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Misdiagnosis of ADHD/ASD in gifted children

Leigh Jamison Rundkvist

Supervisor: Christina Regenbogen, Department of clinical neuroscience
Examiner: Knut Sturidsson, Department of clinical neuroscience

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Abstract

Gifted children in Sweden are largely an unidentified group in spite of their needs for special adaptations in the home and at school to thrive. Without these adaptations, gifted children can develop behavioral and social difficulties. Some personality characteristics common in gifted children can also mimic symptoms of neurodevelopmental disorders. This review investigates the literature on diagnostic procedures and outcomes for gifted children. Nineteen studies and review articles about the diagnosis, performance and outcomes of gifted children with and without Asperger's, ADHD and autism were surveyed. Results showed clinically significant differences between gifted children with and without a diagnosis on a variety of outcomes. Gifted children without a diagnosis performed generally better on cognitive measures, had fewer social and behavioral problems and higher functional levels than gifted children with a diagnosis. Giftedness could also mask certain areas of dysfunction, increasing the risk of missing a diagnosis. Unexpected findings were that gifted children without a diagnosis could have more social difficulties than children with average IQ and that gifted children with ADHD could have more difficulties than average IQ children with ADHD. Clinicians working with gifted children are encouraged to screen for adaptations in the home or in school early in the assessment process to ensure that lack of necessary environmental adjustments are not the primary cause of the child's behavioral and social difficulties.

Keywords: ADHD, ASD, gifted children, misdiagnosis

Sammanfattning

Särskilt begåvade (högbegåvade) barn utgör en tämligen okänd grupp i Sverige trots deras behov av speciella anpassningar i skola och hemmiljö. Utan dessa anpassningar kan särskilt begåvade barn utveckla beteende- och sociala problem. Vissa vanliga personlighetsdrag hos särskilt begåvade barn kan också likna symptom vid neuropsykiatriska diagnoser. Denna översiktsartikel studerar litteraturen kring diagnostik och utfall för särskilt begåvade barn. Nitton studier och översiktsartiklar om diagnostiken, prestationerna och utfall hos särskilt begåvade barn med och utan diagnoserna ADHD, autismspektrumstörning och Aspergers syndrom inkluderades. Resultaten visar på kliniskt signifikanta skillnader mellan särskilt begåvade barn med och utan diagnoser på flera utfall. Särskilt begåvade barn utan diagnoser presterade generellt sett bättre på kognitiva mått, hade färre beteende- och sociala problem och högre funktionsnivåer än särskilt begåvade barn med en neuropsykiatrisk diagnos. Den höga begåvningen kunde också maskera en del funktionsnedsättningar vilket ökade risken för att missa diagnoser. Oväntade fynd var att särskilt begåvade barn kunde ha fler sociala problem än normalbegåvade barn och att särskilt begåvade barn med ADHD kunde ha större problem än normalbegåvade barn med ADHD. Kliniker som arbetar med särskilt begåvade barn uppmuntras att screena för anpassningar i hemmet och skolan tidigt under utredningsprocessen för att utesluta att brister i barnets livsmiljö är huvudorsaken till barnets beteende- och sociala problem.

Nyckelord: ADHD, Aspergers, autism, feldiagnostik, särbegåvade barn

Misdiagnosis of ADHD/ASD in gifted children

Leigh Jamison Rundkvist

Intellectual giftedness is recognized in children all around the world, at each level of society. There exists no consensus on the exact definition of what constitutes intellectual giftedness or high intelligence in the fields of intelligence research or psychiatry (Gere, Capps, Mitchell & Grubbs, 2009; Jellinek, Henderson & Pfeiffer, 2009; Martin, Burns & Schonlau, 2010.). Nor exists any consensus on which cutoff levels are valid definitions of giftedness within the various definitions and models (Gere et al., 2009; Jellinek et al., 2009; Robinson & Olszewski-Kubilius, 1996). Whereas mental retardation is a clinical diagnosis and defined in detail in the DSM-IV TR manual, there are no clear-cut definitions or diagnostic criteria for individuals whose abilities lie at the opposite end of the intelligence spectrum (American Psychiatric Association, 2000; Silverman, 1998). Since giftedness or high intelligence is not a clinical diagnosis, the definitions, cutoffs and inclusion criteria must be defined anew for each study in the field (Martin et al., 2010). Similarly, in the field of gifted education, schools all around the world vary in their admission criteria. And in the field of psychometrics, different test constructors use varying scales and cutoff levels of intelligence.

The lack of a common theoretical framework and nomenclature has not prevented educators in many countries around the world from recognizing the need for special educational interventions for gifted children. In 1972, the US Congress released the Marland Report, which stipulated national guidelines for the identification and education of gifted children (U.S. Commissioner of Education, 1972). In this report, gifted children were identified as a special needs population and this sparked a large number of educational programs for gifted children across the nation. In Sweden, there has not been any specific focus on a national level on the special needs of gifted children in school until May 2015, when the Swedish National Agency for Education (Skolverket) released introductory guidelines and didactic suggestions for teaching gifted children (in Swedish, “särskilt begåvade elever”) (Persson, 2010; Swedish National Agency of Education, 2015). In this material, the cutoff level of giftedness is defined as above the 95th percentile. In intelligence levels this roughly corresponds to an IQ of 124+.

