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Impact Supplement of the Strengths and Difficulties Questionnaire in the Assessment of Functional Impairment in Children with ADHD or ASD in a Mixed Neuropediatric Sample: A Partial Validation Study

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Abstract

Background: In addition to symptoms of neurodevelopmental disorders, functional impairment is crucial to the determination of clinical significance. The aim of this study was to examine partial validity and usefulness of the Strengths and Difficulties Questionnaire's (SDQ) impact supplement (SDQ impact) in measuring functional impairment in children and adolescents diagnosed with attention deficit/hyperactivity disorder (ADHD) or autism spectrum disorder (ASD) in neuropediatric clinics.

Methods: Participants were children and adolescents (N = 337) referred to neuropediatric outpatient clinics for neurodevelopmental assessment. Functional impairment was evaluated using three instruments: the SDQ impact, the Vineland Adaptive Behavior Scale (VABS-II), and the Children's Global Assessment Scale (CGAS). Mental health symptoms and intellectual function were also assessed. We investigated convergent and concurrent validity of the SDQ impact.

Results: The convergent validity of the SDQ impact was shown by its significant correlations with the VABS-II composite score and the CGAS total score. The concurrent validity of the SDQ impact was demonstrated by its significant relationship with ADHD and ASD diagnoses in logistic regression analyses. Using established cutoffs, the sensitivity of the SDQ impact to reveal functional impairment in children with ADHD and ASD diagnoses was demonstrated in this neuropediatric sample, but at the cost of low specificity.

Conclusion: The SDQ impact is an easy-to-use tool, and the overall study results indicate that it is partially valid, suggesting it may be used for the screening of general functional impairment in the neuropediatric population.

KEYWORDS
Attention deficit and hyperactivity disorder; autism spectrum disorder; functional impairment; parental evaluation; screening tool; validity

Introduction

One of the purposes of a diagnostic assessment of a child referred to a neuropediatric clinic is to obtain an accurate picture of the child's developmental functioning and the severity of behavioral difficulties and functional

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impairment across various domains, such as friendships, other close relationships, school, recreation, and health (Hunsley & Mash, 2020). In this article, we focus on the assessment of functional impairment in children with neurodevelopmental disorders, and specifically children with attention deficit/hyperactivity disorder (ADHD) or autism spectrum disorder (ASD).

Neurodevelopmental disorders are behavioral and cognitive syndromes with onset in the developmental period; they are characterized by developmental deficits that vary from specific limitations to global impairments of social skills or intelligence (American Psychiatric Association[APA], 2013; World Health Organization[WHO], 2018). Similarly to mental health disorders, the diagnosis of most neurodevelopmental disorders requires that certain criteria should be fulfilled, including the presence of both specific symptoms and functional impairment or significant distress (APA, 2013).

Functional impairment has been discussed, and partly doubted, as a criterion for diagnosing mental health disorders, with authors pointing out a lack of operationalization and inconsistency in the importance of functional impairment across diagnoses (Ustun & Kennedy, 2009; Wakefield, 2009). Even so, functional impairment is broadly used and is a necessary criterion for clinical significance in the diagnosis of neurodevelopmental disorders, both in the Diagnostic and Statistical Manual of Mental Disorders (DSM) and International Classification of Diseases (ICD) diagnostic systems (APA, 2013; WHO, 2018). Distress refers to subjective emotional discomfort and is a core component of some mental disorders like depression and anxiety. In neurodevelopmental disorders, distress may also be a consequence of the disorder itself (Rapee et al., 2012). In relation to distress, functional impairment has more noticeable and objective aspects of deficits in various domains of functioning across different aspects of life (Rapee et al., 2012; Winters et al., 2005). Unlike criteria related to symptoms, the DSM has little to say about what exactly constitutes impairment (Lewandowski et al., 2006; Ustun & Kennedy, 2009). Nevertheless, functional impairment in daily activities is of high importance in reducing high caseness rates to a clinical significance level (Bird et al., 1990; Narrow et al., 2009; Regier et al., 1998).

To be impaired means to be unable to handle the routine demands of life (Goldstein & Naglieri, 2016). The threshold for functional impairment is based on a conviction of which activities are central to functioning for a particular person according to her age and developmental level. There are a variety of concepts and terminologies related to functioning: functional impairment, adaptive functioning, psychosocial functioning, social competence, social adaptation, disability, or interference (Colburn et al., 2018; Winters et al., 2005). Even though there is no strict definition of impairment in the DSM, popular measurement methods (Zander & Bölte, 2015), like the composite score of the Vineland Adaptive Behavior Scales II (VABS-II; Sparrow et al., 2011), can be used to operationalize impairment criteria. The

VABS-II is typically used in neuropediatric clinics to assess adaptive functioning and impairment in the domains of socialization, communication, and daily living skills in children with neurodevelopmental disorders (e.g., Ashwood et al., 2015). Another method to assess impairment is via omnibus global impairment measures, such as the Children's Global Assessment Scale (CGAS; Bird et al., 1997; Rapee et al., 2012; Shaffer et al., 1983).

