

Co-occurrence of ASD and ADHD traits in the general population

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Introduction

Attention-deficit hyperactivity disorder (ADHD) is a behavioural disorder defined by either an attentional dysfunction, hyperactive/impulsive behaviour or both (DSM-V; American Psychiatric Association, 2013). ADHD is the most common neurodevelopmental disorder (Barkley, 1997) and in roughly half of the children diagnosed with ADHD, symptoms persist into adulthood (Faraone et al., 2010). Therefore, ADHD has also been validated as an adulthood disorder (Faraone & Biederman, 2005), with remaining symptoms in adults including distractibility and difficulties with maintaining goal-directed behaviour rather than hyperactivity. Comorbidity is very commonly reported in ADHD. More specifically, as many as 87% of children diagnosed with ADHD have one other disorder and 67% may have at least two other comorbid disorders (Kadesjö & Gillberg, 2001).

Autism Spectrum Disorder (ASD) is a developmental disorder that severely affects a child's development in three main areas: language ability, social interaction and stereotyped or repetitive behaviours (American Psychiatric Association, 2000; American Psychiatric Association, 2013).

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Recent studies indicate that co-occurrence of ADHD and autistic symptoms is common (Reiersen & Todd, 2008; Simonoff, Pickles, Charman, Chandler, Loucas, & Baird, 2008; Leyfer, Folstein, Bacalman, Davis, Dinh, Morgan, Tager-Flusberg, & Lainhart, 2006). DSM-IV prohibited the co-diagnosis of ADHD and autism spectrum disorder (ASD). After the publication of DSM5 the diagnoses of autistic disorder and ADHD are no longer mutually exclusive. This provides the basis of more differentiated studies on overlap and distinction between both disorders. The rates of co-occurrence between autism and ADHD are within the range of 14–78% (Leyfer et al., 2006; Sinzig, Walter, & Doepfner, 2009; Gargaro et al., 2011). ADHD has also been shown to be the second most common comorbid disorder in individuals diagnosed with an ASD (Simonoff et al., 2008).

Previous studies have found that autism is separate and distinct from ADHD but the core symptoms of attention deficit, impulsivity, and hyperactivity are often part of the autism phenotype (Mayes, Calhoun, Mayes, & Molitoris, 2012). Furthermore, ASD and ADHD share many similar impairments in developmental and cognitive domains (e.g. executive functions, pragmatic language difficulties) (Leitner, 2007). Evidence from neuropsychological studies also suggests common structural brain abnormalities that are shared in those with ASD and ADHD (Brieber et al., 2007). ASD as well as ADHD are both highly heritable neurodevelopmental disorders, and genetic factors account for 70–80 % of the phenotypic variance of each disorder (Faraone et al., 2006; Freitag et al., 2010). Family based studies also indicate familiarity of the co-occurrence of ASD and ADHD symptoms (Mulligan et al., 2009). According to twin studies, about 50–70 % of the covariance of ASD and ADHD symptoms can be explained by shared additive genetic factors (Rommelse et al. 2010; 2011).

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There is a great body of evidence that subclinical autistic traits are common in the general population (Austin, 2005) and, indeed, that they are continuously distributed (Constantino & Todd, 2003). Although clinical diagnoses are defined categorically, ADHD psychopathology can also be viewed dimensionally, with inattentive and hyperactive-impulsive symptoms distributed continuously in the general population (Rodriguez et al., 2007). Evidence at the level of molecular genetics also provides support for the hypothesis that ADHD represents the extreme end of traits present in the general population (Martin et al., 2014; Larsson et al., 2012; Levy et al., 1994). An arbitrary cut off point determines who is considered to be within the various categories and who is not. Many people without a diagnosis might have a number of ADHD-like symptoms but the severity and frequency of those behavioural symptoms is less severe than in those deemed to qualify for a diagnosis.

The dimensionality of ASD has been long established. Evidence that relatives of those with ASD often exhibit characteristics of autism to a lesser degree (Constantino et al., 2006) has prompted the concept of a ‘broader phenotype’ of autism. Typically, this term is used to describe a person who exhibits subclinical traits of autism. Studies on the general population and individuals with ASD traits have found no qualitative differences in the symptoms and behaviours of healthy individuals and those with a diagnosis (Constantino, 2011). Furthermore, there is evidence that these characteristics are not only prevalent in the general population (Constantino & Todd, 2003), but that they are continuously distributed (Hoekstra, Bartels, Verweij, & Boomsma, 2007). The dimensionality of ASD has given rise to the creation of a number of questionnaires developed to assess the level of “autistic traits” that a person may possess. These include the Broader Autism Phenotype Questionnaire (BAPQ; (Hurley, Losh, Parlier, Reznick, & Piven, 2007) and the Autism Spectrum Quotient (AQ; Baron-Cohen,

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Wheelwright, Skinner, Martin, & Clubley, 2001). These scales have been used to reliably discriminate between individuals with a diagnosis of ASD and typically developing individuals (e.g. Baron-Cohen et al., 2001). A similar approach has been more recently adopted by ADHD researchers (e.g. Caci et al., 2009; Panagiotidi, Overton, & Stafford, 2016;2017).

