Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function in a neuro-pediatric sample and its application to mental disorders

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Abstract

The construct validity of the nine-scale version of the Behavior Rating Inventory of Executive Function (BRIEF) parent form was examined in a clinical sample of children and adolescents with neurological and neurodevelopmental disorders (*N* = 281). Confirmatory factor analysis supported a three-factor model separating the inhibitory behavioral control dimension from the emotional control and metacognitive problem-solving dimensions. The Metacognitive factor was also related to a diagnosis of attention deficit/hyperactivity disorder (ADHD) after controlling for age, gender, IQ, adaptive functioning, and a conventional behavioral rating scale, which included inattention-hyperactivity symptoms. The Emotional Regulation factor was related to a diagnosis of oppositional defiant disorder. Correlational analyses indicated that child comorbid emotional and behavioral problems may exacerbate parental BRIEF reporting. Accordingly, when assessing executive function among children with neurological and neurodevelopmental disorders, the BRIEF should be complemented with assessments of mental health problems.

Keywords: Attention Deficit/Hyperactivity Disorder; Behavior Rating of Executive Function; Executive function; Mental health problems; Neurodevelopmental disorders

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INTRODUCTION

Executive dysfunction is a key feature of several neurodevelopmental disorders, most notably attention deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) (Hill, 2004; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). The most frequently used rating scale for executive functions (EFs) is the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) (Toplak, West, & Stanovich, 2013). As a theoretically and clinically derived scale, the BRIEF was developed to provide ecologically valid information about complex, everyday problem-solving demands. EF is operationalized in the BRIEF as a multi-dimensional construct of the inter-related functions of inhibition, shifting (flexibility), emotional control, initiation, working memory, planning abilities, organizational skills, and monitoring. The BRIEF -can differentiate between those with neurodevelopmental disorders, such as ADHD (especially elevated problems on the Working Memory and Inhibit scales) and ASD (especially elevated problems on the Shift scale), and their typically developing peers (Gioia, Isquith, Kenworthy, & Barton, 2002; Mahone et al. 2002; Rosenthal, Wallace, Lawson, Wills, Dixon, & Yerys, 2013).

However, the underlying factor structure of the BRIEF is an unsettled issue. The exploratory factor analysis of the BRIEF and the original eight scales revealed a two-factor solution in both typically developing children and a mixed clinical sample (Gioia et al., 2000). The Behavioral Regulation Index comprises the three scales Inhibit, Shift, and Emotional Control, and the Metacognition Index comprises the five scales Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. The five subsequent studies using confirmatory factor analysis (CFA) have shown somewhat inconsistent results. Gioia, Isquith, Retzlaff, and Espy (2002) conducted CFA in a mixed clinical sample, using a revised nine-scale version that separated the Monitor scale into a Task-Monitor scale, reflecting monitoring of task-related activities, and a Self-Monitor scale, reflecting monitoring of the effects of one's behavior on others (Gioia & Isquith, 2002). A three-factor solution was found to provide a better fit than one-, two-, or four-factor models. In the three-factor solution, the Behavioral Regulation Index was separated into a Behavioral Regulation factor consisting of the Inhibit and Self-Monitor scales and an Emotional Regulation factor composed of the Emotional Control and Shift scales, whereas the Metacognition Index remained unchanged. This finding was replicated in a recent CFA of BRIEF parent and teacher forms examining both the original eight-scale version (i.e., a single Monitor scale) and the revised nine-scale version in a mixed healthy and clinical sample (Egeland & Fallmyr, 2010). In a sample of children and adolescents with intractable epilepsy assessed using the original eight scales, a two-factor rather than a one- or three-factor solution resulted in the best fit based on the parent report form (Slick, Lautzenhiser, Sherman, & Eyrl, 2006). Furthermore, in a sample of children with traumatic brain injury, a two- rather than one-factor solution using the original eight scales was reported for the parent form (Donders, DenBraber, & Vos, 2010); similar findings were reported in a normative study using the Dutch version (Huizinga & Smidts, 2011). Gioia et al. (2002) argued that a three-factor model where the inhibitory behavior control dimension was differentiated from the emotional control dimension was more consistent with Barkley's (1997) influential theory of EF with inhibitory control having a unique and separable role, emotion regulation playing an integral role, and metacognitive aspects of EF forming a separable component (reconstitution). The distinction between inhibitory and more emotional behaviors is also more in accordance with current knowledge of brain function (Denckla, 2002). In other words, EF processes in situations with stronger affective significance (so-called hot EFs) have been shown to activate areas of the brain that control emotions and the brain's reward systems (e.g., the orbito-frontal cortex, ventral striatum, and limbic system), whereas EFs reflecting cognitive processes with little emotional salience (so-called cold EFs) activate the dorsolateral parts of the prefrontal cortex (Castellanos, Sonuga-Barke, Milham, & Tannock, 2006; Skogli, Egeland, Andersen, Hovik, & Øie, 2014). Egeland and Fallmyr (2010) speculated that the Emotional Regulation factor was actually a measure of hot EF, as opposed to the remaining scales comprising the less emotional items. The latest CFA of the BRIEF found support for a three-factor solution using the revised nine-scale version among typically developing children (Granader et al., 2014). However, among higher functioning children with ASD (full scale IQ score (FSIQ) ≥ 70) ($N = 411$) in the same study, none of the models met the goodness of fit criteria, and a plausible explanation for the failure to replicate the factor structure was attributed to the unusual dominance of flexibility problems (the Shift scale and the item "Tries the same approach to a problem over and over even when it does not work") in the ASD EF profiles (Granader et al., 2014).