The extended version of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1999) includes an impact supplement with questions on distress and social impairment in four domains: home life, friendships, classroom learning, and leisure activities. These domains are the main areas of consideration when rating psychosocial disability due to mental disorder, intellectual disability, or other developmental disorders using the WHO's multiaxial classification of child and adolescent mental disorders (WHO, 1996). The VABS-II interview version consists of a lengthy interview with caregivers scored by the clinician, and the unidimensional measure of global functioning in the CGAS represents a clinician's evaluation, based on a wide variety of information gathered about the child. The VABS-II is time-consuming, but routinely used in the evaluation of impaired adaptive functioning in ASD and other neurodevelopmental disorders. The use of the CGAS requires good training, and much time is needed to collect the necessary information. In contrast, the SDQ impact supplement is a questionnaire that is filled out by caregivers; thus, it represents a more efficient use of clinicians' time, and it is directly adapted to the DSM clinical significance criteria for functional impairment and distress. In addition, the SDQ impact score has been found to be a significant predictor of child mental disorders (Lai et al., 2014; Stringaris & Goodman, 2013). Therefore, it would be interesting to determine if routine assessment of functional impairment in children with suspected neurodevelopmental disorder could be done with the SDQ impact supplement with results that are similar to those of established, time-consuming scales or clinical judgment (VABS-II and CGAS).

Accordingly, the aim of this study was to examine indicators of validity and usefulness of the SDQ impact supplement (SDQ impact) in measuring functional impairment in children and adolescents diagnosed with ADHD) or ASD in neuropediatric clinics. Validity is not a property of a test, but a function of what the achieved scores mean, often in some context and sample (Murphy & Davidshofer, 2013). We used a convergent validity strategy (Campbell & Fiske, 1959), a type of a measurement validity (Murphy & Davidshofer, 2013), to show the meaning and implications of the SDQ impact score by comparing its properties with the results of the VABS-II and CGAS. In addition, we used a concurrent validity strategy, a type of criterion-related validity, to examine if a test could be used to make correct decisions (Hayden & Brown, 1999; Murphy & Davidshofer, 2013; Søreide, 2009). We evaluated the accuracy of a diagnostic decision by comparing estimated functional impairment

measured by the SDQ impact score and an ADHD or ASD diagnosis based on an evaluation of both symptoms and functional impairment.

Methods

Participants and Study Setting

Participants were 337 children and adolescents aged 4–18 years (mean [*M*] = 10.03, standard deviation [*SD*] = 3.77; 35% females) referred to developmental/neurological assessment at the neuropediatric outpatient clinics of the University Hospital of North Norway (UNN) (n = 286) and the Finnmark Hospital Trust (n = 51) by a general practitioner (n = 231) or a medical specialist in specialist health services (n = 106). In order to be included in the study, patients had to be referred between October 2012 and July 2016 at the UNN, or between January 2014 and July 2016 at the Finnmark Hospital Trust. The exclusion criteria included age below 4 years, due to a lack of suitability of one or more of the instruments for that age group, and lack of fluency in the Norwegian language. In total 518 children and adolescents were eligible for the study, however around 30% of them were excluded from the study due to time constraints, lack of parental motivation, or insufficient knowledge of the Norwegian language.

The aforementioned neuropediatric outpatient clinics are health service units in the counties of Troms and Finnmark in Northern Norway that serve a population of 266,000 residents. These facilities provide services to children and adolescents with neurodevelopmental disorders or early-acquired disabilities, developmental delays, or intellectual and developmental disabilities. Assessment teams are interdisciplinary, including specialists such as pediatricians, neuropsychologists, special education therapists, and physiotherapists.

The children underwent clinical treatment as usual; the ordinary interdisciplinary developmental/neurological assessment typically takes place over two consecutive days. Participants' neurological/neurodevelopmental diagnoses were provided at the interdisciplinary assessment at the neuropediatric clinics and recorded in electronic medical records. ICD-10 criteria were applied to code the diagnoses (WHO, 1993, 2010). The presence of an intellectual disability (ID) was operationalized as a score below 70 on both a standardized Wechsler Intelligence Test and the VABS-II (for more details see, Halvorsen et al., 2019).

The most frequent neurodevelopmental disorders in the sample were, in decreasing order, specific developmental disorders (33.5%), ID (20.5%), diseases of the nervous system such as epilepsy and cerebral palsy (15.1%), ASD (14.2%), ADHD (13.6%), and congenital malformations, deformations, and chromosomal abnormalities (10.4%). The diagnoses were not mutually

Table 1. Co-existing diagnoses of participants with ADHD and ASD.

ADHD		ASD	
Co-existing diagnoses	*n*	Co-existing diagnoses	*n*
Intellectual disability	8	Intellectual disability	8
ASD	4	ADHD	4
Specific learning disorder	17	Specific learning disorder	2
Neurological disorders	10	Neurological disorders	9
None	0	None	28

ADHD – attention deficit/hyperactivity disorder; ASD – autism spectrum disorder; FSIQ – Full Scale Intelligence Quotient; SDQ – Strengths and Difficulties Questionnaire; VABS-II – Vineland Adaptive Behavior Scales II; CGAS – Children's Global Assessment Scale. **In ADHD –** Neurological disorders: Acquired periventricular cysts of newborn, five cases of congenital malformation syndromes and chromosomal abnormalities, delayed development, focal traumatic brain injury, two cases of diseases of the nervous system (epilepsy and cerebral palsy). **In ASD –** Neurological disorders: three cases of congenital malformation syndromes and chromosomal abnormalities, six cases of diseases of the nervous system (epilepsy, cerebral palsy and hydrocephalus).

exclusive, so a given participant could have more than one diagnosis. Among the participants, 46 were diagnosed with ADHD and 48 with ASD. Most participants with ADHD were diagnosed with "disturbance of activity and attention" (ICD-10 code F90.0; $n = 30$), and some cases of "hyperkinetic conduct disorder" (F90.1, $n = 3$), "other hyperkinetic disorders" (F90.8; $n = 3$), "hyperkinetic disorder, unspecified" (F90.9, $n = 1$), and "attention deficit disorder without hyperactivity" (F98.8; $n = 4$). Participants with ASD were diagnosed with "childhood autism" (ICD-10 code F84.0, $n = 15$), "atypical autism" (F84.1, $n = 14$), "Asperger syndrome" (F84.5, $n = 17$), and "pervasive developmental disorder, unspecified" (F84.9, $n = 2$). Most children with ADHD or ASD had additional, co-existing diagnoses (Table 1).

