appears to me to tap punishment responsivity, a construct that appears to be located in the FFFS in your model. If you did not use a PCA, could you do some other CFAs with various configurations of BIS/FFFS items in order to show better fit with your current 2-factor structure than another plausible way of arranging those 2-factors? Alternatively, if you did use a PCA first, then your CFA should be done in an independent sample.

Response 3:
    The theoretical distinctions between BIS and FFFS items have been discussed in more detail on pages 5 and 6 (paragraph 2; Table 1), which resulted in the testing and comparison of two alternative 2-factor structures of the BIS-FFFS distinction in the Results section (pages 9 – statistical analyses, and 10 – Result section: CFA; see also Figure 2). As highlighted in the Introduction, we believe that being criticized or scolded is associated with anxiety or worry about social comparison, leading to conflict and uncertainty and thus facilitating BIS-mediated anxiety. In support of this, Smillie, Pickering & Jackson (2006) state the following:

    '…White and Depue (1999), however, cited considerable evidence from outside the immediate RST-based personality literature that supports a psychometric fear/anxiety distinction. A large part of this data uses Telegen's (1982) Multidimensional Personality Questionnaire, which includes a broad-focused scale of Negative Emotionality (NEM; similar to Eysenck's "Neuroticism" and Gray's "Anxiety") and a narrow-focus scale of Harm Avoidance (HA; similar to Gray's notion of "Fear"). …Gray and McNaughton's (2000) revisions may have brought the RST view closer to that of Tellegen in this respect: The HA scale concerns reactions to unconditioned and conditioned physical punishers (which seems highly consistent with the undertakings of the FFFS), while the NEM scale reflects sensitivity to uncertainty, social comparison, and failure of one's efforts (which seems somewhat similar to the concept of 'conflict', albeit couched within a social context).[3] White and Depue's (1999) thorough review and promising experimental data may therefore provide preliminary support for, and guidelines for further examination of, the fear/anxiety distinction emphasized in the new RST. …' (p.325)

    Footnote 3: 'A reasonable argument could be made for the relevance of social stimuli to BIS mediated anxiety, due to the conflicting reinforcement signals which characterise such situations. That is, it seems highly unlikely that social exchanges are purely rewarding or punishing; rather, there might be clear perceptions of both (such as the potential for rejection during courtship).' (p. 325)

    The development or identification of scales whose items clearly reflect either conflict and mismatch detection situations (BIS), or pure punishment and fearful threat situations (FFFS), is therefore essential for updating the RST trait model in line with Gray and McNaughton's (2000) revisions. …' (p. 325)

Issue 4:
    'You hypothesize in your discussion that Cogswell's (2006) CFA may have had poorer fit due to lumping BIS and FFFS together. One alternate hypothesis might be that the 3-factor structure of BAS was at issue. Why not include the BAS Scales in your CFA? This would directly test your theorizing about why Cogswell's results came out as they did and contribute further to the literature on factor structure & fit with the BIS/BAS scales.'

Response 4:

We thank the reviewer for this useful comment. We highlight in the MS that the focus of this paper is on the factorial structure of BIS given the theoretical justification of the BIS/FFFS distinction in the revised RST. Nevertheless, a principal component analysis of the BAS has been conducted, which supported the 3-factor structure of BAS in this sample (see page 9, Footnote 2). However, the criticisms towards the BAS subscales have also been discussed in more detail in the discussion and it was highlighted that a general revision of the BAS scale is needed in future research (page 14, paragraph 2). The general claim that poor fit in Cogswell's study may be due to the combination of BIS and FFFS within one scale has been removed.

Issue 5:

'In the path model, why did you not let BIS correlate with the rest of the BIS/BAS scales, when you did let FFFS correlate? BIS does have a relationship with BAS-FS and BAS-RR in your correlations, and it's possible that it might as well in the path model.'

Response 5:

The reviewer's comment has been taken on board and subsequent changes in the path model were implemented. In the revised model, BIS has paths to all three BAS scales – however, the paths between BIS and BAS-DR/BAS-FS were non-significant (page 9 – statistical analyses, see also Figure 3).

Issue 6:

'Also in the path model on page 11, why were pathways that were not predicted but had a significant correlation not tested? For example, the pathway between the BIS and E. A model that includes such pathways versus those that do not can be compared.'

Response 6:

Originally only a-priori hypothesized paths were included in the path model irrespective of the correlations. However, undergoing revisions requested by reviewer 3, transformed variables were applied, which resulted in the correlation between E and BIS becoming non-significant (see page 12, Table 3). The revised path model includes now all significant correlations, but also one additional path between P and BAS-RR (which was near significantly correlated, p=.051) as this relationship was hypothesized a-priori (see page 6, final paragraph; page 8, first paragraph; see also Figure 1 for hypothesis; and page 12 – path model and Figure 3 for analyses).

Discussion

Issue 7:

'Part of your intent was to revise Carver and White's scale to fit with the revised RST, yet you did not revise any part of the BAS scales whose 3-factor structure is not

consistent with Reinforcement Sensitivity Theory (Carver & White, 1994). Obviously, a total reconstruction of the BIS/BAS scales is beyond the scope of this paper, but in the discussion, it would be helpful to more explicitly state limitations of this revised measure.'

Response 7:
We fully agree with the reviewer's comment, however, the focus of this paper was to re-examine the BIS scale and the fear/anxiety distinction in line with the revised RST. Additionally, a principal component analysis on BAS was conducted supporting the 3-factor structure in this sample and thus, applied in subsequent analyses (page 9, footnote 2). However, recognising the issues associated with the BAS scales, the limitations of this scale (and subscales) were discussed in detail in the discussion and limitations of this revised measure were explicitly highlighted (page 14 , paragraph 2).

Issue 8:
'You point out that differential relationships of the three BAS scales to the EPQ suggests one should not use a total BAS score. However, several other research groups have found evidence for a two-factor BAS structure (e.g, Mitchell, Kimbrel, Hundt, Cobb, Nelson-Gray, & Lootens, 2007; Smillie, Jackson, & Dalgliesh, 2006) incorporating impulsivity/sensation seeking and reward responsiveness/drive, which suggests perhaps that one should not use three individual BAS scales. It appears that a revision of both the concept and the measurement of BAS is in order. It may be helpful to explicitly state this. In addition, your data could be used to test such a model.'

Response 8:
We agree with the reviewer and this issue has now been addressed in the discussion. The findings in the literature on the distinction between BAS related reward sensitivity versus impulsivity/sensation seeking/fun seeking have been discussed in more detail (page 13, final paragraph). However, as indicated above, the data presented here support a 3 factor model of BAS. In addition, the implications for further scale refinement of the BAS scale in future studies have been highlighted (page 14, paragraph 2, see also Response 7 above)

Issue 9 – Minor:
-Typo in footnote on page 8? Refers to BAS-RWR, elsewhere referred to as BAS-RR
- Figure 2, the path from P to FFFS. The * is next to the standard error, not the path estimate.
- The authors cite Smillie, Pickering, and Jackson (2006) as "Smillie, Pickering, & Jackson, 2006a" on page 2. Since there are no additional papers by these same authors in this order listed in this manuscript, omit the "a." Please make this change to Smillie, Jackson, and Dalgleish, 2006b on page 13 by removing the "b."

Response 9:
These points have been addressed in the paper – thank you for pointing those out.

Reviewer 3:

General Comment:
'*This is a nicely written article that deals with the practical and theoretical implications of the modifications that Gray and colleagues have recently done on the RST. First, the factor structure of the original BIS scale from Carver and White's BIS/BAS scales is revisited through confirmatory factor analysis. Second, the authors revise the relationship between Eysenck's and Gray's constructs making use of correlations and path analyses.*

The manuscript provides interesting and useful information in a clear manner. The results might be useful for a number of researchers in the field, both theoretically and practically. However, there are a few issues of the method that I'd like to see addressed:'

Response:
We like to thank the reviewer for this supportive comment and the useful and constructive criticisms highlighted on the paper. We have addressed those as follows:

Issue 1:
'*For the confirmatory factor analysis of the items of the BIS scale the authors used ML estimation (p.9). This is not the appropriate estimation method to apply in this case, given that the variables being analyzed are items with 4 answer categories. It is more appropriate to use WLS with an asymptotic covariance matrix to obtain and analyze tetrachoric correlations.*'

Response 1:
We agree with the reviewer's comment and have addressed this issue by applying an asymptotic covariance matrix and polychoric correlations for the CFAs. The results remain the same as in the unrevised version (see page 9 - statistical analyses, page 10 for CFA and Figure 2).

