Psychometric Properties of the Norwegian Aberrant Behavior Checklist and Diagnostic Relationships in a Neuro-pediatric Sample

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Abstract

Introduction: Although the Aberrant Behavior Checklist (ABC) is one of the most widely used behavioral rating scales among people with developmental disabilities, very few studies have examined the factor structure of the non-English versions.*Methods:* The construct validity of the Norwegian ABC was examined in a clinical sample of children and adolescents with neurological and neurodevelopmental disorders ($N = 339$). Diagnoses were obtained from direct interdisciplinary assessments in our neuro-pediatric clinics. *Results*: In an exploratory factor analysis, 46 of the 58 items (79%) loaded most heavily on four of the five original factors in the English version. Confirmatory factor analysis revealed less-than-optimal fit indices for the five-factor solution. Internal consistency was adequate to excellent for all subscales (α range = .76–.95). The ABC showed meaningful overlap and differentiation with the Strengths and Difficulties Questionnaire, the Behavior Rating Inventory of Executive Function, the Vineland Adaptive Behavior Scales, and full scale IQ. There were positive correlations between several of the ABC subscales and diagnoses of attention deficit/hyperactivity disorder, autism spectrum disorder, oppositional defiant disorder, and emotional disorder

Conclusion: Satisfactory psychometric properties were found for the ABC, with the exception of the Inappropriate Speech factor, in a mixed sample of higher functioning children and adolescents with neurodevelopmental and neurological disorders.

Key words: Aberrant Behavior Checklist; Attention Deficit/Hyperactivity Disorder; Autism Spectrum Disorder; Mental Health Problems; Neurodevelopmental disorders

Word count: 6408

Psychometric Properties of the Norwegian Aberrant Behavior Checklist in a Neuro-pediatric Sample and Diagnostic Relationships

Introduction

Children and adolescents with neurodevelopmental disorders such as attention deficit/ hyperactivity disorders (ADHD), autism spectrum disorder (ASD) and intellectual disability (ID) have a high risk of comorbid behavioral and emotional problems compared with typically developing children (Einfeld, Ellis, & Emerson, 2011; Larson, Russ, Kahn, & Halfon, 2011; Simonoff et al., 2008). These mental health problems often emerge in early development, are relatively persistent, and interfere with the child's and the family's everyday life (Einfeld et al., 2006; Herring et al., 2006; Larson et al., 2011). The Aberrant Behavior Checklist (ABC) is one of the most frequently used behavioral rating scales among people with developmental disabilities (XX, 2017 [removed due to blind peer review]). As an instrument empirically derived by principal component analysis, the ABC was developed to provide clinical information about broad clusters of inappropriate and maladaptive behavior among people with developmental disabilities. Its five subscales are called Irritability, Social Withdrawal, Stereotypic Behavior, Hyperactivity/Noncompliance, and Inappropriate Speech. The ABC is sensitive to both pharmacological and psychosocial treatment effects (XX, 2017 [removed due to blind peer review]), and can differentiate between behavioral phenotypes in people with neurodevelopmental disorders (XX, 2017 [removed due to blind peer review]).

XX (2017) [removed due to blind peer review] recently reviewed 14 studies that explored the factor structure of the ABC beyond the initial study (XX, 1985, [removed due to blind peer review]) reporting the ABC's original development. These samples comprised groups of children, adolescents, and adults, mostly with idiopathic ID. In general, factor structure was fairly consistent across age groups, region, and language in which the ABC was presented. Two studies of individuals with fragile X syndrome (Sansone et al., 2012; Wheeler et al., 2013) provided partial evidence for a factor called Social Avoidance that separated

from other items that ordinarily cluster with the Social Withdrawal subscale. This possible deviation in factor structure for individuals with fragile X syndrome awaits further confirmation (as the findings from Wheeler et al. 2013 did not separate as persuasively as those of Sansone et al. 2012). A study by XX (2013) [removed due to blind peer review] indicated that the factor structure for the ABC persisted with children diagnosed with ASD.

Given that the ABC appears in at least 35 languages, it is important to establish linguistic equivalence and to determine consistency of factor structure whenever possible. To the best of our knowledge, only three studies have examined the factor structure of the non-English language ABC versions. Ono (1996) translated the ABC into Japanese and had support staff members rate 322 ambulatory children living in residential facilities maintained by a regional district. Exploratory factor analysis indicated that the factor structure of the Japanese language version was highly consistent with the English version, with 48 of 58 items (83%) loading most heavily with the same respective factors. Siegfrid (2000) translated the ABC into traditional Chinese, and asked support staff members to rate 306 adults attending hostels, sheltered workshops, and activity day centers. In all, 49 of the 58 items (84%) emerged on congruent factors, and Siegfrid concluded that the ABC was a valid and reliable assessment instrument. Lehotkay et al. (2015) translated the ABC into Telugu, an Indian language, and had staff members rate 120 children, adolescents and adults with ID living in residential facilities. Confirmatory factor analysis revealed a factor structure comparable to the original English version.

The Norwegian ABC was used to estimate prevalence of behavioral problems among adolescents and adults with ID in community samples (Martinez-Leal et al. 2011; Myrbakk & Tetzchner, 2008a; 2008b). However, the factor structure of the Norwegian version has not yet been examined. Accordingly, the aims of the present study were to evaluate the factor structure and psychometric properties of the Norwegian ABC in a relatively large neuro-

pediatric outpatient sample of children with neurological and neurodevelopmental disorders. Based on previous psychometric studies (XX 2017 for review [removed due to blind peer review]), we hypothesized that a five factor solution would emerge consistent with the original scale (XX, 1985 [removed due to blind peer review]).

