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Differential diagnosis and comorbidity of ADHD and anxiety in adults

Katie Grogan[1,2]*, Claire I. Gormley[1], Brendan Rooney[1], Robert Whelan[3], Hanni Kiiski[3], Marie Naughton[2] and Jessica Bramham[1,2]

[1]School of Psychology, University College Dublin, Ireland
[2]Adult ADHD Assessment Clinic, St. Patrick's University Hospital, Dublin, Ireland
[3]Whelan Lab-Translational Cognitive Neuroscience, Trinity College Dublin, Ireland

Objectives. The aim of this study was to examine symptom profiles of people diagnosed with attention-deficit/hyperactivity disorder (ADHD) and/or anxiety (ANX) in order to determine the validity of widely used ADHD and ANX rating scales for differential diagnostic use and to develop modified measures that take symptom overlap into account.

Design. A cross-sectional design was used to assess differences in rating scale scores between clinical (n = 52) and control (n = 74) samples as well as differences among subgroups of the clinical sample (22 ADHD; 16 ADHD + ANX; 14 ANX).

Method. Participants completed an online questionnaire where they responded to the Conners Adult ADHD Rating Scale (CAARS; Conners, Erhardt, & Sparrow, 1999) and State Trait Anxiety Inventory scales (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

Results. Results showed that the CAARS and STAI had limited sensitivity and specificity and may lack in ability to differentially diagnose ADHD and/or ANX. Cluster analysis was used to guide the proposal of modifications for the two scales, which were to use inattentive items only for the CAARS and to exclude state ANX-present items on the STAI for use in differential diagnosis. Further parametric analysis supported these proposed modifications.

Conclusions. Clinicians should be made aware of the limitations of the CAARS and STAI scales in terms of specificity, when used to inform differential diagnosis of ADHD and ANX. Further analysis on the psychometric properties of these modified scales is needed in order to confirm that they are valid and reliable scales.

Practitioner points

Clinical implications

- It is possible that widely used self-report rating scales are not valid for use in the context of assessing adult ADHD when ANX is present.
- Clinicians should take alternative approaches to measuring ADHD symptoms in the context of ANX.
- Findings of the present study suggest the use of inattentive items only for the CAARS and to exclude state ANX-present items on the STAI for differential diagnostic use.

*Correspondence should be addressed to Katie Grogan, E113 School of Psychology, Newman Building, University College Dublin, Belfield Campus, Dublin 4, Ireland (email: katie.grogan@ucdonnect.ie).

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Limitations of the study

- The sample sizes of the clinical subgroups were relatively small.
- Diagnoses were not confirmed using a semi-structured clinical interview.
- Alternative cluster approaches (e.g., two-step clustering using larger samples) would provide further insight.

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder with symptoms of inattention, hyperactivity, and impulsivity that begin in childhood and persist into adulthood for the majority of affected children (Guldberg-Kjaer, Sehlin, & Johansson, 2013; Primich & Iennaco, 2012). The prevalence of adult ADHD has been found to be up to 4.4% (de Graaf *et al.*, 2008; Fayyad *et al.*, 2007; Kessler *et al.*, 2006). However, it has been suggested that we are only identifying a fraction of the adult population who have ADHD (Primich & Iennaco, 2012), especially outside the United States where the number of people who are treated for ADHD is negligible (Fayyad *et al.*, 2007).

Adler, Shaw, Sitt, Maya, and Morrill (2009) conducted a survey study of 400 primary care physicians (PCP) with results showing that 48% of PCP reported feeling uncomfortable diagnosing ADHD and 65% stated they would defer to specialists for an ADHD diagnosis compared with 3% for an anxiety (ANX) diagnosis. This highlights major issues in terms of the diagnostic process for ADHD, with comorbidity being the most frequently discussed complication (Gentile, Atiq, & Gillig, 2006; Kooij *et al.*, 2010; Solanto, Etefia, & Marks, 2004; Wadsworth & Harper, 2007; Weisler & Goodman, 2008). Comorbidity has been regarded the rule rather than the exception when it comes to adult ADHD and so an accurate evaluation of comorbid symptoms and disorders is an important aspect of the adult ADHD assessment process (Kooij *et al.*, 2010).

One of the most common co-occurring disorders for people with ADHD is ANX, with up to 47% of adults with ADHD being diagnosed with an ANX disorder (Kessler *et al.*, 2006). Both genetic and environmental factors have been thought to play a role in the comorbidity. ADHD and ANX are found to have a common genetic component with certain maternal clinical variables specifically correlated with offspring variables (Marcoen & Van den Bergh, 2004; Segenreich *et al.*, 2015). Moreover, adults with ADHD tend to experience more adversity throughout their lives due to their ADHD symptoms (e.g., poor performance at work, poor peer relationships), which is thought to contribute to their negative thoughts, negative beliefs, and overall negative mood, so that adults with ADHD often develop an anticipatory ANX and an expectation of failure (Bramham *et al.*, 2012).

