RESEARCH ARTICLE

Association of cognitive and adaptive skills with internalizing and externalizing problems in autistic children and adolescents

Javiera Donoso[1] | **Fiona Rattray**[2] | **Annelies de Bildt**[3,4] | **Julian Tillmann**[5] |
Penny Williams[6] | **Michael Absoud**[6,7] | **Vasiliki Totsika**[1,8,9,10]

[1]Division of Psychiatry, University College London, London, UK

[2]Social, Genetic and Developmental Psychiatry Centre, Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, UK

[3]Department of Child and Adolescent Psychiatry, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands

[4]Accare Child Study Center, Groningen, The Netherlands

[5]Roche Pharma Research and Early Development, Roche Innovation Center Basel, Basel, Switzerland

[6]Evelina London Children's Hospital, Guy's and St Thomas' NHS Foundation Trust, London, UK

[7]Department of Women and Children's Health, Faculty of Life Sciences and Medicine, School of Life Course Sciences, King's College London, London, UK

[8]Centre for Research in Intellectual and Developmental Disabilities, University of Warwick, Coventry, UK

[9]Tavistock and Portman NHS Foundation Trust, London, UK

[10]Millenium Institute for Care Research (MICARE), Santiago, Chile

Correspondence
Vasiliki Totsika, Division of Psychiatry,
University College London, London, UK.
Email: v.totsika@ucl.ac.uk

Abstract

The presence of an intellectual disability (ID) alongside autism is considered to increase the risk for mental health and behavior problems in children and adolescents. Existing evidence is restricted by looking at ID as a categorical classification. The study aimed to examine the association of cognitive and adaptive behavior skills with internalizing and externalizing problems in a large sample of autistic children and adolescents, across a wide range of cognitive skills. Participants were 2759 children and adolescents aged between 4 and 18 years recruited as part of the Simons Simplex Collection (SSC), of whom 709 (approximately 25%) had ID. Multiple regression models examined associations of internalizing and externalizing problems with cognitive and adaptive skills (communication, daily living, and socialization skills). Cognitive skills were not associated with externalizing problems but were associated with more internalizing problems in autistic children without ID (Cog β: 0.126). All adaptive skill domains were inversely associated with externalizing (Communication β: −0.145; Daily-Living β: −0.132; Socialization β: −0.289) and internalizing problems (Communication β: −0.074; Daily-Living β: −0.064; Socialization β: −0.213) in those without ID. Daily living (β: −0.158) and socialization skills (β: −0.104) were inversely correlated with externalizing problems in autistic children with ID, while only socialization problems (β: −0.099) were associated with internalizing problems in this group. Socialization skills were systematically associated with internalizing and externalizing problems across all levels of cognitive functioning. Supporting social skills development may benefit all aspects of child mental health, while recognizing that children with higher cognitive skills are more vulnerable to internalizing problems might assist with earlier identification of these problems.

Lay Summary

Autistic youth are very likely to experience high levels of emotional problems (often called internalizing problems) or difficulties with their behavior (often called externalizing problems). In this study, we investigated whether internalizing and externalizing difficulties are related to cognitive functioning and skills needed in daily life. Cognitive functioning was not associated with externalizing problems in autistic children and adolescents, whether they also had an intellectual disability or not. However, in autistic children without intellectual disability, higher cognitive functioning related to increased internalizing problems. Poorer social skills were associated with increased internalizing and externalizing problems for all participants. Autistic youth without an intellectual disability may be more vulnerable to internalizing problems. Autistic youth who experience more difficulties in their social interactions may be more vulnerable to internalizing and externalizing difficulties whether they have an intellectual disability or not.