Measures

Mental Health Symptoms

The parent version of the SDQ, a brief behavioral screening questionnaire (Goodman, 1997), is part of the Development and Well-Being Assessment (DAWBA; Goodman, Ford et al., 2000) and was used to assess mental health symptoms. The SDQ consists of 25 items that measure symptoms in four problem domains (emotional symptoms, conduct problems, hyperactivity-inattention, and peer problems) and one area of strength (prosocial behavior). The scores in these problem domains are then summed to generate a total difficulties score. There are three response alternatives: "not true" – scored as 0, "somewhat true" – scored as 1, and "certainly true" – scored as 2. The SDQ has satisfying to good psychometric properties, and has been used in clinical and non-clinical child and adolescent populations (Emerson, 2005; Goodman, 2001; Smedje et al., 1999; Stringaris & Goodman, 2013). In the present study, the included domain scores had the following Cronbach's alphas: .76 for

emotional symptoms, .70 for conduct problems, .78 for hyperactivity-inattention, .72 for peer problems, and .78 for prosocial behavior.

Intellectual Function

Children were individually assessed with a standardized Wechsler intelligence test appropriate for their age (WPPSI, WISC; Wechsler, 2007, 2008a, 2008b, 2009, 2012). A small number of children were assessed with Raven's Colored Progressive matrices (Raven, 2004) because of insufficiently completed subtests on the Wechsler test to estimate the FSIQ score, which defined intellectual function. FSIQ scores were missing for 30 children, who were administered a test for younger children.

Functional Impairment

The extended version of the SDQ part of the DAWBA, (Goodman, 1999) includes the SDQ impact supplement, which focuses on the functional impairment of the child in everyday activities. The first question asks whether the parent believes that the child has difficulties in any of the following areas: emotions, concentration, behavior, or getting along others. If the parent answers "yes" to this question, the remaining questions assess chronicity, overall child distress, social impairment, and burden to others. Functional impairment is calculated from the evaluation of overall child distress, and impairment related to family, friends, classroom learning, and leisure activities. There are three response alternatives: "not at all" and "only a little" – scored as 0, "quite a lot" – scored as 1, and "a great deal" – scored as 2. The scores are then combined to give an impact score, ranging from 0 to 10. If the parent answered "no" to the first question on whether the child has difficulties, the SDQ impact score is coded as zero. An SDQ impact score of 0 is considered normal, 1 is defined as borderline, and 2 as abnormal. The SDQ impact score has high concurrent and predictive validity (Stringaris & Goodman, 2013), and demonstrates acceptable to good internal consistency (Aitken et al., 2017; Stringaris & Goodman, 2013).

Adaptive Function

The VABS-II (Sparrow et al., 2011) was used to measure a child's adaptive abilities. It consists of a semi-structured interview with a parent and includes four domains with related subdomains: communication (receptive, expressive, and written), daily living skills (personal, domestic, and community), socialization (interpersonal relationships, play and leisure time, and coping skills) and motor skills (gross and fine). In the present study, we used an Adaptive Behavior Composite score (hereafter referred to as the VABS-II composite score), which was condensed from scores in the subdomains of communication, daily living skills, and socialization. A VABS-II composite standard score of 130 and above was defined as a high adaptive level, a standard score of 115–

129 as moderately high, 86–114 as adequate, 71–85 as moderately low, and 70 and below as a low adaptive level.

General Functioning

The CGAS (Shaffer et al., 1983) is a clinician-rated tool that is used to assess the global psychosocial functioning of the child, taking into account all available information. The score on this scale reflects the lowest overall level of psychosocial functioning (at home, at school, and with peers) of the child or adolescent during the preceding month. The scale is separated into 10-point intervals that are headed with a description of the level of functioning followed by examples of matching behavior and life situations adequate for children and adolescents. The scores range from 1, which represents the most impaired level, to 100, which represents the best level of functioning. In a large Norwegian study of clinicians in outpatient child and adolescent mental health services (Hanssen-Bauer et al., 2007), the interrater reliability of the routine use of the CGAS was found to be moderate (intraclass correlation coefficient = .61).

cutoffs for Functional Impairment

Mild functional impairment was defined as a SDQ impact score of 1 (borderline or quite a lot distress/impairment in just one domain), which conceptually corresponds to a CGAS score of 61 to 70 (Goodman, 1999). An SDQ impact score of 2 or more corresponds conceptually to a CGAS score of 60 or less and is defined as indicating definite functional impairment (Goodman, 1999). The VABS-II composite score served as a proxy for a third functional impairment measure, in addition to the SDQ impact score and the CGAS score. The following cutoffs were applied for the VABS-II composite score (Zander & Bölte, 2015): 1 SD below the mean (85 points) corresponded to mild functional impairment, and 2 SD below the mean (70 points) corresponded to definite functional impairment.

Statistical Analysis

The statistical analyses were carried out using SPSS version 26 for Windows (IBM Corp, 2019). We used Cronbach's alpha (European Federation of Psychologists' Association[EFPA], 2013) to calculate the internal consistency of the scales used in the study. Bivariate associations were examined using the Pearson correlation coefficient.