Issue 2:
'*On page 10, Table 1, the authors should provide information about the distribution of their variables (skewness, kurtosis). This is especially relevant because of the small selected sample with which the authors work. It is to be expected that at least P, N and the FFFS scales will be remarkably skewed. If that was the case the authors should also address this problem for subsequent analyses. They should either transform their variables, or use estimation methods robust to deviations from normality (e.g. MLR).*'

Response 2:

We are grateful for this comment and in line with it skewed variables were transformed and partly normalised (see page 11 - Descriptive Statistics section, and Table 2). Additionally, Spearman correlations on the untransformed variables were conducted and they showed similar relationships as seen with the Pearson correlations with the transformed variables (see page 11, Footnote 4). The transformed variables have been used for subsequent analyses and in line with Kirk (1981) z-scores for the relationships of the two slightly skewed variables with the other variables were given on page 12 in Footnote 5 (see also page 11 – descriptive statistics section for Kirk argument).

Issue 3:
'On the same paragraph, the FFFS scales has not yet been introduced, so it is not clear here to what does the inter-tem correlation belong.'

Response 3:
The mean inter-item correlation has been moved to the CFA section (page 10).

Issue 4.
'On page 10. It might be useful to provide a path diagram displaying both factor models, illustrating which items load on which factor. The diagram should also represent the freely estimated residuals. It should be clear that the one and two factor models are not nested and have the same number of degrees of freedom, so they are not directly comparable in terms of chi-square difference test.'

Response 4:
The paper now includes two diagrams of the best fitting oblique two-factor models (see page 12, Figure 2).

Issue 5.
'On page 11. The estimated correlation between the two factors should be reported.'

Response 5:
The estimated correlation between the two factors is given in the diagrams for both oblique two-factor models (page 12, Figure 2).

Issue 6.
'Why should E, P and N correlated? They should be, in theory, orthogonal.'

Response 6:
The issue has been discussed in Footnote 3 (page 9) – whilst Eysenck originally stated that the factors should be orthogonal, research often shows that they are correlated constructs.

Issue 7:

'Why should the relationships between the BIS and the other Gray's scales be displayed as casual instead of correlational? With these data there is no way to distinguish between one or the other, so the chosen representation must have a theoretical background, which I would like to see explained more clearly.'

Response 7:

A brief explanation of the paths specifications for BIS onto FFFS and BAS has been given in the Method section (see page 9 - Statistical Analyses) stating that paths are specified from BIS to BAS and FFFS as BIS is thought to mediate facilitation and inhibition of the two systems. This seems to be more in line with the recent revisions of the RST (see also Introduction: page 3, paragraph 2).

Issue 8:

'If BIS manages conflict between FFS and BAS, shouldn't it have a negative loading on the BAS scales? (at least on DR and FS). Some of these issues give the slight feeling that the model was specified ad-hoc.'

Response 8:

Within the original RST, BIS and BAS were thought to be orthogonal, within the revisions BIS is mediating approach behaviour during conflict situations. However, as we had not theoretically specified the exact links between BIS and BAS-DR and BAS-FS we had not included those paths in the model. However, in the revised paper, paths between BIS and all three BAS scales were included into the model based on the assumption that BIS mediates BAS (and thus should be linked to all subscales, see page 9 – statistical analyses). However, the results show that except for BAS-RR these paths were non-significant (as with their correlations, see pages 11 and 12), which may support the argument that BAS reward reactivity is distinct from impulsivity/sensation seeking/fun seeking concept (see Smillie et al., 2006) and thus more linked to BIS (see Discussion section, page 13, final paragraph, continue to page 14 top).

Issue 9:

'The results for the BAS-RR scale seem odd. It looks like this scale has shown contradictory results in the past as well. However, it seems to me that the authors have the opportunity to solve this problem with their current approach. It seems like, conceptually and empirically some of the items of the BAS-RR scale might belong better to the (new) BIS scale, whereas others might go well with the BAS-DR scale. It might be interesting if the authors extended their confirmatory factor analysis of items to the BAS scales, trying to sort out the problem of the BAS-RR. This would also make a cleaner picture of their final model (figure 3), especially regarding P.'

Response 9:

This paper focuses on the factorial structure of BIS in light of the recent revisions of the RST and a full factorial analysis of all scales was beyond the scope of this paper. However, a principal component analysis was conducted confirming the three-factor structure in this sample, thus supporting the use of the 3 subscales for further analyses in this study (see Footnote 2, page 9). Moreover, the issue of the problems associated with the BAS subscales has been discussed in more detail in the discussion and the need for future re-evaluation of the BAS scales was highlighted (page 14, paragraph 2).

Issue 10:
'Although it might seem obvious, the authors should acknowledge in their discussion the clear limitations of their sample.'

Response 10:
This limitation has been addressed in the discussion (page 14, final paragraph).

We hope that the revisions we have made to the paper address and answer all of the reviewer concerns and comments, and make the paper more suitable for publication in *Personality and Individual Differences*.

We are looking forward to hearing from you.

Yours sincerely,

Nadja Heym

(Claire Lawrence, Eamonn Ferguson)

An evaluation of the relationship between Gray's revised RST and Eysenck's PEN:

Distinguishing BIS and FFFS in Carver and White's BIS/BAS scales

Abstract

Recent revisions of Gray's Reinforcement Sensitivity Theory (RST) have important implications for self-report measures of approach and avoidance behaviours and how Gray's model relates to other personality models. In this paper, we examine the revised RST by comparing Carver and White's (1994) original one-factor solution of the BIS scale with two alternative two-factor solutions separating BIS-Anxiety and FFFS-Fear. We also examine the relationships between Eysenck's PEN and revised RST factors. Two hundred and twelve participants completed Carver and White's BIS/BAS scales and Eysenck's Personality Questionnaire-Revised. Confirmatory factor analyses of the original BIS scale showed that the hypothesized two-factor model of BIS-Anxiety and FFFS-Fear was the best fit to these data. Associations between the revised RST and Eysenck's PEN were examined using path analysis. In line with theoretical predictions, Psychoticism was related to revised BIS-Anxiety and BAS, Neuroticism to revised BIS-Anxiety and FFFS-Fear, and Extraversion to BAS and FFFS-Fear. Distinctions between BAS subscales and their associations to BIS, N and P were made in terms of past, present and future focus. Possible explanations for mixed findings in the literature and implications for future research are discussed.

Keywords: Behavioural Inhibition System, Behavioural Activation System, Reinforcement Sensitivity Theory, Psychoticism, Confirmatory factor analysis, Path analysis

An evaluation of the relationship between Gray's revised RST and Eysenck's PEN:

Distinguishing BIS and FFFS in Carver and White's BIS/BAS scales

Recent revisions of Gray's Reinforcement Sensitivity Theory (RST; Gray & McNaughton, 2000), have raised two important issues. First, existing measurements assessing the subsystems of the RST are based on the original theory, and as such incorporate revised BIS (referred to here as BIS-Anxiety) and revised FFFS (referred to here as FFFS-Fear) items within a single scale (Smillie, Pickering & Jackson, 2006; Corr & McNaughton, 2008). Second, consequently, little work has been published examining the revised RST's associations with Eysenck's PEN. These two issues are examined in this paper.

The most widely used measures of the original RST constructs are Carver and White's (1994) BIS/BAS scales. Consequently, the main aims of the current paper are to examine (i) the factor structure of Carver and White's (1994) BIS scale in the light of the revised RST to examine if BIS-Anxiety and FFFS-Fear items can be distinguished, and (ii) the relationships of revised BIS-Anxiety, FFFS-Fear and BAS with the Eysenckian conceptualization of personality.

The original RST and its revision

Gray's (1982) original approach, widely known as Reinforcement Sensitivity Theory (RST; Pickering, Corr, Powell, Kumari, Thornton, & Gray, 1997), focused on two orthogonal personality dimensions – (i) the behavioural approach system (BAS) associated with impulsivity, regulating appetitive motivation and responding to signals of reward or non-punishment; and (ii) the behavioural inhibition system (BIS) associated with anxiety, controlling aversive motivation and responding to punishment contingencies and high intensity or novel stimuli. Gray (1987) also proposed a less clearly defined third system – the

Fight/Flight-System (FFS), which was argued to be the causal basis of fear and a threat

response system mediating defensive aggression (fight) or escape responses (flight) when

activated by unconditioned aversive stimuli.

Recent revisions of the RST by Gray and McNaughton (2000) developed the FFS to

incorporate a freeze response (now FFFS). In the revised model, the FFFS mediates

responses to *both* conditioned and unconditioned aversive stimuli and, therefore, becomes the

new punishment associated system (previously BIS). Conversely, in the revised model, BIS is

activated by conflict between reward (BAS) and punishment (FFFS) contingencies, and also

approach-approach and avoidance-avoidance conflicts. Thus, BIS is a conflict detection, risk

assessment and appraisal system, inhibiting ongoing behaviour, directing attention to

potential threat (defensive direction) and responding to conflicting goals until they are

resolved. The greater the conflict and subsequent arousal, the more BIS directs the individual

towards an inhibition of BAS mediated behaviour and facilitation of FFFS-mediated

behaviour (Gray & McNaughton, 2000).