There are certain symptoms that overlap between ADHD and ANX including restlessness/psychomotor agitation, concentration difficulties, decreased attention, increased distractibility, mood swings, and anger outbursts (Kooij *et al.*, 2012). Previous research has found that higher endorsements of hyperactive/impulsive items positively correlated with endorsements of ANX items on self-report symptom rating scales (Grogan & Bramham, 2014). This overlap could result in a missed diagnosis of ADHD in the context of ANX, with ADHD symptoms (e.g., restlessness) being explained by symptoms of ANX rather than ADHD, or vice versa. The implications of inaccurate or missed diagnoses for individuals can include a lack of self-confidence, poor manageability, guilt feelings related to everyday difficulties (Fleischmann & Fleischmann, 2012), inappropriate treatment choice, and disruption in social, occupational, and family domains of life (Houston *et al.*, 2011). Fleischmann and Fleischmann (2012) found that adults diagnosed with ADHD began to believe in their ability to lead more meaningful, manageable lives following an accurate diagnosis.

During a diagnostic assessment for ADHD, self-report screening measures are usually the first indicator of the presence or absence of ADHD and comorbid symptoms. After screening for the presence of symptoms, accurate diagnosis requires a multifaceted approach including gathering information on childhood history, current symptoms, and a measurement of functional impairments (Weisler & Goodman, 2008). This information is gathered by means of a clinical interview, objective collateral interview, neuropsychological testing, and computerized tests of attention and response inhibition (Haavik, Halmøy, Lundervold, & Fasmer, 2010).

The Conners Adults ADHD Rating Scale (CAARS; Conners *et al.*, 1999) is one of the most widely used self-report rating scales for ADHD, comprising of subtests that incorporate symptoms of inattention and hyperactivity/impulsivity from the Diagnostic and Statistical Manual for Mental Disorders, fourth edition revised (DSM-IV-R; APA, 2000), and is useful for screening purposes, diagnostic purposes, and tracking the progression of treatment (Baer & Blais, 2010). Taylor, Deb, and Unwin (2011) conducted a systematic review on 14 separate ADHD rating scales and concluded that for adult ADHD symptom ratings, the CAARS had the best psychometric properties. Self-report rating scales are cost-effective and time-efficient tools used to screen for the presence of symptoms of various disorders. However, self-report rating scales should be used only to complement a comprehensive diagnostic assessment (Asherson *et al.*, 2012).

Two important measures of scale validity are sensitivity and specificity, which are forms of classification (i.e., the ability of a scale to distribute new cases to groups of the same type, for example, ADHD group or non-ADHD group), whereby more valid scales have better discriminant ability in terms of differentiating clinical and non-clinical groups. More precisely, sensitivity is the ability of a scale to correctly identify true cases (ADHD present) and specificity is the ability of a scale to identify true non-cases (ADHD absent).

Many studies have found that the CAARS has good sensitivity, indicating its ability to correctly identify ADHD individuals (Conners *et al.*, 1999; Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999; Taylor *et al.*, 2011). It is not uncommon for a test with high sensitivity to have low specificity and vice versa (Lalkhen & McCluskey, 2008), as it is difficult, but possible, to achieve high levels of both. Other research has suggested that the CAARS has poor specificity and that the scale contains certain items that might be explained by other axis I disorders, such as ANX (Stewart & Liljequist, 2015). For instance, the State Trait Anxiety Inventory (STAI; Spielberger *et al.*, 1983) is a measure of current (state) and ongoing (trait) symptoms of ANX. However, there are certain items on both the STAI and the CAARS that appear to tap into similar constructs, such as 'I tend to squirm or fidget' and 'I am jittery'; 'I'm not sure of myself' and 'I lack self confidence'; 'I feel restless inside even if I am sitting still' and 'I feel nervous and restless'. Although these self-report rating scales are deemed valid for use in a wide variety of clinical populations, it may not be suitable to use these scales in combination when assessing ADHD and comorbid ANX due to overlapping symptoms. Taylor *et al.* (2011) emphasizes the importance of assessing discriminant validity of scales on other psychiatric comparison groups so that the effects of confounding variables can be reduced; however, research of this kind is limited for the CAARS.

Aims of this study

Although the CAARS has been shown to have very good psychometric properties and can accurately aid in the assessment process by correctly identifying people who have ADHD (i.e., good sensitivity), there is concern that these scales may not be able

to accurately identify people who do not have ADHD, particularly in the context of ANX disorders (i.e., poor specificity). The aim of this study was to examine the profile of responses of people with ADHD, ANX, and ADHD and comorbid anxiety (ADHD + ANX) on the CAARS and STAI so that recommendations for modified scales that take account of symptom overlap can be proposed. The first objective was to assess the ability of the CAARS and STAI to discriminate between clinical versus control samples as well as to distinguish between individuals in the clinical subgroups (ADHD, ANX, ADHD + ANX). The second objective was to use cluster analysis to assess the pattern of responses on the CAARS and STAI self-report measures in order to assess overlapping symptoms and to guide the development of a modified CAARS and modified STAI scale. The final objective was to propose changes to be made to the current versions of the CAARS and STAI for differential diagnostic use.

