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Attention-Deficit/Hyperactivity Disorder symptoms: Associations with Gray's and Tellegen's models of personality

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ABSTRACT

Attention-Deficit/Hyperactivity Disorder (ADHD) symptoms of inattention (IA) and hyperactivity/impulsivity (HI) were examined in relation to three personality instruments: Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ); the Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) scales; and the Multidimensional Personality Questionnaire-Brief (MPQ-BF) ($N = 214$). Results showed that IA was associated positively with Sensitivity to Punishment (in the SPSRQ), Negative Emotionality (in the MPQ-BF), and Behavioral Inhibition System (in the BIS/BAS scales). HI was associated positively with Sensitivity to Reward (in the SPSRQ), Reward Responsiveness and Drive (both in the BIS/BAS scales), and Positive Emotionality (in the MPQ-BF). Both IA and HI were associated negatively with Constraint (in the MPQ-BF), and HI was associated positively with Fun Seeking (in the BIS/BAS scales). These findings are interpreted in terms of the original and revised reinforcement sensitivity theories.

1. Introduction

A growing number of studies have shown that Attention-Deficit/Hyperactivity Disorder (ADHD; DSM-IV-TR, American Psychiatric Association, APA, 2000) is systematically related to some of the major personality and temperament dimensions (for a review, Gomez, 2009), thereby raising the possibility that they share common underlying systems. The aim of this study was to examine how the major traits in Gray's (1970, 1982) and Tellegen's (2000) personality theories are related to ADHD.

In Gray's (1970, 1982) original theory, currently referred to as Reinforcement Sensitivity Theory (RST), personality reflects individual differences in two major neurobiological systems, namely the Behavioral Inhibition System (BIS) and the Behavioral Approach System (BAS). The BIS is viewed as being sensitive to signals of punishment, frustrative nonreward and novelty. Its activation results in anxiety and avoidance behaviors. The BAS is viewed as being sensitive to signals of reward and nonpunishment. Its activation results in positive emotion and approach behaviors. Traits relating to anxiety and impulsivity are linked to the BAS and BIS, respectively.

The original RST or o-RST has been substantially updated by Gray and McNaughton (2000) and McNaughton and Corr (2004; for a review see Corr, 2008). In the revised model or r-RST, BAS is conceptualized as in o-RST. Although the BIS is still linked to anxiety, it is not related to mediating reactions to punishment (as in the original model) but to resolving goal conflicts, especially approach-avoidance conflicts. It is also linked to cognitive processes, such as attention and memory, involved in resolving such conflicts. Too high or too low BIS activity is assumed to be dysfunctional. Reactions to all types of punishment are now postulated to be mediated by a Fight-Flight-Freeze System (FFFS), which in many respects is comparable to the original or o-BIS. The FFFS mediates the emotion of fear.

O-RST of personality has spawned a large literature (Corr, 2008), the majority of which is based on two psychometric measures: the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001) and, most notably, the Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) scales (Carver & White, 1994). In the SPSRQ, the sensitivity to punishment (SP) and sensitivity to reward (SR) scales measure the traits of the BIS and BAS, respectively. In the BIS/BAS scales, the BIS scale and BAS scale measure their namesakes. However, Heym, Ferguson, and Lawrence (2008) have shown that the seven items in the BIS scale can be separated into subscales for Anxiety (BIS-Anxiety) and Fear (BIS-Fear). According to them, these measure the BIS and FFFS, respectively, as conceptualized in r-RST. The BAS scale has subscales for Reward Responsiveness (BAS-RR), Drive (BAS-DR) and Fun Seeking (BAS-FS). BAS-RR measures ap-

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proach motivation in anticipation of a future reward; BAS-DR measures goal-directed behavior; and BAS-FS measures motivation to approach immediately (a form of impulsivity). Smillie, Jackson, and Dalgleish (2006) have shown that these scales are better conceptualized as comprising two factors: a super-factor (reward reactivity) for the BAS-RR and BAS-DR factors, and another factor for BAS-FS (impulsivity). They have argued that BAS-FS may not be related to BAS, as conceptualized in o-RST.

