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Neuropsychological correlates of the YAQ-S and YAQ-I self- and informant-reported ADHD symptomatology, emotional and social problems and delinquent behaviour

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Objectives. The objective was to evaluate the relationship between self- and informant-rated symptoms of ADHD and performance on neuropsychological tests of attention and impulsivity (Letter Cancellation Test [LCT], Continuous Performance Test [CPT] and Matching Familiar Figures test [MFF]).

Design. Participants were clinical referrals for assessment of ADHD in adulthood and healthy controls.

Method. ADHD adults were compared with individuals with mild psychiatric disorders (including attention problems), a healthy control group on neuropsychological measures of attention (CPT and LCT) and on impulsivity (MFF). Secondly, the scores obtained on these measures were correlated with the Young ADHD Questionnaire-S (YAQ-S) and Young ADHD Questionnaire-I (YAQ-I) self- and informant-reported scales of ADHD symptomatology, emotional problems, delinquency, and social functioning.

Results. The ADHD group were more impaired than the healthy controls on neuropsychological measures, but only the MFF differentiated them from the psychiatric controls. Tests of attentional control positively correlated with the self-reported functioning of the ADHD group but not among the psychiatric or normal controls. There was a positive correlation between tests of attention (but not impulsivity) and self-ratings of ADHD symptomatology for the ADHD group, suggesting that ADHD adults are better at recognizing attentional problems than impulse control. A positive correlation was found between the Delinquency scale and a test of impulsivity for the ADHD group only.

Conclusions. The findings suggest that there are neuropsychological underpinnings of the ADHD syndrome but neuropsychological tests may discriminate poorly between ADHD and mild psychiatric disorders. ADHD adults may be more reliable informants of adult functioning than their parents, although they may underreport impulsive behaviour.

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It is estimated that approximately 0.5% to 1% of the young adult population has ADHD (Toone & van der Linden, 1997). Yet many adults are undiagnosed. Individuals often have a long history of presenting to psychiatric services for their problems, which are not recognized as relating to ADHD (Young, Toone, & Tyson, 2003). Even once ADHD is identified to be a possible source of the problem, diagnosing it in adulthood for the first time can be problematic because documenting a history of childhood ADHD depends on the reliability of self- and/or informant reports. Without reliable and valid childhood information, clinicians must base their assessment on the patient's presentation, self-report and informant-report (if available) of current symptoms. This is complicated by high rates of co-morbidity of symptoms, reported to be up to 40% for anxiety, 70% for depression, and 45% personality disorder (Biederman, Newcorn, & Sprich, 1991; Young, 2000). It has been suggested that adults from a community-based sample can give true and accurate accounts of childhood and current symptoms of ADHD, especially when faced with specific rather than open-ended questioning (Murphy & Schachar, 2000). However, this finding has not been supported by epidemiological and clinical studies of adolescents (Danckaerts, Heptinstall, Chadwick, & Taylor, 1999; Smith, Pelham, Gnagy, Molina, & Evans, 2000).

The accuracy of reporting sources can be examined by relating these to cognitive deficits determined from performance on neuropsychological tests. Impairments in children and adults have been reported on tests that require sustained attention (Douglas, 1988; Sergeant, 1988; Young, Channon, & Toone, 2000), the suppression of inappropriate responses (Ross, Hommer, Breiger, Varley, & Radant, 1994; Rubia *et al.*, 1998; Schachar, Tannock, Mariott, & Logan, 1995; Shue & Douglas, 1992), executive processes, self-regulation and memory functioning (Aman, Roberts, & Pennington, 1998; Houghton *et al.*, 1999; Oades, 1998; Seidman, Biederman, Faraone, Weber, & Ouellette, 1997).

This study evaluates the association between self- and informant-ratings of current functioning on the Young ADHD Questionnaire-S (YAQ-S) and Young ADHD Questionnaire-I (YAQ-I) self-rated and informant-rated questionnaires (Young, 2004), and cognitive functioning on tests of attention and impulsivity, comparing an ADHD symptomatic group with individuals with mild psychiatric disorders (including attentional complaints) and a healthy control group. The YAQ-S and YAQ-I questionnaires provide four scales: (1) ADHD symptomatology relating to underlying core symptoms of attention, hyperactivity, and impulsivity; (2) emotional problems relating to feelings of anxiety, depression, anger, lability, and the impact of mood on social relationships; (3) delinquency relating to aggressive behaviours, damage or theft of property, police contact, and substance misuse; and (4) social functioning relating to the ability to engage positively and socialize with others. Poor agreement was previously found between self- and informant-ratings on the ADHD symptomatology scale in spite of good internal consistency of this scale for each proband group (Young, 2004). This study aimed to identify which is more valid by correlating self- and informant-ratings on the YAQ-S and YAQ-I questionnaires with performance on neuropsychological tests of attention and impulse control, that is, a Letter Cancellation Test (LCT; Lezak, 1983) to assess selective attention; a Continuous Performance Test (CPT; Erlenmeyer-Kimling & Cornblatt, 1978) to assess vigilance, and the Matching Familiar Figures test (MFF; Cairnes & Cammock, 1978) to assess impulse control.