We also included assessment of convergent and divergent validity of the ABC in relation to the Vineland Adaptive Behavior Scales (i.e., VABS-II; Sparrow, Cicchetti, & Balla, 2011), more specific behavior rating scales (i.e., the Strengths and Difficulties Questionnaire [SDQ; Goodman, 1999] and the Behavior Rating Inventory of Executive function [BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000]), and a Wechsler intelligence test. We hypothesized that we would see: i) inverse correlations between ABC Social withdrawal on the one hand and VABS-II Communication and VABS-II Socialization on the other hand; ii) positive correlations between ABC and SDQ subscales and BRIEF Behavioral Regulation Index that assess externalizing symptoms and between ABC Social Withdrawal and SDQ emotional problems; iii) a negative correlation between ABC Social Withdrawal and SDQ Prosocial behavior; and iv) inverse correlation between ABC Stereotypic Behavior and full scale IQ (FSIQ). We also expected younger children to have higher scores for the ABC Hyperactivity/Noncompliance subscale, and boys to have higher scores on the ABC Hyperactivity/Noncompliance and Stereotypic Behavior subscales than girls. Finally, we examined ABC subscales as predictors of concurrent diagnostic categories (i.e., ADHD, ASD, ID, Emotional disorder, and oppositional defiant disorder [ODD]) using logistic regression analyses. We predicted that: i) ABC Hyperactivity/Noncompliance would be related to an ADHD diagnosis; ii) ABC Social Withdrawal would be related to an ASD diagnosis; and iii) ABC Irritability and Hyperactivity/Noncompliance would be related to presence of an ODD diagnosis.

Methods

Participants

Three hundred and thirty-nine children and adolescents (220 boys and 119 girls) participated in the study. The children were referred for a developmental/neurological assessment to the neuro-pedatric outpatient clinics at the University Hospital of North Norway (UNN) (n = 285) and the Finnmark Hospital Trust (n = 54) by general practitioners (n = 232) or medical practitioners in specialist health services (n = 107). The neuro-pediatric outpatient clinics are health service units in the counties of Troms and Finnmark in northern Norway serving a population of 266,000 residents. These facilities provide services to children and adolescents with neurodevelopmental disorders or early-acquired neurological disabilities. Assessments in the clinics were interdisciplinary and included specialists such as paediatricians, neuropsychologists, special education therapists, and physiotherapists. The exclusion criteria for this study included an age below four years. This is due to a lack of suitability of one or more of the instruments for that age group. In addition, a lack of parental fluency in Norwegian was also a criterion for exclusion. The participants were between 4 and 18 years of age (M = 10.12, SD = 3.86). The numbers of participants in different age groups were: a) 4–7 years = 105 (31.0%), b) 8–12 years =123 (36.3%), and c)13 –18 years = 111 (32.7%). The mean FSIQ, as assessed by an individualized intelligence test, was 76.31 (SD = 17.11, range 40-140), and the mean adaptive level of functioning, as assessed by the VABS-II (Sparrow et al., 2011) standard score, was 67.06 (SD = 15.21, range 20-112) (see Tables 1 and 3). Approximately half of the parents had college or university degrees (56.1 %), and 39.3% had a high school diploma.

The most frequent neurodevelopmental disorders in the sample were, in descending order: (a) specific developmental disorders (33.0%), (b) ID (20.4%, none with severe IDs), (c) other diseases of the nervous system such as epilepsy and cerebral palsy (17.7%), (d) ASD (15.6%), (e) ADHD

(13.9%), and (f) congenital malformations and chromosomal abnormalities (12.4%). The diagnoses were not mutually exclusive, so a given subject could have more than one diagnosis. Accordingly, among children with ASD, 17.0% had a comorbid diagnosis of ID, 9.4% had a comorbid ADHD diagnosis, and 22.6% had a comorbid diagnosis of other developmental/neurological disorders. Among children with ADHD, 19.1% had a comorbid diagnosis of ID, 10.6% had a comorbid ASD diagnosis, and 51.1% had a comorbid diagnosis of other developmental/neurological disorders (mostly specific developmental disorder). In addition, 13.9% of the sample did not receive a neurodevelopmental and/or neurological disorder diagnosis (70.2% boys, mean age 11.15 (*SD* = 3.96), mean FSIQ 88.91 (*SD* = 19.14), mean VABS-II total score 76.30 (*SD* = 13.97).Comorbid emotional disorders (anxiety disorders $n = 53$; major depression $n = 16$) and/or disruptive behavior disorder (ODD $n = 40$; conduct disorder $n = 6$), as assessed by the Developmental Well-Being Assessment (DAWBA; Goodman, Ford, Richards, Gatward, & Meltzer, 2000), were present in 13.0% and 13.6% of the participants, respectively. For further description of the design and samples, see XX et al. [removed due to blind peer review] (2018, 2019).