No study so far, however, has looked at co-occurrence of ADHD and ASD traits in a non-clinical adult population. In addition to this, in this study we examined co-occurrence of ADHD and ASD symptomatology utilising measures with subscales that allowed us to examine symptoms of inattention and impulsivity separately, as well as different core autistic symptoms. Multiple measures of the symptom domains of ADHD, and autism were employed in order to compensate for potential problematic self-reflection in individuals with high autistic traits (Anholt et al., 2010). The findings from our research will provide useful information about the nature of both disorders and will provide support for the spectrum hypothesis of developmental disorders.

Method

Participants

334 English-speaking participants were recruited via the Sheffield volunteers list. Members of the list were invited to participate by email. The research was approved by the Department of Psychology's Research Ethics Committee. Potential participants were provided with a short paragraph describing the study and a hyperlink taking them to the study website (Qualtrics). All the questionnaires used in the survey were initially designed as "pen-and-paper". Our experiment was carried out online. However, this approach was not highly likely to affect the results, since evidence suggests that there is little variation in responses when pen-and-paper

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questionnaires are administered online (Van De Looij-Jansen et al., 2008; Mangunkusumo et al., 2005).

Since the questionnaires we used have been previously found to misclassify individuals with other disorders as having ADHD or ASD (McCann et al., 2000; Roy-Byrne et al., 1997; Stein et al., 1995; Hill et al., 2009), only data from participants who had not been previously diagnosed with ADHD, ASD, dyslexia, or other mental disorders were used in the analysis. As a result, 58 participants were excluded.

The majority of the participants (74.3%, 205) were female and the mean age was 34 (SD= 13.6, range = 19 - 98). The majority of the sample (76.1%) were British citizens. 45.3% of the participants had completed a postgraduate, 26.8% had an undergraduate degree, and the rest did not attend higher education.

Measures

Four scales were used to measure ADHD and ASD traits. All scales were used in previous studies to estimate the prevalence and correlates of adult ADHD in population surveys (Kessler et al., 2005; Adler et al., 2006; Roy-Byrne et al., 1997) and autistic traits in healthy and clinical populations (Sasson et al., 2013; Woodbury-Smith et al., 2005).

Adult ADHD Self-Report Scale (ASRS-v1.1)

The ASRS is an instrument consisting of the 18 DSM-IV-TR criteria and was developed in conjunction with the World Health Organization (WHO), and the Workgroup on Adult ADHD. The scores obtained through the ASRS have been found to be predictive of symptoms consistent with ADHD (Adler et al., 2006).

The ASRS was developed by Adler et al. (2003) and Kessler et al. (2005) and contains eighteen items from DSM-IV-TR (American Psychiatric Association, 2000) but measures the

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frequencies of the symptoms. Participants answer how often the ADHD symptoms occur (0 =never, 1 =rarely, 2=sometimes, 3 =often, 4 =very often). The ASRS has a two factorial structure (Reuter et al., 2006) which includes an inattention scale and a hyperactivity/impulsivity scale. The ASRS examines only current adult symptoms of ADHD. The reliabilities (Cronbach's alpha) for the two subscales of inattention (.75) and impulsivity (.77) as well as for the total ASRS (.82) are satisfactory (Reuter, Kirsch, & Hennig, 2006).

Wender Utah Rating Scale (WURS-25)

The short version of the Wender Utah Rating Scale, WURS-25, is a 25-item self-report questionnaire for the retrospective assessment of childhood ADHD symptoms; high scores indicate greater symptoms. It is based on the 61 item WURS developed by Ward et al. (1993) but only includes the items that measure ADHD symptoms. The 25 items in the WURS describe ADHD behaviours and symptoms (for example "Concentration problems, easily distracted"), which are rated on a 5-point scale, ranging from 0 ("not at all or very slightly") to 4 ("very much"). Possible total scores range from 0 to 100. It comprises of five subscales; Conduct Problems, Impulsivity Problems, Mood Difficulties, Inattention/Anxiety, Academic Concerns. A cut-off score of 46 was proposed to detect adult with ADHD (Philipsen et al., 2008; Fossati et al., 2002). Data suggest that when WURS can correctly identify 86% of the patients with ADHD and 99% of the normal subjects (Ward, 1993). The WURS-25 has been found sensitive in detecting ADHD (McCann, Scheele, Ward, & Roy-Byrne, 2000; Ward et al., 1993), and has high internal consistency (Wierzbicki, 2005).