Method

Participants

Participants included 126 individuals over the age of 18 who were divided into a clinical sample (n = 52) and a control sample (n = 74) (see Table 1 for sample characteristics). Control participants were recruited from a university sample. Clinical participants were recruited at an adult ADHD specialist clinic and through support group websites. The clinical sample was further divided into subgroups of people with ADHD (n = 22), ANX (n = 14), and ADHD + ANX (n = 16), based on having received a formal diagnosis of each of the disorders. Participants were included in the clinical group if they received a new diagnosis of ADHD and/or ANX at the adult ADHD specialist clinic or if they had already received a diagnosis of ADHD and/or ANX previously. Participants recruited from the adult ADHD specialist clinic received a formal diagnosis of ADHD with/without comorbid ANX from a multidisciplinary team which included a consultant psychiatrist, clinical psychologist, and clinical nurse manager using the Conners Adult ADHD Diagnostic Interview for DSM-IV (Conners, Epstein, & Johnson, 2001). Participants recruited from support group websites reported having received a diagnosis of ADHD and/or ANX by means of the following question on the questionnaire: 'Do you have a formal diagnosis of any of the following disorders?' The University Office of Research Ethics granted ethical approval in March 2014. The hospital granted ethical approval in March 2015.

Table 1. Sample characteristics

Sample	*n*	Male:female	Mean age in years (*SD*)	Age range
Clinical sample	52	25:27	30.87 (9.86)	18–55
ADHD	22	14:8	30.64 (7.56)	18–44
ADHD + ANX	16	7:9	31.00 (11.38)	18–51
ANX	14	4:10	31.07 (11.81)	18–55
Control sample	74	21:53	27.64 (7.89)	18–52
Total sample	126	46:80	28.97 (8.86)	18–55

Note. ADHD = attention-deficit/hyperactivity disorder; ANX = anxiety; ADHD + ANX = ADHD + comorbid anxiety.

Measures

Conners Adult ADHD Rating Scale – long version

This version of the CAARS (Conners *et al.*, 1999) is made up of 66 items which can be divided into eight subscales: inattention/memory problems, hyperactivity/restlessness, impulsivity/emotional lability, problems with self-concept, DSM-IV inattentive symptoms, DSM-IV hyperactive/impulsive symptoms, DSM-IV ADHD total symptoms, and ADHD index. Ratings are given on a 4-point scale with responses including 'Not at all, never', 'Just a little, once in a while', 'Pretty much, often', and 'Very much, very frequently'. Conners *et al.* (1999) indicate that individuals scoring $T > 70$ on the ADHD index are likely to meet diagnostic criteria.

In a systematic literature review conducted by Taylor *et al.* (2011), the CAARS was found to have the most robust psychometric properties of 14 separate scales and the best content validity of all the adult symptoms rating scales. The CAARS has high internal consistency (.86–.92), high test–retest reliability (r = .80–.91), a diagnostic sensitivity of up to 97%, specificity of up to 83%, and overall correct classification of 85% (Conners *et al.*, 1999; Luty *et al.*, 2009; Macey, 2003). CAARS was found to have better convergent validity of DSM-IV factors in comparison with other adult ADHD rating scales (Kooij *et al.*, 2008). In a more recent study, the CAARS showed good internal consistency across all eight subscales (Cronbach's alpha = .740–.893) and for the whole scale (Cronbach's alpha = .967) within a sample of college students (Fuller-Killgore, Burlison, & Dwyer, 2013).

State Trait Anxiety Inventory – Form Y

The STAI (Spielberger *et al.*, 1983) is a 40-item questionnaire consisting of two subscales; the state subscale contains 20 items relating to current symptoms of ANX and the trait subscale contains 20 items relating to general symptoms of ANX. All items are rated using a 4-point scale with answers 'almost never', 'sometimes', 'often', and 'almost always'. The STAI-Y is a more recent version of the STAI-X with improved psychometric properties (Spielberger & Reheiser, 2009). During scale composition, the authors (Spielberger *et al.*, 1983) reported good internal consistency of both the state (.93) and trait (.90) subscales according to Cronbach's alpha, across a sample including high school and college students, working adults, and military recruits. Test–retest stability coefficients for the trait subscale ranged from .73 to .86, but were lower for the state subscale (.33), which was expected and was desirable as an accurate measure of state ANX should be influenced by situational factors occurring during testing resulting in fluctuating scores (Spielberger *et al.*, 1983). The trait subscale has good concurrent validity with other measures of trait ANX such as the Taylor Manifest Anxiety Scale and the Cattell and Scheier's Anxiety Scale Questionnaire, with coefficients of .73 and .85, respectively. More recently, Ortuño-Sierra, García-Velasco, Inchausti, Debbané, and Fonseca-Pedrero (2016) reported internal consistency of .98 and .94 and test–retest reliability of .81 and .93 for non-clinical and clinical samples, respectively, for the STAI, concluding that the scale has adequate psychometric properties.

The STAI was initially viewed as a set of unidimensional, bipolar constructs (state ANX and trait ANX). However, the STAI was constructed using 10 ANX-present and 10 ANX-absent items in each subscale in order to reduce acquiescence. More recently, a four-factor model has been produced (state ANX present, state ANX absent, trait ANX present, and trait ANX absent) (Vigneau & Cormier, 2008). The STAI has often been used to assess ANX levels in adults with ADHD, demonstrating higher levels of ANX in adults with ADHD compared to controls (Pehlivanidis, Papanikolaou, Spyropoulou, & Papadimitriou, 2014)

and higher levels of trait ANX than state ANX (Müller *et al.*, 2007). Although *T*-scores are not provided, raw scores were converted to *T*-scores based on the norms outlined by Crawford, Cayley, Lovibond, Wilson, and Hartley (2011), whereby *T*-scores >70 indicated cut-off for ANX.