Measures

The ABC–Community (XX, 1994; XX, 2017 [removed due to blind peer review]) is a rating scale with 58 items for assessing behavior problems in children, adolescents, and adults with intellectual disability. The items are summed within five subscales: (I) Irritability (15 items), (II) Social Withdrawal (16 items), (III) Stereotypic Behavior (7 items), (IV) Hyperactivity/Noncompliance (16 items), and (V) Inappropriate Speech (4 items). Each item is rated on a four-point scale from (0) not a problem, through (3) the problem is severe. The Norwegian version of the ABC was developed for research purposes (Myrbakk & Tetzchner, 2008a; 2008b). It was translated with permission from the publisher/authors by clinical psychologist Even Myrbakk. Myrbakk translated the ABC to Norwegian, and it was back-

translated by a native English-speaking independent clinician with extensive experience in the ID/neurodevelopmental disorder field. Various forms of reliability and validity have been shown to be satisfactory in a wide range of studies with the English-language ABC but also with the Japanese, Chinese and Indian versions (XX, 2017 [removed due to blind peer review]; Lehotkay et al., 2015).

The DAWBA (Goodman et al., 2000) was used to establish diagnoses of emotional and behavioral disorders based on DSM-IV (APA, 2000) diagnostic criteria (www.dawba.info). Three different versions are available: a detailed psychiatric interview for parents that required approximately 50 min and was completed by the majority of parents in the present study (n = 310); a 30-min youth interview (n = 106); and a brief 10-min questionnaire for teachers (n = 224). The DAWBA has shown good ability to discriminate between population-based and clinic-based samples and between different diagnoses (Goodman et al., 2000). In both Norway and Great Britain, the DAWBA generates realistic estimates of the prevalence of mental illnesses; it also has a high predictive validity when used in public health services (Heiervang et al., 2007; Meltzer, Gatward, Goodman, & Ford, 2003). Good-to-excellent interrater reliability has been reported in both British and Norwegian studies, with k = 0.86-0.91 reported for any diagnoses, k = 0.57- 0.93 for emotional diagnoses, and k = 0.93-1.0 for conduct disorders (Ford, Goodman, & Meltzer, 1999; Heiervang, Goodman, & Goodman, 2008). Good to excellent agreement between diagnoses from clinical practice and diagnoses based solely on the DAWBA has also been reported, with k = 0.57-0.76 (Foreman & Ford, 2008; Foreman, Morton, & Ford, 2009).

The SDQ parent version (Goodman, 1999) was used to assess mental health symptoms. The SDQ, which is administered as part of the DAWBA (Goodman et al., 2000), is a 25-item mental health questionnaire covering four problem areas (emotional, hyperactivity-inattention, conduct, and peer problems), one area of strength (prosocial

behavior), and additional questions related to distress and functional impairment. Each item is rated on a three-point scale from 0 (not true) through 2 (certainly true). In the current study, we included the SDQ problem scales and the strength scale. The SDQ has been validated in different cultures, with results indicating good psychometric properties (Achenbach et al., 2008). The SDQ scores were missing for 23 children.

The BRIEF parent form (Gioia et al., 2000) is composed of 86 items. Parents indicate whether their children, aged 5 to 18 years, exhibit problems with specific behaviors within the eight theoretically and clinically derived domains. In the standard version, the Behavior Regulation Index score (BRI) is computed from the Inhibit, Shift, and Emotional Control subscales. The Metacognition Index (MCI) is based on scores from the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor subscales. The Global Executive Composite is a summary score that incorporates all eight clinical subscales. Parents respond to how often their child displayed a given behavior (e.g., "forgets what he/she was doing" or "talks at the wrong times" from the Working Memory and Inhibit scales, respectively) in the past six months on a three-point Likert scale (never, sometimes, and often), with higher scores indicating poorer executive function. The BRIEF scores were missing for 53 children, in addition to 19 children who were below 5 years.

The VABS-II (Sparrow et al., 2011), a semi-structured interview, was used to establish the child's adaptive level of functioning and includes the following 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, the total, Communication, Daily Living Skills, and Socialization scores were used. VABS-II scores were missing for twenty children.

Intellectual function. The children were individually assessed with a standardized Wechsler Intelligence Scale appropriate for their ages (WPPSI, WISC; Wechsler, 2007, 2008a, 2008b, 2009, 2012). For a small number of children (n = 13), we used the FSIQ score from the Raven's Colored Progressive Matrices (Raven, 2004) because of insufficient completed subtests on the Wechsler test to estimate FSIQ. The intellectual level was defined by the FSIQ score. For thirty-eight children, the FSIQ scores were missing due to the administration of a test appropriate for chronologically younger children. These children were not included in the analyses relying on the FSIQ.