Tellegen's (2000) personality model has three primary factors, namely Positive Emotionality (PEN), Negative Emotionality (PEN), and Constraint (CON). PEN measures dispositions towards positive emotions, and appetitive approach, and NEN measures negative emotions, reactivity to stress and emotional liability, and defense withdrawal. Thus, conceptually, PEN can be linked to the BAS, especially reward reactivity (Watson, Wiese, Vaidya, & Tellegen, 1999), while NEN can be linked to o-BIS. The empirical data is supportive of links between the NEN and o-BIS, and between CON and both the o-BIS (negatively) and the BAS (Carver & White, 1994). Tellegen's (2000) model of personality is measured using the Multidimensional Personality Questionnaire (MPQ; Tellegen, 2000). There is also a brief version of the MPQ (MPQ-BF; Patrick, Curtin, & Tellegen, 2002).

For the diagnosis of ADHD, DSM-IV (and also DSM-IV TR, APA, 2000) lists 18 symptoms under two separate symptom groups, namely inattention (IA) and hyperactivity/impulsivity (HI), with nine symptoms for each group. DSM-IV indicates that there are three types of ADHD: (a) ADHD inattentive type (presence of only the IA symptom group); (b) ADHD hyperactive/impulsivity type (presence of only the HI symptom group); and (c) ADHD combined type (presence of both IA and HI symptom groups). In children, the related externalizing disorders of Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD) are highly comorbid with ADHD (Pliszka, 1998). Although originating in childhood, ADHD is now regarded as a valid adult disorder (American Psychiatric Association, 1994). Follow-up studies have shown that while ADHD is fairly stable from childhood to adulthood, ADHD behaviors decline with age, and they are relatively higher among males than females (Biederman, Mick, & Faraone, 2000). Also, Harpold et al. (2007) has noted that the spectrum of behaviors in ODD is also highly comorbid with ADHD among adults.

Theoretical models suggest that ADHD is associated with a response inhibition deficit (Barkley, 1997), dysfunctions involving responses to rewards (for a review, see Luman, Oosterlann, and Sergeant (2005)), underactive BIS (as proposed in the original RST; Quay, 1988), and insensitivity to delayed rewards (Sagvolden, Aase, Zeiner, & Berger, 1998). In contrast to these single pathway models, there are dual pathways models of ADHD that implicate different processes for the IA and HI symptom groups. Sonuga-Barke (2003) has proposed that deficits in executive functioning underlie the IA symptoms, while deficits in reward response underlie the HI symptoms. Martel and Nigg (2006) have linked problems with cognitive control processes to the IA symptoms, and problems with motivational control processes to HI symptoms.

A handful of studies have examined how the traits in Gray's (1970, 1982) o-RST and Tellegen's (2000) models are related to ADHD. Hundt, Kimbrel, Mitchell, and Nelson-Gray (2008) found that IA correlated positively with SP, while HI correlated positively with SR. Mitchell and Nelson-Gray (2006) used composite measures of the BIS and BAS, derived from the SPSRQ, BIS/BAS scales, and measures of trait impulsivity and anxiety and found that both IA and HI correlated positively with the composite BAS and BIS measures. These relationships held even when CD was partialled out in the analyses. Cukrowicz, Taylor, Schatschneider, and Iacono (2006) compared the personality profiles of "pure" ADHD (i.e., without CD), ADHD + CD, CD, and normative control groups of adolescents and children for the traits in the MPQ. They found no group difference for PEN. All three clinical groups had high scores for NEN and lower scores for CON, compared to the normative mean. The ADHD + CD group had more extreme scores compared to "pure" ADHD and "pure" CD groups, who did not differ from each other.