For decades, the main focus of special education interventions in Sweden has been on children with learning disabilities, psychological disorders and low achievement in the classroom (Persson, 2010). Gifted children have been largely ignored or misunderstood and left to their own devices in Swedish classrooms as admission to gifted education based on identification of high intellectual or theoretical ability has been prohibited in Swedish schools until 2014, when several national top programs in several theoretical subjects opened for seventh-graders (Skolverket, 2015b). The lack of recognition of gifted students and necessary adaptations of the school environment have been shown to cause problem behaviors such as social problems (Persson, 2010), attention deficits (Amend & Beljan, 2009; Nelson, Rinn & Hartnett; 2006 Robinson & Olszewski-Kubilius, 1996), academic underachievement (Persson, 2010; Robinson & Olszewski-Kubilius, 1996) , oppositional behavior (Nelson et. al, 2006; Robinson & Olszewski-Kubilius, 1996), hyperactivity and depression (Amend & Beljan, 2009; Robinson & Olszewski-Kubilius, 1996) - behaviors that can easily be mistaken for common symptoms of neurodevelopmental and psychological disorders.

Research also shows that high intelligence can correlate with qualitative differences in behavior and cognitive function compared to normal children, such as singular interests and unusual behaviors (Beljan et al., 2006; Gere et al., 2009; Goerss, Amend, Webb, Webb & Beljan, 2006; Nelson & Hartnett, 2006). Theories about asynchronous development in gifted children indicate that different cognitive and emotional functions mature at differing rates compared with average children (Baum & Olenchak, 2002; Robinson & Olszewski-Kubilius, 1996; Silverman, 1998). Other research on gifted children focuses on specific personality characteristics, so-called overexcitabilities, which are considered to be much more prevalent in this group (Alias, A., Rahman, S., Majid, R. A., & Yassin, S. F. M., 2013; Baum & Olenchak, 2002; Gere et al., 2009; Robinson et al. 1996). Some of these characteristics can mimic the diagnostic criteria of neurodevelopmental disorders (Alias, Rahman, Majid & Yassin, 2013; Beljan et al., 2006; Goerss et al., 2006; Nelson et al., 2006; Robinson & Olszewski-Kubilius, 1996; Silverman, 1998).

Whereas some gifted children demonstrate problem behaviors due to poorly adapted environments or characteristics related to being gifted, there are also gifted children with true disabilities and other disorders, the so-called “twice-exceptional” children (Budding & Chidekel, 2012; McCoach et al., 2001). The literature on twice-exceptionality indicates that a problem of

underdiagnosis in some cases can be caused by the giftedness masking the disability or disorder through an increased ability to compensate for dysfunction. In other cases, the disability or disorder can mask the giftedness by lowering a potentially high performance of a child to an average level (McCoach et al., 2001). Together these circumstances create a complex diagnostic challenge for any clinician assessing a gifted child for learning disabilities or neurodevelopmental disorders.

In Sweden, there are only three university-level classes covering the characteristics of giftedness in children and their special needs, all for teachers. Two are elective Master-level courses on how to adapt the classroom environment for gifted children, given at the Department of Special Education at Stockholm University, and one is a course for schoolteachers in Mathematical didactics at Linnéuniversitetet (Stockholms Universitet, 2015a; Stockholms Universitet, 2015b; Linnéuniversitet, 2015). This creates a general lack of awareness among Swedish healthcare and school professionals who deal with children on a daily basis, which increases the risk for misunderstandings and misinterpretations of gifted behaviors in children (Persson, 2010). This lack of information is further compounded by the fact that many research populations in other countries are recruited in gifted schools, which indicates that both the home and school environments have largely been supportive for the individual child. This may limit the generalizability of the results to the population of Swedish gifted children, who may largely go unrecognized and unsupported, both in their home and in their school environments (Persson, 2010).

In recent years, however, there has been a small but growing interest in the plight of gifted children in Swedish schools. A few municipalities have collaborated to develop educational materials on how to support students gifted in the area of mathematics (Sveriges Kommuner och Landsting, 2014). The guidelines for school psychologists from the National Board of Health and Welfare (Socialstyrelsen) state that:

> "It should also be noted that even very high results on Wechsler Intelligence Scale for Children (WISC) can indicate that adaptations need to be made. Gifted children can aim their frustration and lack of stimulation toward activities and behaviors that can be misinterpreted as inattentional or social problems," (p. 26, Socialstyrelsen, 2013).

In Skolverket's first educational material about gifted children in the classroom, released at the end of May, 2015, it says:

> "In the group of gifted students there are children and youth who risk not faring well if the school does not provide social acceptance, appropriate challenge and the leadership and stimulation they are entitled to. There are many examples of gifted students who have dropped out of school or been given an ADHD diagnosis in error," (p. 2, Skolverket, 2015a).