The revised RST and Eysenckian theory

Gray (1981) originally suggested that BIS should be positively related to Eysenck's

Neuroticism (N) but negatively to Extraversion (E), whilst BAS should be positively related

to both E and N. However, the findings have been mixed. E has been consistently and

strongly associated with BAS, whilst the proposed negative relationship between E and BIS

is usually found, but somewhat weaker (see Torrubia, Avila & Caseras, 2008 for review).

Similarly, evidence for the positive relationship between N and BIS has been consistently

demonstrated; however, correlations between N and BAS have been low, except for some

subscales (e.g. Zelenski & Larsen, 1999; Jackson & Smillie, 2004). Further, the development

of the Psychoticism (P) scale (Eysenck & Eysenck, 1976) resulted in a shift of impulsivity

items from E to P. As a result, it was suggested that BAS is also positively related to P

(Pickering & Gray, 1999). Indeed, there is evidence for the positive association of BAS with

P (see Torrubia et al., 2008), psychopathy (Newman, MacCoon, Vaughn & Sadeh, 2005), and

the development of conduct disorder (Quay, 1993). Finally, while Gray (1988) also predicted

that P should be negatively associated with BIS, findings are mixed, with P shown to be

negatively related, positively related or not at all related to BIS (see Torrubia et al., 2008 for

review).

In sum, in the original RST, BIS is associated with high N, low E and low P, and BAS

with high N, E and P. This means that P and E have similar links to BAS and BIS, which

questions the distinctiveness of P and E within the RST account. Gray (1981) also aligned

FFS with P according to the lack of fear hypothesis in psychopathy (Fowles, 1980). However,

the differentiations between fear and anxiety and their links to P and psychopathy are

ambiguous at times. Taken together, the relationship between the FFS and Eysenckian

personality has not been clear-cut (Corr, 2001), and following the revisions of the RST, the

relationships between the RST components and other personality constructs require re-

evaluation (Corr & McNaughton, 2008).

Evaluating Carver and White's BIS/BAS scales

Corr and McNaughton (2008) recently highlighted the need to distinguish FFFS and

BIS in psychometric measurements as these systems control different, if not opposite

motivational tendencies. However, Smillie, Pickering and Jackson (2006) identify that all

major scales assessing BIS are based on the original RST, and therefore, items reflect both

BIS-Anxiety *and* punishment responsivity (FFFS-Fear). This paper re-examines the most

widely used measure of RST constructs - Carver and White's (1994) BIS/BAS scales - to

examine if BIS-Anxiety and FFFS-Fear items are distinguishable, and evaluate their associations with Eysenck's PEN.

Carver and White (1994) derived four subscales based on the original RST – one assessing BIS and three assessing BAS, comprising (i) Drive (BAS-DR): related to goal-directed behaviour, (ii) Fun Seeking (BAS-FS): assessing motivation to approach immediately rewarding stimuli, and (iii) Reward Responsiveness (BAS-RR): measuring approach motivation in anticipation of a future reward. While these scales have been extensively used in the literature, several criticisms have been made. Using Confirmatory Factor Analysis (CFA), Cogswell, Alloy, van Dulmen and Fresco (2006) failed to find adequate fit of the BIS/BAS scales and identified two problematic items in the Carver and White's BIS scale ("Even if something bad is about to happen to me, I rarely experience *fear or nervousness*" and "I have very few *fears* compared to my friends"; italics added). Indeed Johnson, Turner and Iwata (2003) showed that the same two items formed a separate factor from the remaining BIS items using exploratory factor analysis (EFA). In light of the revised RST, these two items potentially belong to FFFS-Fear. Furthermore, discussing the revised RST, Corr and McNaughton (2008) point out how items of the BIS scale conceptually may tap into either BIS or FFFS or both and identify these two items as FFFS. They also categorize the item "If I think *something unpleasant is going to happen* I usually get pretty worked up" as BIS. However, this item conceptually also fits within the FFFS-Fear as it is a direct response to an anticipated punishment contingency. This would suggest an alternative conceptualization of Carver and White's BIS scale with three FFFS items. The remaining four items in the original BIS scale capture the notion of worry about social comparison (e.g. '*criticism or scolding*') and failure (e.g. '*making mistakes*'), which are more associated with conflict or uncertainty and thus, BIS mediated anxiety (see Smillie et al., 2006). There are, therefore, three potential factor models of Carver and White's BIS: (i) the original one-factor

structure, (ii) a two-factor model based on Johnson et al. (2003) identifying a two-item FFFS factor from BIS (the Johnson et al. model), and (iii) and a two-factor model with three FFFS items separated from BIS (the target model, see table 1).

***********INSERT TABLE 1 ABOUT HERE************

Past, present and future orientation in the RST

With regards to BAS, the lack of theoretical justification for the split of Carver and White's BAS scale into three sub-factors (Torrubia, Avila, Molto & Caseras, 2001) and their associations with Eysenckian dimensions have been criticized (Zuckerman, Joireman, Kraft & Kuhlman, 1999). For instance, BAS-RR occasionally correlates positively with N (e.g. Zelenski & Larsen, 1999; Jackson & Smillie, 2004). Similarly, BAS-RR correlates positively with BIS, whilst BAS-FS and BAS-DR correlate negatively to it (e.g. Cogswell et al., 2006). This may be because BAS-RR items tap both into notions of contemplation of consequences and conscientiousness in pursuing reward contingencies (e.g. "When I'm doing well at something, I love to keep at it").

Consequently, it could be argued that BAS-RR is focused on planning and working towards positive future outcomes and desire not to lose future benefits. This 'future' emphasis is not found in BAS-FS or BAS-DR items. Therefore, BAS-RR may be more aligned with concepts of future-oriented planning, worry and management of uncertainty – similar to aspects of BIS and N. As these future-orientated motivations are contrary to P (e.g. Eysenck, 1992), the item content of the BAS-RR scale suggests a negative relationship with P. Conversely, BAS-FS items are associated with instant gratification and lack of future contemplation (e.g. "I often act on the spur of the moment") and sensation seeking (e.g. "I crave excitement and new sensations"), which are strongly linked with Psychoticism (Eysenck & Eysenck, 1976). Moreover, BAS-FS, predicts criminal intent and imprudent

behaviour (O'Gorman & Baxter, 2002), which are associated with P. Finally, items in the BAS-DR scale could be interpreted simultaneously as relating to (i) not giving up and being conscientious and (ii) instant gratification (e.g. "If I see a chance to get something I want, I move on it right away"). As a result, items simultaneously relate to high or low P-related traits and so the relationship between BAS-DR and P is unclear.

Aims of the current study and hypotheses

There are two main issues addressed in this paper:

First, whether Carver and White's BIS scale is better conceptualized as a two-factor model, incorporating BIS-Anxiety and FFFS-Fear items rather than a single factor. Traditionally, the subsystems were orthogonal, but the revised RST suggests correlational relationships between RST sub-systems and traits (e.g. Smillie et al., 2006). Thus, the current paper tests both oblique and orthogonal models.

Second, the relationship of BIS-Anxiety, BAS and FFFS-Fear with Eysenck's PEN is explored. Predictions with regards to the association of P, E and N with the components of the RST are specified, as follows:

(i)   In the revised RST, reduced punishment sensitivity is associated with FFFS-Fear. Therefore, we predict that E is positively related to BAS and negatively to FFFS-Fear.

(ii)   We predict that N is positively associated with both BIS-Anxiety and FFFS-Fear, and in addition that *both* - N and BIS-Anxiety are positively linked to BAS-RR. Further, it is predicted that N and BIS-Anxiety are negatively related to BAS-FS.

(iii)   We hypothesize that P is positively related to BAS-FS, but negatively to BAS-RR and BIS-Anxiety. Following Gray (1981), the relationship between P and FFFS-Fear is predicted to be negative.

The hypothesized links between the PEN and the RST are represented in Figure 1.

***********INSERT FIGURE 1 ABOUT HERE***********

Method

Participants

Two-hundred and twelve undergraduates were recruited from a large University in the UK. Due to missing data, 3 participants were excluded. The mean age was 21.58 (SD = 3.97: 132 were females and 77 were males[1]). The local ethical review board approved the study.

Measures

The 100-item EPQ-R (Eysenck, Eysenck & Barrett, 1985) was used to assess Psychoticism, Extroversion and Neuroticism. The EPQ-R has a yes/no answer format with yes being scored as 1 and no as 0.

Carver and White's (1994) BIS/BAS scales were used comprising: BIS; BAS – Reward Responsiveness (BAS-RR); BAS – Drive (BAS-DR); and BAS – Fun Seeking (BAS-FS). Items are scored on a scale of 1 (very true for me) to 4 (very false for me).