The convergent validity of the SDQ impact supplement was evaluated by the association between the SDQ impact score, and the VABS-II composite score and CGAS total score, respectively. In order to demonstrate convergent validity, it is generally recommended that the correlation between

the measure in question (SDQ impact score) and the criterion measure meet or exceed 0.30 (Campbell & Fiske, 1959). A concurrent validity strategy is used to determine if a test can be validly used in decision-making (for example, to determine a diagnosis). The recommended procedure is to correlate the score of the test with a measurable outcome (Murphy & Davidshofer, 2013). The concurrent validity of the SDQ impact supplement was demonstrated by a significant relationship between the SDQ impact score and the ADHD and ASD diagnosis status, both using Pearson's correlation coefficients, and by the results of hierarchical logistic regressions controlled for possible covariates of functional impairment.

Three separate hierarchical multiple logistic regression analyses were performed, using ASD and ADHD diagnoses as dependent variables. In the first step, we included control variables: gender, age, and intellectual function expressed as FSIQ; the next step included mental health symptoms. The last step consisted of one of the indicators of functional impairment or adaptive ability: SDQ impact score (indicating functional impairment and distress = clinical significance), VABS-II composite score indicating adaptive ability, or CGAS score indicating global psychosocial functioning. The overall model was tested using a chi-square statistic.

Descriptive statistics were used to determine the different levels of functional impairment measured in children diagnosed with ADHD and ASD. Percentages of children with ADHD and ASD that belonged to groups with mild/borderline and definite impairment were calculated.

Receiver-operating characteristic curve analysis (ROC-analysis; Ogilvie & Creelman, 1968) was used to assess how well the SDQ impact score captured diagnoses. The overall diagnostic accuracy of the SDQ impact supplement was measured by the area under the curve (AUC), and sensitivity, specificity, and diagnostic likelihood ratio [DLR = sensitivity/(1-specificity); a ratio of true positives to false positives] were also calculated for each of the possible SDQ impact scores (Deeks & Altman, 2004; Hayden & Brown, 1999; Søreide, 2009). AUC can range from 0 (prediction worse than random decision-making) through 0.5 (no predictive ability; random decision-making) to 1 (perfect discrimination/accuracy), (Søreide, 2009).

Ethical Considerations

Written informed consent was obtained from the parents of all participants and children above 12 years included in the study. The data protection officer at the UNN and the Finnmark Hospital Trust has approved the use of de-identified data for research purposes.

Results

The majority of the parents (N = 337) that completed the SDQ impact supplement reported that they believed their child had difficulties in one or more of the following areas: emotions, concentration, behavior, or getting along with others. Only 10.7% reported that they did not believe their child had any problem in these areas, while 26.0% perceived minor problems and 63.3% experienced definite or severe problems. Parents who believed their child had difficulties reported that these difficulties interfered with the child's everyday life in different areas. The majority 95.7% (N = 303) of the parents answered that their child's problems had lasted for over a year. The SDQ impact scores ranged from 0 to 10 (M = 3.48, SD = 2.90), and the VABS-II composite scores ranged from 20 to 112 (M = 67.10, SD = 15.15). Likewise, the range of the CGAS total scores was between 11 and 100 (M = 55.58, SD = 13.85).

SDQ Impact Supplement and Convergent Validity

The SDQ impact score correlated significantly with the VABS-II composite score (r = – .36, p < .001); the correlation with the CGAS score was weaker, yet still significant (r = – .29, p < .001). However, the strongest association was between the VABS-II composite score and the CGAS score (r = .55, p < .001; Table 2).

SDQ Impact Supplement and Concurrent Validity

The SDQ impact score correlated significantly with both ADHD diagnosis (r = .28, p < .001) and ASD diagnosis (r = .21, p < .001; Table 2). Similarly, the VABS-II composite score correlated significantly with ADHD diagnosis (r = – .17, p < .01) and ASD diagnosis (r = – .23, p < .001). Comparably, the CGAS total score was significantly associated only with ASD diagnosis (r = – .29, p < .001). Logistic regression analyses (Tables 3 and 4) confirmed the relationship between the SDQ impact score and ADHD and ASD diagnoses, when symptom and control variables were taken into account.

Functional Impairment, Assessed by Different Measures, and Clinical Diagnoses

Thirty-six participants (10.7%) had missing data on FSIQ score. As logistic regression analyses included only those participants with measurements recorded for all three instruments (i.e., SDQ impact score, VABS-II composite score, and CGAS total score), 61 participants without these measurements were excluded.

Table 2. Bivariate relationships between ADHD and ASD diagnosis, and predictor variables.

	M (*SD*)/*n* (%)	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ADHD	40 (13.2%)	–												
2 ASD	48 (15.8%)	−.06	–											
3 Gender	106 (35%)	−.16**	−.03	–										
4 Age	10.04 (3.77)	.03	−.05	.09	–									
5 FSIQ	76.93 (16.63)	−.03	−.27***	−.11	−.05	–								
6 SDQ emotional symptoms	3.31 (2.62)	−.02	.06	.20***	.14*	−.08	–							
7 SDQ conduct problems	2.12 (2.01)	.24***	.04	−.07	−.05	−.02	.25***	–						
8 SDQ hyperactivity-inattention	5.26 (2.56)	.36***	.09	−.07	−.17**	−.10	.28***	.51***	–					
9 SDQ peer problems	3.86 (2.51)	.10	.29***	−.02	−.19**	.03	.36***	.39***	.35***	–				
10 SDQ prosocial score	7.06 (2.32)	−.09	−.19***	.09	−.02	−.11	−.17**	−.52***	−.31***	−.39***	–			
11 SDQ impact score	3.48 (2.90)	.28***	.21***	.03	.08	−.04	.50***	.36***	.46***	.54***	−.34***	–		
12 VABS-II composite score	67.10 (15.15)	−.17**	−.23***	.07	.14*	.31***	−.17**	−.31***	−.36***	−.32***	−.37***	−.36***	–	
13 CGAS total score	55.58 (13.85)	−.08	−.29***	.09	−.06	.24***	−.14*	−.22***	−.19**	−.32***	.27***	−.29***	.55***	–