The differential diagnosis section about ADHD in the DSM IV-TR manual, which is not translated into Swedish but used in Swedish clinical practice, states that clinicians needs to screen for inadequate stimulation before diagnosing a child with ADHD: "Inattention in the classroom may also occur when children with high intelligence are placed in academically understimulating environments," (American Psychiatric Association, 2000). However, in the condensed Swedish translation of DSM IV-TR, the desktop Mini-DSM manual, these recommendations are not included (MINI-D IV, 2002).

In spite of these information sources the awareness of the risks in the diagnostic procedure of gifted children remains low among many Swedish healthcare and school professionals (Persson, 2010). Since there is no practice of intelligence screening in Swedish schools, the only gifted children that are identified through intelligence testing are those assessed in psychiatry and school settings for problematic behaviors and mental illness. This biases the selection such that gifted children in Sweden without any behavioral, emotional or educational issues rarely ever are identified. This can increase the risk of underdiagnosis as subclinical levels of diagnostic criteria can mistakenly be interpreted as characteristics inherent to being gifted when many gifted children in fact have no difficulties in their everyday life once necessary adaptations have been made in their home and school environments (Amend & Beljan, 2009)

There is also a general scarcity of international peer-reviewed research literature in the field and most of the literature consists of non-peer-reviewed popular science, clinical opinion or books, forms which are generally considered to be lower quality in the scientific hierarchy. Given the growing number of gifted children being referred to assessments for attention-deficit hyperactivity disorder (ADHD) or Asperger's syndrome (now included in the diagnosis Autism Spectrum Disorder) (Baum & Olenchak, 2002) it is of vital importance that knowledge about diagnosing this particular group spreads among the professionals that work with children. It is

therefore the purpose of this review article to summarize clinically relevant peer-reviewed information on the diagnosis of ADHD or ASD in gifted children in order to aid Swedish clinicians in the complex process of neurodevelopmental assessment of gifted children as well as to help elevate the general scientific status of this particular area of research in Sweden.

Methods

The search engines used were PubMed, PsychInfo, World of Science and Google Scholar. The keywords used were "gifted" together with combinations of "misdiagnosis", "ADHD", "attention-deficit", "ASD", "Aspergers" "differential diagnosis" and "twice-exceptional". Reference lists were manually reviewed to identify relevant literature. Most articles were identified using cross-referencing from reference lists. The Wechsler Technical and Interpretive Manual for the WISC-IV (Wechsler, 2003) was included in the review for its highly relevant validity studies of both gifted children as well as ADHD, Asperger's and ASD groups, and overall clinical importance. Studies comparing differences in diagnostics and outcomes between gifted children with and without a diagnosis of either ADHD or ASD were included, as were literature reviews of the area. Non-peer-reviewed articles, books, pure "clinical opinion" articles, and publications not written in English were excluded from the search. Nineteen articles were selected.

Results

In the following sections, gifted children without diagnoses will be called "gifted WO", gifted children with ADHD will be called "gifted WADHD" and gifted children with autism or Asperger's will be called "gifted WASD".

The results are presented in Table 1 (see Appendix). Two avoid redundancy, only relevant results from sources not otherwise included in this review are presented from the three review articles. The IQ levels in the studied children ranged from 120 to 157.

Results show that there are significant group differences between the performances on a variety of measures and outcomes between gifted WASD or WADHD and gifted WO. Chae, Kim and Noh (2003) showed that gifted WADHD had slower processing speed than gifted WO and Antshel and colleagues (2007) showed that gifted WADHD performed worse on Block design and Freedom from distraction index than gifted WO. Gifted WADHD also had more

social and emotional difficulties (Chae et al, 2003; Moon, Zentall, Gsrkovic, Hall & Stormont, 2001; Antshel et al, 2007; Foley-Nicpon, Rickels, Assouline & Richards, 2012; Antshel, 2008) and difficulties with schoolwork (Zentall, Moon, Hall & Grksovic, 2001; Antshel, 2008) than gifted WO. Whitaker, Bell, Houskamp and O'Callaghan (2015) showed that gifted WADHD scored lower than gifted WO on tests of memory. However, Zentall and colleagues (2001) showed that gifted WADHD scored higher on creativity than gifted WO.

Gifted WASD have more problems than gifted with atypicality, withdrawal, behavioral inhibition and adaptive behavior than gifted WO (Foley Nicpon, Doobay & Assouline, 2010; Assouline, Nicpon & Doobay, 2009). Assouline and colleagues' study (2009) also showed that the gifted WASD scored lower than the gifted WO on tests of memory, attention and self-reliance. Both Assouline et al. (2009) and Doobay, Foley-Nicpon, Ali and Assouline (2014) showed that gifted WASD had slower processing speed index scores than gifted WO. Gifted WASD also had more social and emotional difficulties than gifted WO (Doobay et al, 2014; Foley Nicpon et al., 2010).