When the relations between the traits of o-RST and Tellegen's model, the empirical data on their relationships with IA and HI, and the theoretical models of ADHD are considered together, they raise the possibility that ADHD may be related to dysfunctional BIS and BAS (involving both poor reward reactivity and impulsivity). Since r-BIS is associated with cognitive, attention and memory processes when resolving goal-directed conflicts, it can be speculated further that ADHD may be associated with dysfunctions in these respect. In terms of IA and HI separately, existing data is mixed. While Hundt et al. (2008) found associations for IA with BIS, and HI with BAS, Mitchell and Nelson-Gray (2006) found that both IA and HI correlated positively with BAS and BIS.

In addition to the mixed findings, there are significant gaps and limitations in relation to the existing data on the relationships of ADHD with the personality traits proposed in RST and Tellegen's models. First, there has been no study on how the BIS/BAS scales by themselves (i.e., not combined in composites with other related measures) are related to ADHD. Thus we have no data on how IA and HI are related to different scales of the BIS/BAS scales, or to BAS-reward reactivity as opposed to impulsivity. Second, no study has examined the relevance of Tellegen's model for ADHD in a community sample. Such studies will allow additional evaluation of how IA and HI are related to BAS-reward reactivity (measured by PEN) and Impulsivity (measured by CON). Third, existing data have not explored the relationships of IA and HI with the traits in r-RST. Fourth, not all past studies have controlled for ODD and/or CD. Controlling for such problems is critical as they have been linked to concurrent overactive BAS and underactive BIS (Quay, 1988). Fifth, although age and sex are known to influence ADHD symptom levels, their effects were not controlled in previous studies.

Given these gaps and limitations, this study examined, in a community sample, the relationships of the traits in the RST and Tellegen's personality models with IA and HI. To allow for an examination of r-RST, the BIS scale of the BIS/BAS scales was also examined for BIS-Anxiety (measure of r-BIS) and BIS-Fear (measure of FFFS in r-RST). In all analyses, the potential confounding effects of ODD, age and sex were partialled out. The study also used a path model to examine the relationships of IA and HI with composite scores, based on factors obtained from an exploratory factor analysis of all the scales in three personality measures. The composite scores were BIS, BAS-reward reactivity, and Impulsivity. As existing data for the relationship of the various personality traits (examined here) with IA and HI is either mixed or lacking, no specific prediction was made.

2. Method

2.1. Participants

Two-hundred and fourteen adults (115 females and 99 males), with age ranging from 18 to 76 years (mean age = 31.71, *SD* = 16.48) were recruited through several sources from the State of Victoria, Australia. For the entire sample, the mean (*SD*) scores for the IA and HI symptom groups were 5.84 (4.03) and 5.75 (3.76), respectively. These scores compare to 6.44 (4.55) and 6.25 (4.42) for IA and HI respectively for a large Australian community group (Gomez, submitted for publication). Thus on the whole the sample in this study can be seen as having about normative levels of the IA and HI traits.

2.2. Measures

ADHD ratings were obtained using the Current Symptom Scale (CSS; Barkley & Murphy, 1998). This measure contains the DSM-IV symptoms of ADHD (18 items) and ODD (8 items). For all items, participants indicate how often they have experienced each symptom over the past 6 months as follows: 0 = "never or rarely", 1 = "sometimes", 2 = "often" and 3 = "very often"). In the current study the Cronbach's alpha values for the IA, HI and ODD symptom groups were .83, .78, and .92 respectively.

The personality measures used were the SPSRQ (Torrubia et al., 2001), BIS/BAS scales (Carver & White, 1994) and the MPQ-BF (Patrick et al., 2002). Details of these measures have been described in the introduction. Psychometrically, all these measures have been shown to have good convergent, discriminant and concurrent validity. For the current sample, the Cronbach's α values of the SP and SR scales were both 79. For the BIS (total), BAS-Total, BAS-Reward Responsiveness, BAS-Drive and BAS-Fun Seeking scales, respectively, were .74, .83, .80, .84 and .78. For BIS-Anxiety and BIS-Fear, they were .73 and .44, respectively. The Cronbach's alpha values for the MPQ-BF have ranged from .75 to .84 for the different primary trait scales.