It was hypothesized that: (1) patients diagnosed with ADHD would be significantly more impaired than normal and clinical controls on measures of attention and impulsivity; and (2) there would be a positive correlation between ratings by both patients and

informants on neuropsychological test performance (both measures of attention and impulsivity) and the ADHD symptomatology scale of the YAQ-S and YAQ-I.

Method

Participants

ADHD group

There were 60 adult ADHD patients (47 male and 13 female) meeting the DSM-IV criteria for ADHD. Their mean age was 24.9 ($SD = 5.7$). Exclusion criteria included a history of learning disability, psychotic illness, significant brain damage, or individuals in remission of their childhood ADHD symptoms.

Clinical control group (CCG)

These were 34 patients (25 male and 9 female) referred for assessment for ADHD but who did not meet the ADHD or exclusion criteria. Their mean age was 24.8 ($SD = 5.4$). This CCG consisted of people suffering primarily from anxiety disorders (44.1%), depression (20.6%), personality disorder (20.6%), or dysphoric symptomatology (14.7%).

All the patients in the two clinic groups underwent a comprehensive psychiatric evaluation including a semi-structured interview based on the DSM-IV criteria for ADHD. Each positive self-rating had to be endorsed by the assessor on the basis of supplementary questioning or other information (e.g. documentation). Whenever possible, a parent was also interviewed to establish whether there was a history of ADHD features during early childhood (i.e. before the age of 7). This judgment was based upon an unstructured interview, although in order to obtain a final positive rating, a score of 15 or more was required on the Conners' Global Index parent scale (CGI-p; Conners, 2000). For cases in which the Conners ratings were unclear, a final positive rating was made in cases where school reports and/or other childhood documentation provided evidence of hyperactivity and attentional difficulties.

Normal control group (NCG)

There were 32 healthy local community controls (21 male and 11 female) recruited by advertisements in general practitioner health centres. The controls had a mean age of 24.6 ($SD = 6.3$).

Participants for all three groups were predominantly middle-class young men. Social class was determined by father's occupation as defined by the Registrar-General's 1979 classification of occupations. The mean predicted intelligence quotients (IQ) derived from the National Adult Reading Test (Nelson, 1982; Nelson & Willison, 1991) ranged from 97 to 102. There was no significant difference between groups for age ($F(2, 125) = 0.01$, *ns*), IQ ($F(2, 125) = 1.98$, *ns*), social class ($F(2, 96) = 2.13$, *ns*) and gender ($\chi^2 = 1.74$, $df = 2$, *ns*).

Measures

The YAQ-S (Young, 2004) is a 112-item self-report questionnaire. Each item is rated on an 8-point Likert scale, ranging from '*not at all*' (1, 2) to '*most of the time*' (7, 8), with the label '*sometimes*' indicating a range of in-between scores (3, 4, 5, 6). Factor analysis of

the YAQ-S determined four conceptually meaningful subscales: (1) ADHD symptomatology relating to underlying core symptoms of attention, hyperactivity, and impulsivity; (2) emotional problems relating to feelings of anxiety, depression, anger, lability, and the impact of mood on social relationships; (3) delinquency relating to aggressive behaviours, damage or theft of property, police contact and substance misuse; and (4) social functioning relating to the ability to positively engage and socialize with others. Internal consistency was good, with Cronbach's α ranging from .76 to .98 for all subscales.

The YAQ-I (Young, 2004) is a parallel scale of the YAQ-S for which instructions are adapted to make it applicable for informants to complete. With the exception of the Social functioning scale for the ADHD group ($\alpha = .50$), internal consistency was good, with Cronbach's α ranging from .82 to .96.

The revised [MFF-20] version of the MFF (Cairnes & Cammock, 1978) of impulsiveness versus reflectiveness in cognitive style. Impulsiveness is represented by an enduring disposition to respond rapidly but incorrectly in a situation where there is uncertainty about which response is correct. Individuals are shown a set of very similar pictures differing only on points of detail. The pictures also have a duplicate of one picture presented by itself. The task is to match the single picture with the identical member of the initial set. Performance was scored according to the number of errors.