Results also show that gifted WADHD perform differently or have different outcomes than average-IQ children who have the same diagnosis. Antshel (2008) found that gifted adolescents with ADHD had significantly lower levels of smoking, conduct disorder and antisocial activities than average-IQ youth with ADHD. However, Foley-Nicpon, Allmon, Sieck and Stinson (2011) found that gifted students WADHD had more difficulty switching attention on creativity tasks than average-IQ students WADHD.

Some results indicate that gifted WO can have more emotional or social difficulties than in average-IQ children, such as oppositional behavior and hyperactivity (Alloway & Elsworth, 2012; Chae et al, 2003). Other results indicate that giftedness could mask symptoms of psychological disorders (Wood, 2012). Chae et al (2003) showed that giftedness correlates with better performance on tests of attention. Rinn and Reynolds (2012) showed that high scores on an overexcitability personality measure correlated with ADHD Index subscale scores.

Further results indicate that lack of cues of giftedness during the diagnostic process may increase the clinician's risk of overlooking giftedness as a factor in explaining problem behaviors (Hartnett, 2004). A replication with another professional group gave contradictory findings (Rinn & Nelson, 2008). When it comes to diagnosing ADHD, Leroux and Levitt-Perlman (2000) found qualitative differences in how natural high-energy characteristics of gifted children may differ

from actual diagnostic criteria. Wechsler (2003) found that gifted children WO score much higher on the subtest Arithmetic than ASD/Asperger, ADHD and average ability groups.

Several measures were used in at least two studies, see Figure 1.

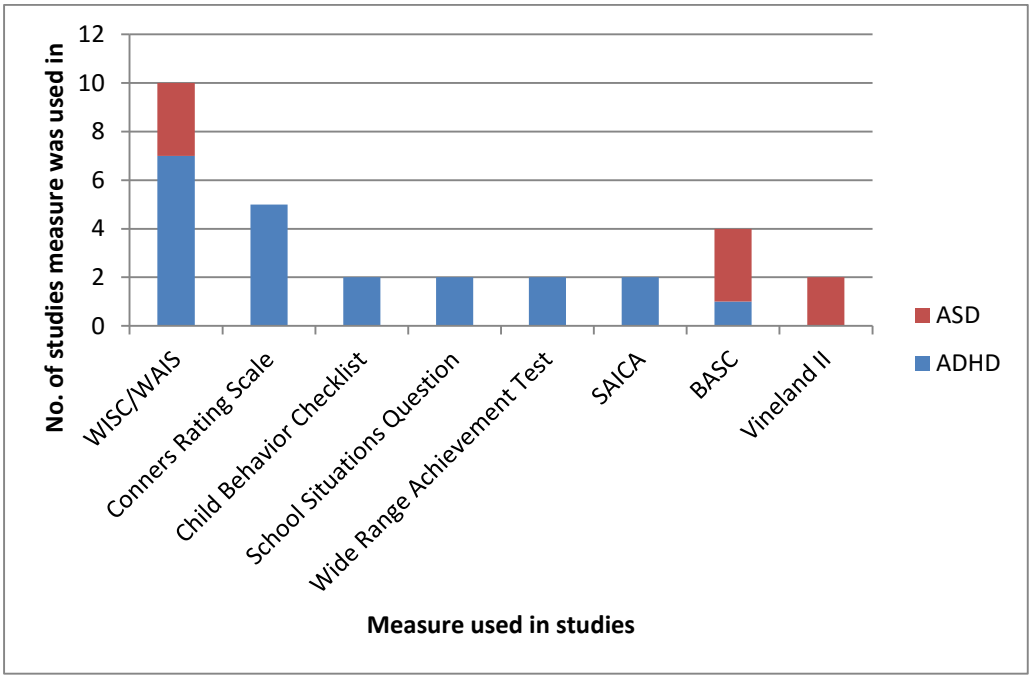

Figure 1: Summary of Measures Used in Studies. ASD = Autism Spectrum Disorder; ADHD = Attention-Deficit Hyperactivity Disorder; WISC = Wechsler Intelligence Scale for Children; WAIS = Wechsler Adult Intelligence Scale; SAICA = Social Adjustment Inventory for Children and Adolescents; BASC = Behavioral Assessment System for Children.

Discussion

Assessment of neurodevelopmental disorders in gifted children is a complex task for clinicians. Many clinically significant differences between the performances and outcomes of gifted WASD or WADHD and gifted WO showed that the diagnoses ADHD and ASD correlated negatively with functioning level regarding a variety of measures. The results support that the diagnoses ADHD and ASD are valid in gifted children and also indicate that giftedness in and of itself does not automatically result in behavioral, emotional or educational difficulties.

Some unexpected benefits of being twice-exceptional were that gifted WADHD could regenerate organizational strategies after having learned them once, which average-ability

children WADHD could not do (Whitaker et al., 2015). Also, Antshel and colleagues (2008) found that gifted adolescents WADHD smoked less and had less conduct disorder and antisocial activities than average-ability youth WADHD.