2.3. Procedure

Ethics approval was obtained from the University of Ballarat Human Ethics Committee. All participants were from the general community. Most were recruited in shopping centers (mainly as they entered or left supermarkets), sporting and recreational clubs (at set locations approved by management), and social groups for senior citizens (at set locations approved by management). Research assistants approached potential participants directly in these centers. The research assistants then explained the procedure. If they were interested in participating, they were given the questionnaires and a plain language statement about the study. The plain language statement indicated to participants to complete the questionnaire as quickly as possible, without spending too much time on any one question, and also to rate each item without assistance from friends, colleagues or others. Participants returned the questionnaire in prepaid envelopes or handed them to the experimenter. In all, around 350 questionnaires were distributed; resulting is return rate of approximately 61%. Because of ethical restrictions, we were not able to obtain any information from those who did not participate.

3. Results

Table 1 shows the mean and *SD* scores for all the study variables. It also includes the partial correlations of IA and HI with all the personality measures, controlling for age, sex and ODD. Table 2 provides the results of the regression analyses, also controlling for age, sex and ODD effects. We will focus here on the regression findings in Table 2.

As shown in Table 2, SP was positively associated with IA, while SR was positively associated with HI. For the BIS/BAS scales that included separate scores for BIS-Anxiety and BIS-Fear, none of the measures were associated with IA, and BAS-FS was associated positively with HI. When the total BIS scores were used, the BIS scale was positively associated with IA, and BAS-FS was associated with HI positively. For the MPQ-BF, both IA and HI were negatively associated with CON, and positively with NEN. Also, PEN was associated positively with HI, and negatively with IA. In addition, in all analyses, both IA and HI were positively associated with ODD, but were not related to age or sex.

Table 1
Descriptive scores, partial correlations (controlling for ODD) of the Major Traits of the SPSRQ, BIS/BAS scales, and MPQ-BF with inattention and hyperactivity/impulsivity.

Scales	Mean (*SD*)	Partial correlation	
		IA	HI
Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ)			
Sensitivity to Reward	9.35 (4.45)	.03 (.12)	.24*** (30***)
Sensitivity to Punishment	11.15 (95.68)	.25*** (.28***)	−.05 (.02)
Behavioral Inhibition System/Behavioral Activation System scales (BIS/BAS scales)			
BAS-Total	36.63 (5.15)	.04 (.06)	.23*** (.23***)
BAS-Reward Responsiveness	15.92 (2.21)	−.01 (−.01)	.11 (.12)
BAS-Drive	9.87 (2.34)	.03 (.04)	.18** (.17*)
BAS-Fun Seeking	10.8 (2.13)	.09 (.11)	.26*** (26***)
BIS-Total	19.71 (3.00)	.10 (.15*)	.04 (.10)
BIS-Anxiety	11.51 (1.97)	.10 (.14*)	.03
BIS-Fear	8.27 (1.42)	.07 (.07)	.02
Multidimensional Personality Questionnaire-Brief (MPQ-BF)			
Positive Emotionality (PEN)	68.36 (14.40)	−.26*** (−.27***)	.08 (.05)
Negative Emotionality (NEN)	38.25 (15.85)	.19** (.33***)	.21** (.38***)
Constraint (CON)	80.41 (16.00)	−.31*** (−.31***)	−.26*** (−.26***)
Mean/SD		5.84 (4.03)	5.75 (3.76)

Note: IA = inattention; HI = hyperactivity/impulsivity. Values in parenthesis are partial correlations when ODD was not also controlled for. The correlation between IA and HI was .57 ($p < .00$) when age, sex and ODD were controlled; and .64 ($p < .001$) when age and sex were controlled.
** $p < .01$.
*** $p < .001$.

Table 2
Standard beta values of the regression analyses of inattention and hyperactivity/impulsivity on the traits of the SPSRQ, BIS/BAS scales, and MPQ-BF.