The CPT (Erlenmeyer-Kimling & Cornblatt, 1978) evaluating sustained vigilance in a signal detection task. The individual is required to sit in front of a video monitor attached to a microcomputer, on which pictures comprising a number and a simple shape are presented. Each stimulus picture is presented for 1 second with a 1.5 second inter-stimulus interval. The individual's task is to press the space bar on the computer keyboard whenever a picture appears that is identical to the preceding one. Altogether, 192 stimuli are presented, among which are 24 pairs of successively identical stimuli. Incorrect identifications (errors of commission or false positives), and failures to identify (errors of omission or false negatives) were recorded.

LCT of selective attention (Lezak, 1983). This consists of rows of letters randomly interspersed with a designated target letter. Strategy of search is derived from the reading process, as participants search from left to right, line by line, from top to bottom. Performance was scored for number of errors and number of lines completed within a 2-minute time limit and calculating a percentage of errors score.

Procedure

The YAQ-S and neuropsychological test battery were administered prior to the psychiatric assessment of the clinical groups. The YAQ-I was completed by a parent who accompanied participants to their appointment.

Results

Group differences

There were two comparisons of interest: the ADHD group versus the clinic controls, and the ADHD group versus the healthy controls. To explore group differences, one-way analyses of variance (ANOVA) were predominantly used to compare all three groups, with subsequent Bonferroni *post hoc* pairwise comparisons ($\alpha = .05$). Mean scores and standard deviations for the three groups are shown in Table 1.

Table 1. Mean score of neuropsychological tests (standard deviation in brackets) for ADHD, clinic control and NCGs

	ADHD (N = 54–60)	Clinical controls (N = 32–34)	Normal controls (N = 32)	F
MFF error score	8.02 (5.93)	5.47 (3.71)	4.47 (3.11)	6.62[**]
CPT errors of omission	3.91 (4.66)	2.27 (2.28)	0.72 (1.53)	8.76[***]
CPT errors of commission	2.94 (3.96)	1.62 (1.74)	0.87 (2.22)	4.96[**]
LCT % incorrect	12.14 (12.54)	8.51 (10.39)	4.50 (5.82)	5.50[**]

*$p < .05$, **$p < .01$, ***$p < .001$.

Matching Familiar Figures test
There was a significant main effect for the number of errors made across trials until the correct response was achieved, $F(2, 123) = 6.62$, $p < .01$, and *post hoc* comparisons revealed that the ADHD group made significantly more errors than the NCG ($p < .01$) and the CCG ($p < .05$).

Continuous Performance Test
Errors of omission or false negatives represent failures to identify a target. ANOVA showed a significant main effect between groups, $F(2, 118) = 8.76$, $p < .001$, and *post hoc* comparisons showed the ADHD group made significantly more false negatives than the NCG ($p < .001$), but did not differ significantly from the CCG. Errors of commission or false positives represent incorrect identifications. ANOVA showed a significant main effect between groups, $F(2, 115) = 4.96$, $p < .01$, and *post hoc* comparisons showed the ADHD group made significantly more false positives than the NCG ($p < .01$), but did not differ significantly from the CCG.

Letter Cancellation Test
ANOVA showed a significant group difference in accuracy (i.e. the percentage of errors made), $F(2, 123) = 5.50$, $p < .01$. *Post hoc* comparisons showed that the ADHD group made significantly more letter cancellations than the NCG ($p < .01$), but did not differ significantly from the CCG.

Correlation between the YAQ-S, YAQ-I, and neuropsychological test scores
In order to investigate the extent to which the neuropsychological tests related to self- and informant-reported ADHD symptomatology and associated co-morbid problems, the scores were correlated with the four subscales of the YAQ-S and YAQ-I by the use of Pearson correlation coefficients. Table 2 gives the correlations between the neuropsychological tests and the YAQ-S and YAQ-I subscales by group. With respect to self-ratings of functioning, of the three groups, the only significant positive correlations were found between the neuropsychological functioning of the ADHD group and the ADHD scale and the Delinquency scale. For this group, there were significant positive correlations between the ADHD scale and measures of sustained attention (i.e. CPT errors of omission) and selective attention (i.e. LCT), and between the Delinquency scale and a measure of impulsivity (i.e. CPT errors of commission). There was a significant negative correlation between the Social functioning scale and

Table 2. Correlation between neuropsychology test scores and subscales of the YAQ-S and YAQ-I