Procedure

The children underwent the ordinary interdisciplinary assessment of neurodevelopmental/neurological disorders and an additional assessment of the presence of comorbid behavioural and emotional disorders at the same time, typically over two consecutive days. Paediatricians specializing in neurology examined subjects for the presence of a neurological/neurodevelopmental disorder; the examinations included, for instance, MRI Caput, EEG and/or genetic testing if indicated. Children with muscle disease or motor delays were also examined by a physiotherapist. All children were examined by a clinical psychologist/neuropsychologist; these examinations included a standardized intelligence scale and the VABS-II. Diagnoses of neurological and neurodevelopmental disorders, including ASD, ADHD, and ID, were obtained from interdisciplinary assessments in the neuropaediatric clinics. The ICD-10 criteria (World Health Organization [WHO], 1993, 2010) were used to code diagnoses. The presence of an ID was operationalized as scoring below 70 on *both* the standardized intelligence test and the VABS-II. The parents and children who agreed to participate, in addition to their teachers, further underwent an assessment (using the web-based version of the DAWBA) of the presence of comorbid mental disorders among the children. After completion of the DAWBA interview, two expert raters (X and Y, both of

whom are senior clinical specialists in neuropsychology with at least 15 years of experience in the field and are trained in DAWBA rating (Publication removed due to double-blind peer review), generated diagnostic ratings based on the structured (yes/no) and semi-structured (free text) answers provided by parents, teachers and young persons after reviewing the full DAWBA information (XX et al., [removed due to blind peer review] 2018, 2019). The decision rules from the DSM-IV (APA, 2000) diagnostic criteria were used. Comorbidity was registered whenever the diagnostic criteria for more than one diagnosis were met, without attention to the exclusion rules of the DSM-IV. To ensure that there were enough cases for analysis, we grouped the diagnoses into categories: emotional disorders (diagnoses related to separation anxiety, specific phobias, social phobia, panic attacks and agoraphobia, post-traumatic stress disorder, generalized anxiety, compulsions and obsession, depression, and deliberate self-harm) and conduct disorders (diagnoses related to awkward and troublesome behaviour).The parents completed the ABC on the same day as the neuro-pediatric assessments. Informed consent was obtained from all individual participants included in the study. The study was approved by the appropriate ethics committee. The data protection officer at UNN and Finnmark Hospital Trust approved the use of de-identified data for research purposes.

Data Analyses

To examine how well the original five-factor structure would fit the Norwegian version of the ABC-C, exploratory and confirmatory factor analyses were conducted. For the exploratory analyses, Prinicipal Components Analysis with Promax rotation (Hendrickson & White, 1964) was used, and the number of factors was determined by an inspection of the Scree-plot (Cattell, 1966). We also examined the factor structure via confirmatory factor

analysis (CFA) using Mplus 7.4 to examine the fit between the original five-factor solution and the present data. For comparison purposes, also the simpler one-factor solution was estimated. To evaluate model fit several goodness of fit indices were calculated. This included in addition to the overall χ^2 statistics, root mean squared error of approximation (RMSEA), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI). The following "rule-of thumb" criteria for the relative fit indices were used: RMSEA ≤ 0.06, TLI and CFI ≥ 0.90 or preferably 0.95 (Hu & Bentler, 1998, 1999). The χ^2 statistic represents the difference between the hypothesized and the observed model where a low value (preferably non-significant) indicates a good fit. However, as this index also depends on sample size and model size, a significant χ^2 may represent a well-fitting model (Cheung & Rensvold, 2002).

The remaining statistical analyses were conducted using SPSS 24. To address the relationship between ABC subscales, convergent and divergent validity, age and gender Pearson's correlations were used. Cohen's criteria (1988) for what constitute a small, medium and large effect were employed (r = .10, .30, and .50, respectively). Hierarchical logistic regression analyses were conducted to examine ABC subscales as predictors of diagnostic groups after controlling for age, gender, and FSIQ. For all analyses, the independent variables included age; gender (0 = girl, 1 = boy); FSIQ, and the ABC subscales. The dependent variables were the dummy variables ADHD (without ASD or ID), ASD (without ADHD or ID), ID (without ADHD or ASD), ODD, and emotional disorders. Tolerance values were inspected to examine the possibility of multicollinearity. For the present data set, a minimal tolerance problem was not observed for any of the predictors. The following guidelines were used for assessing the effect sizes: (a) an OR of 1.68 was treated as a small effect, (b) an OR of 3.47 as a medium effect, and (c) an OR of 6.71 was regarded as large (Chen, Cohen, & Chen, 2010). The equivalent values for OR less than 1.00 would be 0.59 (small effect), 0.29 (medium effect), and 0.15 (large effect).

Results

Participant characteristics and ABC scores

Table 1 shows the demographic data for the main diagnostic groups, and Table 2 provides the means, standard deviations, internal consistency, and inter-correlations for the ABC subscales. With the exception of Emotional disorder, the main diagnostic groups (i.e., ADHD, ASD, ID, and ODD) had a predominance of males consistent with findings from epidemiological studies (Thapar & Rutter, 2015). Overall, the average ABC scores were similar or slightly lower to those reported for community samples (XX, 2002; XX, 1992 [removed due to blind peer review]). The Cronbach's α coefficients were adequate to excellent, with coefficients ranging from .76 – .95 (EFPA, 2013). The ABC subscales were moderately to highly correlated with one another (r between .41 and .78, $p < .001$).

Table 1

Table 2

Factor analyses results

The exploratory analysis indicated five factors based on an inspection of the Scree-plot. This solution accounted for 55% of the total common variance. The results are presented in the Appendix. A total of 46 of the original 58 items (79%) loaded most heavily on their

original factor based on the English version (XX, 1985[removed due to blind peer review]). The three items related to self-injurious behaviour from the Irritability factor loaded on a separate factor. The four items originally from the Inappropriate Speech factor did not form a separate factor, and had low loadings on the other factors. Accordingly, the four factors (Irritability, Social Withdrawal, Stereotypic Behavior, and Hyperactivity) seem to correspond to their respective factors in the original ABC, but not the Inappropriate Speech factor.