Procedure

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[1] The data were examined for sex differences. As expected, females scored significantly lower in P and higher in N, BIS-Anxiety, FFFS-Fear and BAS-RR than males. Partial correlations controlling for participant sex showed no changes compared to the zero-order correlations. Therefore, the sample was treated as one group.

Questionnaires were distributed via e-mail distribution lists of academic departments and a participant pool database as part of a larger data collection.

Statistical Analyses

Confirmatory factor analysis (CFA) was used to compare the three conceptual models of Carver and White's BIS items[2]. Models were estimated with weighted least squares in LISREL 8.7 and ran from polychoric correlations estimated from the asymptotic covariance matrix (Du Toit, Du Toit, Jöreskog & Sörbom, 1999). Oblique and orthogonal versions of the 2-factor models were specified. Items and their associated error variance in the 1- and 2-factor models were specified as free. In all models, factor variances were fixed at unity. The path model (using scale scores) examining the relationship the between revised RST factors and Eysenckian PEN was specified from zero-order correlations and estimated using maximum likelihood (Du Toit et al., 1999). Within the path model P, E and N were specified as correlated[3] as were BAS-RR, BAS-FS, BAS-DR and FFFS-Fear. Paths were specified according to the predictions. As BIS is thought to mediate and resolve conflict between the other two systems, additional paths were specified for BIS on FFFS and all three BAS scales. All errors were set as free. Model fit (CFA and path model) was assessed using the χ^2-value, the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI) and the Incremental Fit Index (IFI). A model with a RMSEA below .05 and CFI and IFI approaching .96 indicates a good fit of the data (Hu & Bentler, 1999).

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[2] The focus of this paper is on the BIS rather than BAS, as with the revised RST there are theoretical reasons for the existing BIS scale not to be unidimensional but to incorporate two factors. A principal component analysis of the Carver & White (1992) BAS items supported the three factor solution accounting for 51.89% of the variance, and thus, supporting the use of those 3 factors (BAS-RR, BAS-DR and BAS-FS) in the current analyses.

[3] Although Eysenck proposed an orthogonal relationship between P, E and N, the literature often shows slight correlations between the factors (e.g. Knyazev, Belopolsky, Bodunov & Wilson, 2004; Alexopoulos & Kalaitzidis, 2004).

Results

Confirmatory factor analysis of Carver and White's BIS Scale

The Carver and White (1994) single factor model had poor fit to the data (χ^2= 38.99, df=14, p<.001, RMSEA=.09, NFI=.90, CFI=.93, IFI=.93, N=209). The two-factor Johnson et al. model (see Table 1) also demonstrated poor fit to the data for both the orthogonal (χ^2=114.67, df=15, p<.001; RMSEA=.18, NFI=.70, CFI=.72, IFI=.73, N=209) and oblique (χ^2=25.80, df=13, p<.05; RMSEA=.07, NFI=.93, CFI=.96, IFI=.97) specifications. With respect to the Target model (see Table 1), the orthogonal model was a poor fit (χ^2=110.33, df=14, p<.001; RMSEA=.18, NFI=.71, CFI=.73, IFI=.74, N=209), however, the oblique model showed good fit to these data (χ^2=14.91, df=13, p=.31, RMSEA=.027, NFI=0.96, CFI=.99, IFI=.99, N=209). The two-factor models are shown in Figure 2. The oblique Target model was a better fit to these data than the oblique Johnson et al. model in terms of the RMSEA, NFI, CFI and IFI. Furthermore, the χ^2 difference test between the Target model and the one-factor structure was significant ($\Delta\chi^2$ (1) = 24.08, p < 01) and therefore, indicates that this is a better fit than the existing single factor model. This supports an oblique two-factor structure incorporating a BIS-Anxiety scale with four items and a FFFS-Fear scale with three items. The Cronbach's alphas were .75 for BIS-Anxiety and .73 for FFFS-Fear. The mean inter-item correlation for FFFS-Fear was .47.

***********INSERT FIGURE 2 ABOUT HERE***********

Descriptive Statistics

Descriptive statistics and scale reliabilities for all measures are shown in Table 2. The internal consistencies are all acceptable, except for BAS-RR (Cronbach's alpha = .57).

A number of variables (P, BIS-Anxiety, FFFS-Fear and BAS-RR) were significantly skewed. To conform to assumptions for subsequent correlational analyses, the significantly skewed items were normalized with negatively skewed variables (BIS-Anxiety, FFFS-Fear and BAS-RR) being reflected, then square-root transformed (together with the positively skewed P), and then again reflected. This procedure normalised P and FFFS-Fear with their skew values becoming non-significant. BIS-Anxiety and BAS-RR, remained slightly skewed but they reduced from a z-score of -4.2 to -2.4 and -4.0 to -2.5, respectively. The results from these mildly skewed scale scores in subsequent analyses were considered significant and reliable if their relationships with other variables had a p-value of .01 or less (see Kirk, 1981).

***********INSERT TABLE 2 ABOUT HERE************

Zero-order Correlations

The zero-order correlations[4] between the revised RST factors and Eysenck's PEN factors are presented in Table 4. All hypotheses were supported. Increased P was significantly associated with reduced BIS-Anxiety and FFFS-Fear. P was negatively associated with BAS-RR (r=-.135, p=.051) and positively to BAS-FS. E was positively associated to all three BAS scales, and negatively with FFFS-Fear and N. Both N and BIS-Anxiety were associated with increased FFFS-Fear and BAS-RR, and reduced BAS-FS. N, BIS-Anxiety and FFFS-Fear were positively related to each other.

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[4] Similar correlations were achieved running Spearman's rho correlations with the untransformed variables.

***********INSERT TABLE 3 ABOUT HERE***********

Path Model

The specified path model (see Figure 3) demonstrated excellent fit to these data (χ^2=3.87, df=3, p=.28, RMSEA=.038, NFI= .99, CFI=1.0, N=209). The paths were specified in line with the predictions, linking: P with BIS-Anxiety, FFFS-Fear, BAS-RR and BAS-FS; E with FFFS-Fear and all BAS scales; N with BIS-Anxiety, FFFS-Fear, BAS-RR and BAS-FS. BIS-Anxiety was linked with FFFS-Fear and the three BAS scales. All paths were significant, except those between N and BAS-FS, and BIS-Anxiety and BAS-DR/BAS-FS[5].

***********INSERT FIGURE 3 ABOUT HERE***********

Discussion

This paper makes two key contributions to the RST literature. First, BIS-Anxiety and FFFS-Fear are distinguished within Carver and White's (1994) existing BIS scale, supporting the revised RST (Gray & McNaughton, 2000). Second, in line with predictions, Extraversion was situated between BAS and FFFS-Fear, instead of being a balance between BAS and BIS (Gray, 1981), such that individuals high in E demonstrate increased drive, fun-seeking and reward responsivity, as well as low punishment sensitivity. This supports findings that individuals high in E show increased reward-contingent learning, and are less sensitive to punishment (Eysenck, 1990). The link to FFFS rather than BIS may explain the weak associations of E with BIS in the literature as BIS scales typically incorporate both - FFFS and BIS items.

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[5] The z-scores for the significant relationships of BIS-Anxiety with BAS-RR (z=4.03), FFFS-Fear (z=3.69), P (z=-5.08) and N (z=6.05), as well as of BAS-RR with BAS-FS (z=2.99), BAS-DR (z=4.64) and N (z=2.91) are associated with p<.01. Thus the effects are strong enough to withstand the slight deviation from normality in BIS-Anxiety and BAS-RR (Kirk, 1981). The link between BAS-RR and P is associated with z=2.26, p=.012.

Neuroticism was positioned between BIS-Anxiety and FFFS-Fear. Those high in N may be more likely to perceive conflict when encountering ambiguous stimuli. Thus, BIS would be more readily activated, favoring engagement of the FFFS and increased avoidance behaviour. However, the positive relationship between BIS-Anxiety and BAS-RR, suggests that although BIS tends to bias towards facilitating avoidance behaviour (FFFS), under conditions of long-term reward, BIS may not inhibit approach behaviour.

Psychoticism was associated with BIS, BAS and FFFS. However, while Psychoticism was negatively linked to FFFS-Fear, its path to BIS was nearly three times as strong, suggesting that the association of P with lack of fear may be due to deficits in BIS. This would have implications for the lack of fear hypothesis in psychopathy (Fowles, 1980), such that research needs to focus on the distinction between anxiety and fear as potential underlying mechanism for the emotional and cognitive deficits associated with psychopathy.