	ADHD		Clinical controls		Normal controls	
	YAQ-S (N = 54–60)	YAQ-I (N = 39–43)	YAQ-S (N = 32–34)	YAQ-I (N = 21–22)	YAQ-S (N = 32)	YAQ-I (N = 29)
Social scale						
MFF error score	−.23	.19	−.04	.19	.22	.17
CPT errors of omission	−.27*	−.11	−.46**	−.26	−.21	−.04
CPT errors of commission	.02	−.02	−.42*	−.11	.03	.14
LCT % incorrect	−.18	−.10	.10	.12	.15	.15
ADHD scale						
MFF error score	−.03	−.13	.03	.11	.18	.12
CPT errors of omission	.27*	.18	.10	−.33	.29	.04
CPT errors of commission	−.01	.03	.14	.21	.22	.06
LCT % incorrect	.25*	.12	.15	−.37	.09	.27
Emotional scale						
MFF error score	−.15	−.36*	.05	.04	−.06	−.07
CPT errors of omission	.07	−.07	.27	−.05	.01	−.01
CPT errors of commission	−.04	−.02	.20	.22	−.07	−.08
LCT % incorrect	.13	−.08	.03	−.23	−.12	.04
Delinquency scale						
MFF error score	−.23	−.20	.01	.15	−.20	−.21
CPT errors of omission	.06	.12	−.12	−.26	.15	−.13
CPT errors of commission	.31*	.22	−.05	−.15	.13	−.09
LCT % incorrect	.01	.01	−.16	−.28	.04	.08

*p < .05, **p < .01 (one-tailed test for ADHD scale by ADHD group).

sustained attention (CPT errors of omission) for both the ADHD and CCG groups, and between the Social functioning scale and a measure of impulsivity (CPT errors of commission) for the CCG only. There was only one significant correlation for informant-ratings of functioning on the YAQ-I, which was a negative correlation between the Emotional scale and impulsive behaviour on the MFF for the ADHD group. However, after controlling for multiple comparisons by applying Bonferroni adjustment to the standard .05 α level, none of the correlations remained significant. This means that in view of the number of correlations carried out, the significance of the individual correlations in Table 2 should be treated with caution.

Discussion

As hypothesized, compared with normal controls, the ADHD group performed significantly less well on tests involving sustained attention (CPT errors of omission), selective attention (LCT), and impulsivity (MFF and CPT errors of commission). The lack of a significant difference on the neuropsychological measures between the ADHD and CCGs may, in part, have been due to the low number of participants in the CCG. It is noteworthy that on all the neuropsychological measures, the clinical controls had lower error scores than the ADHD group, although *post hoc* comparisons did not reach significance. Future research should include a larger group of clinical controls in order to establish the power of the differences in the scores, as well as the significance level.

In a study of children aged between 5 and 15, Marsh and Williams (2004) found that hyperactivity–impulsivity declined more rapidly with age than attention. However, the present study involving adults with a mean age of 25 years, both impulsivity and attentional problems were significantly impaired. The most discriminative test in terms of differentiating the ADHD group from both control groups was the MFF measure of impulse control. Previous studies that have included a mild psychiatric disordered control group have also found that the predictive power of neuropsychological tests of attention are poor discriminators of ADHD and mild psychiatric disorders (Doyle, Biederman, Seidman, Weber, & Faraone, 2000; Walker, Shores, Trollor, Lee, & Sachdev, 2000). The usefulness of the CPT (long considered the 'gold standard test' of an attention deficit) is controversial when it comes to being able to discriminate between ADHD and mild psychiatric disorders (Corkum & Siegel, 1993, 1995; Koelega, 1995). Perhaps more discriminatory tests of attention need to be identified. Cognitive theories emphasize the construct of impulsiveness, suggesting that failure to inhibit or delay a behavioural response is the central deficit in ADHD (Barkely, 1997; Quay, 1988, 1997; Schachar, Tannock, & Logan, 1993; Sonuga-Barke, 1995). Prefrontal hypoactivity has been demonstrated in ADHD by neuroimaging studies using inhibitory control tasks in adolescents and young adults (Rubia *et al.*, 2000; 1999). Thus, tasks of response inhibition (e.g. a visual stop paradigm) may be more specific in their discrimination between ADHD and mild psychiatric disorders, although normal adult control data on these tasks will need to be established.