INTRODUCTION

Autism Spectrum Disorder (hereafter 'autism') is a neurodevelopmental condition characterized by impaired social interaction and communication skills, and restricted, repetitive interests and behaviors (American Psychological Association, 2013). The prevalence of autism is estimated at about 1%–2% of children and adolescents in developed countries (Zeidan et al., 2022). Current research estimates that approximately 30% of autistic children also present with intellectual disability (ID) (Baio et al., 2018; Zeidan et al., 2022). ID is a neurodevelopmental disability diagnosed when significant limitations in cognitive skills (e.g., IQ scores below 70) are present in conjunction with significant limitations in adaptive behavior (Tassé et al., 2016). As a term, adaptive behavior refers to behaviors that individuals use to meet the demands of everyday life, including social communication and practical daily living skills (Tassé et al., 2012). While cognitive skills and adaptive behavior are different constructs, a positive association between adaptive behavior and IQ in autistic and neurotypical individuals is widely reported (Åsberg Johnels et al., 2021; Duncan & Bishop, 2015). However, the gap between adaptive behavior and cognitive skills may be more pronounced in autistic individuals with higher IQ than those with lower IQ (Alvares et al., 2020; Åsberg Johnels et al., 2021; Bradshaw et al., 2019; Duncan & Bishop, 2015; Kanne et al., 2011; Tillmann et al., 2019).

Autistic children and adolescents present with internalizing and externalizing behaviors and mental health problems at rates significantly higher than typically developing children (Chandler et al., 2016; Lai et al., 2019; Simonoff et al., 2008; Tureck et al., 2014). Internalizing problems are directed inwards and manifest as emotional symptoms such as fearfulness, anxiety, social withdrawal and depression. These symptoms are associated with difficulties such as disrupted appetite and sleep, lack of joy and diminished self-worth, negatively impacting health and everyday life (Durbeej et al., 2019). Conversely, externalizing problems are directed outwards, generating discomfort and conflict in the surrounding environment (Forns et al., 2011) through, for example, irritable, aggressive, and disruptive behavior and transgression of social norms. Determining factors that contribute to development of internalizing and externalizing problems is important when considering resource allocation and choice of interventions.

There is increasing recognition that internalizing and externalizing problems show differential associations with cognitive and adaptive functioning (e.g., Blanken et al., 2017; Ratcliffe et al., 2015), though the pattern of associations remains unclear. This lack of clarity is mostly due to the fact that studies use different operationalizations of cognitive and adaptive skill functioning (e.g., by measuring one domain of functioning only, such as social skills) and/or use either dimensional or categorical approaches for the measurement of cognitive and adaptive functioning (using a categorial ID classification vs using continuous IQ scores).

Several studies have examined whether co-occurring ID is associated with the presence of internalizing and externalizing problems among autistic children and adolescents (Mayes et al., 2022; Yarger & Redcay, 2020) but findings have been inconsistent. While some studies have suggested that co-occurring ID may exacerbate some types of internalizing and externalizing problems in autistic children (Kurzius-Spencer et al., 2018; Mayes, Calhoun, Murray, Ahuja, & Smith, 2011; Totsika, Hastings, Emerson, Lancaster, & Berridge, 2011) others have found no significant association between ID and conduct disorders in autistic children (Goldin et al., 2014; Simonoff et al., 2008) or between IQ scores and internalizing problems (Gjevik et al., 2011; Simonoff et al., 2008; Strang

et al., 2012; van Steensel et al., 2013). However, most of these studies included small, convenience samples, limiting the generalizability of findings.

In a large population-representative study of 5-year-old children that compared autistic children with and without ID, researchers found similar levels of externalizing and internalizing problems (specifically conduct problems and emotional symptoms) in autistic children with ID compared to children with autism only or ID only (Totsika, Hastings, Emerson, Berridge, & Lancaster, 2011). In a large study by Kurzius-Spencer et al. (2018), levels of externalizing problems were similar between autistic children with and without ID (Kurzius-Spencer et al., 2018). However, children with co-occurring ID presented with higher levels of specific internalizing problems such as self-injury and unusual fear responses but lower levels of sleep and mood problems. Other studies have reported lower levels of internalizing problems such as depression and anxiety among children with co-occurring ID compared to children without ID (Estes et al., 2007; Hallett et al., 2013; Mayes, Calhoun, Murray, & Zahid, 2011; Salazar et al., 2015) or no differences between groups (Mingins et al., 2021). A significant limitation of the existing evidence is that studies have used a categorical classification either in the form of an ID variable or a dichotomized IQ score, restricting analysis options and statistical power.