Procedures

Participants were given a short description of the research and provided with an online link to the study. Participants were first asked to read the information sheet and then to provide consent, after which they were given time to complete the questionnaire. Consent was given by means of ticking a box, and data were collected only if the participant had provided informed consent. No identifying information was recorded.

Data analyses

Data were stored and statistical analyses were performed using Predictive Analytics Software version 20 (IBM Corp, 2011). Sensitivity and specificity were calculated using the following formulae:

$$\text{Sensitivity} = \frac{\text{number of true positives}}{\text{number of true positives + number of false negatives}},$$

$$\text{Specificity} = \frac{\text{number of true negatives}}{\text{number of true negatives + number of false positives}}.$$

T-tests were used to assess the differences between the CAARS and STAI subscale scores of the clinical and control samples. A one-way analysis of variance was used to assess the difference between the CAARS and STAI subscale scores for the ADHD, ADHD + ANX, and ANX subgroups. Based on the methodology used by Donnchadha *et al.* (2013), we used cluster analysis by item in order to disentangle overlapping symptoms. Lewandowski, Sperry, Cohen, and Öngür (2014) emphasize the importance of using cluster analytic approaches for cross-diagnostic samples presenting with similar difficulties. Hierarchical cluster analysis is recommended for smaller sample sizes and for cluster analysis of items rather than cases (Hair, Black, Babin, Anderson, & Tatham, 2010) and is a stable and reproducible procedure. Ward's hierarchical agglomerative method was selected for the purpose of this research, with the squared Euclidean distance used as the measure of similarity. One-way ANCOVAs were used to examine any differences between the samples and groups in terms of the cluster total scores and on the proposed modified scale scores while adjusting for age. Bonferroni's correction was used to account for multiple comparisons and corrected p values are stated beneath tables.

Results

Objective 1

The first objective was to assess the ability of the CAARS and STAI to discriminate between clinical versus control samples as well as to distinguish between individuals in the clinical subgroups (ADHD, ANX, ADHD + ANX). This objective was subdivided into two

objectives, namely 1a and 1b. Objective 1a was to assess the sensitivity and specificity of each subscale on the CAARS and STAI. Sensitivity and specificity were calculated using *T*-scores of 70 as the cut-off criteria for both scales. Objective 1b was to assess whether there are any differences in mean scores across all subscales between the clinical and control samples, as well as between the subgroups of the clinical samples.

Sensitivity and specificity of CAARS and STAI subscales

Sensitivity and specificity rates were calculated for each subscale of the CAARS and STAI for the whole sample, and specificity rates for the clinical sample were also obtained (see Table 2). The CAARS inattention/memory problems, CAARS DSM inattentive symptoms, and CAARS DSM-IV total symptoms showed better sensitivity (>70%) in comparison with other subtests (<70%). Overall, specificity rates for the whole sample were generally good (>70%) across all subscales for the CAARS and STAI. However, specificity of subscales for the clinical sample was lower than specificity of subscales for the whole sample. This suggests that both scales have poorer discriminant ability when used cross-diagnostically in comparison with clinical versus control comparisons.

Subscale score differences across the samples and subgroups

As sensitivity and specificity classify individuals based on cut-off scores ($T = 70$), we assessed whether there are any differences between mean scores across all subscales for the clinical and control samples, as well as between the subgroups of the clinical samples. *T*-tests were used to assess the differences between the CAARS and STAI subscale scores of the clinical and control samples (see Table 3). Results showed that there was a significant difference between the two groups in terms of each of the eight CAARS subscales, and for the two STAI subscales. Analysis of the means suggests that the clinical group scored higher on each CAARS and STAI subscale than the control group.

A one-way analysis of variance was used to assess the differences between the CAARS and STAI subscale scores for the ADHD, ADHD + ANX, and ANX subgroups (see Table 4). Results showed that the CAARS inattention/memory problems and CAARS DSM inattentive symptoms scores differed between the three groups. Least significant difference (LSD) *post-hoc* analysis showed that the ADHD group and the ADHD + ANX

Table 2. Sensitivity and specificity of each of the CAARS and STAI subscales

	Sensitivity (%)	Specificity (whole sample) (%)	Specificity (clinical sample) (%)
CAARS inattention/memory problems	81.58	80.68	50.00
CAARS hyperactivity/restlessness	21.05	95.45	78.57
CAARS impulsivity/emotional lability	28.95	88.64	64.29
CAARS problems with self-concept	39.47	87.50	71.43
CAARS DSM inattentive symptoms	94.74	73.86	42.86
CAARS DSM hyperactivity/impulsivity symptoms	28.95	92.05	85.71
CAARS DSM total symptoms	76.32	78.41	35.71
CAARS ADHD index	52.63	87.50	57.14
STAI state	50.00	84.38	77.27
STAI trait	66.67	86.46	63.64

Table 3. Analysis of the control sample and clinical sample in terms of CAARS and STAI subscale scores