Autism spectrum quotient (AQ)

The AQ is a 50-item questionnaire designed to measure characteristics of autism in the general population. The AQ contains 5 subscales assessing different areas that are affected in

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people with ASD; social skills, attention switching, attention to detail, communication, and imagination. All items are rated on a 4-point scale: “definitely agree”, “slightly agree”, “slightly disagree”, and “definitely disagree.” High scores indicate characteristics more similar to ASD. Baron-Cohen et al. (2001) scored the measure in a binary manner (one for response in direction of autism characteristics, zero for response in opposite direction), producing total scores ranging from zero to 50. Results from the AQ have been replicated across cultures (Hoekstra, Bartels, Cath, & Boomsma, 2008; Wakabayashi, Baron-Cohen, Wheelwright, & Tojo, 2006).

The AQ demonstrates acceptable test–retest reliability ($r = .78$) (Hoekstra et al., 2008).

Broad autism phenotype questionnaire (BAPQ)

The broad autism phenotype (BAP) refers to a set of personality and language characteristics that reflect the phenotypic expression of the genetic liability to autism, in non-autistic individuals. Unlike other self-report measures of autism symptomatology like the Autism Quotient (AQ), the BAPQ was specifically designed to assess BAP traits in unaffected individuals and is validated against direct clinical assessments of the BAP.

The BAPQ is a questionnaire that has been shown to be very effective in capturing qualitatively similar but milder traits of autism (Hurley et al., 2007). It contains 36 items and is split into 3 subscales; Aloof Personality, Rigid Behaviours, and Pragmatic Language. These three components parallel the social deficits, stereotyped-repetitive behaviors and social language deficits that define the syndrome of autism (American Psychiatric Association, 2000). The BAPQ has high sensitivity and specificity for detecting the BAP ($>70\%$) (Hurley et al., 2007). All subscales and total scores of the BAPQ have moderate-to-high reliabilities (over .80) (Sasson et al., 2013).

Demographics questionnaire

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Demographics were collected for each participant regarding their age, gender, and education. In addition to this, participants were asked to disclose whether they were diagnosed with any mental disorder or neurodevelopmental disorder.

Results

Questionnaire Characteristics

Internal consistency (Cronbach's alpha) of the total ASRS scale was .83. This is consistent with previous studies (.82, Reuter et al., 2005; .88, Adler et al., 2006). The reliabilities for the two subscales inattention (.77) and hyperactivity (.74) were also satisfactory.

The WURS-25 reliability was high (.91). We used 5 subscales as previous studies (Caci et al., 2010). The internal consistency was high for conduct problems (.87), impulsivity problems (.82), mood difficulties (.74), inattention/anxiety (.72), academic concerns (.65).

Internal consistency (Cronbach's alpha) of the total AQ scale was .85. Overall AQ scale, as well as the social skill (.81), attention to detail (.58), attention switching (.59), communication (.65), imagination (.58) subscales had values similar to those reported previously (Austin, 2005; Baron-Cohen et al., 2001; Jobe & White, 2007),

The BAPQ reliability was high (.92). Aloof subscale (.85), pragmatic language (.83), rigid (.89). Similar values to the ones reported in original paper (Cronbach's a coefficient was .94 for the aloof subscale, .91 for the rigid subscale, .85 for the pragmatic language subscale and .95 across all 36 items; Hurley et al., 1997).

Descriptive Statistics

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Statistical analysis was performed using IBM Statistical Package for Social Sciences (IBM SPSS, version 20.0). Tests of normality (Kolmogorov–Smirnov test; KS) suggested that the data were normally distributed ($p > .20$).

Analysis revealed that there were no significant gender differences when looking at: ASRS ($t(270) = -.099, p = .92$); AQ ($t(270) = .59, p = .56$); WURS ($t(270) = 1.25, p = .21$); and BAPQ scores ($t(270) = 1.27, p = .2$).