ADHD – attention deficit/hyperactivity disorder; ASD – autism spectrum disorder; *M* – mean; *SD* – standard deviation; FSIQ – Full Scale Intelligence Quotient; SDQ – Strengths and Difficulties Questionnaire; VABS-II – Vineland Adaptive Behavior Scales II; CGAS – Children's Global Assessment Scale. ADHD/ASD diagnosis: 0 – absent, 1 – present; gender: 0 – male, 1 – female; *n* (%) for variable value = 1; *p <.05. **p <.01, ***p < .001 (two-tailed test).

Table 3. Summary of three models with hierarchical logistic regression analyses predicting an ADHD diagnosis (N = 274).

	Model 1[a]			Model 2[b]			Model 3[c]		
Predictor	*B*	*S.E.*	*OR*	*B*	*S.E.*	*OR*	*B*	*S.E.*	*OR*
Step 1									
Gender	−2.25*	0.60	0.29	−1.11*	0.56	0.33	−1.03	0.56	0.36
Age	0.17*	0.07	1.18	0.15*	0.07	1.16	0.13*	0.06	1.14
FSIQ	0.01	0.01	1.01	0.02	0.01	1.02	0.01	0.01	1.01
Step 2									
SDQ emotional symptoms	−0.32**	0.11	0.72	−0.16	0.09	0.85	−0.14	0.09	0.87
SDQ conduct problems	0.20	0.13	1.23	0.12	0.12	1.13	0.13	0.12	1.14
SDQ hyperactivity-inattention	0.46***	0.12	1.59	0.49***	0.11	1.63	0.51***	0.11	1.67
SDQ peer problems	−0.21	0.12	0.81	−0.10	0.11	0.91	−0.07	0.11	0.93
SDQ prosocial behavior	0.14	0.11	1.15	0.13	0.11	1.14	0.07	0.11	1.08
Step 3									
SDQ impact score	0.46***	0.11	1.58						
VABS-II composite score				−0.05*	0.02	0.95			
CGAS total score							−0.02	0.02	0.98

ADHD – attention deficit/hyperactivity disorder; *B* – estimated change in log odds for a one-unit change in the independent variable; *S.E.* – standard error; *OR* – odds ratio; FSIQ – Full Scale Intelligence Quotient; SDQ – Strengths and Difficulties Questionnaire; VABS-II – Vineland Adaptive Behavior Scales II; CGAS – Children's Global Assessment Scale. * $p < .05$, ** $p < .01$, *** $p < .001$.

[a]Overall model: χ^2 (9) = 65.31***. Cox & Snell R^2 = .21, Nagelkerke R^2 = .40. $\Delta\chi^2_{1step}$ = 8.58*; $\Delta\chi^2_{2step}$ = 37.93***; $\Delta\chi^2_{3step}$ = 18.79***.

[b]Overall model: χ^2 (9) = 50.88***. Cox & Snell R^2 = .17, Nagelkerke R^2 = .32. $\Delta\chi^2_{1step}$ = 8.58*; $\Delta\chi^2_{2step}$ = 37.93***; $\Delta\chi^2_{3step}$ = 4.36*.

[c]Overall model: χ^2 (9) = 47.78***. Cox & Snell R^2 = .16, Nagelkerke R^2 = .30. $\Delta\chi^2_{1step}$ = 8.58*; $\Delta\chi^2_{2step}$ = 37.93***; $\Delta\chi^2_{3step}$ = 1.27.

Table 4. Summary of three models with hierarchical logistic regression analyses predicting an ASD diagnosis (N = 274).

	Model 1[a]			Model 2[b]			Model 3[c]		
Predictor	*B*	*S.E.*	*OR*	*B*	*S.E.*	*OR*	*B*	*S.E.*	*OR*
Step 1									
Gender	0.10	0.46	1.11	0.22	0.47	1.25	0.35	0.50	1.41
Age	−0.15*	0.06	0.86	−0.11	0.06	0.90	−0.18**	0.06	0.83
FSIQ	0.06***	0.01	1.06	0.08***	0.02	1.08	0.07***	0.01	1.07
Step 2									
SDQ emotional symptoms	−0.09	0.09	0.92	0.01	0.08	1.01	−0.03	0.09	0.97
SDQ conduct problems	−0.20	0.12	0.82	−0.23	0.13	0.80	−0.26*	0.12	0.77
SDQ hyperactivity-inattention	0.01	0.09	1.01	0.01	0.10	1.01	0.11	0.10	1.11
SDQ peer problems	0.41***	0.11	1.50	0.43***	0.11	1.54	0.39***	0.11	1.48
SDQ prosocial behavior	−0.06	0.10	0.94	0.02	0.11	1.02	−0.04	0.11	0.96
Step 3									
SDQ impact score	0.25**	0.10	1.28						
VABS-II composite score				−0.09***	0.02	0.91			
CGAS total score							−0.10***	0.02	0.91

ASD – autism spectrum disorder; *B* – estimated change in log odds for a one-unit change in the independent variable; *S.E.* – standard error; *OR* – odds ratio; FSIQ – Full Scale Intelligence Quotient; SDQ – Strengths and Difficulties Questionnaire; VABS-II – Vineland Adaptive Behavior Scales II; CGAS – Children's Global Assessment Scale. * $p < .05$, ** $p < .01$, *** $p < .001$.