Whilst E was positively associated with all BAS components, P was positively linked to BAS-FS, weakly negatively linked to BAS-RR, and not linked to BAS-DR. This pattern of associations was also found by Smillie, Jackson and Dalgleish (2006). They argued that BAS-FS may be less related to Gray's concept of BAS and proposed a distinction between reward reactivity incorporating BAS-DR, BAS-RR and E versus trait impulsivity incorporating BAS-FS, P and impulsiveness. This supports our argument that BAS-RR is associated with the motivation to persevere to achieve a future reward and is conceptually different to the impulsive behaviour associated with P and BAS-FS. Thus, high P individuals are less motivated to appraise situations for future outcomes due to deficits in BIS, and are more sensitive to instant gratification and fun seeking contingencies with a focus on "here and now". These deficits in decision-making are thought to underlie the sensitivity to short-term reward and inability to appreciate long-term consequences of those high in P (Mitchell, Colledge, Leonard, & Blair, 2002). Conversely, a common ground for the positive

relationships between N, BIS-Anxiety and BAS-RR may be risk assessment based on past experiences and contemplation of consequences of behaviour. This emphasizes rumination and future worry, with a focus on "yesterday and tomorrow".

The differential relationships of the BAS subscales with the PEN, questions the uniformity of the BAS construct in the Carver and White scales and highlights the problem of using total BAS scores as there may be suppressor effects due to opposite directions of relationships for BAS-RR and BAS-FS. Nevertheless, the distinction between these scales in their relationship with BIS-Anxiety might prove useful in future studies. While the data presented here supports a three factor model of BAS, evidence in the literature suggests a possible two-factor structure of BAS (Smillie et al., 2006) indicating that a revision of BAS measurements needs to form part of future research. Moreover, even though the FFFS-Fear and BIS-Anxiety scales derived in this study were reliable, they cover only a limited range of relevant behavior. Thus, a general revision of these scales with inclusion of additional items may be beneficial and conclusions should be drawn with those limitations in mind.

Finally, this paper suggests that the revised RST may account for mixed findings in the literature, but despite calls by Smillie, Pickering and Jackson (2006) for the revised RST to be incorporated into research examining sensitivity to punishment and reward, most researchers still continue to apply the original RST. This may be because there are currently no validated scales incorporating the revisions of the RST. This paper has shown that research on the revised RST can be conducted using existing measures such as Carver and White's BIS/BAS scales. Although the current findings are preliminary and in urgent need of replication with greater sample sizes, it is crucial for the research community to incorporate the revisions of the RST in their current and future research to achieve more specific and theory driven distinctions between different motivations and behavioral tendencies. Finally,

the findings of this study also have implications for other scales tapping into the RST

constructs, and suggest their re-evaluation in the light of the revised RST.

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Response to Reviewers
Revisions to: **Ms. Ref. No.: PAID-D-08-00106**
A re-evaluation of the relationship between Eysenck's PEN and Gray's revised RST:
Psychoticism in the here and now - BIS in the yesterday and tomorrow!

Reviewer 1

General Comment:

'In this study the authors examine associations among Eysenck's PEN and indices relevant to Gray's RST, using Carver and White's (1994) BIS/BAS scales to index RST constructs. Noting important theoretical distinctions between Gray's early (1987) and revised (Gray & McNaughton, 2000) theory (e.g., the reallocation of sensitivity to conditioned fear stimuli from the BIS to FFFS), the authors inspect the C&W BIS scale items and, on rational grounds, identify items more related to "fear" than to "anxiety" and demonstrate, using CFA, statistical support for separate BIS-anxiety and FFFS-fear scales. Associations among these scales generally conform to hypotheses and provide a useful contribution to the literature on relations between PEN and RST constructs.

The manuscript is well-written, well-organized, and concise. Hypotheses are clearly stated, methods and analyses clearly described, and results are presented in a straightforward manner. Recognizing that there is some pressure on authors to limit introductory material in light of word or page limits for manuscripts, the few concerns I had about this manuscript relate mainly to issues in their literature review.'

Response:

We thank the reviewer for the positive comments about the paper and for the extremely helpful and detailed comments on the MS. We agree with all of the points made by the reviewer and have addressed each as detailed below.

Issue 1:

'On p.3 the authors note, regarding the literature on relations between E and BIS, that "the negative relationship . is not always found", citing a single reference. Of course, even a single instance supports the descriptor "not always," but this characterization hardly describes what the bulk of the literature with which I am familiar seems to show. See, e.g., the following correlations and associated references:

-.14   Carver & White (1994), Study 2
-.19   Jorm et al. (1999)
-.20   Caseras et al. (2003)
-.16   Heubeck et al. (1998)
-.14   Franken et al. (2005)
-.12   Muller & Wytykowska (2005), Study 4
-.11   Chi et al. (2005)

Unless the authors have a number of other exceptional findings with which I am not familiar, wouldn't ". is usually found" (citing the above) be a fairer characterization of the literature than the one they have chosen?'

Response 1:

We agree with this comment and have changed the wording on page 3 (paragraph 3) highlighting that the negative link between E and BIS is usually found, but is typically weaker. We refer to the recent review chapter by Torrubia, Avila and Caseras (2008) who quoted most of the references indicated above by the reviewer and came to the same conclusions.

Issue 2:

'Also on p. 3, the authors note that evidence for a positive relationship between N and BAS has not been consistently demonstrated. Again, in much of the literature with which I am familiar, except for an occasional positive relationship between N and Reward Responsivity, correlations between N and BAS (Total score or subscales) have pretty consistently been very low (i.e., < .10) and sometimes on the order of "0" if not negative. See, e.g.,

> *Jorm et al. (1999) except for RR = .25*
> *Caseras et al. (2003)*
> *McHoskey et al. (1998) Study 1 (BAS-T = .00)*
> *Franken et al. (2005), except RR = .13*
> *Smillie et al. (2006) Study 2*
> *Muller & Wytykowska (2005) Study 4, (BAS-T = .05)*
> *Chi et al. (2005), except RR = .24*
> *Jackson & Smillie (2004), except RR = .14*
> *Zelenski & Larsen (1999), except RR = .25*
> *Gremore et al. (2005), (BAS-T = .16)*
> *Smolewska et al (2006)*

So again, the author's characterization of what the bulk of the literature shows seems to understate, if not misstate, the state of affairs.'

Response 2:

The manuscript stated: '…evidence for the positive relationship between N and BIS has been consistently demonstrated but not for BAS', which was indeed in line with the reviewer's comment (i.e. low relationship between N and BAS). However, to make this more explicit, the phrase 'but not for BAS' has been excluded and instead the following phrase added with some additional references: '…however, correlations between N and BAS have been low, except for some subscales (e.g. Zelenski & Larsen, 1999; Jackson & Smillie, 2004).' (page 3, paragraph 3). This is in line with the reviewer's argument as well as the before mentioned review chapter by Torrubia et al. (2008) who point out the same issue.

However, with regards to the subscale Reward Responsiveness and its links to N - this has not been explicitly highlighted here on page 3, as the Carver and White subscales are introduced later in the paper. However, the occasional positive correlation between N and BAS-RR has been explicitly highlighted on page 6 (paragraph 2) and further discussed in the discussion (page 13 and 14, first paragraphs).

Issue 3:
    'On p. 5 the authors cite a single source, Heubeck et al. (1998), in support of the assertion that the BIS/BAS scales have been "well validated" in the literature. In fact the Heubeck paper is very tepid and cautious in its appraisal of the BIS/BAS scales, raising a number of questions about the construct validity of these scales and, particularly in the case of BIS, concerns about the lack of adequate coverage of functions attributed to BIS in early RST. Along with Heubeck, a number of other investigators (Jorm et al., 1999; Brenner et al., 2005) criticize BIS as mainly assessing constructs in the negative emotionality spectrum. Thus, as presented the authors assertion of "well validated" seems an overly sanguine characterization of the literature regarding these measures.'

Response 3:
    Appropriate changes have been detailed – the phrase 'well validated' has been changed to 'extensively used' (page 5, paragraph 2), which we feel is more appropriate, and the Cogswell et al (2006) and Johnson et al (2003) studies as well as Corr and McNaughton review (2008) have been discussed in more detail with regards to criticisms on the factor structure of BIS rather than the Heubeck study, which did not add to this argument (page 5, paragraph 2).

Issue 4:
    'On p. 5 the authors make the case for parsing the C&W BIS scale into separate scales. This would be a good place to at least mention that in one prior study (Johnson et al., 2003) the two more obvious "fear" items loaded together to form a separate factor/ couplet from the remaining 5 BIS items. It may be worth exploring the fit of this alternative structure for BIS as well.

Response 4:
    This comment was particularly useful - the Johnson et al. reference has been incorporated into the MS and incorporated as a second alternative model in the CFA, separating only the two fear items they highlight into the FFFS-Fear in contrast to the three item FFFS factor we propose (e.g. page 5 paragraph 2, continue to page 6 top and Table 1; and page 10; Figure 2).