	Inattention	Hyperactivity/Impulsivity
Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ)		
Age	−.06 (−.13)	−.07 (−.14*)
Sex	.04 (.07)	−.07 (.04)
Oppositional Defiant Disorder	.35***	.39***
Sensitivity to Reward	.01 (.06)	.25*** (.33***)
Sensitivity to Punishment	.24*** (.28***)	−.09 (−.05)
BIS/BAS scales (using BIS-Anxiety and BIS-Fear scores)		
Age	−.04 (−.12)	−.07 (−.14*)
Sex	.02 (.07)	−.07 (.04)
Oppositional Defiant Disorder	.36***	.41***
BAS-Reward Responsiveness	−.08 (−.08)	−.01 (−.03)
BAS-Drive	.02 (.02)	.09 (.09)
BAS-Fun Seeking	.12 (.15)	.23*** (.31***)
BIS-Anxiety	.11 (.14)	.00 (.05)
BIS-Fear	.02 (.05)	.06 (.09)
BIS/BAS scales (using total BIS score)		
Age	−.03 (−.11)	−.05 (−.13)
Sex	.03 (.08)	−.01 (.05)
Oppositional Defiant Disorder	.36***	.41***
BAS-Reward Responsiveness	−.09 (−.09)	−.02 (−.03)
BAS-Drive	.02 (.02)	.09 (.09)
BAS-Fun Seeking	.13 (.17*)	.22*** (.26***)
BIS-Total	.14* (.20**)	.09 (.14*)
Multidimensional Personality Questionnaire-Brief (MPQ-BF)		
Age	.01 (−.03)	−.01 (−.06)
Sex	−.05 (−.03)	−.06 (−.04)
Oppositional Defiant Disorder	.26***	.31***
Positive Emotionality	−.20** (−.20**)	.13* (.13*)
Negative Emotionality	.18** (.30***)	.24*** (.38***)
Constraint	−.29*** (−.30***)	−.26*** (−.28***)

Note: Values in parenthesis are standard beta values when ODD was not also controlled for.
* $p < .05$.
** $p < .001$.
*** $p < .001$.

Table 3
Factor loadings from the EFA involving the personality traits in the BIS/BAS scales, SP/SRQ and MPQ measures.

Scales	Factors		
	1	2	3
Sensitivity Reward (SR)	*.56*	.31	−.35
Sensitivity Punishment (SP)	−.18	*.81*	−.03
BAS-Reward Responsiveness (BAS-RR)	*.61*	.14	.06
BAS-Drive (BAS-DR)	*.63*	.02	−.10
BAS-Fun Seeking (BAS-FS)	.44	−.00	*−.55*
BIS-Anxiety	.18	*.65*	.28
BIS-Fear	.03	*.45*	.29
Positive Emotionality (PEN)	*.70*	−.35	.16
Negative Emotionality (NEN)	.05	*.50*	−.22
Constraint (CON)	.06	.08	*.74*
Eigenvalues	2.65	2.27	1.45
% of variance	26.48	22.73	14.46

Note: Factor loadings ⩾ .45 are italicized.
Factor names: 1 = BAS-Reward Responsiveness; 2 = BIS; and 3 = Impulsivity.

In order to better comprehend the relations of the scales in the SPSRQ, BIS/BAS scales and the MPQ-BF, an exploratory factor analysis (EFA), using principal axis factoring with oblique rotation, was conducted with all these scales, and then the composite scores of the factors from the EFA was used to predict IA and HI simultaneously, using path analysis. The composite scores were obtained by adding the *z* scores of the scales (reversing CON) comprising the factors. To maintain model simplicity only the effects of ODD were controlled in the path analysis. Age and sex were not controlled as they were not associated with IA and HI in the regression analyses.

The result of the EFA, presented in Table 3, indicated three factors with eigenvalues more than unity. The first and second factors represented mainly the scales associated with BAS-reward reactivity and the o-BIS, respectively. The third factor comprised impulsivity measures (BAS-FS and CON).