The confirmatory factor analysis results were estimated for a one factor model (RMSEA = 0.112, TLI = 0.490, CFI = 0.507) and a five-factor model (RMSEA = 0.091, TLI = 0.665, CFI = 0.679). The χ^2 values were significant for both models. The five factor model had better fit indices compared to the one-factor model, but the fit-indices were still below the recommended values. A six-factor model with items related to self-injurious behaviour as a separate factor, was also tested with slightly better fit-indices compared to the five-factor model, but still below recommended values (RMSEA = 0.085, TLI = 0.706, CFI = 0.719).

Relationship between ABC and demographic/clinical variables

Table 3 shows the correlations among the examined variables as well as descriptive statistics. As expected, ABC Social Withdrawal was negatively correlated to VABS-II Communication and VABS-II Socialization. In fact, all ABC subscales were moderately to weakly correlated with VABS-II domain scales (r between -.22 and -.51, $p < .001$). The highest correlations were between VABS-II Socialization and ABC subscales (r between -.33 and -.51, $p < .001$). Moreover, as expected ABC and SDQ scales reflecting externalizing symptoms (i.e., ABC Irritability, ABC Hyperactivity/Noncompliance, SDQ Behavioral problems, and SDQ Inattention/Hyperactivity problems) were moderately correlated (r between .44 and .64, $p < .001$). Likewise, the BRIEF Behavioral Regulation Index (reflecting problems with inhibition, mental flexibility, and emotional control) was strongly correlated

with the ABC Irritability and Hyperactivity/Noncompliance subscales (r = .80 and .77, p < .001, respectively). ABC Social Withdrawal was as expected moderately to weakly correlated with both SDQ Emotional Problems and SDQ Prosocial Behavior (r < .40). Unexpectedly ABC Stereotypic Behavior was not significantly related to FSIQ, as were none of the other ABC subscales. In relation to age, younger children had significantly higher scores on all ABC subscales except Social Withdrawal and Stereotypic Behavior. Boys had significantly higher scores on the ABC Hyperactivity/Noncompliance and Stereotypic Behavior scales than girls. Correlations between ABC subscales and diagnostic categories were in the expected directions (Table 3).

Table 3

Relationship between ABC factors and diagnostic status

In the regression analyses shown in Table 4, the overall model predicting the presence of an ADHD diagnosis was significant [$\chi^2(8) = 17.03, p = .03$] and correctly predicted 90.7% of the group memberships. Regarding the ABC factors, the ABC Hyperactivity/Noncompliance independently predicted a diagnosis of ADHD after controlling for age, gender, and the FSIQ score. The OR was 1.07 reflecting a small effect. The overall model predicting the presence of ASD was significant [$\chi^2(8) = 53.09, p < .001$] and correctly predicted 89.4% of the group memberships. ABC Social Withdrawal was the only significant predictor among the ABC factors after controlling for age, gender, and the FSIQ score. The OR was1.12 reflecting a small effect. Likewise, the overall model predicting the presence of ID was significant [$\chi^2(8) = 106.18, p < .001$] and correctly predicted 84.7% of the group

memberships. None of the ABC subscales were a significant predictor after controlling for age, gender, and the FSIQ score. Regarding the presence of ODD, the overall model was significant [$\chi^2(8) = 52.15, p < .001$] and correctly predicted 85.2% of the group memberships. The ABC Irritability subscale independently predicted a diagnosis of ODD after taking into account age, gender, and the FSIQ score. The OR was 1.14 reflecting a small effect. Finally, the overall model predicting the presence of an emotional disorder was significant [$\chi^2(8) = 65.97, p < .001$] and correctly predicted 87.7% of the group memberships. The ABC Irritability and Social Withdrawal subscales were significant predictors after controlling for age, gender, and the FSIQ score. OR was 1.19 and 1.13, respectively, reflecting effects of small magnitude.

Table 4

Discussion

Although the ABC is one of the most widely used behavioral rating scales among people with developmental disabilities, very few studies (all with Asian participants) have examined the factor structure of the non-English versions (Lehotkay et al., 2015; Ono, 1996; Siegfrid, 2000). Therefore, the aim of the present study was to examine the psychometric properties of the Norwegian ABC in a varied neuropediatric outpatient sample.

In largely keeping with the first hypothesis, we found that 46 of the 58 items (79%) loaded most heavily on four of the original five ABC factors (Irritability, Social Withdrawal, Stereotypic Behavior, and Hyperactivity/Noncompliance) in the exploratory factor analysis

(EFA). However, the Inappropriate Speech factor did not emerge with three of its four items loading on the Hyperactivity/Noncompliance and/or Stereotypic Behavior factors. Difficulties in replicating the Inappropriate Speech factor have been reported in a minority of studies among children and adolescents (e.g., XX, 2002; XX, 1992 [removed due to blind peer review]). Furthermore, we found that the three self-injurious behavior (SIB) items from the Irritability subscale emerged as a separate factor. Frequency of SIB in the sample was very low with only 12 participants (3.5%) receiving a total combined score of 3 or greater (Brinkely et al., 2007). An SIB factor has also been reported among children and youth with ASD (Brinkley et al., 2007), Fragile X syndrome (Sansone et al. 2011), and idiopathic intellectual disability (XX, 1992 [removed due to blind peer review]). Brinkley et al. (2007) suggested that a separate SIB factor may be a characteristic unique to ASD, but other data show clear evidence of self injury coupled with other forms of irritability (XX., 2014[removed due to blind peer review]).