We estimated the prevalence of ADHD by using the ASRS cut-off points for both parts of the scale as recommended by its authors (Kessler et al., 2005). 7.2% of respondents ($n = 20$) were classified as highly likely to have ADHD, an additional 13% ($n = 36$) were classified as probably having ADHD, and an additional 79.7% ($n = 220$) were classified as unlikely to have ADHD.

4.3% of the participants had a score over 32 on the AQ, which was the score reported by Baron-Cohen et al (2001)'s original paper at which 80% of those with autism score. Only 1% of the participants ($N = 3$) had scores over both the ASRS and the AQ cut-off points and could potentially qualify for both diagnoses.

Relationship between ASRS and WURS-25

A moderate correlation was found between the ASRS and all the WURS subscales ($r(276) = .585, p < .01$). Higher ASRS scores were associated with more childhood ADHD symptoms as assessed on the WURS. The WURS was also significantly correlated with the inattention ($r(276) = .551, p < .01$) and the hyperactivity ($r(276) = .444, p < .01$) subscales of the ASRS (Table 1).

Relationship between AQ and the BAPQ

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A strong correlation was found between the AQ and the BAPQ overall scores, $r(276) = .79, p < .01$.

Overall AQ scores were moderately to strongly associated with BAPQ subscale scores ($r > .6$). Total BAPQ scores were also correlated with AQ subscale scores (Table 1).

Relationship between autistic and ADHD traits

The relationship between the total ADHD traits and the ASD traits was examined. Pearson's correlation coefficients between total scores on the ASRS, the WURS, the AQ, and BAPQ and between their subscales are summarized in Table 1.

Overall, ADHD traits were associated with ASD-like symptoms. In particular total ASRS scores were associated with the Imagination and the Communication subscales of the AQ. Furthermore, higher overall ADHD traits were related to BAPQ scores and two of its subscales; Pragmatic Language and Rigid Behaviours.

Inattention traits were associated with AQ total scores as well as Attention Switching scores. Higher inattention on the ASRS was also associated with the Aloof subscale of the BAPQ. Hyperactivity scores were correlated with the communication related subscales of the AQ and the BAPQ; Communication and Pragmatic Language respectively.

Additionally, there were significant positive correlations between all of the subscales of WURS combined and the total BAPQ and AQ score.

A multiple regression was conducted to see if self-reported ASD traits predicted the total value of current ADHD symptoms (ASRS scores). More specifically the AQ and BAPQ subscales, which significantly correlated with ASRS scores, were added as predictors. The results of the regression showed that three of the predictors (Pragmatic Language, Social Skills,

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and Communication subscale scores) could explain 23% of the variance in ASRS scores ($F(3, 272) = 27.1, p < .01, R^2 = .23, R^2_{\text{Adjusted}} = .22$). No other traits made significant contributions.

Discussion

This study, to our knowledge, is the first to investigate the co-occurrence of ADHD and autistic traits in an adult non-referred sample. Comorbidity rates between autism and ADHD have been found to be high in clinical samples. This study investigated whether high ADHD traits co-occur with autistic traits in the general population. Results showed that there is an overlap between ADHD and autistic traits. This relationship was mostly found in attention and communication skills symptoms.

Our findings are similar to those found in studies of children and adolescent populations (Taylor et al., 2005). Subtype differences were identified with inattentive ADHD symptoms showing the strongest associations with ASD symptoms, in particular with attention switching, aloofness, and rigidity.

The only subscale from the AQ not correlated with ADHD symptoms was the attention to detail subscale. Previous factor analysis on the AQ by Hoekstra et al. (2008) and Wakabayashi et al. (2006) suggests that the attention to detail subscale is slightly different from the other four AQ subscales. Specifically, the attention to detail factor is the only one not correlated with the other domains of the AQ. This finding is consistent with previous research in clinical populations showing that tendency to focus on detail might be specific to autism (Booth, Charlton, Hughes, & Happé, 2003).

Difficulty with communication is one of the core criteria for autism spectrum disorders (American Psychiatric Association, 2000). Early studies investigated the language abilities of first-degree relatives of those with autism, finding evidence that parents (Folstein et al., 1999)

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and twin siblings (Le Couteur et al., 1996) both experienced language difficulties. This suggests that communication issues are part of the ASD phenotype. Communication is also impaired in children and adults with ADHD. Previous studies have found that pragmatic language skills are impaired in many children with ADHD (Staikova et al., 2013; Kim & Kaiser, 2000; Camarata & Gibson, 1999).