Taken together, these data highlight a need to further elucidate the underlying factor structure of the BRIEF parent form and to address whether use of the revised nine-scale version is warranted. In the present study, we conducted a CFA of the BRIEF parent form for the 9-scale division in a neuro-pediatric sample of children with neurological and neurodevelopmental disorders. We hypothesized that a three-factor model that separated the Behavioral Regulation Index into Behavioral Regulation and Emotional Regulation factors in addition to the Metacognition factor (Egeland & Fallmyr, 2010;

Gioia et al., 2002) would (a) fit the data better than a model consisting of two related factors consistent with prior exploratory factor analysis of the BRIEF (e.g., Gioia et al., 2000), and (b) fit the data better than a one-factor model in line with the view of EFs as a unitary construct. Then we explored the clinical utility of the factor model for the BRIEF yielded through the CFA indicated above, in relation to the diagnostic categories of ADHD, ASD, and intellectual disability (ID) in addition to oppositional defiant disorder (ODD) and emotional disorder in the neuro-pediatric sample. Previous research has indicated especially elevated problems for the Working Memory and Inhibit scales (part of the Metacognition and Behavioral Regulation indices, respectively) among children with ADHD (Gioia et al., 2002; Mahone et al., 2002; Toplak, Bucciarelli, Jain, & Tannock, 2009; Usher, Leon, Standford, Holmbeck, & Bryant, 2016) and especially elevated problems on the Shift scale (part of the Emotional Regulation factor) among children with ASD (Gioia et al., 2002; Granader et al., 2014; Rosenthal et al., 2013). Among children with ID, elevated problems on the Working Memory and Initiate scales (part of the Metacognition Index) have been reported (Gioia et al., 2000: Memosevic & Sinanovic, 2014). Furthermore, a recent study found greater impairment on the Metacognitive factor, followed by the Behavioral Regulation factor, but not on the Emotional Regulation factor, among adults with ADHD (Roth, Lance, Isquith, Fischer, & Giancola, 2013). Another study reported poorer functioning among adults with ADHD than in the healthy control group on both the Behavioral Regulation and Metacognition factors, with the largest difference found for the latter factor (Rotenberg-Shpigelman, Rapaport, Stern, & Hartmen-Maeir, 2008). Based on these findings we hypothesized that: a) the Metacognition and Behavioral Regulation indices would be related to an ADHD status, b) the Emotional Regulation factor would be related to an ASD status, and c) the Metacognition Index would be related to an ID status. We did not have a specific hypothesis regarding the BRIEF factors in relation to an ODD or emotional disorder status. Finally, we examined whether the BRIEF factors would provide clinically relevant information for predicting the concurrent diagnostic categories, especially ADHD and ASD, beyond the information gained from other behavioral rating scale measures.

METHOD

Participants

Two hundred eighty-one children and adolescents (176 boys and 105 girls) participated in the study. The children were referred for a developmental/neurological assessment to the neuro-pediatric outpatient clinics at the University Hospital of North Norway (UNN) (*n* = 182) and the Finnmark Hospital Trust (*n* = 45) by a general practitioner (*n* = 188) or a medical specialist in specialist health services (*n* = 93). The neuro-pediatric outpatient clinics are specialized health service units in the counties of Troms and Finnmark in northern Norway. The UNN and Finnmark Hospital Trust are specialist health care hospitals serving a population of 266,000 residents in the county municipalities of Finnmark, Troms and northern Nordland. 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 pediatricians specializing in neurology and neuropsychologists, special education therapists, and physiotherapists The exclusion criteria for taking part in this BRIEF study included an age below 5 years, because this age is the lowest at which the BRIEF measure can be used, and parent lack of knowledge of the Norwegian language. The participants were between 5 and 18 years of age (M = 10.96, SD = 3.36). The mean FSIQ, as assessed by a standardized intelligence test, was 76.01 (SD = 16.12, range 40-125), and the mean adaptive level of functioning, as assessed by the Vineland Adaptive Behavior Scales (VABS-II; Sparrow, Cicchetti, & Balla) total score, was 68.05 (SD = 15.01, range 32-112) (see Table 4 for additional information). The majority of the children lived with both parents (80.7%). Approximately half of the parents had obtained a college or university degree (56.2%), and 39.1% had obtained a high school diploma.

The most frequent neurodevelopmental disorders in the sample were, in descending order, specific developmental disorders (34.5%), ID (19.6%, none with severe IDs), other diseases of the nervous system such as epilepsy and cerebral palsy (18.5%), ASD (14.6%), ADHD (14.6%), and congenital malformations and chromosomal abnormalities (12.5%). The diagnoses are not mutually exclusive. Comorbid emotional disorders (anxiety disorders n = 49; major depression n = 13) and/or behavioral disorders (ODD n = 37; conduct disorder n = 6), as assessed by the Developmental Well-Being Assessment (DAWBA; Goodman, Ford, Richards, Gatward, & Meltzer, 2000), were present in 14.2% and 15.3% of the participants, respectively. Regarding medication, a total of n = 23 of the participants used psychotropic medication according to the parent reports (ADHD group n = 9, ASD group n = 1, ID group n = 4, ODD group n = 5, and Emotional group n = 4). The medication status data were missing for n = 41 of the participants, but the missing data were not systematically related to the diagnostic groups. We did not have specific information regarding the types of psychotropic medications that were taken. The use of psychotropic medications was not significantly related to any of the BRIEF variables as indicated by the correlation analyses. Written informed consent was obtained before inclusion in the study. The study was approved by the appropriate ethics committee.

Measures

The BRIEF parent form (Gioia et al., 2000) is composed of 86 items. The parent indicates whether their child, aged 5 to 18 years, exhibits problems with specific behaviors within the original eight and revised nine (Gioia et al., 2002) theoretically and clinically derived domains (described earlier). In the standard version, the Behavior Regulation Index score (BRI) is computed from the Inhibit, Shift, and Emotional Control scales. The Metacognition Index (MCI) is based on scores from the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor scales. The Global Executive Composite is a summary score that incorporates all eight clinical scales. Parents respond to how often their child has 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 psychometric properties of the Norwegian version were considered satisfactory for clinical use in Norway (Fallmyr & Egeland, 2011).

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 was approximately 50 min in length and was completed by the majority of the parents in the present study (n = 265); a 30-min youth interview (n = 108); and a brief 10-min questionnaire for teachers (n = 200). The DAWBA has shown a 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 diagnoses (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 parent version of the Strengths and Difficulties Questionnaire (SDQ, 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. 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 VABS-II (Sparrow et al., 2011),which is a semi-structured interview, is 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. The VABS-II scores were missing for fifteen children.