[a]Overall model: χ^2 (9) = 61.72***. Cox & Snell R^2 = .20, Nagelkerke R^2 = .35. $\Delta\chi^2_{1step}$ = 21.06***; $\Delta\chi^2_{2step}$ = 33.48***; $\Delta\chi^2_{3step}$ = 7.17**.

[b]Overall model: χ^2 (9) = 73.72***. Cox & Snell R^2 = .24, Nagelkerke R^2 = .41. $\Delta\chi^2_{1step}$ = 21.06***; $\Delta\chi^2_{2step}$ = 33.48***; $\Delta\chi^2_{3step}$ = 19.17***.

[c]Overall model: χ^2 (9) = 78.09***. Cox & Snell R^2 = .25, Nagelkerke R^2 = .44. $\Delta\chi^2_{1step}$ = 21.06***; $\Delta\chi^2_{2step}$ = 33.48***; $\Delta\chi^2_{3step}$ = 23.53***.

Table 5. Percentage of children with ADHD (n = 40) and ASD (n = 48) at different impairment levels as measured by VABS-II composite score, CGAS total score and SDQ impact score.

	At least mild impairment (%)		Definite impairment (%)	
	ADHD	ASD	ADHD	ASD
SDQ impact score	98	92	96	83
VABS-II composite score	100	98	83	83
CGAS total score	98	96	78	78

ADHD – attention deficit/hyperactivity disorder; ASD – autism spectrum disorder; SDQ – Strengths and Difficulties Questionnaire; VABS-II – Vineland Adaptive Behavior Scales II; CGAS – Children's Global Assessment Scale. Cutoffs for mild/borderline and severe/definite impairment: SDQ impact score cutoffs: 1 and 2; VABS-II cutoffs 85 and 70; CGAS cutoffs 70 and 60.

The overall regression models for an ADHD diagnosis were significant (Table 3, footnote). The first two steps in all three models were significantly associated with an ADHD diagnosis. There were differences between the models in the third step (Table 3). The effect of the SDQ impact score in predicting an ADHD diagnosis was significant ($\Delta\chi^2_{3step} = 18.79^{***}$, $p < .001$), as was the effect of the VABS-II composite score ($\Delta\chi^2_{3step} = 4.36^{*}$, $p < .05$). The CGAS total score did not significantly improve the model ($\Delta\chi^2_{3step} = 1.27$, $p = .26$).

In relation to the association between functional impairment and an ASD diagnosis, results of overall regression analyses were also significant (Table 4, footnote). All three steps were significantly associated with an ASD diagnosis (Table 4). Prediction of an ASD diagnosis was significantly improved by the SDQ impact score ($\Delta\chi^2_{3step} = 7.17^{***}$, $p < .01$), VABS-II composite score ($\Delta\chi^2_{3step} = 19.17^{*}$, $p < .001$), and CGAS total score ($\Delta\chi^2_{3step} = 23.53$, $p < .001$).

We looked at the number of children with ADHD and ASD diagnoses that met the criteria of at least mild/borderline and severe/definite functional impairment as measured by the three chosen instruments (Table 5). Applying the selected cutoffs for at least mild/borderline functional impairment, 98 to 100% of children with an ADHD diagnosis ($N = 40$), and 92% (SDQ impact score) to 98% (VABS-II composite score) of children with an ASD diagnosis ($N = 48$), fulfilled the criterion. When applying cutoffs for severe/definite functional impairment, 78% (CGAS score) and 83% (VABS-II composite score and SDQ impact score) of children diagnosed with ADHD and ASD, and 83% children diagnosed with ASD and 95% children diagnosed with ADHD (SDQ impact score) fulfilled the criterion.

Sensitivity and Specificity of the SDQ Impact Score

The extent to which the SDQ impact score distinguished ADHD and ASD diagnoses was examined by computing sensitivity and specificity (i.e., false positives; Table 6). For the comparisons in ADHD diagnoses, a SDQ impact score of 8 (score range 0–10) gave the highest DLR of 2.81. For ASD diagnoses, a SDQ impact score of 10 gave the highest DLR (Table 6). However, all DLRs

Table 6. Sensitivity and false positives (1 – specificity) when applying SDQ impact score to determine ADHD and ASD diagnoses.

	ADHD			ASD		
SDQ impact score	Sensitivity	False positives	DLR	Sensitivity	False positives	DLR
1	97.8%	75.6%	1.29	91.7%	76.5%	1.20
2	95.7%	64.9%	1.47	83.3%	66.8%	1.25
3	89.1%	55.0%	1.62	72.9%	57.4%	1.27
4	69.6%	42.6%	1.63	64.6%	43.3%	1.49
5	58.7%	32.3%	1.82	50.0%	33.6%	1.49
6	47.8%	19.6%	2.44	45.8%	19.7%	2.32
7	39.1%	14.1%	2.77	31.3%	15.2%	2.36
8	26.1%	9.3%	2.81	22.9%	9.7%	2.36
9	13.0%	5.5%	2.36	16.7%	4.8%	3.48
10	2.2%	3.1%	0.71	8.3%	2.1%	3.95

ADHD – attention deficit/hyperactivity disorder; ASD – autism spectrum disorder; DLR – diagnostic likelihood ratio. Sensitivity is defined as the percentage of children who have the ADHD or ASD diagnosis and who were positively identified as belonging to these groups by their SDQ impact scores. Specificity is defined by the percentage of children without these diagnoses who were identified as not having functional impairment as measured by SDQ impact scores.