When investigating whether giftedness masks lower levels of function and behavioral problems, Chae and colleagues (2003) showed that gifted WADHD performed better on several attentional variables than average-ability children WADHD, indicating a need for higher norms when assessing gifted children for inattention. Wood (2012) found average parent and teacher Conners 3 ratings of ADHD symptoms, learning problems and executive functioning in a sample of either gifted WADHD or students "not thriving" in school. This raises the question of the validity of Conners 3 for gifted populations. It also indicates the need for clinicians to be extra vigilant when gifted children function at average levels by performing additional testing.

While most studies found that giftedness has a protective effect by, for example, the gifted child's ability to compensate for lower levels of functioning or use of more elaborate strategies, other unexpected results indicated that giftedness even without a diagnosis of ADHD or ASD can correlate with more social difficulties and hyperactivity than in average-IQ children. Alloway and Elsworth (2012) showed that both gifted children WO and average-ability children WADHD exhibited more hyperactivity and oppositional behavior than normal average-ability children. Other unexpected results were that gifted WADHD had worse emotional adjustment and more severe social problem behaviors than average-ability children WADHD (Moon et al., 2001).

Hartnett's (2004) study of professionals' attributions of childrens' problem behaviors indicates the need for prompting clinicians about giftedness as a possible explanation. Zentall et al. (2001) showed that gifted WO enjoyed school more, enjoyed working alone more and had fewer homework problems than gifted WADHD. The study also showed that gifted WADHD were more creative than gifted WO, the only result that was more positive for the gifted WADHD group.

Several of the measures used in the studies are common in Swedish school psychology and child psychiatry. Therefore, many results have clinical utility as they show how diagnostic criteria manifest themselves in a gifted population and specifically how gifted children perform on the measures. This is useful as most validity testing is done on normally distributed populations.

The Wechsler instruments WISC (Wechsler Intelligence Scale for Children) and WAIS (Wechsler Adult Intelligence Scales) are widely used in research, clinical and educational settings. For children with ADHD or Asperger's syndrome, previous research and the US validation study for the WISC-IV indicated that the Working Memory Index and Processing Speed Index were significantly lower than the Verbal Comprehension Index and Perceptual Reasoning Index. The two subtests Coding (Processing Speed Index) and Arithmetic (Working Memory Index) were weakest in relation to the other subtests (Wechsler, 2003). The Swedish validation studies for ADHD/AS populations revealed the same pattern (Wechsler, 2007). These patterns were also supported both by Assouline et al. (2009) and Doobay et al. (2014).

Chae et al. (2003) showed that gifted WADHD performed worse on the Coding subtest than gifted WO. There was no difference between the groups in the Freedom from Distractability Index (FDI), which however showed significant differences between average-ability children with and without ADHD. This may indicate that tests of attention and continuous performance may be more useful than FDI in identifying gifted WADHD. However, Antshel et al. (2007) showed significant differences between gifted WO and gifted WADHD on the FDI. This could potentially be explained by the larger sample size and a larger group of gifted WADHD in Antshel's study.

The relationships between the index results of the group of gifted children in the US validation process mimicked the patterns shown in the ADHD and Asperger's syndrome group, albeit at a higher level of ability such that the Verbal Comprehension subtest and Perceptual Reasoning subtest scores were found in the 120+ range whereas the Working Memory subtest and Processing Speed subtest scores were found in the average range (Wechsler, 2003). This was supported by the findings of Doobay et al., (2014). However, the one distinct difference between the gifted WO group and the ADHD/ASD groups is the WISC Arithmetic subtest, where the gifted WO performed much better (Wechsler, 2003). While performance on the Arithmetic subtest is found to be lower for twice-exceptional children with learning disorders than for gifted WO (Nielsen, 2002; Lovett & Lewandowski, 2006), future research will have to show if this is true for gifted WADHD and WASD as well. Still, as the Arithmetic subtest is one of the supplementary WISC subtests, clinicians assessing gifted children for ADHD or ASD should make sure to include it in the administration of the test battery.

Diagnostic criteria for both ADHD and ASD have recently changed with the release of the DSM-5 (American Psychiatric Association, 2013). The studies reviewed in this paper used diagnostic criteria for ADHD, autistic spectrum disorder and Asperger's syndrome in DSM-IV-TR (American Psychiatric Association, 2000). In the new DSM-5, Asperger's syndrome has disappeared and is now included in Autistic Spectrum Disorder. The diagnostic criteria for ASD in DSM-5 differ from the criteria for Asperger's in DSM-IV-TR such that all three criteria under "A" and at least two criteria under "B" must be fulfilled, along with problems in everyday functioning. This should increase the specificity of the diagnostic process, hopefully reducing the risk for misdiagnosis of gifted children. However, in the differential diagnosis chapter of the ADHD section, the sentence about screening for lack of stimulation in classroom settings has been excluded, increasing the probability that clinicians overlook this risk during the diagnostic screening process, as shown by Hartnett (2004).