The children were individually assessed with a standardized Wechsler Intelligence Test appropriate for their ages (Wechsler, 2007, 2008a, 2008b, 2009, 2012). A small number of children (n = 9) wasassessed with Raven's Colored Progressive

Matrices (Raven, 2004). The intellectual level was defined by the FSIQ score. For twenty-five 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

Diagnoses of neurological and neurodevelopmental disorders including ASD, ADHD, and ID were obtained from interdisciplinary assessments in the neuro-pediatric clinics. The ICD-10 criteria (WHO, 1993, 2010) were used to code the diagnoses. The presence of an ID was operationalized as score below 70 on both a standardized Wechsler Intelligence Test and the VABS-II. The patients who agreed to participate underwent an additional assessment (with the DAWBA) to examine the presence of comorbid emotional and behavioral disorders. Parents, teachers, and children above the age of 11 were informants. After completion of the DAWBA interview, two expert raters (BM and PHB, both of whom are senior clinical specialists in neuropsychology with at least 15 years of experience in the field and are trained in the DAWBA rating) (Brøndbo, Mathiassen, Martinussen, Heiervang, Eriksen, & Kvernmo, 2012) generated diagnostic ratings based on the answers provided by the parents, teachers and young persons after reviewing the DAWBA information (Halvorsen et al. submitted). The parents completed one BRIEF parent form. We did not have specific information concerning whether one or both parents completed the form. The BRIEF data were validated in terms of the validity scale scores (negativity and inconsistency) (Gioia et al., 2000).

Data analyses

The factor structure of the Norwegian version of the BRIEF was examined via confirmatory factor analyses using AMOS 24. The mean raw score ratings for each of the nine BRIEF scales based on parent ratings (Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor, subdivided into Task-Monitor and Self-Monitor) were entered as measured variables in the three a priori models. The original two-factor model of Gioia et al. (2000) was tested against the more recently suggested three-factor model (Egeland & Fallmyr, 2010; Gioia et al., 2002; Roth et al., 2013). For comparison purposes, the simpler one-factor model was also examined. To evaluate model fit, several goodness of fit indices were calculated. This included, in addition to overall χ^2 statistics, the χ^2/df, root mean square 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: χ^2/df < 5.0, RMSEA $\leq$ 0.06, TLI and CFI $\geq$ 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) represents 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 χ^2/df has some of the same problems as χ^2 but may be used for comparing models, as the smallest χ^2 in relation to the degrees of freedom represents the most parsimonious model (Keith & Reynolds, 2012). Because the models are nested, a direct comparison of the differences in model fit was possible by testing incremental changes in χ^2.

The remaining statistical analyses were conducted using SPSS 24. To address the second research question, the relationship between the BRIEF factors and the diagnostic categories was examined by using Pearson's correlation coefficient (two-tailed). Hierarchical logistic regression analyses were conducted to explore whether the BRIEF factors could provide clinically relevant information for prediction of the diagnostic categories beyond that gained from other behavioral rating scales. For all analyses, the independent variables included age; gender (0 = girl, 1 = boy); FSIQ, VABS, and SDQ scales, and the BRIEF factors. The dependent variables were the dummy variables ADHD (i.e., ADHD without ASD or ID), ASD (i.e., ASD without ADHD or ID), ID (i.e., ID without ADHD or ASD), ODD, and emotional disorders. Because gender and age are known to influence scores on the BRIEF parent form (Gioia et al., 2000), we initially included the interaction term in the regression analyses but subsequently excluded it from the analyses because it was non-significant. 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.

RESULTS

Confirmatory factor analysis

Table 1 provides the means, standard deviations, internal consistency, and inter-correlations for the BRIEF variables. The average BRIEF scores were fairly similar to those reported for other clinical samples (Egeland & Fallmyr, 2010; Gioia et al., 2000). The Cronbach's α coefficients were good to excellent, with coefficients ranging from .82 – .98 (EFPA, 2013). The BRIEF scales were moderately to highly correlated with one another. The correlation coefficients between the five scales within the Metacognition (MC9) factor ranged from .79–.92. The correlation coefficients between the two scales making up the Behavior Regulation Index (BR9) were .93 (Inhibit) and .95 (Self-Monitor) with the BR9 factor. The subscales Shift and Emotional Control both had correlation coefficients of .93 with the Emotional Regulation (ER9) factor or index.

The correlation between the Self-Monitor and Task-Monitor scales was moderate (.52). This correlation was lowest between Self-Monitor and all other subscales.

Table 1 about here

Confirmatory factor analysis results

Table 2 summarizes the fit indices for the three models and the differences between the nested models in terms of the $\Delta\chi^2$. The single-factor model had poor fit based on all of the computed indices. The two-factor model showed an adequate fit on most indices and was significantly better than the one-factor model. Finally, the three-factor model was significantly better than the two-factor solution, and the fit indices were acceptable for χ^2/df, TLI, and CFI and were marginally acceptable for RMSEA (0.106). Thus, the three-factor solution appeared to best represent the data. The superior three-factor model(Model 3) is presented in Figure 1.

Table 2 about here

Figure 1 about here

Relationship between BRIEF factors and the diagnostic status

Table 3 shows the demographic data for the diagnostic groups, and Table 4 shows the correlations among the examined variables as well as descriptive statistics. All three BRIEF factors [i.e., BR9 (the Behavior Regulation factor), ER9 (the Emotional Regulation factor), and MC9 (the Metacognition factor)] were significantly related to an ADHD diagnosis. MC9 was the only BRIEF factor not significantly related to ASD. None of the BRIEF factors was significantly related to an ID diagnosis . The strongest correlations were between the BRIEF factors and the diagnosis of ODD, in which BR9 and ER9 were moderately correlated with the diagnosis (r = .46 and r = 45, respectively, both p values <.001). Regarding emotional disorders, the strongest BRIEF factor correlation was between ER9 and this diagnosis ($r = .35$, $p < .001$). Regarding the other behavioral rating scale measures (i.e., SDQ and VABS), the correlations with diagnostic categories were in the expected directions (Table 4).