In the present study, confirmatory factor analyses (CFA) results showed that the original 5-factor model was preferred above a 1-factor (total score) model. However, the CFA indicated less-than-optimal factor fit for the original ABC model. The most plausible explanation for not replicating the Inappropriate Speech factor in the EFA and the less-than-optimal factor fit from the CFA is likely related to important subject differences between the current sample and the other purely developmental disability samples that have been studied before. Most previous samples have comprised individuals with ID and/or ASD (XX, 2017 [removed due to blind peer review]). The current study sample included a mix of children and adolescents with neurodevelopmental disorders (e.g., specific learning disorder, ADHD, ASD) and/or neurological disorders (e.g., cerebral palsy, epilepsy). That is, the sample was very heterogeneous with a minority of subjects having ID (20.4%, in which 84.6% had mild ID and only 15.4% with a moderate ID), the FSIQ range was from 40-140 ($M = 76.31$) with

numerous subjects having normal/typical IQ, and relatively few with ASD (15.6%). Accordingly, the sample had relatively good verbal skills. Previous studies not replicating the Inappropriate Speech factor (XX 2002, XX 1992; removed due to blind peer review) also used very diverse samples comprising children who had milder developmental disabilities and relatively good verbal skills. In addition, we cannot not rule out the possibility of cultural or language differences influencing scores on the Norwegian ABC. However, parental perceptions and reporting of behavioral symptoms in Norwegian have been found comparable to those of English parents on other scales (Heiervang, Goodman, & Goodman, 2008). Taken together, in the present study the original 5-factor solution had appropriate internal consistency for all subscales and four of the original 5-factors were found to be fairly robust. As with English-language studies, inclusion of non-English ABC studies has documented substantial concordance with the original factor content. Nevertheless, the ABC items related to inappropriate speech and to self injury deserve further careful examination in the future. We hope that further attention to these items will disclose whether the items truly behave differently than other translations or whether there were unique subject features in this study that resulted in atypical presentation or lower prevalence of behaviors.

In terms of convergent and divergent validity, we found meaningful overlap and differentiation between the ABC and other measures of behavioral issues, and adaptive functioning (i.e., SDQ, BRIEF, VABS-II) in the correlational analyzes. More specifically, the Social Withdrawal subscale was inversely related to VABS-II Communication and Socialization, and SDQ Prosocial behavior, and positively related to SDQ Emotional Problems. We found positive correlations between the ABC and the SDQ and BRIEF indexes assessing externalizing symptoms. We did not find a significant inverse correlation between the Stereotypic Behavior subscale and FSIQ. Once again, this likely can be attributed to our sample composition of relatively high-functioning children in terms of FSIQ as previous

studies reporting an inverse relation included more disabled participants (i.e., mostly severe/profound ID XX, 2017 [removed due to blind peer review]). Overall, we found age and gender effects in line with our predictions. That is, younger children had significantly elevated scores on most of the ABC subscales with exception of the Social Withdrawal and Stereotypic Behavior subscales (consistent with XX, 2002 [removed due to blind peer review]). In addition, boys had elevated scores on the Hyperactivity/Noncompliance and Stereotypic Behavior subscales.

An examination of the predictive/criterion validity of parental ratings of the original ABC factors using logistic hierarchical regression, controlling for the variance explained by age, gender and FSIQ, showed that the ABC Hyperactivity/Noncompliance subscale was related to an ADHD diagnosis. Likewise, the ABC Social Withdrawal was related to an ASD diagnosis, and ABC Irritability was associated with an ODD diagnosis. Unexpectedly, we did not find ABC Hyperactivity/Noncompliance to be related to a concurrent ODD diagnosis in the hierarchical regression analyses. This was probably due to the considerable overlap between the Irritability and Hyperactivity/Noncompliance subscales ($r = .78$). We also found that the ABC Irritability and Social Withdrawal subscales were related to concurrent Emotional diagnoses after controlling for age, gender, and FSIQ.

The results of the present study should be interpreted in light of several methodological limitations. The diagnoses of ADHD and ASD were based on the ICD-10 criteria and were obtained from medical records. Accordingly, the diagnosis of ADHD required the combination of inattention and hyperactivity-impulsiveness symptoms, and thus the generalizability for the present study's findings for the DSM-V (APA, 2013) and ADHD subtypes of predominantly inattentive and hyperactivity/impulsive presentations should be examined in future studies. The diagnoses of neurodevelopmental disorders were obtained from interdisciplinary assessments, including those of pediatricians and specialists in clinical

neuropsychology. However, only spare information was available regarding whether the diagnoses were based on standardized diagnostic interviews. Conversely, the sample was well described in terms of FSIQ and adaptive functioning (VABS-II scores), and the diagnoses of ODD and emotional disorders were obtained from a structured diagnostic interview (DAWBA). Thus although test-retest stability of parental reporting was not evaluated, the present study was a fairly thorough examination of the psychometric properties of the Norwegian ABC.