Misdiagnosis is frequently mentioned in the literature about gifted children indicating that many clinicians believe that there may be a risk that a gifted child could obtain a diagnosis of ADHD or ASD either as a result of lack of recognition and adaptations in the home and school or due to the clinician's lack of experience with the group. However, this review found a lack of quantitative research regarding risk and frequency of misdiagnosis occurring in the gifted group. The question of how to operationalize clinical misdiagnosis for research purposes also requires careful thought. As the diagnostic criteria in the DSM-5 are based exclusively on behavioral criteria (with the exception of PTSD) and etiology is not considered in the diagnostic process, getting a diagnosis based on a mismatch between the individual and its environment would probably not constitute a formal clinical error. Whereas in Sweden there are many resources available for children diagnosed with neurodevelopmental disorders through LSS (Law of support and service to certain groups of disabled, 1993:387), getting diagnosed with ADHD or ASD could also be stigmatizing and lead to a number of complications both professionally and insurance-wise. If a mismatch between the special needs of a gifted child and its environment is identified as the primary factor behind the child's social and behavioral issues, treatment should be based on adequate adaptations and stimulation in school and home environments as well as social interaction with other gifted children before social or behavioral programs and medication.

Limitations

Effect sizes were not reported in some studies. Some studies had a significance level of 0.05, others used 0.01. The levels of giftedness varied substantially between IQ 120 and 157, which is more than two standard deviations. Many studies had small samples and few studies compared three groups: average IQ with ADHD/ASD, gifted ADHD/ASD and purely gifted samples. Many subjects were recruited from gifted schools, which indicates a bias toward supportive school and home environments and screening for behavioral and academic problems. This may decrease the generalizability to Swedish children.

Conclusion and future directions

This review clearly shows that there are significant clinical differences between gifted children with and without diagnoses of ADHD or ASD. There are also several unexpected findings which raise the question if diagnostic procedures for normative populations are equally valid for gifted populations. Some characteristics of gifted children can mimic diagnostic criteria for neurodevelopmental and psychological disorders. While most studies in this review need replicating for Swedish purposes, it seems wise for any clinician working with this population to study what literature exists on the special characteristics and needs of gifted children to reduce the risks of mis- and underdiagnosis.

The conclusions also raise an ethical dilemma about assessing a gifted child for ADHD or ASD if there is any risk that lack of adaptations in the child's environment is the primary cause of the problematic behaviors and the problem behaviors disappear once the adaptations are in place. It would therefore be prudent to include screening for adaptations in the school and at home as soon as giftedness is identified early in the assessment process. And if no adaptations have been made, pause the assessment process and see if such interventions have any effect on the child. This is especially relevant in Sweden where no screening for giftedness is done in educational settings and the awareness of qualitative characteristics typical in gifted children is low among school staff, pediatric healthcare professionals and the population in general.

Future research should include identifying what proportion of Swedish gifted children referred for assessment of ADHD and ASD have developed problems due to poor adaptations in the environment, as well focus on identifying any distinguishing characteristics this particular

group may have from truly twice-exceptional children. Focus should also lie on carefully distinguishing in which cases giftedness has a protective effect and when it has a more detrimental effect compared to average IQ children. Since many of the adaptations must be made in the school environment, research within the field of special education is an important area for this group of children. And as the diagnostic criteria for ASD has been changed in DSM-5 future research must use the new criteria.

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Appendix 1. Table 1: Summary of Results

Article	Measures	Groups of participants	Diagnosis	Results
Alloway & Elsworth (2012)	• WASI subtests Vocabulary and Block design • Two measures from Automated Working Memory Assessment • Conners Teacher Rating Scale-Revised Short Forms (CTRS-R, 5 subscales) • Working Memory Rating Scale	• 44 gifted (IQ 124 +) • 38 average ability (IQ 90-115) • 46 low ability (IQ <86) • 83 ADHD (unmedicated)	ADHD	• The relationship between IQ and working memory diminishes with ability. • CTRS-R: Both high ability (gifted WO) and ADHD groups exhibited more oppositional behavior, hyperactivity and ADHD-index behaviors than average and low ability groups
Chae et. al (2003)	• Test of variables of attention (T.O.V.A.) • KEDI-WISC • Korea Child Behavior Checklist (K-CBCL)	• 106 gifted (IQ 130-157) • 71 average ability (IQ 83-127) • 9,4% of sample had ADHD	ADHD	• T.O.V.A.: Gifted WADHD performed better on omission errors, commission errors and sensitivity than average WADHD. • KEDI-WISC: Gifted WADHD lower performance on coding subtest than gifted WO. • K-CBCL: Gifted WADHD more poorly on social skills than gifted. Gifted WO more poorly than average ability children.
Moon et. al (2001)	• Conners Parents' Rating Scale-Revised (CPRS-R) • Conners Teachers' Rating Scale-Revised (CTRS-R) • Home Situations Questionnaire-Revised (HSQ-R) • School Situations Questionnaire (SSQ) • Family Environment Scale (FES)	• 3 gifted (IQ 124+) with ADHD • 3 gifted (IQ 124+) • 3 average ability with ADHD	ADHD	• Combined gifted WADHD poorest emotional adjustment, least mature, of the three groups. • Combined gifted WADHD group most severe social problem behaviors of the three groups. • Families of combined gifted WADHD children did least group activities together. • *Comment: data pooled from several measures to achieve results - no specific results from each respective measure reported in the study.*