Table 3 about here

Table 4 about here

In the regression analyses shown in Table 5, the overall model predicting the presence of an ADHD diagnosis was significant [$\chi^2(14) = 27.97$, $p = .014$] and correctly predicted 90.0% of the group memberships. Regarding the BRIEF factors, the MC9 independently predicted a diagnosis of ADHD after controlling for age, gender, and the FSIQ, VABS, and SDQ scores. The overall model predicting the presence of ASD was significant [$\chi^2(14) = 66.43$, $p < .001$] and correctly predicted 93.9% of the group memberships. None of the BRIEF factors was a significant predictor after controlling for age, gender, and the FSIQ, VABS and SDQ scores. Likewise, the overall model predicting the presence of ID was significant [$\chi^2(14) = 103.55$, $p < .001$] and correctly predicted 89.6% of the group memberships. None of the BRIEF factors was a significant predictor after controlling for age, gender, and the FSIQ, VABS and SDQ scores. Regarding the presence of ODD, the overall model was significant [$\chi^2(14) = 68.40$, $p < .001$] and correctly predicted 86.3% of the group memberships. The BRIEF factor ER9 independently predicted a diagnosis of ODD after taking into account age, gender, and the FSIQ, VABS and SDQ scores. Finally, the overall model predicting the presence of an emotional disorder was significant [$\chi^2(14) = 94.03$, $p < .001$] and correctly predicted 89.8% of the group memberships. None of the BRIEF factors was a significant predictor after controlling for age, gender, FSIQ, and the VABS, and SDQ scores.

Table 5 about here

DISCUSSION

This study sought to expand current knowledge on the factor structure of the BRIEF parent form and to address the question of whether using the revised nine-scale version of the test was warranted. The results corroborated findings from Gioia et al. (2002) and Egeland and Fallmyr (2010) and showed that a three-factor model was preferable to either the original two-factor model or a one-factor model viewing EF as a unitary construct. When using the nine-scale revision of the rating test among children between 5 and 18 years of age, dividing the Monitor scale into the Self-Monitor and Task-Monitor scales allows expansion of the BRIEF structure. More specifically, the Inhibitory Behavior Control dimension is separated from the Emotional Control dimension, whereas the Metacognitive factor is the same as that obtained in the exploratory factor analyses (e.g., Gioia et al., 2000). The adult version of the BRIEF (BRIEF-A; Roth, Isquith, & Gioia, 2005) has incorporated this nine-scale division. The evidence from three distinct but related dimensions of EFs, [i.e., control of behavior via inhibition, flexible emotional control, and metacognitive problem-solving (reconstitution)] is also more in line with theoretical accounts of EF (Barkley, 1997) and neuroimaging studies that have identified two dissociable prefrontal brain systems for attention and emotion (i.e., the dorsal and ventral systems) (Dolcos & McCarthy, 2006). The Working Memory subscale, which is part of the Metacognitive index, has been related to the frontal gray brain volume (Mahone, Martin, Kates, Hay, & Horska, 2009). However, the brain-behavior relationship concerning the BRIEF factor scores (or the subscales thereof) and the validity of the three-factor division of the rating test need to be further examined. Notably, a recent large study using the nine-scale version of the BRIEF parent form among highly functioning children with ASD did not replicate the normative factor structure, possibly due to the dominance of flexibility problems in the

ASD EF profile, in which a cognitive flexibility item loaded highly on all BRIEF Metacognitive Index scales (Granader et al., 2014). Hence, this discrepancy also underscores the need for further studies to investigate the construct validity of the BRIEF in more specific populations.

Moreover, the three-factor model of the BRIEFdistinguished among different clinical groups in the present study. As expected, the bivariate analyses showed that the Metacognitive and Behavioral factor scores as well as the Emotional factor score were related to a diagnosis of ADHD without comorbid ID or ASD. As expected, the Emotional factor score and the Behavioral factor score were significantly correlated with an ASD diagnosis without comorbid ID or ADHD. However, contrary to our hypothesis, the Metacognitive factor score was not significantly related to an ID status without comorbid ASD or ADHD. One potential explanation for the latter nil finding may be that this level of analysis is too broad and thus using a subscale-level analysis (i.e., with the Working Memory and Initiate scales) may be more appropriate. Additionally, the nil finding may reflect parents' expectations in their reporting of EF problems among children with ID (i.e., perhaps parents do not view certain behaviors as "abnormal" for a child with a global cognitive disability and instead evaluate their child's functioning based on expectations adjusted for the child's lower levels of cognitive and adaptive functioning) (Gioia et al., 2000). Beacuse the BRIEF has not been used extensively among children with ID (Memisevic & Sinanovic, 2014), more studies on the ID population are needed. Moreover, we found that all three BRIEF factors were related to a concurrent diagnosis of ODD and emotional disorder among the children in the neuro-pediatric sample. The Emotional Regulation factor score correlated more strongly with concurrent diagnoses of ODD and emotional disorder (mostly anxiety disorders) than with the neurodevelopmental diagnoses.