Issue 5:
    'The authors are careful to note (1) the preliminary nature of their findings and need for replication, (2) that the parsed BIS scales "cover only a limited range of relevant behavior," and (3) the need for general revision of scales in light of revised RST. I agree with these cautions but, in light of the tendency of investigators to continue, now

8 years after Gray & McNaughton (2000) to continue testing the earlier theory, I think I would be inclined to make the cautions somewhat more forcefully.'

Response 5:
　　　　The limitations of this study and findings (e.g. need for replication, limited range, greater sample size) have been highlighted more explicitly in the discussion by stating that any conclusions should be drawn with those limitations in mind (page 14, paragraph 2 and 3) and further weight has been put on the importance to incorporate the revised RST in future research in the final paragraph (page 14).

<div align="center"><u>**Reviewer 2:**</u></div>

General Comment:
　　　　'This paper addresses two major issues: 1) revisions of Carver and White's scale to fit the revised RST (particularly the distinctions between the BIS and FFFS), and 2) the relationship of Gray's revised dimensions to Eysenck's dimensions. A new psychometrically sound, theory-based scale is desperately needed in the field, and as such this paper represents a step in that direction, although certainly more revision to the scale is necessary. I think this paper's most substantial contribution to the literature would be the revised BIS scale that separates BIS-Anxiety and FFFS. The relationship of Gray's dimensions to Eysenck's dimensions has been examined in some depth previously, but in this paper they provide some data on convergent and divergent validity for the new BIS-Anxiety and FFFS scales. This is a clear, well-written paper that I think would provide a beneficial addition to the existing RST literature. However, I recommend that some issues be addressed before it is suitable for publication in PAID.'

Response:
　　　　We thank the reviewer for their supportive comment. We agree with the points raised and have addressed each comment as detailed below.

<u>**Introduction:**</u>

Issue 1:
　　　　I might suggest a new title; the meaning of the part after the colon is not immediately clear until one reads the paper

Response 1:
　　　　We agree with the reviewer and changed the title to make it more focused and relevant for the literature.

Issue 2:
　　　　Good explanation of Gray's theory, with a minor change. On page 3, the authors correctly point out that the BIS is activated by approach-avoidance conflicts (which come

from reward and punishment contingencies). Please also note that approach-approach conflicts or avoidance-avoidance conflicts can activate the BIS as well.

Response 2:
We thank the referee for the positive comment and have added that approach-approach and avoidance- avoidance conflicts can also activate BIS (page 3, paragraph 2).

Results:
Issue 3:
Did you use any kind of principle components analysis or exploratory factor analysis to decide which original BIS items would be moved to the new BIS scale? If not, how do we know that your current FFFS scale and BIS scale are the best possible ones that can be made from Carver & White's BIS scale? I am unclear why certain items ended up on the FFFS scale versus the BIS scale. For example, the item "Criticism or scolding hurts me quite a bit" does not appear to me to tap "conflict and uncertainty," which you state to be a main theme of BIS-Anxiety. Rather, it appears to me to tap punishment responsivity, a construct that appears to be located in the FFFS in your model. If you did not use a PCA, could you do some other CFAs with various configurations of BIS/FFFS items in order to show better fit with your current 2-factor structure than another plausible way of arranging those 2-factors? Alternatively, if you did use a PCA first, then your CFA should be done in an independent sample.

Response 3:
The theoretical distinctions between BIS and FFFS items have been discussed in more detail on pages 5 and 6 (paragraph 2; Table 1), which resulted in the testing and comparison of two alternative 2-factor structures of the BIS-FFFS distinction in the Results section (pages 9 – statistical analyses, and 10 – Result section: CFA; see also Figure 2). As highlighted in the Introduction, we believe that being criticized or scolded is associated with anxiety or worry about social comparison, leading to conflict and uncertainty and thus facilitating BIS-mediated anxiety. In support of this, Smillie, Pickering & Jackson (2006) state the following:

> '…White and Depue (1999), however, cited considerable evidence from outside the immediate RST-based personality literature that supports a psychometric fear/anxiety distinction. A large part of this data uses Telegen's (1982) Multidimensional Personality Questionnaire, which includes a broad-focused scale of Negative Emotionality (NEM; similar to Eysenck's "Neuroticism" and Gray's "Anxiety") and a narrow-focus scale of Harm Avoidance (HA; similar to Gray's notion of "Fear"). …Gray and McNaughton's (2000) revisions may have brought the RST view closer to that of Tellegen in this respect: The HA scale concerns reactions to unconditioned and conditioned physical punishers (which seems highly consistent with the undertakings of the FFFS), while the NEM scale reflects sensitivity to uncertainty, social comparison, and failure of one's efforts (which seems somewhat similar to the concept of 'conflict', albeit couched within a social context).[3] White and Depue's (1999)

thorough review and promising experimental data may therefore provide preliminary support for, and guidelines for further examination of, the fear/anxiety distinction emphasized in the new RST. …' (p.325)

Footnote 3: 'A reasonable argument could be made for the relevance of social stimuli to BIS mediated anxiety, due to the conflicting reinforcement signals which characterise such situations. That is, it seems highly unlikely that social exchanges are purely rewarding or punishing; rather, there might be clear perceptions of both (such as the potential for rejection during courtship).' (p. 325)

The development or identification of scales whose items clearly reflect either conflict and mismatch detection situations (BIS), or pure punishment and fearful threat situations (FFFS), is therefore essential for updating the RST trait model in line with Gray and McNaughton's (2000) revisions. …' (p. 325)

Issue 4:
'You hypothesize in your discussion that Cogswell's (2006) CFA may have had poorer fit due to lumping BIS and FFFS together. One alternate hypothesis might be that the 3-factor structure of BAS was at issue. Why not include the BAS Scales in your CFA? This would directly test your theorizing about why Cogswell's results came out as they did and contribute further to the literature on factor structure & fit with the BIS/BAS scales.'

Response 4:
We thank the reviewer for this useful comment. We highlight in the MS that the focus of this paper is on the factorial structure of BIS given the theoretical justification of the BIS/FFFS distinction in the revised RST. Nevertheless, a principal component analysis of the BAS has been conducted, which supported the 3-factor structure of BAS in this sample (see page 9, Footnote 2). However, the criticisms towards the BAS subscales have also been discussed in more detail in the discussion and it was highlighted that a general revision of the BAS scale is needed in future research (page 14, paragraph 2). The general claim that poor fit in Cogswell's study may be due to the combination of BIS and FFFS within one scale has been removed.

Issue 5:
'In the path model, why did you not let BIS correlate with the rest of the BIS/BAS scales, when you did let FFFS correlate? BIS does have a relationship with BAS-FS and BAS-RR in your correlations, and it's possible that it might as well in the path model.'

Response 5:
The reviewer's comment has been taken on board and subsequent changes in the path model were implemented. In the revised model, BIS has paths to all three BAS scales – however, the paths between BIS and BAS-DR/BAS-FS were non-significant (page 9 – statistical analyses, see also Figure 3).

Issue 6:

'Also in the path model on page 11, why were pathways that were not predicted but had a significant correlation not tested? For example, the pathway between the BIS and E. A model that includes such pathways versus those that do not can be compared.'

Response 6:

Originally only a-priori hypothesized paths were included in the path model irrespective of the correlations. However, undergoing revisions requested by reviewer 3, transformed variables were applied, which resulted in the correlation between E and BIS becoming non-significant (see page 12, Table 3). The revised path model includes now all significant correlations, but also one additional path between P and BAS-RR (which was near significantly correlated, p=.051) as this relationship was hypothesized a-priori (see page 6, final paragraph; page 8, first paragraph; see also Figure 1 for hypothesis; and page 12 – path model and Figure 3 for analyses).

Discussion

Issue 7:

'Part of your intent was to revise Carver and White's scale to fit with the revised RST, yet you did not revise any part of the BAS scales whose 3-factor structure is not consistent with Reinforcement Sensitivity Theory (Carver & White, 1994). Obviously, a total reconstruction of the BIS/BAS scales is beyond the scope of this paper, but in the discussion, it would be helpful to more explicitly state limitations of this revised measure.'

Response 7:

We fully agree with the reviewer's comment, however, the focus of this paper was to re-examine the BIS scale and the fear/anxiety distinction in line with the revised RST. Additionally, a principal component analysis on BAS was conducted supporting the 3-factor structure in this sample and thus, applied in subsequent analyses (page 9, footnote 2). However, recognising the issues associated with the BAS scales, the limitations of this scale (and subscales) were discussed in detail in the discussion and limitations of this revised measure were explicitly highlighted (page 14 , paragraph 2).

Issue 8:

'You point out that differential relationships of the three BAS scales to the EPQ suggests one should not use a total BAS score. However, several other research groups have found evidence for a two-factor BAS structure (e.g, Mitchell, Kimbrel, Hundt, Cobb, Nelson-Gray, & Lootens, 2007; Smillie, Jackson, & Dalgliesh, 2006) incorporating impulsivity/sensation seeking and reward responsiveness/drive, which suggests perhaps that one should not use three individual BAS scales. It appears that a revision of both the concept and the measurement of BAS is in order. It may be helpful to explicitly state this. In addition, your data could be used to test such a model.'