Article	Measures	Groups of participants	Diagnosis	Results
Wood (2012)	• Conners Parents' Rating Scale-Revised (CPRS-R) • Conners Teachers' Rating Scale-Revised (CTRS-R)	• 36 parents & 11 teachers of 21 children (IQ "exceptional performance"), some with ADHD diagnosis, others "not thriving" referred for ADHD assessment.	ADHD	• Average ADHD symptom, learning problems and executive functioning ratings from both parents and teachers.
Antshel et. al (2008)	• WISC Freedom from distraction index (DS and AR subtests) • WISC subtests Block Design and Vocabulary • Wide Range Achievement test (WRAT) • Social Adjustment Inventory for Children and Adolescents (SAICA)	• 49 gifted (IQ 120+) with ADHD • 92 gifted (IQ 120+)	ADHD	• SAICA: Gifted WADHD lower results in school behavior, spare time activities, spare time problems, problems with peers, problems with the opposite sex and problems with parents. • Smoking, conduct disorder and antisocial activities significantly lower in gifted WADHD youth than in average IQ WADHD youth.
Antshel et al (2007)	• WISC Freedom from distraction index (DS and AR subtests) • WISC subtests Block Design and Vocabulary • Wide Range Achievement test (WRAT) • Social Adjustment Inventory for Children and Adolescents (SAICA) • Child Behavior Checklist Social Competence Scales (CBCL)	• 49 gifted (IQ 120+ with ADHD) • 92 gifted (IQ 120+)	ADHD	• WISC: Gifted WADHD performed significantly worse on Block Design and Freedom from distraction index. • Gifted WADHD more likely to have repeated a grade. • CBCL: Gifted WADHD performed worse across all domains. • SAICA: Gifted WADHD significantly more problems with school behavior, spare time activities, spare time problems, problems with peers, problems with the opposite sex, relationship with father, problems with parents.

Article	Measures	Groups of participants	Diagnosis	Results
Zentall et. al (2001)	• Conners Parents' Rating Scale-Revised (CPRS-R) • Conners Teachers' Rating Scale-Revised (CTRS-R) • School Situations Questionnaire (SSQ)	• 3 gifted (IQ 126+) with ADHD • 3 gifted (IQ 126+) • 3 average ability (IQ 90+) with ADHD	ADHD	• Gifted WADHD significant problems with inattention and overall classwork, gifted WO did not. • Gifted WADHD had no reports of poor reading skills compared with average ability WADHD. • Gifted WADHD had problems starting schoolwork, resistance to writing, careless schoolwork, less enjoyment of free reading than gifted WO. • Gifted WADHD expressed more problems with math (complaints of boring, too long, too routine) than gifted WO. • Gifted WADHD had problems with homework, gifted WO did not. • Gifted WADHD more creative than gifted WO. • Gifted WADHD still have problems in school after adaptation of educational challenges. • Gifted WADHD prefer to working with others and do not enjoy school whereas gifted prefer working alone and enjoy school.
Rinn & Reynolds (2012)	• Overexcitabilities Questionnaire II • Conners ADHD/DSM IV Scales-Adolescents	• 116 students enrolled in summer program for intellectually gifted (Duke TIP)	ADHD	• Positive correlations between psychomotor OE scores and DSM IV Hyperactive-Impulsive subscale scores. • Positive correlation between sensual OE scores and Conners' ADHD Index subscale score. • Positive correlation between Imaginational OE scare and Conners ADHD index, DSM IV inattentive, DSM IV Hyperactive-Impulsive and DSM IV Total scores.
Whitaker et. al (2015)	• WISC-IV • California Verbal Learning Test - Children's Version (CVLT-C)	• 30 Gifted (IQ 130+) with ADHD • 39 Gifted (IQ 130+) without ADHD • 56 Average IQ (85-114) with ADHD	ADHD	• CVLT-C: Gifted WO scored higher than gifted WADHD. • CVLT-C: Gifted WADHD scored higher than average WADHD.

Article	Measures	Groups of participants	Diagnosis	Results
Foley Nicpon et. al (2012)	• WISC-IV or WAIS-III • Behavioral Assessment System for Children II Self-report Personality (BASC II SRP) • PH-2	• 54 gifted (IQ 120+) with ADHD • 37 gifted (IQ 120+)	ADHD	• BASC II SRM: Gifted WADHD twice as likely to have low self-esteem compared to gifted WO. • PH-2: Gifted WADHD less overall happiness and positive impressions of own behavior than gifted WO.
Hartnett et. al (2004)	• Two versions of one vignette about a 7-year-old boy with behavioral difficulties: unbiased (no suggestion of giftedness as a cause of behavioral problems; and biased: suggestion of giftedness as cause of behavioral problems.	• 41 Master's level school counseling students	ADHD	• No school counselors suggested giftedness as a cause of behavioral problems in the unbiased vignette; 10 chose either giftedness or giftedness WADHD in the biased vignette.
Rinn & Nelson (2008)	• Two versions of one vignette about a 7-year-old boy with behavioral difficulties: unbiased (no suggestion of giftedness as a cause of behavioral problems; and biased: suggestion of giftedness as cause of behavioral problems.	• 132 preservice teachers (education majors)	ADHD	• 20 preservice teachers chose either gifted or combined gifted WADHD in the biased vignette and 14 chose either gifted or combined gifted WADHD in the unbiased vignette.