The findings of the path analysis (obtained using M*Plus* software) are presented in Fig. 1. As shown, IA was positively associated with composite o-BIS and Impulsivity, while HI was positively associated with composite BAS-reward reactivity and Impulsivity.

4. Discussion

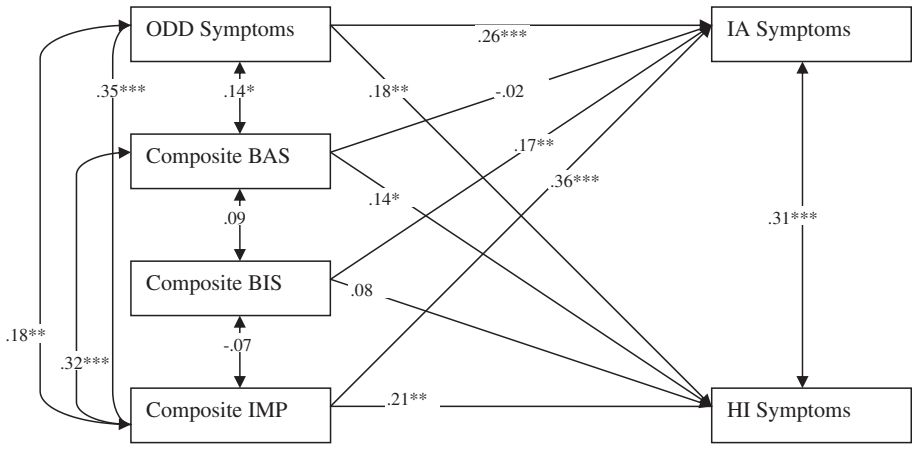
The major findings from the regression analyses were that IA was positively associated with SP, BIS (total) and NEN, and negatively with PEN. In contrast, HI was positively associated with SR, BAS-RR, BAS-DR and PEN. Both IA and HI were associated negatively with CON, and HI was associated positively with BIS-FS. These findings were mostly as expected. The findings for SP and SR were similar to those reported by Hundt et al. (2008). The findings involving the BIS/BAS scales and the MPQ-BF are new.

The findings in the path analysis were that composite BIS (comprising SP, BIS-Anxiety, BIS-Fear and NEN scales) was associated positively with IA, while composite BAS-reward reactivity (comprising SR, BAS-RR, BAS-DR and PEN) was associated positively with HI. Composite Impulsivity (comprising BAS-FS and CON) was associated positively with both IA with HI. These findings differ from that reported by Mitchell and Nelson-Gray (2006). They reported that both the BAS and the BIS were positively associated with IA and HI. These differences may be related to the scales that comprised the composites for the BAS and BIS. In Mitchell and Nelson-Gray's study, the BIS comprised scores from SP, BIS and a trait anxiety scale, and BAS comprised scores from SR, BAS-RR, BAS-DR, BAS-FS and a trait impulsivity scale. Furthermore that study did not have a composite for Impulsivity.

Overall, the findings in the current study suggest that while both IA and HI are associated with poor response inhibition or high impulsivity, they are primarily distinguished in terms of IA being associated with higher punishment sensitivity, while HI being associated with higher reward sensitivity. This is consistent with ADHD theories implicating dysfunctional responses to the reward and punishment systems (Quay, 1988). Also, since both IA and HI were associated with Impulsivity it can be argued that ADHD in general is associated with impulsivity. This view is consistent with models that suggest that ADHD is a disorder of response disinhibition (Barkley, 1997).

When viewed in terms of the o-RST, the primary distinction between IA and HI is that IA is associated with overactive BIS, while HI is associated with overactive BAS.