Taylor and colleagues (2015) used a twin design to examine whether specific dimensional autistic traits would display differential degrees of aetiological overlap with specific traits of ADHD. They found the strongest genetic associations between communication difficulties characteristic of ASD and traits of ADHD. In particular, in pragmatic aspects of communication. This is similar to our findings. The strongest relationship between current and retrospective ADHD traits and autistic traits was found between the ASRS and the pragmatic language subscale of the BAPQ ($r=.39$ and $r=.5$ respectively). These findings are in line with the fractionable autism triad hypothesis (Happé, Ronald, & Plomin, 2006), according to which the core symptoms of ASD (social impairment, communication difficulties, and rigid and repetitive behaviours) are associated with different causal influences.

A study by Anholt and colleagues (2010) looked at ADHD and ASD traits in individuals with OCD. Moderate positive correlations were identified between the AQ attention switching subscale and inattention ADHD symptoms, as well as the social skill subscale of the AQ and all the ADHD measures. The same relationship was found in our study, which employed two measures of autistic and ADHD symptoms.

The relationship between the inattention subscale of the ASRS, the inattention subscale from WURS, and the attention switching subscale of the AQ was particularly interesting. It might appear that AQ attention switching and ADHD inattention scales measure opposite traits;

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inattention in ADHD refers to difficulty in sustaining attention (more related to distractibility), whereas attention switching problems refer to difficulties in diverting attention between tasks (hyperfocus). Even though it appears contradictory, ADHD patients report both types of symptoms (Oades & Christiansen, 2008). Since this is a study on undiagnosed, healthy population, these findings could inform attention research suggesting these two extreme manifestations of attention deficits could be controlled by the same mechanism.

ADHD traits had stronger correlations with childhood symptoms of ADHD as measured by the WURS. This could suggest that even in the undiagnosed population ADHD traits tend to subside with age. A longitudinal study could examine the relationship between ADHD and ASD traits across lifespan.

A moderate relationship was found between ASRS and WURS measures. This finding is consistent with previous studies (Caci et al., 2010). A number of explanations could be offered for this. The WURS is based on memory recall of childhood symptoms related to ADHD. Childhood symptoms could have subsided in adulthood. Alternatively, this discrepancy could be a result of the fact that it is based on retrospective assessment of symptoms, which can be affected by faulty recollection (Caci et al., 2010).

Stronger correlations were reported between ADHD symptoms and the BAPQ. This could be due to the nature of the scale; the BAPQ has been found more suitable to measure ASD traits in subclinical populations (Ingersoll, Hopwood, Wainer, & Donnellan, 2011).

Both ADHD and ASD in childhood are more commonly diagnosed in males. Unlike studies of childhood ADHD, which report a greater prevalence of ADHD in males, gender ratios tend to be equal in studies of adult ADHD (Faraone et al., 2006; Fredriksen et al., 2014). This is not usually the case with autistic traits. Previous studies in healthy populations have also showed

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that autistic traits are more common in males (Baron-Cohen et al., 2001). The lack of gender differences in the AQ could be due to the small number of males that completed the study.

Limitations

Our study suffers from a number of limitations. Since the study was conducted online, we were unable to assess IQ. Previous studies have found that there is a negative correlation between autistic traits and IQ ($r = -.27$) (Hoekstra, Happé, Baron-Cohen & Ronald, 2010). Similarly, IQ can potentially affect ASRS scores (Gray et al., 2014). However, we attempted to estimate the potential effect of intelligence by using information about the participants' education level, which can be used to estimate IQ (Rammstedt, & Rammsayer, 2002). No effect of education was found on ADHD and ASD scores.

The unequal distribution of male and female participant is another limitation of our study. This is common in studies recruiting opportunity samples, as women are more likely to take part (Curtin, Presser, & Singer, 2000). Future studies could recruit an equal number of participants from each gender.

Another possible limitation of the present study relates to its reliance on self-report measures to assess personality traits in participants. The response bias could partly account for the high levels of co-occurrence of ADHD and ASD traits. One could argue that individuals who report abnormal behaviour on one measure are more likely to report difficulties on other measures. As a result, future studies should include behavioural measures as well as self-reports.

Conclusion

In this study we report the findings of a study measuring co-occurrence of ADHD and ASD traits on the general population. Both childhood and current ADHD traits were associated with autistic symptoms. Weak to moderate correlations were found between ADHD and ASD

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traits in a number of areas, including social skills, communication, and attention. Our results seem to mirror findings from previous studies on clinical populations, further supporting the dimensionality of ADHD and ASD, and suggesting that these disorders might share substantial aetiology.

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