have poor discriminative value (Hayden & Brown, 1999; Søreide, 2009). In children with an ADHD diagnosis, the DLR was 1.29 for the cutoff of SDQ impact score equal to 1 (mild/borderline functional impairment), and 1.47 for the SDQ impact score cutoff equal to 2 (severe/definite functional impairment). In children with ASD, the corresponding DLRs were 1.2 and 1.25. The accuracy of the SDQ impact score in indicating ADHD and ASD diagnoses is revealed by the AUC in the ROC-analysis. AUC can be interpreted as the probability that a randomly selected individual with an ADHD or ASD diagnosis has a higher SDQ impact score than a randomly selected individual without this diagnosis in our neuropediatric sample. The AUC for those with an ADHD diagnosis was acceptable (.72), while the AUC for those with an ASD diagnosis was .65, interpretable as poor (Hosmer et al., 2013).

Discussion

The aim of this study was to examine partial validity and usefulness of the SDQ impact supplement in assessing functional impairment in children and adolescents diagnosed with ADHD and ASD in the neuropediatric clinics. Overall, the results of our study supported concurrent and convergent validity and usefulness of the SDQ impact supplement, with the nuances discussed below.

The SDQ impact supplement, which contains five questions regarding difficulties in different domains of social and everyday life functioning (family, friends, classroom learning, and leisure activities) and distress, was internally consistent. The SDQ impact score significantly correlated with other indicators of functional impairment. The correlation between the SDQ impact score and the VABS-II composite score met the minimum value ($r \geq 0.30$) to support convergent validity. The correlation between the SDQ impact score

and the CGAS total score fell just below the minimum value. The VABS-II and CGAS – both standardized clinical instruments – were more related to each other, possibly because both are clinician's evaluations based on the information achieved from a parent, in contrast to the SDQ that is a pure parentally reported measurement tool. In addition, the VABS-II and CGAS measure quite different aspects of functional impairment. The VABS-II is designed to assess problems in adaptive functioning compared to a typically developing population, and similarly to SDQ impact capture social impairment; while the CGAS captures functional impairment beyond adaptive skills, including symptom severity, rather than social and occupational impairment (Ditterline et al., 2016; Lewandowski et al., 2016; Smith et al., 2011; Ustun & Kennedy, 2009; Winters et al., 2005).

Because functional impairment is part of having ADHD or ASD (APA, 2013; WHO, 2018), it was expected that there would be an association between the diagnoses and the functional impairment expressed directly by the SDQ impact score. In the bivariate analyses, ADHD diagnosis correlated weakly with the SDQ impact score and the VABS-II composite score. ASD diagnosis was significantly, yet weakly correlated with all indicators of functional impairment. The reason for the quite low correlations observed may be that ADHD and ASD are neurodevelopmental disorders that are diagnosed based on many criteria, of which impairment is only one. Further, using a dichotomous diagnosis variable leads to reduced information that can attenuate correlations. Secondly, validity coefficients greater than .3 are fairly uncommon in applied settings, and the levels of concurrent validity rarely exceed .6 or .7 (Murphy & Davidshofer, 2013). Regression analyses confirmed the results of these initial bivariate analyses. The conclusion from multiple regression analyses could be that functional impairment expressed by the SDQ impact score increased the probability of an ADHD diagnosis. All indicators of functional impairment/adaptive functioning increased the probability of an ASD diagnosis.

We should be aware that the SDQ impact supplement was created as an extension of the SDQ, which focuses on screening for mental health caseness (Goodman, 1999) and is primarily used to evaluate functional impairment in these patients (Goodman, Renfrew et al., 2000). The stronger relationship observed between the SDQ impact score and ADHD than with ASD may be a direct result of the SDQ's application (e.g., the assessment of hyperactivity-inattention). However, when asking about impaired functions related to disorder symptoms, very general functional impairment areas, such as impairment related to family, friends, classroom learning, and leisure activities, in addition to distress, are listed. These can concern both children with ADHD and ASD, and in a study by Russell et al. (2013), children from both diagnostic groups were assessed with similar ranges of SDQ impact scores. The reason for this may be that these impairment domains are known to concern children

both with ADHD (Erskine et al., 2016; Wehmeier et al., 2010) and ASD (Kasari et al., 2011). The neuropediatric sample in our study consisted of children with complex difficulties (Gillberg et al., 2013), and children with ADHD and ASD had many co-existing diagnoses (see, Table 1) that might have resulted in functional impairment. We cannot conclude which specific symptoms of ADHD, ASD, or co-occurring mental disorder (e.g., Bakken et al., 2010; Mitchison & Njardvik, 2019; Simonoff et al., 2008; Taylor et al., 2011) may lead to a particular functional impairment (Vazquez et al., 2018), as the relationships between these factors are complicated and reciprocal (Dykens, 2000; Thapar & Rutter, 2015), and they often have a common biological vulnerability (Barnett et al., 2006).

The cutoffs we chose to define mild and definite functional impairment when measured by the SDQ impact supplement, VABS-II, and CGAS applied to children with ADHD and ASD diagnoses, and indicated that these instruments evenly captured functional impairment, indirectly confirming the concurrent validity of the SDQ impact supplement. Regardless of the instrument used, almost all children with an ADHD diagnosis were classified as having at least mild functional impairment. This number was a little lower among participants with ASD, but there were still no big differences observed across instruments. When applying the criterion of definite functional impairment, all the instruments classified around 80% of participants with ASD as impaired. The situation was different for ADHD, where the same percentages of participants as in the ASD group were classified as having definite functional impairment when using the VABS-II and CGAS, while almost all the participants with ADHD were so classified by the SDQ impact supplement. It is possible that the SDQ impact supplement is especially sensitive when uncovering functional impairment in participants with ADHD. When ADHD is suspected, a clinician may be especially committed to asking about level of function at home, with friends, at school, and in leisure activities, and actively use this information to assess whether the child has ADHD. It is also possible that parents tend to evaluate these children and adolescents as especially impaired when the assessment method does not demand specific descriptions of everyday situations, but instead just a general evaluation.