A conservative, examinination of the predictive validity of parental ratings on the BRIEF factor scores , controlling for the variance explained by age, gender, IQ, adaptive functioning (VABS-II), and a conventional mental health measure, including ratings of inattention-hyperactivity symptoms (SDQ) showed that the Metacognitive index predicted a concurrent diagnosis of ADHD. Similarly, the Emotional Regulation factor predicted a concurrent diagnosis of ODD. These findings provide further evidence of the discriminant validity of the BRIEF as a measure of executive problem-solving skills in everyday situations and not just as a reflection of general behavioral disruptions and impairments (Mcauley, Chen, Goos, Schachar, & Crosbie, 2010). The Metacognitive factor has been related to ADHD in recent studies (e.g., Rotenberg-Shpigelman et al., 2008; Roth et al., 2013) hence, the possibility of a specific BRIEF profile of ADHD warrants further examination. The Behavioral Regulation factor did not remain significantly associated with an ADHD status after controlling for demographic characteristics, including IQ, adaptive functioning, and a diagnostic screening instrument, which included inattention-hyperactivity symptoms, conduct problems, and peer problems (SDQ). Likewise, the Emotional Regulation and the Behavioral Regulation factors did not remain significantly associated with an ASD status after controlling for the same factors. This analysis is a highly conservative test of the BRIEF factors, since the BRIEF is not intended as a diagnostic tool in its own right in contrast to the control variables (e.g., IQ, VABS-II, and SDQ) included in the regression models. A failure to find the BRIEF factors as significant predictors of ASD or ID after controlling for the variance explained by the other factors, underscores that the BRIEF should be used in a broad clinical context for the assessment and diagnosis of neurodevelopmental disorders (Gioia et al., 2002). The finding that difficulties with flexible emotional control characterize children with ODD even after controlling for behavioral disruptions and impairment indicates that the BRIEF can provide valuable information in relation to intervention/treatment plans and possibly for understanding the etiology and/or maintenance of these behavioral problems. There is an on-going debate as to whether diagnostic categories are associated with specific or shared intermediate cognitive phenotypes (Gottesman & Gould, 2003; Leno et al., 2017). Further research examining whether EF impairments in everyday behavior are indicative of neurodevelopmental disorders in general or differ between diagnostic categories may yield fruitful insights into the etiology of the disorders. Accordingly, investigating the generalizability of the present study's finding to other samples by directly comparing EFs among youths with different neurodevelopmental disorders after controlling for co-occurring symptoms will be important. 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 requires the combination of inattention and hyperactivity-impulsiveness symptoms, and thus the generalizability of 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 pediatricians specializing in neurology and specialists in clinical neuropsychology. However, only sparse 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). Replicating the factor structure of the BRIEF parent form in the present study together with findings from other psychometric studies of the BRIEF in Norway (Egeland & Fallmyr, 2010; Fallmyr & Egeland, 2011) indicate that the translated version of the BRIEF can be used as a reliable and valid measure of EFs in Norway.

In conclusion, the results from the present study, together with those of other studies (Egeland & Fallmyr, 2010; Gioia et al., 2002; Granader et al., 2014), lead us to recommend the use of the nine-scale version of the BRIEF parent form when assessing EFs in everyday situations in mixed clinical and healthy samples. Child comorbid emotional and behavioral problems may exacerbate parental BRIEF reporting. Accordingly, when assessing EFs among children with neurological and neurodevelopmental disorders, the BRIEF should be complemented with assessments of mental health problems.

DISCLOSURE OF INTEREST

The authors report no conflicts of interest.

REFERENCES

Achenbach, T. H., Becker, A., Dopfner, M., Heiervang, E., Roessner, V., Steinhausen, H.C., Rothenberger, A. (2008). Multicultural assessment of child and adolescent psychopathology with ASEBA and SDQ instruments: Research findings, applications, and future directions. *Journal of Child Psychology and Psychiatry, 49,* 251-275.

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders. Fourth edition. Text Revision. (DSM-V-TR).* Washington, DC: American Psychiatric Association.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders. Fifth edition. (DSM-5).* Arlington, VA: American Psychiatric Association.

Barkley, R. A. (1997). *ADHD and the nature of self-control.* New York: Guilford Press.

Brøndbo, H., Mathiassen, B., Martinussen, M., Heiervang, E., Eriksen, M., &, Kvernmo, S. (2012). Agreement on web-based diagnoses and severity of mental health problems in Norwegian child and adolescent mental health services. *Clinical Practice & Epidemiology in Mental Health, 8,* 16-21.

Castellanos, F. X., Sonuga-Barke, E .J., Milham, E. J., & Tannock, R. (2006). Characterizing cognition in ADHD: Beyond executive dysfunction. *Trends in Cognitive Science, 10,* 117-123.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for estimating measurement invariance. *Structural Equation Modelling, 9,* 233-255.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

Denckla, M. B. (2002).The behavior rating inventory of executive function: Commentary. *Child Neuropsychology, 8*, 304-306.

Dolcos, F., & McCarthy, G. (2006). Brain systems mediating cognitive inferences by emotional distraction. *The Journal of Neuroscience, 26,* 2072-2079.

Donders, J., DenBraber, D., & Vos, L. (2010). Construct and criterion validity of the Behavior Rating Inventory of Executive Function (BRIEF) in children refreed for neuropsychological assessment after paediatric brain injury. *Journal of Neuropsychology, 4*, 197-209.

Egeland, J., & Fallmyr, Ø. (2010). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function (BRIEF): Support for a distinction between emotional and behavioral regulation. *Child Neuropsychology, 16,* 326-337.

European Federation of Psychologists' Association (EFPA) (2013). *EFPA review model for the description and evaluation of psychological tests: Test review form and notes for reviewers, v 4.2.6:* EFPA.

Fallmyr, Ø., & Egeland, J. (2011). Psykometriske egenskaper for den norske versjonen av spørreskjemaet BRIEF (Behavior Rating Inventory of Executive Functioning) [Psychometric propreties of the Norweagian version of BRIEF]. *Journal of the Norwegian Psychological Association, 48,* 339-343.

Ford, T., Goodman, R., & Meltzer, H. (1999). The British child and adolescent mental health survey: The prevalence of DSM-IV disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 42*, 1203-1211.

Foreman, D. M., & Ford, T. (2008). Assessing the diagnostic accuracy of the identification of hyperkinetic disorders following the introduction of government guidelines in England. *Child and Adolescent Psychiatry and Mental Health, 2,* 32.

Foreman, D. M., Morton, S., & Ford, T. (2009). Exploring the clinical utility of the Development and Well-being Assessment (DAWBA) in the detection of hyperkinetic disorders and associated diagnoses in clinical practice. *Journal of Child Psychology and Psychiatry, 50,* 460-470.

Gioia, G. A., & Isquith, P. K. (2002). Two faces of Monitor: Thy self and thy task [Abstract]. *Journal of the International Neuropsychological Society, 8*, 229.