Subscale	Control group *M* (*SD*)	Clinical group *M* (*SD*)	*t*	*p*
CAARS inattention/memory problems	11.46 (8.83)	26.40 (7.96)	9.731	.000*
CAARS hyperactivity/restlessness	11.57 (6.49)	19.50 (8.32)	6.007	.000*
CAARS impulsivity/emotional lability	9.50 (7.01)	18.00 (7.41)	6.544	.000*
CAARS problems with self-concept	6.62 (5.01)	12.81 (4.17)	7.305	.000*
CAARS DSM inattentive symptoms	7.81 (7.08)	19.63 (6.59)	9.493	.000*
CAARS DSM hyperactivity/impulsivity symptoms	7.11 (4.55)	12.77 (6.11)	5.964	.000*
CAARS DSM total symptoms	14.92 (11.11)	32.40 (10.64)	8.850	.000*
CAARS ADHD index	10.49 (6.98)	21.38 (6.54)	8.856	.000*
STAI state	38.64 (13.20)	53.67 (13.19)	6.296	.000*
STAI trait	40.70 (12.30)	58.08 (10.51)	8.279	.000*

Bonferroni-corrected p value = .005; *$p < .005$.

Table 4. The difference between the ADHD, ADHD + ANX, and ANX groups in terms of CAARS and STAI subscale scores

	Group				
Subscale	ADHD *M* (*SD*)	ADHD + ANX *M* (*SD*)	ANX *M* (*SD*)	*F*	*p*
CAARS inattention/memory problems	28.55 (5.99)	29.06 (5.01)	20.00 (10.06)	7.893	.001*
CAARS hyperactivity/restlessness	19.59 (8.86)	20.38 (8.39)	18.36 (7.80)	0.215	.807
CAARS impulsivity/emotional lability	17.00 (7.55)	20.81 (6.50)	16.36 (7.76)	1.745	.185
CAARS problems with self-concept	11.23 (4.50)	14.63 (3.05)	13.21 (4.02)	3.476	.039
CAARS DSM inattentive symptoms	20.77 (4.40)	22.69 (4.03)	14.36 (8.78)	8.425	.001*
CAARS DSM hyperactivity/ impulsivity symptoms	12.27 (6.40)	14.31 (5.57)	11.79 (6.33)	0.757	.474
CAARS DSM total symptoms	33.05 (9.08)	37.00 (7.98)	26.14 (12.99)	4.497	.016
CAARS ADHD index	20.86 (5.32)	24.44 (5.41)	18.71 (8.29)	3.240	.048
STAI state	48.63 (15.69)	58.19 (9.05)	56.43 (10.70)	3.078	.055
STAI trait	53.59 (10.21)	62.13 (8.79)	60.50 (10.75)	3.976	.025

Notes. ADHD = attention-deficit/hyperactivity disorder; ANX = anxiety; ADHD + ANX = ADHD + comorbid anxiety.
Bonferroni-corrected p value = .005, *$p < .005$.

group had significantly higher ratings for CAARS inattention/memory problems than the ANX group ($p = .001$, $p = .001$, respectively) but that there was no significant difference between the ADHD group and the ADHD + ANX group ($p = .825$). LSD analysis also showed that the ADHD group and the ADHD + ANX group had significantly higher ratings for CAARS DSM inattentive symptoms than the ANX group ($p = .002$, $p = .000$, respectively) but that there was no significant difference between the ADHD group and the ADHD + ANX group ($p = .320$). There were no significant differences between the three groups in terms of CAARS hyperactivity/restlessness, impulsivity/emotional lability, problems with self-concept, hyperactivity/impulsivity symptoms, DSM total symptoms, and ADHD index, or the STAI state or trait subscale scores.

Objective 2

Objective 2 was to use cluster analysis to assess the pattern of responses of all participants on the CAARS and STAI self-report measures in order to assess overlapping symptoms and to guide the development of a modified CAARS and modified STAI scale.

Cluster analysis was used to find clusters of STAI and CAARS items for which similar response patterns were observed (see Figure 1). Forty STAI items and 66 CAARS items were examined using cluster analysis with many cluster solutions being formed. Having more than seven clusters increases the heterogeneity between clusters which is not helpful in terms of interpretation (Hair *et al.*, 2010); therefore, we narrowed our selection to up to seven clusters only. The percentage change in heterogeneity is the stopping rule selected for the purpose of cluster solution selection. This stopping rule suggests that a large increase in the per cent of heterogeneity between one stage and the next implies a substantial increase in heterogeneity, and therefore, the cluster solution prior to this increase is the best fitting solution. The largest increase was seen between the one- and two-cluster solutions (12.46%); however, a two-cluster solution provides limited information and should be avoided (Hair *et al.*, 2010). Therefore, we will focus on a three-cluster solution because the next largest per cent increase occurs at this stage (10.49%). The increase at this point is relatively large, favouring a three-cluster solution over a two-cluster solution and suggesting a possible stopping point.

Cluster 1 contained 19 items, which related to problems with attention, forgetfulness, distractibility, or memory problems, and will be referred to as the 'inattention/memory' cluster. Six items were from the CAARS DSM inattentive symptoms subscale, 10 items were from the CAARS inattention/memory problems subscale, and three items were from the CAARS ADHD index subscale. This cluster contained no STAI items.

Cluster 2 comprised of 32 items, consisting mostly of STAI trait items, STAI state ANX-absent items, and CAARS self-concept items relating to emotional state or traits or perceptions of well-being and will be referred to as the 'emotions and well-being' cluster. Eighteen items were from the STAI trait subscale, 10 items were from the STAI state ANX-absent subscale, and four items were from the CAARS problems with self-concept subscale.