Article	Measures	Groups of participants	Diagnosis	Results
Antshel (2008)		Review	ADHD	• Processing speed inversely correlated with IQ. • Working memory positively correlated with IQ. • Executive functions more strongly associated with IQ in gifted populations than in average intelligence populations. • Negative correlation between brain effort during cognitive tasks and IQ.
Leroux & Levitt-Perlman (2000)		Review	ADHD	• Hyperactivity in gifted children "focused, directed, intense"; hyperactivity in ADHD children: "random, diffuse, constant". • Challenging authority in gifted children: "heightened intellectual perception, questioning of judgement"; in ADHD children: "impulsivity, oppositional behavior".
Foley Nicpon et. al (2011)	• EEG Consistency index	Review	ADHD	• Consistency Index (EEG): Gifted students WADHD had greater difficulty shifting attention on creativity tasks than other students with ADHD.
Wechlser (2003)	• WISC-IV	• 63 gifted (IQ 130+ on one index) • ADHD: (IQ 97.6) • Aspergers syndrome: (IQ 99.2)	ADHD/ASD	• WISC-IV profile for gifted resembles profiles for ADHD and Asperger populations with the exception of Arithmetic subtest where gifted score above average.

Article	Measures	Groups of participants	Diagnosis	Results
Assouline et. al (2009)	• WISC-IV • Woodcock-Johnson Achievement Battery • NEPSY II • Behavioral Assessment System for Children II-Parent Rating Scale (BASC II PRS), Teacher Rating Scale (BASC II TRS) • Social Skills Rating System (SSRS) • Vineland II • Autism Diagnostic Observation Schedule (ADOS) • Autism Diagnostic Interview Revised (ADI-R)	• 1 gifted (IQ 145+) with ASD • 1 gifted (145+)	ASD	• WISC-IV: Gifted WASD lower performance on processing speed (PSI) • NEPSY II: Gifted WASD lower performance on attention, behavioral inhibition and memory for faces. • BASC II Self-Report: Self-reliance scale in clinically significant range for gifted WASD • BASC II Parents Rating Scale: Functional communication and Atypicality in clinically significant range for gifted WASD. • BASC II Teacher Rating Scale: Withdrawal and Adaptability in clinically significant range for gifted WASD. • SSRS Self-report: Gifted WASD lower scores than gifted WO. • SSRS Parent Report: Gifted lower values than gifted WASD. • Vineland II: Gifted WASD perform worse on Adaptive behavior composite than gifted WO. • ADOS and ADI-R significant differences, gifted scores within average range, total values not reported. Results consistent with ASD diagnosis for "gifted WASD" child and no ASD diagnosis for "gifted" child.
Foley Nicpon et. al (2010)	• Behavior Assessment System for Children II – Parent Rating Scale (BASC II PRS) • Behavior Assessment System for Children II – Teacher Rating Scale (BASC II TRS) • Behavior Assessment System for Children II – Self-Reported Personality (BASC II SRP)	• 52 parents and 42 teachers of 54 gifted (IQ 120+) with ASD, 38 children, 14 adolescents.	ASD	• BASC II PRS: Parents of gifted children WASD gave elevated ratings on Behavioral symptoms index, Externalizing problems composite, Internalizing problems composite, Adaptive skills composite compared to normative samples. Atypicality subtest in clinical range. • BASC II PRS: Parents of adolescents WASD gave elevated ratings on Behavioral symptoms index, Internalizing problems composite, Adaptive skills composite compared to normative samples. Withdrawal subtest in clinical range.

Article	Measures	Groups of participants	Diagnosis	Results
Doobay et. al (2014)	• WISC-IV or WAIS-III • Behavioral Assessment System for Children II-Parent Rating Scale (BASC II PRS) • Teacher rating scales • Self-report of Personality • Vineland Adaptive Behavior Scales II (survey interview or parent/caregiver rating form)	• 40 gifted (IQ 130+) with ASD • 41 gifted (IQ 130+)	ASD	• WISC-IV/WAIS-III: gifted WASD group lower PSI scores on Wechsler scale. • Vineland II: gifted WASD group lower on measures Communication domain, Daily Living Skills Domain and Socialization Domain. • BASC II PRS: gifted WASD group significantly higher on measures Behavioral Symptoms Index and Adaptive Skills Index. • Gifted WASD group significantly higher on Behavioral Symptoms Index. Significant difference on Clinical Subscale scores. • Gifted WASD group significantly higher on Emotional Symptoms Index but both values are in the average range.

ADHD: Attention-Deficit Hyperactivity Disorder; ASD: with autism or Asperger diagnosis; WO: without diagnosis; WADHD with ADHD diagnosis; WASD: with autism or Asperger diagnosis