In conclusion, the ABC was developed for assessing broad clusters of inappropriate and maladaptive behavior among people with developmental disabilities. Few previous studies have examined the psychometric properties for non-English versions, especially among more mildly impaired youth. Overall, the present study confirms that the Norwegian translation is useful for assessing most ABC domains. However, items from the Inappropriate Speech subscale and those related to self injury did not replicate in the exploratory factor analysis. Further data from more impaired youth will help to elucidate whether this reflects a weakness of the translation or presence of relatively mild symptoms for these children.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Table x

Supplemental table/appendix

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Table 1

Demographic Characteristics for Main Diagnostic Groups

Diagnostic Group	*n*	Sex		Age	IQ	Parents with a college/university degree
		Males (%)	Females (%)	*M* (*SD*)	*M* (*SD*)	(%)
ADHD	34	28 (82.4)	6 (17.6)	11.00 (3.35)	80.26 (12.20)	15 (48.4)
ASD	40	28 (70.0)	12 (30.0)	9.60 (3.88)	93.32 (13.10)	25 (67.5)
ID	52	30 (57.7)	22 (42.3)	9.62 (4.04)	58.44 (7.63)	22 (51.2)
ODD	46	32 (69.6)	14 (30.4)	10.33 (3.13)	78.24 (16.28)	24 (54.6)
Emotional disorder	44	20 (45.5)	24 (54.5)	11.80 (3.70)	75.05 (14.45)	17 (45.9)
Total	339	220 (64.9)	119 (35.1)	10.12 (3.86)	76.31 (17.11)	173 (56.1)

Note. ADHD (without ASD or ID). ASD (without ADHD or ID) and ID (without ADHD or ASD). The subgroups do not reach an *N* of 339 because we only included subgroups relevant for the focus of this paper.

Table 2

Descriptive Statistics, Cronbach's Alpha Values and Inter-correlations for the ABC Scales

ABC scale	α	*M* (*SD*)	1	2	3	4	5
1.Irritability	.92	6.12 (7.29)	-				
2.Social Withdrawal	.89	5.73 (6.22)	.49	-			
3.Stereotypic Behavior	.84	1.53 (2.73)	.47	.42	-		
4.Hyperactivity/Noncompliance	.95	9.70 (9.84)	.78	.41	.53	-	
5.Innapropriate Speech	.76	1.72 (2.26)	.60	.43	.58	.67	-

Note. All correlations were significant at $p < .001$ (two-tailed).

Table 3

Bivariate Relationships between ABC Subscales and Demographic/Clinical Variables

Variable	M (SD)/ n (%)	Irritability	Social Withdrawal	Stereotypic Behavior	Hyperactivity/ Noncompliance	Inappropriate Speech
Age	10.12 (3.86)	-.14**	.16**	-.09	-.24***	-.11*
Gender [1]	220 (64.9)	.01	.00	.11*	.15**	.07
FSIQ	76.31 (17.11)	-.02	.11	.04	-.01	-.02
VABS-II Communication	64.60 (13.90)	-.22***	-.27***	-.22***	-.33***	-.27***
VABS-II Daily Living Skills	74.31 (14.62)	-.26***	-.24***	-.24***	-.37***	-.33***
VABS-II Socialization	72.31 (15.61)	-.40***	-.41***	-.33***	-.51***	-.43***
VABS-II Total	67.06 (15.21)	-.32***	-.36***	-.31***	-.44***	-.39***
SDQ Emotional Problems	3.40 (2.62)	.38***	.36****	.14**	.19***	.23***
SDQ Behavioral Problems	2.03 (1.91)	.62***	.27***	.22***	.60***	.38***
SDQ Inattention/Hyperactivity	5.30 (2.61)	.44***	.21***	.31***	.64***	.47***
SDQ Peer problems	3.80 (2.50)	.30***	.43***	.19***	.30***	.32***
SDQ Prosocial	7.04 (2.38)	-.34***	-.38***	-.17**	-.33***	-.19***
SDQ Total	14.51 (6.95)	.60***	.45***	.31***	.59***	.49***
SDQ Impact	3.94 (2.79)	.35***	.40***	.12*	.34***	.23***
BRIEF BRI[2]	47.03 (13.81)	.80***	.52***	.46***	.77***	.64***
BRIEF MCI[2]	83.46 (21.01)	.52***	.58***	.35***	.61***	.45***
BRIEF GEC[2]	130.49 (32.51)	.68***	.59***	.42***	.73***	.56***
ADHD Status[3]	34 (10.0)	.14**	.11*	.04	.23***	.15**
ASD Status[4]	40 (11.8)	.09	.21***	.17**	.07	.15**
ID Status[5]	52 (15.3)	.10	-.02	.03	.04	.00
ODD Status[6]	46 (14.8)	.42***	.17**	.14**	.38***	.25***
Emotional Disorder[7]	44 (14.2)	.29***	.35***	.07	.13*	.09

Note. [1] Gender:1 = boy and 0 = girl.[2]BRI = Behavioral Regulation Index. MCI = Metacognition Index. GEC = Global Executive Composite. Raw scores.[3]ADHD Status: : 1 = present and 0 = absence.[4]ASD Status:= 1 = present and 0 = absence.[5]ID Status: 1 = present and 0 = absence. [6]ODD Status 1 = present and 0 = absence. [7]Emotional disorder: 1 = present and 0 = absence. * $p <$ .05, ** $p <$ .01, *** $p <$ .001 (2-tailed test).