In r-RST, the BIS is associated with higher anxiety and difficulties with the cognitive processes involved in attention and memory scanning to help resolve concurrent goal conflicts. As in the original model, the BAS consists of reward-orientation and impulsiveness. Thus when viewed in terms of the r-RST, the findings here suggest that IA is associated with dysfunctions with the attention, cognitive and memory processes needed for resolving concurrent goal conflicts, while HI is associated to impulsive motivation to rewards. This interpretation is consistent with dual pathways models that implicate deficits in executive functioning for the IA symp-



* $p < .05$; ** $p < .001$; *** $p < .001$.

Fig. 1. Standardized coefficients for path model.

toms, and deficits in reward responses for the HI symptoms (Martel & Nigg, 2006; Sonuga-Barke, 2003). A notable finding here of relevance to r-RST is that the BIS-Fear scale was not associated with IA or HI. If it is accepted that the BIS-Fear measure taps the FFFS, then it can be concluded that the FFFS has no relevance for understanding ADHD.

The relationships speculated here for IA and HI have implications for understanding the personality profiles of the different ADHD types. For example, in terms of r-RST, the findings suggest that the ADHD inattentive type has difficulties with the cognitive processes involved in attention and memory scanning to help resolve concurrent goal conflicts, and are more prone to anxious (high BIS) and impulsive responses. The ADHD hyperactivity/impulsive type is impulsive, and highly sensitive to rewards (high BAS). Given that the ADHD combined type have high IA and HI symptoms, this type can be conceptualized to have a personality profile reflecting the features of both IA and HI. As the proposal for ADHD subtypes in DSM-V is essentially the same as in DSM-IV (www.dsm5.org), the findings here could turn out to be also relevant for ADHD in the next edition of the DSM.

The findings in this study also have implications for the use of personality questionnaires for screening ADHD. Of the three personality measures, the SPSRQ was the best measure for differentiating IA and HI. This raises the possibility that the SPSRQ would be useful for screening the different ADHD types. For this measure, the inattentive type will have high SP scores, the hyperactive–impulsive will have high SR scores, and the combined type will have high SP and SR scores.

In closing, our findings report new information on the relationship between some major traits of personality and ADHD. A major strength of this study is that these relations were established with ODD, age and sex partialled out. Other strengths included examination of relations in terms of Tellegen's model, r-RST, and BAS-reward reactivity distinct from impulsivity. These have not been examined previously. Also, the study covered individuals from 18 to 76 years, thereby increasing the applicability of results more generally. However, there are also limitations in the current study. First, as the validity of the BIS-Fear scale for measuring FFFS is tentative, the findings and interpretations involving this measure have to be viewed cautiously. Second, as all measures involved self-ratings, it may be possible that the findings were confounded by common method variance. Third, as this was a cross-sectional study, the findings show only associations and not causal relations. Fourth, we did not screen for cognitive impairments that may manifest as inattention or hyperactivity. Given that the sample included older individuals, it cannot be ruled out that findings here were not confounded by such deficits. Fifth, as ethics approval for this study did not permit collection of information about individuals prior to inviting them to participate, there is no information about those who did not respond to the invitation to participate in this study (approximately 39%), and therefore how this impacted the results. Despite these limitations, the findings in the current study do provide a strong basis for more studies in this area, controlling for the limitations raised here.

References

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders DSM-IV TR* (Text revision). Washington, DC: Author.

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121*, 65–94.

Barkley, R., & Murphy, K. R. (1998). *Attention deficit hyperactivity disorder: A clinical workbook* (2nd ed.). NY: Guilford Press.

Biederman, J., Mick, E., & Faraone, S. V. (2000). Age-dependent decline of symptoms of attention deficit hyperactivity disorder: Impact of remission definition and symptom type. *American Journal of Psychiatry, 157*, 816–818.

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

Corr, P. J. (2008). Reinforcement sensitivity theory (RST): Introduction. In P. J. Corr (Ed.), *The reinforcement sensitivity theory of personality* (pp. 1–43). Cambridge: Cambridge University Press.