Response 8:

We agree with the reviewer and this issue has now been addressed in the discussion. The findings in the literature on the distinction between BAS related reward sensitivity versus impulsivity/sensation seeking/fun seeking have been discussed in more detail (page 13, final paragraph). However, as indicated above, the data presented here support a 3 factor model of BAS. In addition, the implications for further scale refinement of the BAS scale in future studies have been highlighted (page 14, paragraph 2, see also Response 7 above)

Issue 9 – Minor:

-Typo in footnote on page 8? Refers to BAS-RWR, elsewhere referred to as BAS-RR
- Figure 2, the path from P to FFFS. The * is next to the standard error, not the path estimate.
- The authors cite Smillie, Pickering, and Jackson (2006) as "Smillie, Pickering, & Jackson, 2006a" on page 2. Since there are no additional papers by these same authors in this order listed in this manuscript, omit the "a." Please make this change to Smillie, Jackson, and Dalgleish, 2006b on page 13 by removing the "b."

Response 9:

These points have been addressed in the paper – thank you for pointing those out.

Reviewer 3:

General Comment:

‘*This is a nicely written article that deals with the practical and theoretical implications of the modifications that Gray and colleagues have recently done on the RST. First, the factor structure of the original BIS scale from Carver and White's BIS/BAS scales is revisited through confirmatory factor analysis. Second, the authors revise the relationship between Eysenck's and Gray's constructs making use of correlations and path analyses.*

The manuscript provides interesting and useful information in a clear manner. The results might be useful for a number of researchers in the field, both theoretically and practically. However, there are a few issues of the method that I'd like to see addressed:’

Response:

We like to thank the reviewer for this supportive comment and the useful and constructive criticisms highlighted on the paper. We have addressed those as follows:

Issue 1:

‘*For the confirmatory factor analysis of the items of the BIS scale the authors used ML estimation (p.9). This is not the appropriate estimation method to apply in this*

case, given that the variables being analyzed are items with 4 answer categories. It is more appropriate to use WLS with an asymptotic covariance matrix to obtain and analyze tetrachoric correlations.'

Response 1:
We agree with the reviewer's comment and have addressed this issue by applying an asymptotic covariance matrix and polychoric correlations for the CFAs. The results remain the same as in the unrevised version (see page 9 - statistical analyses, page 10 for CFA and Figure 2).

Issue 2:
'On page 10, Table 1, the authors should provide information about the distribution of their variables (skewness, kurtosis). This is especially relevant because of the small selected sample with which the authors work. It is to be expected that at least P, N and the FFFS scales will be remarkably skewed. If that was the case the authors should also address this problem for subsequent analyses. They should either transform their variables, or use estimation methods robust to deviations from normality (e.g. MLR).'

Response 2:
We are grateful for this comment and in line with it skewed variables were transformed and partly normalised (see page 11 - Descriptive Statistics section, and Table 2). Additionally, Spearman correlations on the untransformed variables were conducted and they showed similar relationships as seen with the Pearson correlations with the transformed variables (see page 11, Footnote 4). The transformed variables have been used for subsequent analyses and in line with Kirk (1981) z-scores for the relationships of the two slightly skewed variables with the other variables were given on page 12 in Footnote 5 (see also page 11 – descriptive statistics section for Kirk argument).

Issue 3:
'On the same paragraph, the FFFS scales has not yet been introduced, so it is not clear here to what does the inter-tem correlation belong.'

Response 3:
The mean inter-item correlation has been moved to the CFA section (page 10).

Issue 4.
'On page 10. It might be useful to provide a path diagram displaying both factor models, illustrating which items load on which factor. The diagram should also represent the freely estimated residuals. It should be clear that the one and two factor models are not nested and have the same number of degrees of freedom, so they are not directly comparable in terms of chi-square difference test.'

Response 4:
The paper now includes two diagrams of the best fitting oblique two-factor models (see page 12, Figure 2).

Issue 5.
'On page 11. The estimated correlation between the two factors should be reported.'

Response 5:
The estimated correlation between the two factors is given in the diagrams for both oblique two-factor models (page 12, Figure 2).

Issue 6.
'Why should E, P and N correlated? They should be, in theory, orthogonal.'

Response 6:
The issue has been discussed in Footnote 3 (page 9) – whilst Eysenck originally stated that the factors should be orthogonal, research often shows that they are correlated constructs.

Issue 7:
'Why should the relationships between the BIS and the other Gray's scales be displayed as casual instead of correlational? With these data there is no way to distinguish between one or the other, so the chosen representation must have a theoretical background, which I would like to see explained more clearly.'

Response 7:
A brief explanation of the paths specifications for BIS onto FFFS and BAS has been given in the Method section (see page 9 - Statistical Analyses) stating that paths are specified from BIS to BAS and FFFS as BIS is thought to mediate facilitation and inhibition of the two systems. This seems to be more in line with the recent revisions of the RST (see also Introduction: page 3, paragraph 2).

Issue 8:
'If BIS manages conflict between FFS and BAS, shouldn't it have a negative loading on the BAS scales? (at least on DR and FS). Some of these issues give the slight feeling that the model was specified ad-hoc.'

Response 8:
Within the original RST, BIS and BAS were thought to be orthogonal, within the revisions BIS is mediating approach behaviour during conflict situations. However, as we had not theoretically specified the exact links between BIS and BAS-DR and BAS-FS we

had not included those paths in the model. However, in the revised paper, paths between BIS and all three BAS scales were included into the model based on the assumption that BIS mediates BAS (and thus should be linked to all subscales, see page 9 – statistical analyses). However, the results show that except for BAS-RR these paths were non-significant (as with their correlations, see pages 11 and 12), which may support the argument that BAS reward reactivity is distinct from impulsivity/sensation seeking/fun seeking concept (see Smillie et al., 2006) and thus more linked to BIS (see Discussion section, page 13, final paragraph, continue to page 14 top).

Issue 9:

'The results for the BAS-RR scale seem odd. It looks like this scale has shown contradictory results in the past as well. However, it seems to me that the authors have the opportunity to solve this problem with their current approach. It seems like, conceptually and empirically some of the items of the BAS-RR scale might belong better to the (new) BIS scale, whereas others might go well with the BAS-DR scale. It might be interesting if the authors extended their confirmatory factor analysis of items to the BAS scales, trying to sort out the problem of the BAS-RR. This would also make a cleaner picture of their final model (figure 3), especially regarding P.'

Response 9:

This paper focuses on the factorial structure of BIS in light of the recent revisions of the RST and a full factorial analysis of all scales was beyond the scope of this paper. However, a principal component analysis was conducted confirming the three-factor structure in this sample, thus supporting the use of the 3 subscales for further analyses in this study (see Footnote 2, page 9). Moreover, the issue of the problems associated with the BAS subscales has been discussed in more detail in the discussion and the need for future re-evaluation of the BAS scales was highlighted (page 14, paragraph 2).

Issue 10:

'Although it might seem obvious, the authors should acknowledge in their discussion the clear limitations of their sample.'

Response 10:

This limitation has been addressed in the discussion (page 14, final paragraph).

We hope that the revisions we have made to the paper address and answer all of the reviewer concerns and comments, and make the paper more suitable for publication in *Personality and Individual Differences*.

An evaluation of the relationship between Gray's revised RST and Eysenck's PEN:

Distinguishing BIS and FFFS in Carver and White's BIS/BAS scales

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Figure 1

Hypothesized relationships between Eysenck's and Gray's models of personality

E	N	P
Future orientated: Approach to future reward	*Future orientated: Avoidance of future harm and loss of reward*	*Here and now orientated: Approach to immediate reward*
Positively linked to:	Positively linked to:	Positively linked to:
BAS-RR BAS-DR BAS-FS	BAS-RR BIS-Anxiety FFFS-Fear	BAS-FS
Negatively related to:	Negatively related to:	Negatively related to:
FFFS-Fear	BAS-FS	BAS-RR BIS-Anxiety FFFS-Fear

Figure 2

Confirmatory Factor Analysis of the two oblique two-factor models separating BIS-Anxiety and FFFS-Fear, with either two (Johnson et al;

$\chi^2=25.80$, df=13, p<.05; RMSEA=.07, NFI=.93, CFI=.96, IFI=.97) or three FFFS-items (Target; $\chi^2=14.91$, df=13, p=.31, RMSEA=.027,