The validity coefficient (Bubany, 2007) is only one of many factors that determine the degree to which a test may change the quality of clinical decisions. Taking into account the sensitivity and specificity of a test is also important when considering its accuracy (Murphy & Davidshofer, 2013). The SDQ impact supplement at the assumed cutoffs of the SDQ impact score (i.e., 1 and 2) gave high sensitivity, but the likelihood ratios showed that these cutoffs gave many false positives. Therefore, it would be unreasonable to expect that the SDQ impact supplement could assess whether someone meets the diagnostic criteria of functional impairment. Obviously, the diagnostic accuracy of the SDQ impact supplement refers to the quality of the

information provided by the chosen cutoffs; however, the accuracy should be distinguished from the usefulness of the received information (Søreide, 2009). A test is not useful unless it leads to decisions that are significantly better than those taken randomly (Murphy & Davidshofer, 2013), and our results indicate that the SDQ impact supplement significantly, although slightly, improved the possibility to make clinical decisions. Here it is crucial to remember that our neuropediatric sample included children and adolescents referred for neuropsychological/neurological assessment. That kind of restricted sample can cause biased results (see, Angold et al., 1999). Indeed, the differences in SDQ impact score between participants with ADHD or ASD and other functionally impaired children in our study are certainly less pronounced than those expected between these diagnostic groups and a control group in a general population (Russell et al., 2013).

Taking into account the clinical context and the specific patient population, both significant correlations and significant associations of the SDQ impact score with the VABS-II composite score and the CGAS total score, and significant associations between the SDQ impact score and clinical diagnoses of ADHD and ASD, in addition to ROC-analyses on sensitivity and specificity, altogether indicate that the SDQ impact supplement shows indications of both convergent and concurrent validity in screening functional impairment in the neuropediatric population.

Strengths and Limitations

The strength of the present study included the possibility of comparing the SDQ impact supplement with other established instruments that measure functional impairment. Another strength was the use of a standardized assessment of children's intellectual function. The relationship between functional impairment and diagnoses were controlled for by a relatively broad range of correlates, including symptoms of general psychopathology, gender, age, and intellectual function. We studied a population with real clinical diagnoses and had a chance to see the level of functional impairment in children who had already been diagnosed – and then check to what degree these children were impaired in the eyes of their parents. At the same time, we know the influence that child functional impairment has on parents is an important factor for parents seeking medical/psychological help for their children and a common reason for referral (Angold et al., 1998; Burns et al., 1995; Sasser et al., 2017). Mapping functional impairment by parents of youths or children with decreased ability to communicate these difficulties is especially important, as parents have easier access to children's visible impairment than to their internal distress (Colburn et al., 2018), and, generally, recognizing psychological problems is commonly inferred from impairments caused by the problem (Ezpeleta et al., 2001). An advantage of the SDQ impact supplement is its

cultural and context neutrality (see: Haack & Gerdes, 2011), as the parent is generally asked about the child's problems in everyday life areas without pointing out specific situations.

We should note some limitations in our study as well. First of all, we wonder if it is acceptable to use a short form to evaluate a phenomenon as complex as functional impairment (Winters et al., 2005). However, Bird et al. (1997) supported using global measures of impairment both for epidemiological and clinical purposes. We employed a clinical sample, with children that were referred for neuropediatric assessment; this presupposes that their parents probably saw them as impaired, so the results are limited to comparable clinical populations. There is both a statistical and conceptual problem with criterion-related validation of a test in a preselected sample, which makes it difficult to generalize the results to decision-making in the general population (Guion & Cranny, 1982). The observed associations may be less significant, as the variation in a selected population is restricted (i.e., participants are too similar to each other and too different from other samples), (Murphy & Davidshofer, 2013).

In addition, the cross-sectional design precludes any interpretations regarding the causality of the identified associations. The diagnostic groups were small and many of the children had co-existing neurodevelopmental or neurological disorders. Moreover, several had co-existing mental health problems (Halvorsen et al., 2019). A large proportion of the children in our sample were more or less functionally impaired. The SDQ impact score is not specific to a disorder: functional impairment can exist due to many different symptoms. Ratings of symptoms and impairment are at best moderately correlated, because symptoms are not proxies for impairment (Lewandowski et al., 2006). Obviously, the best way to determine functional impairment specific to some symptoms is to screen all the important areas of functioning. However, such advanced measurement methods should include parameters of impairment that are diagnosis-specific, otherwise there is a risk of a halo effect in ratings for specific impairments (Bird et al., 2000). We should also be aware that functional impairment can be caused by both symptoms and an unadjusted environment (WHO, 2001).

Conclusion

Using established cutoffs (Goodman, 1999), we demonstrated the sensitivity of the SDQ impact supplement to detect functional impairment in children with ADHD and ASD, but this comes at a cost of low specificity (large proportion of false positives). Thus, the SDQ impact supplement is not suitable for capturing functional impairment specific to these diagnoses; however, it is valid in capturing general functional impairment in a neuropediatric population. In addition, the SDQ impact supplement is easy to use, and can be especially

convenient, as it provides useful information about functional impairment as seen by parents without taking up much of parents' time and while saving clinicians' time.

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