Gioia, G. A., Isquith, P.K., Guy, S. C., & Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function (BRIEF).* Lutz, FL: Psychological Assessment resources, Inc.

Gioia, G. A., Isquith, P. K., Kenworthy, L., & Barton, R. M. (2002). Profiles of everyday executive function in acquired and developmental disorders. *Child Neuropsychology, 8*, 121-137.

Gioia, G. A., Isquith, P. K., Retzlaff, P. D., & Espy, K. A. (2002). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function (BRIEF) in a clinical sample. *Child Neuropsychology, 8,* 249-257.

Goodman, R. (1999). The extended version of the Strengths and Difficulties Questionnaire as a guide to child psychiatric caseness and consequent burden. *Journal of Child Psychology and Psychiatry, 40*, 791-799.

Goodman, R., Ford, T., Richards, H., Gatward, R., & Meltzer, H. (2000). The development and well-being assessment: description and initial validation of an integrated assessment of child and adolescent psychopathology. *Journal of Child Psychology and Psychiatry, 41*, 645-655.

Gottesman, I. I., & Gould, T. D. (2003). The endophenotype concept in psychiatry: Etymology and strategic intentions. *American Journal of Psychiatry, 160*, 636-645.

Granader, Y., Wallace, G. L., Hardy, K. K., Yerys, B. E., Lawson, R. A., Rosenthal, M. et al. (2014). Characterizing the factor structure of parent reported executive function in autism spectrum disorders: the impact of cognitive inflexibility. *Journal of Autism and Developmental Disorders, 44*, 3056-3062.

Halvorsen, M., Mathiassen, B., Myrbakk, E., Brøndbo, P.H., Sætrum, A., Steinsvik, O.O., & Martinussen, M. (submitted). Emotional and behavioral disorders in children and adolescents with neurodevelopmental disorders.

Heiervang, E., Goodman, A., & Goodman, R. (2008). The Nordic advantage in child mental health: separating health differences from reporting style in cross-cultural comparison of psychopathology. *Journal of Child Psychology and Psychiatry, 49,* 678-685.

Heiervang, E., Stormark, K. M., Lundervold, A. J., Heimann, M., Goodman, R., Posserud, M. B.,…Gillberg, C. (2007). Psychiatric disorders in Norwegian 8- to 10-year-olds: An epidemiological survey of prevalence, risk factors, and service use. *Journal of the American Academy of Child & Adolescent Psychiatry, 46,* 438-447.

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences, 8*, 26-32.

Hu, L. T., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3*, 424–453.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.

Huizinga, M., & Smidts, D. P. (2011). Age-related changes in executive function: A normative study with the Dutch version of the Behavior Rating Inventory of Executive Function (BRIEF). *Child Neuropsychology, 17,* 51-66.

Keith, T. Z., & Reynolds, M. R. (2012). Using confirmatory factor analysis to aid in understanding the constructs measured by intelligence tests. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 758-799). New York: Guilford Press.

Leno, V. C., Chandler, S., White, P., Pickles, A., Baird, G., Hobson, C,…Simonoff, E. (2017). Testing the specificity of executive functioning impairments in adolescents with ADHD, ODD/CD and ASD. *European Child & Adolescent Psychiatry.* https://doi.org/10.1007/s00787-017-1089-5

Mahone, E. M., Cirino, P. T., Cutting, L. E., Cerrone, P. M., Hagelthorn, K. M., Hiemenz, J. R. et al. (2002). Validity of the Behavior Rating Inventory of Executive Function in children with ADHD and/or Tourette syndrome. *Archives of Clinical Neuropsychology, 17,* 643-662.

Mahone, E. M., Martin, R., Kates, W. R., Hay, T., & Horska, A. (2009). Neuroimaging correlates of parent ratings of working memory in typically developing children. *Journal of the International Neuropsychological Society, 15,* 31-41.

Mcauley, T., Chen, S., Goos, L., Schachar, R., & Crosbie, J. (2010). Is the Behavior Rating Inventory of Executive Function more strongly associated with measures of impairment or executive function? *Journal of the International Neuropsychological Society, 16,* 495-505.

Meltzer, H., Gatward, R., Goodman, R., & Ford, T. (2003). Mental health of children and adolescents in Great Britain. *International Review of Psychiatry, 15,* 185-187.

Memisevic, H., & Sinanovic, O. (2014). Executive function in children with intellectual disability – the effects of sex, level and aetiology of intellectual disability. *Journal of Intellectual Disability Research, 58,* 830-837.

Raven, J. (2004). *The Raven's – educational coloured progressive matrices and crichton vocabulary scale*. Norwegian Manual supplement. Stockholm, Pearson Assessment.

Rosenthal, M., Wallace, G. L., Lawson, R., Wills, M.C., Dixon, E., & Yerys, B. E. (2013). Impairments in real-world executive function increase from childhood to adolescence in autism spectrum disorders. *Neuropsychology, 27*, 13-18.

Rotenberg-Shpigelman, S., Rapaport, R., Stern, A., & Hartmen-Maeir, A. (2008). Content validity and internal consistency reliability of the Behavior Rating Inventory of Executive Function – adult version (BRIEF-A) in Israeli adults with attention-deficit/hyperactivity disorder. *Israeli Journal of Occupational Therapy, 17*, 77-96.

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2005). *Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A).* Lutz, FL: Psychological Assessment Resources.

Roth, R. M., Lance, C.E., Isquith, P. K., Fischer, A. S., & Giancola, P. R. (2013). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function-Adult Version in healthy adults and application to attention-deficit/hyperactivity disorder. *Archives of Clinical Neuropsychology, 28*, 425-434.

Skogli, E. W., Egeland, J., Andersen, P. N., Hovik, K. T., & Øie, M. (2014). Few differences in hot and cold executive functions in children and adolescents with comorbid and inattentive subtypes of ADHD. *Child Neuropsychology, 20*, 162-181.

Slick, D. J., Lautzenhiser, A., Sherman, E. M. S., & Eyrl, K. (2006). Frequency of scale elevations and factor structure of the Behavior Rating Inventory of Executive Function (BRIEF) in children and adolescents with intractable epilepsy. *Child Neuropsychology, 12,* 181-189.

Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2011). *Vineland adaptive behavior scales (2nd ed.).* Norwegian Manual supplement. Stockholm, Pearson Assessment.

Toplak, M. E., Bucciarelli, S. M., Jain, U., & Tannock, R. (2009).Execeutive functions: performance-based measures and the behavior Rating Inventory of Executive Function (BRIEF) in adolescents with attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology, 15*, 53-72.

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner Review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, 54*, 131-143.

Usher, A. M. L., Leon, S. C., Standford, L. D., Holmbeck, G. N., & Bryant, F. B. (2016). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Functioning (BRIEF) in children and adolescents with ADHD. *Child Neuropsychology, 22,* 907-918.

Wechsler, D. (2007). *Wechsler abbreviated scale of intelligence (WASI).* Norwegian manual supplement. Stockholm, Pearson Assessment.

Wechsler, D. (2008a). *Wechsler adult intelligence scale (4th ed.). (WAIS-IV).* Norwegian manual supplement. Stockholm, Pearson Assessment.

Wechsler, D. (2008b). *Wechsler preschool and primary scale of intelligence (3rd ed.). (WPPSI-III).* Norwegian manual supplement. Stockholm, Pearson Assessment.

Wechsler, D. (2009). *Wechsler intelligence scale for children (4th ed.). (WISC-IV).* Norwegian manual supplement. Stockholm, Pearson Assessment.

Wechsler, D. (2012). *Wechsler preschool and primary scale of intelligence (4^{th} ed.). (WPPSI-IV)*. Norwegian manual supplement. Stockholm, Pearson Assessment.

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit /hyperactivity disorder: A meta-analytic review. *Biological Psychiatry, 57*, 1336-1346.

World Health Organization (1993). *The ICD-10 classification of mental and behavioural disorders. Diagnostic criteria for research*. Switzerland.

World Health Organization (2010). *International Statistical Classification of Diseases and Related Health Problems 10^{th} Revision*. World Health Organization, Geneva.

Table 1

Descriptive Statistics, Cronbach's Alpha Values and Inter-correlations for all BRIEF Scales and Indices

BRIEF scale	α	*M* (*SD*)	1	2	3	4	5	6	7	8	9	10	11	12
1.Inhibit	.92	1.63 (0.56)	-											
2.Shift	.87	1.76 (0.54)	.64	-										
3.Emotional C.	.92	1.67 (0.55)	.69	.72	-									
4.Initiate	.82	1.78 (0.49)	.50	.69	.55	-								
5.Working Mem.	.90	2.04 (0.53)	.55	.60	.51	.72	-							
6.Plan/Organize.	.92	1.88 (0.57)	.53	.64	.51	.79	.76	-						
7.Org. of Mat.	.86	1.86 (0.57)	.51	.48	.51	.58	.58	.63	-					
8.Task-monitor	.82	1.97 (0.63)	.49	.48	.39	.61	.64	.73	.56	-				
9.Self-Monitor	.87	1.90 (0.66)	.76	.69	.65	.63	.54	.60	.53	.52	-			
10.GEC[1]	.98	1.83 (0.45)	.79	.82	.77	.84	.82	.86	.76	.73	.81	-		
11.MC9[2]	.96	1.90 (0.48)	.60	.67	.58	.86	.86	.92	.79	.84	.66	.94	-	
12.ER9[2]	.94	1.71 (0.50)	.72	.93	.93	.67	.60	.62	.53	.47	.72	.85	.67	-
13.BR9[2]	.94	1.77 (0.57)	.93	.71	.71	.61	.58	.60	.56	.53	.95	.86	.68	.77

Note. Mean raw scores range from 1-3, with higher scores reflecting worse executive function.

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

[1]GEC = Global Executive Composite.

[2]Metacognition, Emotional Regulation, and Behavior Regulation index scores based on the nine-scale division.

Table 2

Summary of Fit Indices for Three Nested Brief Models (9 Scales)

Model	df	χ^2	χ^2/df	RMSEA (90%CI)	TLI	CFI
1.One factor	27	316.55***	11.72	0.195 (0.18-0.22)	0.80	0.85
Model 1 s 2	1	192.44***				
2.Two factor	26	124.11***	4.77	0.116 (0.10-0.14)	0.93	0.95
Model 2 vs 3	2	23.72***				
3.Three factor	24	100.39***	4.18	0.106 (0.09-0.13)	0.94	0.96

Note. df = model degrees of freedom; χ^2 = chi-square value; χ^2/df = normed chi-square, RMSA = standardized root mean squared residual;

CI = confidence interval, TIL = Tucker-Lewis index; CFI = Comparative fit index.

***p* < .001

Table 3

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	29	22 (75.9)	7 (24.1)	11.38 (2.98)	81.08 (11.21)	12 (46.2)
ASD	29	20 (69.0)	9 (31.0)	10.07 (3.38)	93.16 (11.38)	20 (71.4)
ID	40	23 (57.5)	17 (42.5)	11.23 (3.27)	58.50 (7.74)	15 (45.5)
ODD	43	30 (69.8)	13 (30.2)	10.63 (2.91)	78.00 (16.74)	23 (56.1)
Emotional disorder	40	21 (52.5)	19 (47.5)	11.93 (3.25)	77.27 (14.59)	17 (48.6)
Total	281	176 (62.6)	105 (37.4)	10.96 (3.36)	76.01 (16.12)	145 (56.2)