Cluster 3 consisted of 55 items, all relating to hyperactivity, impulsivity, stress, nervousness, worry, and inattention (to a lesser extent), and will be referred to as the 'hyperactivity, impulsivity, and anxiety' cluster. Twelve items were from the CAARS impulsivity/emotional lability subscale, a further 12 items were from the CAARS hyperactivity/restlessness subscale, nine items were from the CAARS DSM hyperactive/impulsive symptoms subscale, 10 items were from the STAI state ANX-present subscale, three items were from the CAARS ADHD index subscale, three items were from the CAARS DSM inattentive symptoms subscale, two items were from the CAARS inattention/memory problems subscale, two items were from the CAARS problems with self-concept subscale, and there were two STAI trait ANX items.

One-way ANOVAs were used to examine any differences between the clinical and control groups as well as the subgroups of the clinical sample in terms of the cluster total scores (see Table 5). A significant difference was found between the clinical and control groups for Cluster 1 ('inattention/memory' cluster), Cluster 2 ('emotions and well-being' cluster), and Cluster 3 ('hyperactivity, impulsivity, and anxiety' cluster). Observation of the means shows that the clinical group had significantly higher ratings on each of the three clusters compared to the control group. A significant difference was found between the subgroups of the clinical sample for Cluster 1 and Cluster 2, but not Cluster 3. LSD *post-hoc* analysis showed that the ADHD group and the ADHD + ANX group had significantly

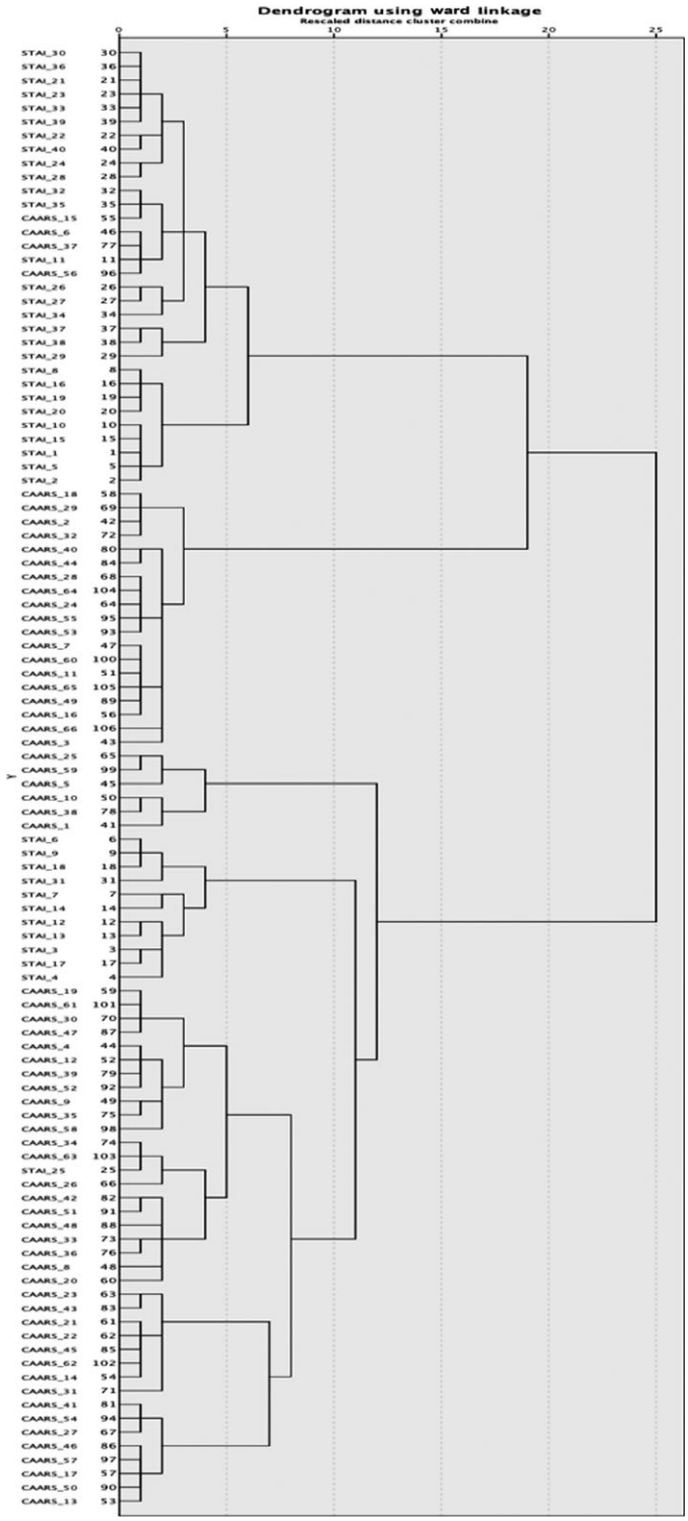

Figure 1. Dendrogram displaying cluster outcomes for the whole sample analysis.