Cukrowicz, K. C., Taylor, J., Schatschneider, C., & Iacono, W. G. (2006). Personality differences in children and adolescents with attention-deficit/hyperactivity disorder, conduct disorder, and controls. *Journal of Child Psychology and Psychiatry, 47*, 151–159.

Gomez, R. (2009). ADHD and personality. In P. Corr & G. Matthews (Eds.), *Cambridge handbook of personality* (pp. 704–715). Cambridge: Cambridge University Press.

Gomez, R. (submitted for publication). ADHD in Australian adults: Prevalence, normative scores and gender and age differences.

Gray, J. A. (1970). The psychophysiological basis of introversion–extraversion. *Behavior Research and Therapy, 8*, 249–266.

Gray, J. A. (1982). *The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system*. Oxford: Oxford University Press.

Gray, J. A., & McNaughton, N. (2000). *The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system* (2nd ed). Oxford: Oxford University Press.

Harpold, T., Biederman, J., Gignac, M., Hammerness, P., Surman, C., Potter, A., et al. (2007). Is Oppositional Defiant Disorder a meaningful diagnosis in adults? Results from a large sample of adults with ADHD. *The Journal of Nervous and Mental Disease, 195*, 601–605.

Heym, N., Ferguson, E., & Lawrence, C. (2008). 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. *Personality and Individual Differences, 45*, 709–715.

Hundt, N. E., Kimbrel, N. A., Mitchell, T. J., & Nelson-Gray, R. O. (2008). High BAS, but not low BIS, predicts externalizing symptoms in adults. *Personality and Individual Differences, 40*, 565–575.

Luman, M., Oosterlann, J., & Sergeant, J. A. (2005). The impact of reinforcement contingencies on AD/HD: A review and theoretical appraisal. *Clinical Psychology Review, 25*, 183–213.

Martel, M. M., & Nigg, J. T. (2006). Child ADHD and personality/temperament traits of reactive and effortful control, resiliency, and emotionality. *Journal of Child Psychology & Psychiatry, 47*, 1175–1183.

McNaughton, N., & Corr, P. J. (2004). A two-dimensional view of defensive systems: Defensive distance and fear/anxiety. *Neuroscience and Biobehavioral Reviews, 28*, 285–305.

Mitchell, J. T., & Nelson-Gray, R. O. (2006). Attention-deficit/hyperactivity disorder symptoms in adults: Relationship to Gray's behavioral approach system. *Personality and Individual Differences, 40*, 749–760.

Patrick, C. J., Curtin, J. J., & Tellegen, A. (2002). Development and validation of a brief form of the Multidimensional Personality Questionnaire. *Psychological Assessment, 14*, 150–163.

Pliszka, S. R. (1998). Comorbidity of attention-deficit/hyperactivity disorder: An overview. *Journal of Clinical Psychiatry, 59*, 50–58.

Quay, H. C. (1988). The behavioral reward and inhibition systems in childhood behaviour disorders. In L. M. Bloomingdale (Ed.). *Attention deficit disorder* (Vol. 3, pp. 176–186). Oxford, UK: Pergamon.

Sagvolden, T., Aase, H., Zeiner, P., & Berger, D. F. (1998). Altered reinforcement mechanisms in attention deficit/hyperactivity disorder. *Behavioral Brain Research, 94*, 61–71.

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

Sonuga-Barke, E. J. S. (2003). The dual pathway model of AD/HD: An elaboration of neuro-developmental characteristics. *Neuroscience and Biobehavioral Reviews, 27*, 593–604.

Tellegen, A. (2000). *Manual for the Multidimensional Personality Questionnaire*. Minneapolis: University of Minnesota Press.

Torrubia, R., Avila, C., Molto, J., & Caseras, X. (2001). The sensitivity to punishment and sensitivity to reward questionnaire (SRSRQ) as a measure of Gray's anxiety and impulsivity dimensions. *Personality and Individual Differences, 31*, 837–862.

Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations and psychobiological evidence. *Journal of Abnormal Psychology, 103*, 18–31.