Table 4

Descriptive Statistics and Correlations for Main Variables

Variable	*M (SD)*/ *n* (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Predictors																			
1.Age	10.96 (3.36)	-																	
2.Gender male[1]	176 (62.6)	-.06	-																
3.FSIQ	76.01 (16.12)	-.05	.05	-															
4.Communication	65.54 (13.84)	.02	-.08	.41***	-														
5.Socialization	73.63 (15.67)	.20***	-.17**	.08	.66***	-													
6.Daily Living	75.47 (13.76)	.22***	-.06	.32***	.66***	.68***	-												
7.SDQ Emotional	3.54 (2.62)	.07	-.13*	-.03	-.21***	-.16*	-.16*	-											
8.SDQ Conduct	2.05 (1.99)	.06	.07	.01	-.25***	-.39***	-.23***	.26***	-										
9.SDQ Hyper	5.25 (2.62)	-.13*	.11	-.06	-.36***	-.39***	-.29***	.30***	.51***	-									
10. SDQ Peer	3.93 (2.56)	.19**	.05	.06	-.27***	-.43***	-.22***	.35***	.38***	.35***	-								
11. SDQ Prosocial	7.09 (2.39)	-.05	-.12	-.13*	.30***	.51***	.27***	-.17**	-.56***	-.32***	-.40***	-							
12. BRIEF BR9[2]	1.77 (0.57)	-.10	.14*	.06	-.36***	-.60***	-.37***	.21***	.57***	.57***	.42***	-.42***	-						
13. BRIEF ER9[2]	1.71 (0.50)	-.02	.10	.06	-.30***	-.51***	-.34***	.51***	.51***	.44***	.47***	-.44***	.76***	-					
14. BRIEF MC9[2]	1.90 (0.48)	.18**	.17**	.06	-.37***	-.40***	-.30***	.36***	.45***	.49***	.40***	-.37***	.65***	.68***	-				
Diagnoses																			
15. ADHD[3]	29 (10.3)	.04	.09	-.11	-.11	-.13*	-.09	-.01	.13*	.24***	.06	-.03	.19***	.15*	.22***	-			
16. ASD[4]	29 (10.3)	-.09	.04	.35***	.00	-.19**	-.06	.06	-.05	.01	.17**	-.12	.15**	.18**	.07	-.12	-		
17. ID[5]	40 (14.2)	.03	-.04	-.47***	-.30***	-.22***	-.30***	.00	.11	.02	.11	-.04	.01	.02	-.03	-.14*	-.14*	-	
18. ODD[6]	43 (16.3)	-.04	.06	.05	-.13*	-.29***	-.15*	.11	.50***	.25***	.26***	-.35***	.46***	.45***	.26***	.06	.09	.09	-
19. Emotional[7]	40 (15.2)	.12*	-.09	.03	-.08	-.06	-.01	.52***	.12*	.10	.21***	-.11	.16*	.35***	.22***	.07	-.00	-.05	.04

Note. [1]Boy = 1 and 0 = girl. [2]Behavior Regulation, Emotional Regulation, and Metacognitition from the nine-scale division. [3]ADHD = 1 and 0 = absence. [4]ASD = 1 and 0 = absence. [5]ID = 1 and 0 = absence. [6]ODD = 1 and 0 = absence. [7]Emotional disorder = 1 and 0 = absence. * $p < .05$, ** $p < .01$, *** $p < .001$ (2-tailed).

Table 5

Summary of Hierarchical Logistic Regression Analyses for variables Predicting Diagnoses (N = 230)

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	-0.04	0.09	0.96	-0.08	0.12	0.92	0.07	0.11	1.07	0.04	0.09	1.04	0.11	0.11	1.11
Gender	0.18	0.59	1.20	-0.75	0.67	0.47	-0.30	0.59	0.74	0.35	0.52	1.42	-0.01	0.57	0.99
FSIQ	0.04	0.02	1.04	0.13***	0.03	1.14	-0.13***	0.03	0.88	-0.01	0.02	0.99	-0.03	0.02	0.97
Step 2															
VABS Communication	-0.04	0.04	0.96	-0.02	0.04	0.98	-0.05	0.04	0.95	0.01	0.03	1.01	-0.01	0.04	0.99
VABS Daily Living Skills	-0.01	0.03	0.99	-0.01	0.03	0.99	-0.05	0.03	0.95	0.01	0.02	1.01	0.06	0.03	1.06
VABS Socialization	-0.00	0.03	1.00	-0.04	0.04	0.96	-0.07	0.04	0.94	-0.01	0.03	0.99	0.01	0.03	1.01
SDQ Emotional Symptoms	-0.26	0.14	0.77	-0.03	0.15	0.97	0.06	0.14	1.06	-0.13	0.12	0.88	0.77***	0.16	2.16
SDQ Conduct Problems	-0.04	0.17	0.97	-0.56*	0.25	0.57	0.13	0.19	1.14	0.41**	0.15	1.50	-0.19	0.21	0.83
SDQ Hyperactivity	0.29*	0.14	1.33	-0.01	0.15	0.99	-0.15	0.15	0.87	-0.08	0.12	0.92	-0.03	0.14	0.97
SDQ Peer Problems	-0.02	0.12	0.98	0.33*	0.14	1.39	0.08	0.14	1.09	0.01	0.11	1.01	-0.05	0.13	0.95
SDQ Prosocial	0.22	0.15	1.25	0.01	0.17	1.01	-0.01	0.16	0.99	-0.08	0.12	0.92	-0.15	0.14	0.86
Step 3															
BRIEF BR9[6]	-0.07	0.06	0.93	0.04	0.08	1.04	0.01	0.07	1.01	0.07	0.06	1.07	0.01	0.07	1.01
BRIEF ER9[6]	0.05	0.05	1.05	0.08	0.06	1.09	-0.05	0.06	0.95	0.12*	0.05	1.13	0.11	0.06	1.12
BRIEF MC9[6]	0.05*	0.02	1.05	-0.03	0.03	0.97	-0.03	0.03	0.97	-0.03	0.02	0.97	0.01	0.03	1.01

Note [1]Cox & Snell R^2= .11, Nagelkerke R^2 =.25.[2] Cox & Snell R^2= .25, Nagelkerke R^2 =.51.[3]Cox & Snell R^2= .36, Nagelkerke R^2 = .62 [4]Cox & Snell R^2= .26, Nagelkerke R^2 =.44.[5] Cox & Snell R^2= .34, Nagelkerke R^2 = .59. [6]Behavior Regulation, Emotional Regulation, and Metacognition index scores based on the nine-scale division. .* $p < .05$; ** $p < .01$; *** $p < .001$.