The hypothesis that there would be a positive correlation between neuropsychological test performance and ADHD symptoms was supported for self-rated functioning on the YAQ-S but not informant-rated functioning on the YAQ-I. There was only one negative correlation for informant ratings between the Emotional scale and impulsive behaviour (MFF) for the ADHD group. Tests of attentional control positively correlated with the self-reported functioning of the ADHD group but not the psychiatric or normal

controls, emphasizing the neuropsychological underpinnings of the ADHD syndrome. The results suggest that ADHD adults, in certain circumstances, may be more accurate and reliable informants of their current ADHD symptoms than other informants. This is consistent with the findings of Murphy and Schachar (2000), who found that non-referred individuals can give reliable and valid accounts of ADHD symptoms. Nevertheless, parents have been reported to be more reliable informants than adults with ADHD when predicting adult treatment response (Wender, Reimherr, & Wood, 1981). Therefore, the reliability and validity of the reporting of ADHD symptoms by adult patients and their parents may depend on the context of what is being reported, and whether it refers to a prospective or retrospective evaluation. For example, with regard to retrospective reporting of symptoms, parents may be rating their adult child in terms of symptoms that were evident in childhood, but may have been in remission at the time of the assessment in adulthood. In addition, a parent may know less about the severity and frequency of ADHD symptoms experienced by an adult child who may be employed and living independently. The apparent ability of adults with ADHD to report their symptoms is contrary to epidemiological and clinical studies of adolescents that found that they were poor sources of reporting hyperactivity and ADHD symptomatology (Danckaerts, Heptinstall, Chadwick, & Taylor, 1999; Smith, Pelham, Gnagy, Molina, & Evans, 2000). Future research should focus on the potential ability of partners, as an independent source of information about ADHD symptoms and general functioning, because they may be more reliable informants than parents of adult functioning.

Although the ADHD group appears, in some respects, to be more reliable informants of their functioning than their parents, their insight may be limited to a knowledge and understanding of their attention deficit rather than their impaired behavioural control. Significant positive correlations were found between self-reported ADHD symptoms on the ADHD scale of the YAQ-S, the CPT errors of omission (sustained attention), and LCT error score (selective attention), providing predictive validity for the YAQ-S. Thus, their self-rated symptoms of ADHD were significantly associated with deficits on measures of attentional control but not on impulsivity, suggesting that they may be better at the self-regulation and monitoring of attentional problems than impulse control. Additionally, they may view a difficulty with attentional control to be more problematic than a difficulty with behavioural control because they have developed impulse control strategies for everyday functioning that are not readily transferable to a novel task. However, this seems unlikely because the positive correlation found between the Delinquency scale and the errors of commission on the CPT measure of impulsivity for the ADHD group indicates that their poor impulse control is associated with delinquent behaviour. Antisocial delinquent behaviour has consistently been found to be strongly associated with ADHD in empirical studies of children and adults (Mannuzza, Klein, Konig, & Giampino, 1989; Satterfield, Swanson, Schell, & Lee, 1994). In the present paper, impulsivity is construed as a failure to inhibit or delay a behavioural response, and this was measured by a perceptual-motor task; the MFF. There is often a poor relationship between self-report and perceptual measures of impulsivity (Gudjonsson & Roberts, 1981; Van der Brock & Bradshaw, 1993), although this may relate to the nature of the self-report questionnaire and neuropsychological (impulsivity) tests used (Dolan & Anderson, 2002).

The negative correlation between the social functioning of the ADHD group and the CPT errors of omission score (a measure of sustained attention) suggests that attentional control and social behaviour are related. Inattention and distractibility may be perceived

by others as an inability to listen or a lack of interest. They may be viewed as fickle or insincere, flitting from person to person, and/or inappropriately changing topics of conversation in social situations. This may be a general problem for individuals with attentional problems, as the CCG also had a negative correlation between their self-rated Social functioning scale and their performance on the CPT.

While there is increasing awareness that ADHD continues into adulthood, it remains an under-diagnosed and under-treated adult psychiatric disorder. The ultimate goal is to be able to make the diagnosis in adults for the first time with confidence. This goal is complicated by the heterogeneity of the syndrome and high rates of co-morbidity in adulthood (Young, 2004, 2000). The strength of the study is the incorporation of this control group who were referred for attentional problems and may be misdiagnosed as ADHD. Neuropsychological tests may lack specificity and discriminate poorly between ADHD and mild psychiatric disorders. The MFF test was the single most discriminative measure. This emphasizes the need for a comprehensive clinical assessment, which includes a reliable childhood history, in addition to current symptoms (Young, Toone, & Tyson, 2003). Although parents may be important sources of information about childhood functioning, they may not be so reliable for adult functioning if they are not involved with them on a daily basis. Our results suggest that adults can give a valid description of their ADHD symptoms, although clinicians should be aware that they may under-report some of their symptoms, particularly those relating to impulsive behaviour. This study emphasizes the importance of incorporating information from multiple sources when conducting a comprehensive assessment of ADHD in adulthood, including neuropsychological assessment and information from self- and informant-reports.

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