Table 5. The difference between the clinical and control samples and the subgroups of the clinical sample in terms of cluster total scores and proposed modified CAARS and STAI scores

		Clinical				
Cluster	Control	ADHD *M* (*SD*)	ADHD + ANX *M* (*SD*)	ANX *M* (*SD*)	Statistic	*p*
Cluster 1	38.65 (15.06)	62.79 (13.05)			$t = 9.411$	.000***
		66.36 (8.87)	67.94 (6.95)	51.29 (17.00)	$F = 10.218$	.000***
Cluster 2	68.23 (20.53)	96.38 (16.80)			$t = 8.204$	.000***
		88.59 (17.83)	103.69 (11.66)	100.29 (15.85)	$F = 4.912$	.011*
Cluster 3	100.87 (27.36)	139.00 (28.21)			$t = 7.667$	.000***
		134.23 (29.16)	149.50 (24.41)	134.50 (29.41)	$F = 1.642$	.204

Notes. *$p < .05$; **$p < .01$; ***$p < .001$.

higher ratings for Cluster 1 'inattentive symptoms' than the ANX group ($p = .000$ and $p = .000$, respectively), but that there was no significant difference between the ADHD and ADHD + ANX groups ($p = .670$). LSD analysis also showed that the ADHD group had significantly lower Cluster 2 ('emotions and well-being') scores than the ADHD + ANX group ($p = .005$) and that the difference between the ADHD group and the ANX group is approaching significance ($p = .034$) (because of Bonferroni's corrections) but that there was no significant difference between the ANX group and the ADHD + ANX group ($p = .555$).

Objective 3

Objective 3 was to propose changes to be made to the current versions of the CAARS and STAI for differential diagnostic use based on cluster analysis findings. Cluster analysis showed that Cluster 1 (items relating to attention, forgetfulness, distractibility, and memory problems) and Cluster 2 (items relating to emotional state or traits or perceptions of well-being) might contain items that can successfully distinguish between the three clinical subgroups. The proposal for the modified CAARS therefore included CAARS items from Cluster 1, which was free from STAI items. The proposal for the modified STAI included STAI items from Cluster 2, and omitted CAARS items that appear to overlap.

ANCOVAs were calculated to examine the differences between groups in terms of the modified CAARS and modified STAI while controlling for age. ANCOVAs were firstly performed to assess differences in scores between the control and clinical samples. Age was significantly related to modified CAARS scores $F(1, 126) = 4.856$, $p = .029$, and there was a significant difference between the clinical ($M = 62.239$; $SD = 1.968$) and control ($M = 39.021$; $SD = 1.613$) groups after age was accounted for $F(1, 126) = 82.168$, $p = .000$, $\eta p^2 = .394$. Age was not significantly related to modified STAI scores $F(1, 126) = 2.107$, $p = .149$, and there was a significant difference between the clinical ($M = 83.073$; $SD = 2.318$) and control ($M = 59.457$; $SD = 1.900$) groups after age was accounted for $F(1, 126) = 61.297$, $p = .000$, $\eta p^2 = .327$.

ANCOVAs were then performed to assess differences in scores between the subgroups of the clinical sample. Age was not significantly related to modified CAARS scores $F(1, 48) = 1.542$, $p = .220$, and there was a significant difference between the clinical

subgroup scores after age was accounted for $F(2, 48) = 10.394$, $p = .000$, $\eta p^2 = .302$. *Post-hoc* analysis showed that the ADHD ($M = 66.409$; $SD = 2.372$) and ADHD + ANX ($M = 67.911$; $SD = 2.782$) groups had larger modified CAARS scores compared to the ANX ($M = 51.245$; $SD = 2.974$) group, but that there was no difference between the ADHD and ADHD + ANX groups ($p = .000$; $p = .000$; $p = .683$). Age was not significantly related to modified STAI scores $F(1, 48) = .716$, $p = .402$, and there was a significant difference between the clinical subgroup scores after age was accounted for $F(2, 48) = 4.427$, $p = .017$, $\eta p^2 = .156$. *Post-hoc* analysis showed that the ANX ($M = 86.894$; $SD = 3.774$) and ADHD + ANX ($M = 89.727$; $SD = 3.530$) groups had larger modified STAI scores compared to the ADHD group ($M = 76.812$; $SD = 3.011$), but that there was no difference between the ANX and ADHD + ANX groups ($p = .042$; $p = .008$; $p = .586$).

Reliability analysis of original and modified CAARS and STAI

Cronbach's alpha was used to measure the reliability of the original and modified CAARS and STAI scales. Cronbach's alpha for the 66 items of the original CAARS scale was .982 and for the 40 items of the original STAI was .974. For the 19 items of the proposed modified CAARS scale, Cronbach's alpha was .980, and for the 28 items of the proposed modified STAI, Cronbach's alpha was .970. This indicated excellent reliability for both original and modified versions of the CAARS and STAI.

Discussion

The overall aim of the present study was to examine the profile of responses of people with ADHD, ANX, and ADHD + ANX on the CAARS and STAI so that recommendations for modified scales that take account of symptom overlap can be proposed. The three objectives were (1) to assess the ability of the CAARS and STAI to discriminate between clinical versus control samples as well as to distinguish between individuals in the clinical subgroups (ADHD, ANX, ADHD + ANX); (2) to use cluster analysis to assess the pattern of responses on the CAARS and STAI self-report measures in order to assess overlapping symptoms and to guide the development of a modified CAARS and modified STAI scale; and (3) to propose changes to be made to the current versions of the CAARS and STAI for use in differential diagnosis.