Table 4 *Summary of Hierarchical Logistic Regression Analyses for variables Predicting Diagnoses (N = 301/277)*

Predictor	ADHD[1]			ASD[2]			ID[3]			ODD[4]			Emotional Disorder[5]		
	β	*SE*	*OR*	β	*SE*	*OR*	β	*SE*	*OR*	β	*SE*	*OR*	β	*SE*	*OR*
Step 1															
Age	0.12*	0.06	1.13	-0.11	0.06	0.90	-0.13	0.06	0.88	0.13*	0.06	1.14	0.15*	0.06	1.16
Gender	0.89	0.54	2.44	-0.16	0.50	0.85	-0.33	0.42	0.72	0.61	0.45	1.84	-0.77	0.43	0.47
FSIQ	0.01	0.01	1.01	0.07***	0.01	1.07	-0.15***	0.02	0.86	0.01	0.01	1.01	-0.02	0.01	0.99
Step 2															
Irritability	-.0.03	0.05	0.97	0.03	0.05	1.03	0.07	0.05	1.07	0.13**	0.04	1.14	0.17***	0.05	1.19
Social Withdrawal	0.02	0.04	1.02	0.11**	0.04	1.12	-0.01	0.05	1.00	-0.04	0.04	0.96	0.12***	0.04	1.13
Stereotypic Behavior	-0.18	0.12	0.84	0.01	0.09	1.01	0.13	0.09	1.14	-0.13	0.09	0.88	-0.16	0.09	0.85
Hyperactivity/Nonc.	0.07*	0.04	1.07	-0.07	0.05	0.93	-0.01	0.04	0.99	0.05	0.04	1.05	-0.05	0.04	0.95
Inappropriate Speech	0.05	0.13	1.05	0.20	0.12	1.22	-0.27	0.14	0.77	0.05	0.12	1.05	-0.07	0.13	0.94

Note. The dependent variables ODD and Emotional Disorder were based on DAWBA[1]ADHD without ASD or ID. Nagelkerke R^2 = .12. Cox & Snell R^2= .06.[2]ASD without ID or ADHD. Nagelkerke R^2 =.33. Cox & Snell R^2= .16. [3]ID without ASD or ADHD. Nagelkerke R^2 =.49. Cox & Snell R^2= .30. [4]Nagelkerke R^2 =.30. Cox & Snell R^2= .17.[5] Nagelkerke R^2 =.37. Cox & Snell R^2= .21.

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

Table X (Appendix)
Principal Component Analysis (Promax Rotation) of the 58 ABC Items

Item # and short form/original factor (F1-F5)	Components				
	1	2	3	4	5
10. Tantrums (F1)	.89				
4. Aggresive (F1)	.86				
57. Temper tantrums (F1)	.80				
14. Irritable (F1)	.78				
47. Stamps feet (F1)	.76				
36. Mood changes (F1)	.68				
29. Demands (F1)	.63				
19. Yells (F1)	.63				
34. Cries (F1)	.60				
7. Boisterous (F4)	.52	.42			
18. Disobedient (F4)	.52	.45			
41. Cries and Screams (F1)	.50				
8. Screams (F1)	.47				
24. Uncooperative (F4)	.36		.31		
39. Not sit still (F4)		.86			
15. Restless (F4)		.83			
1. Active (F4)		.80			
38. Not stay in seat (F4)		.79			
54. Excessively active (F4)		.75			
31. Disrupts group (F4)		.64			
44. Easily distracted (F4)		.60			
21. Disturbs other (F4)	.33	.59			
13. Impulsive (F4)	.35	.56			
48. Runs or jumps (F4)		.56			
56. Ignores directions (F4)	.37	.49			
51. Pays no attention (F4)	.40	.49			
28. Not pay attention (F4)		.47	.34		
9. Talks excessively (F5)		.35			
33. Talks to self (F5)					
42. Prefers alone (F2)			.81		
5. Seeks isolation (F2)		-.33	.79		
16. Withdrawn (F2)			.78		
30. Isolates self (F2)		-.38	.77		
3. Sluggish (F2)			.68		
53. Inactive (F2)	-.32		.60		

58. Few social reactions (F2)			.58		
32. Stays in one position (F2)			.56		
40. Difficult to get through (F2)		.31	.56		
12. Preoccupied (F2)			.53		
55. Responds neg. to affect. (F2)			.52		
25. Depressed mood (F1)	.37		.48		
20. Lacks emotional response (F2)			.48		
37. Unresponsive (F2)		.41	.48		
43. Does not communicate (F2)		.31	.47		
26. Resists contact (F2)			.47		
23. Watches others (F2)			.42		
6. Body movements (F3)				.83	
35. Repetitive hand movem. (F3)				.83	
11. Repetitive movements (F3)				.82	
45. Waves extremities (F3)				.68	
27. Body movements (F3)				.52	
49. Rocks body (F3)				.43	
46. Repeats words (F5)		.32		.33	
22. Repetitive speech (F5)		.30		.31	
17. Odd behavior (F3)					
50. Hurts self (F1)					.87
2. Injures self (F1)					.81
52. Self-violence (F1)					.78

Note: Loadings < .30 were omitted from the Table. Original ABC factors: Factor 1 (Irritability), Factor 2 (Social Withdrawal), Factor 3 (Stereotypic Behavior), Factor 4 (Hyperactivity), Factor 5 (Inappropriate Speech).