NFI=0.96,CFI=.99, IFI=.99, N=209).
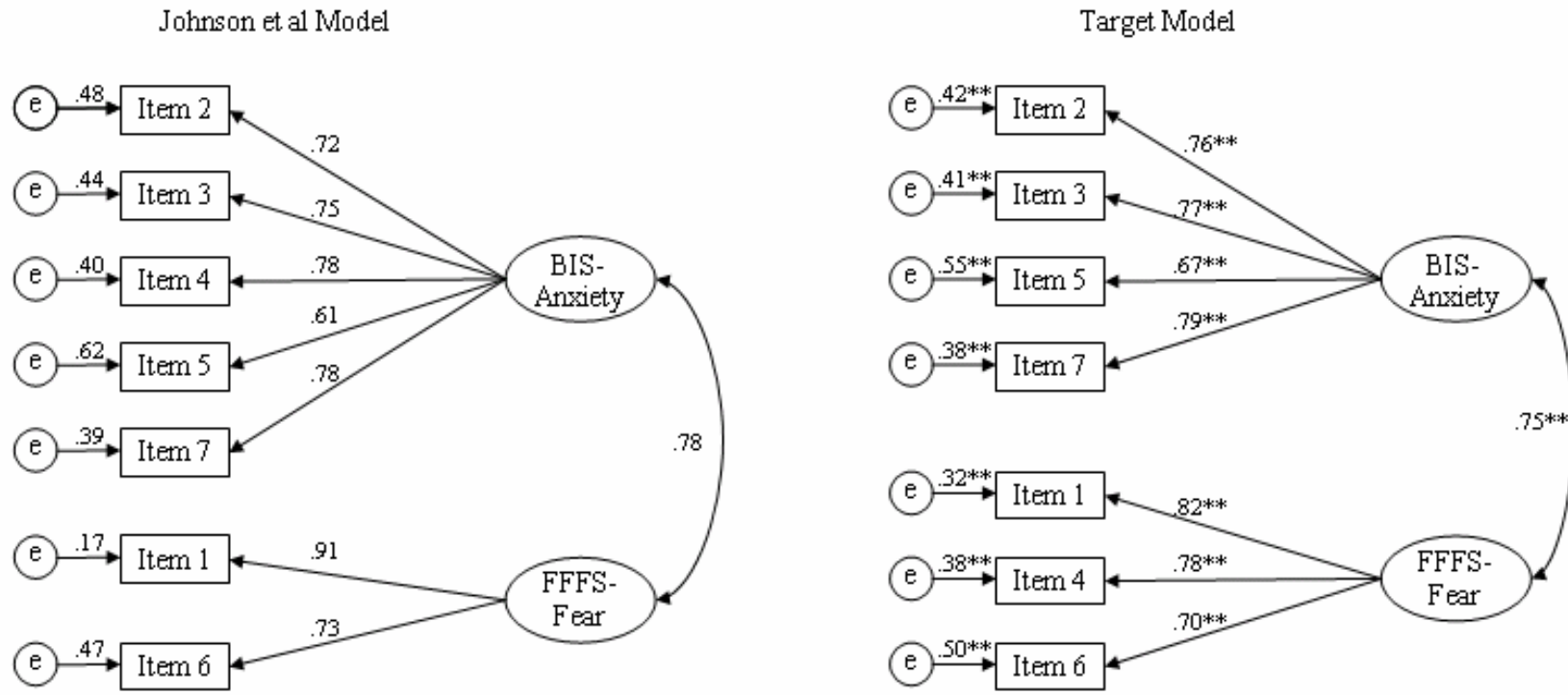
Note: All coefficients are standardized

Figure 3

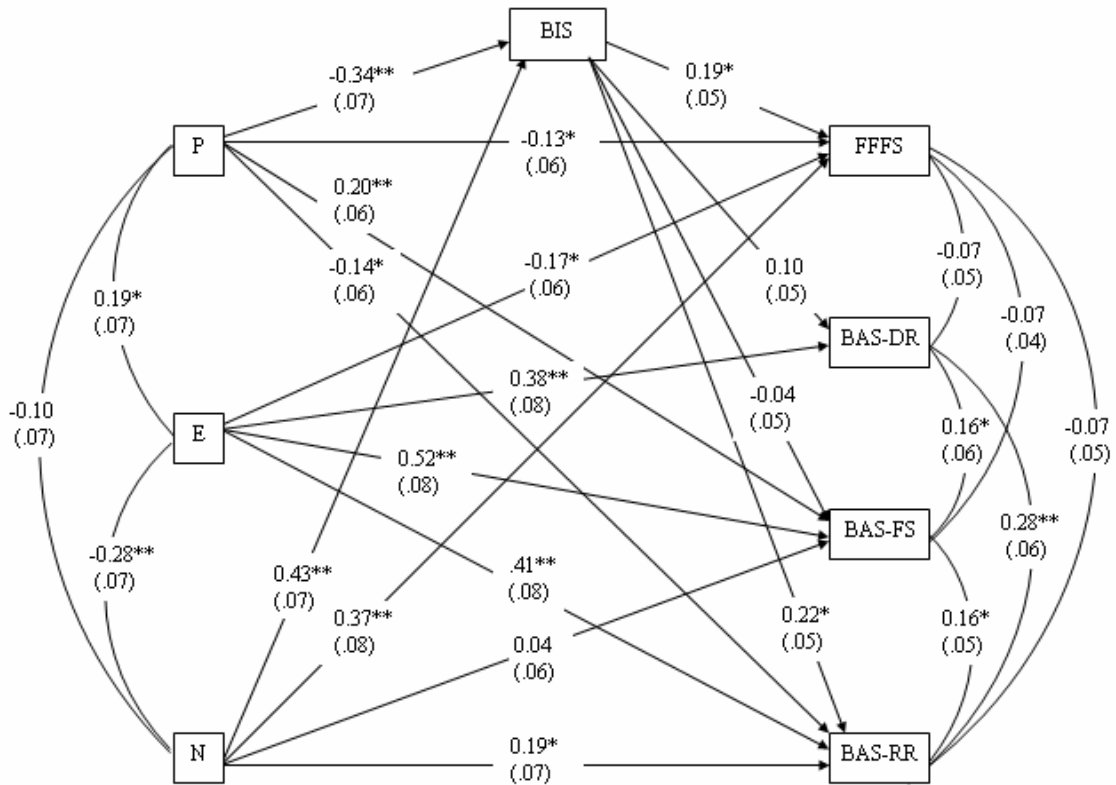*Path model assessing the relationship between PEN and revised RST, N=209*

Table 1

Carver & White's BIS items with FFFS vs BIS distinction by Johnson et al. (2003) and the

distinction proposed by the current study (Target model)

Items:	Carver & White	Johnson et al. model	Target model
1. Even if something bad is about to happen to me I rarely experience fear or nervousness	BIS	FFFS	FFFS
2. Criticism or scolding hurts me quite a bit	BIS	BIS	BIS
3. I feel pretty worried or upset when I think or know somebody is angry at me	BIS	BIS	BIS
4. If I think something unpleasant is going to happen I usually get pretty worked up	BIS	BIS	FFFS
5. I feel worried when I think I have done poorly at something important	BIS	BIS	BIS
6. I have very few fears compared to my friends	BIS	FFFS	FFFS
7. I worry about making mistakes	BIS	BIS	BIS

Table 2

Descriptive Statistics and Reliability values for each scale

Scale	α	Mean	SD	Skew Values
P	.71	0.18	0.12	0.860**
P^t		0.40	0.14	-0.265
E	.85	0.59	0.22	-0.320
N	.87	0.52	0.24	-0.163
BIS-Anxiety	.75	3.20	0.62	0.704**
BIS-Anx ^{t}		1.71	0.21	-0.405**
FFFS-Fear	.73	2.90	0.70	-0.403**
FFFS-Fear ^{t}		1.57	0.24	-0.052
BAS-RR	.57	3.38	0.41	-0.678**
BAS-RR ^{t}		1.79	0.13	-0.425**
BAS-DR	.76	2.57	0.63	0.079
BAS-FS	.73	2.91	0.61	-0.145

Note: SE Skew = 0.168, Z test for significance of skew = coefficient of skew/SE of skew: * $p < .05$, ** $p < .01$, superscript t denotes transformed variables

Table 3

Correlations for all Variables

	P^t	E	N	BIS-Anxiety^t	FFFS-Fear^t	BAS-DR	BAS-FS	BAS-RR^t
P^t	1							
E	.186**	1						
N	-.105	-.285**	1					
BIS-Anxiety^t	-.380**	-.124	.470**	1				
FFFS-Fear^t	-.282**	-.320**	.533*	.500**	1			
BAS-Drive	.131	.372**	-.050	.071	-.151*	1		
BAS- Fun Seeking	.332**	.550**	-.150*	-.183**	-.302**	.375**	1	
BAS-Reward Responsiveness^t	-.135	.304**	.201**	.377**	.091	.421**	.280**	1

Note. * p<.05, ** p<.001; N = 209, superscript t denotes transformed variables