Sensitivity and specificity of original CAARS and STAI

Aside from the CAARS inattention/memory problems and DSM-IV inattentive symptoms, all other subscales on the CAARS and STAI had poor sensitivity. Overall, specificity rates were generally good (>70%) across all subscales for the whole sample. However, specificity rates of subscales for the clinical sample were observably lower than specificity of subscales for the whole sample. It was found that the CAARS and STAI have poor discriminant ability among a clinical sample of individuals with ADHD, ADHD + ANX, and ANX. This indicates that symptom overlap results in an inflation of symptoms on both scales for all clinical subgroups. This concern has been expressed previously in the literature (Stewart & Liljequist, 2015; Taylor *et al.*, 2011). Although previous experts in the area (i.e., Houston *et al.*, 2011) have proposed new screening tools that take account of symptom overlap of certain axis I disorders, this has yet to take place in the context of ADHD and ANX symptoms specifically.

Usage of scales in clinical samples

Further analysis of symptoms aimed to assess differences between groups of participants without using the stringent cut-off ($T > 70$) for criteria. It was found that the clinical group scored higher on the CAARS and STAI than the control samples, but there were no differences on the two scales when comparing the subgroups of the clinical sample. The only exceptions were the CAARS inattention/memory and DSM inattentive symptoms subscales. Stewart and Liljequist (2015) also found that the inattentive symptoms were best able to distinguish between an ADHD versus non-ADHD clinical group, which is consistent with inattention being the hallmark of adult ADHD (Barkley, 1990). This is also supported by our finding that the inattentive symptoms are most sensitive in identifying ADHD participants.

Overlapping symptoms identified by cluster analysis

Cluster analysis demonstrated three distinct findings that were confirmed using parametric analysis. Firstly, it was apparent that the majority of inattentive items remain dissimilar to any of the ANX items, suggesting that there is no overlap between inattentive symptoms and ANX symptoms. Secondly, there appears to be a similarity between all STAI items (except STAI state ANX-present items) and CAARS self-concept items. This finding suggests that the formation of a modified STAI scale for use with people with ADHD should not include STAI state ANX-present items. Furthermore, caution should be made in interpreting scores for adults with ADHD who have high scores on the CAARS self-concept subscale, as these individuals might also endorse high STAI trait and STAI state ANX-absent items. Thirdly, the majority of CAARS items relating to hyperactivity, impulsivity, restlessness, and emotional lability are similar to the STAI state (ANX present) items, suggesting that a distinct overlap occurs for these symptom types. These items are therefore unable to distinguish individuals with ADHD from individuals with ANX as both samples endorse items similarly. This suggests that these items should not be used to make decisions on differential diagnosis in the context of ADHD and ANX.

Proposal for modified CAARS and STAI scales

Based on cluster analysis findings, we propose that a modified version of the CAARS for use in the context of symptoms of ANX would include inattentive symptoms only, such as those inattentive items found in Cluster 1. This proposal was supported by the finding that there were significant differences between individuals with ADHD ($\pm$ ANX) and those with ANX alone on the modified CAARS. Many hyperactive and impulsive items as well as self-concept items overlap with ANX items – a finding supported by the literature (Grogan & Bramham, 2014; Kooij *et al*., 2008) – and so we advise that they be omitted from the modified CAARS as they will likely result in a false elevation of ADHD symptoms in the context of ANX, or vice versa. We propose that a modified version of the STAI exclude state ANX-present items, as these specific STAI items appear to be endorsed similarly to CAARS items and might lead to over-reporting of ANX symptoms for some ADHD individuals. This proposal was also supported by the finding that there were significant differences between individuals with ANX ($\pm$ ADHD) and those with ADHD alone on the modified STAI. However, we also caution the use of this modified scale in the context of ADHD individuals who have high self-concept ratings on the CAARS as there appears to be a relationship between these items.

However, we acknowledge that there are certain limitations in the present research design. A larger sample size for the clinical subgroups would be desirable for more robust findings. Furthermore, participants were divided into clinical subgroups based on previous clinical diagnoses. It would be preferable to use more rigorous examination, such as a structured clinical interview for DSM-V in order to confirm these diagnoses. From the analysis point of view, examining alternative clustering methods (e.g., two-step clustering) may also provide further insights. Future research without these limitations is needed to provide further support for the modified CAARS and STAI scales proposed.

Implications of findings and conclusions

The CAARS and STAI appear effective in distinguishing between clinical and control samples; however, clinicians cannot presume the absence of comorbid disorders when using self-report screening measures. For this reason, clinicians should be wary of using the CAARS or STAI in the context of suspected comorbid symptoms, as some items may be falsely elevated due to symptom overlap. Furthermore, it is advisable that an alternative approach be taken when screening adults for ADHD in the presence or suspected presence of ANX. In this context, a modified version of the CAARS that includes only inattentive symptoms has been proposed to be best able to distinguish between the two disorders. Similarly, the use of the STAI in the context of ADHD should be modified so that state ANX-present items are omitted as they overlap with many CAARS items. As the number of adults seeking an ADHD assessment and the rates of ADHD diagnoses are increasing, it is pertinent to assess and utilize accurate measures during the diagnostic process.

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