In a study investigating the relationship between gastrointestinal conditions and psychiatric outcomes in autistic children and adolescents, Neuhaus et al. (2018) also examined the contribution of psychosocial factors (including IQ and adaptive behavior) to internalizing, externalizing and self-injurious behavior (Neuhaus et al., 2018). Data were drawn from the Simons Simplex Collection (SSC) cohort and associations explored by age group (younger group—age 4–9 years; older group—age 10–17 years). IQ domains (verbal and non-verbal) were considered separately and adaptive behavior as a composite measure. Whilst verbal IQ was positively associated with both internalizing and externalizing problems across age bands, non-verbal IQ was negatively associated with just externalizing problems in the older group. Lower adaptive behavior contributed significantly to internalizing symptoms in the younger group but to externalizing symptoms across age ranges. This study provides valuable insight into the contribution of age to associations between psychosocial and psychiatric variables and to the nature of those relationships. However, it did not allow for interrogation of the subdomains of adaptive behavior or whether associations held with the presence or absence of an ID.

Findings from two recent meta-analyses illustrate well how conclusions may differ depending on whether studies include children with co-occurring ID and whether IQ scores are used as a continuous or categorical variable. Edirisooriya et al. (2021) examined the relationship between IQ scores and two distinct internalizing problems (anxiety and depression) in young autistic adolescents ($n = 812$) (Edirisooriya et al., 2021). Although no significant overall association between IQ scores and parent-reported anxiety was found, when researchers split the sample by IQ score, they found a very small negative association for those above 70 (suggesting anxiety increases as IQ decreases in those with IQs in the 70+ category) and a small positive association in those with an IQ score below 70 (suggesting an increase in anxiety as IQ scores increase for those with an overall IQ score below 70). Mingins et al. (2021) conducted a similar meta-analysis but included data from more autistic children ($n = 18,430$), across childhood and adolescence, also including studies with autistic participants with ID. In terms of the overall association between IQ scores and anxiety symptoms, Mingins et al. (2021) found a very small correlation ($r = 0.08$), similar to the Edirisooriya study, though in the Mingins study it was significant probably due to the large sample size. Interestingly, Mingins et al. (2021) found the association increased to 0.18 when restricted to studies that included children with co-occurring ID, but became near zero when studies did not include autistic children with ID.

Findings from the Edirisooriya et al. (2021) and Mingins et al. (2021) reviews suggest overall small to very small associations between IQ scores and anxiety symptoms, though there still remains lack of clarity regarding the direction and magnitude of this association; as illustrated above different conclusions are reached depending on whether IQ scores are considered (as either continuous or categorical classification) and/or whether ID is considered. Further, the presence of a small, positive association between IQ scores and depression in the Edirisooriya et al. (2021) meta-analysis—contrasting with the near zero and non-significant association with anxiety in the same study—suggests that the use of narrowband diagnostic constructs, such as depression and anxiety, can lead to different conclusions regarding associations with cognitive skills. Broadband classifications of symptoms (into internalizing and externalizing problems) is both empirically validated (Achenbach, 1966) and an approach that reflects better the fact that autistic individuals experience symptoms that come under separate diagnostic categories.

The association between mental health and specific adaptive behaviors, such as communication skills or social skills, has attracted less research attention. Language ability has been associated with different patterns of internalizing and externalizing problems, with minimally verbal children showing greater irritability, hyperactivity and lethargy symptoms but overall fewer internalizing symptoms than their verbally fluent peers (Fok & Bal, 2019). In a sample of 2079 autistic children and adolescents from the Simons Simplex Collection (SSC) cohort, a large sample of autistic children from the United States, Neuhaus et al. (2019) found that increased aggression, irritability, inattention problems and self-injurious behavior were associated with poorer social skills (a subdomain of adaptive

behavior) (Neuhaus et al., 2019). In that study, researchers were primarily interested in the association between emotional dysregulation and social skills, so they did not examine other aspects of adaptive skill functioning (Neuhaus et al., 2019). To the best of our knowledge, no studies have considered all domains of adaptive behaviors thereby limiting our understanding of potentially differential associations with internalizing and externalizing problems.

The aim of the present study was to add to the evidence on the relationship of cognitive skills and specific domains of adaptive behavior with internalizing and externalizing problems in autistic children. To address limitations in existing evidence: (a) the study explored these associations using continuous measures of cognitive skills and adaptive behavior in autistic children as a whole and also in subgroups of autistic children with and without an ID to examine whether the pattern of associations seen in the whole sample would be replicated in groups with different ID status; (b) the study used broadband dimensions of child mental health problems (internalizing and externalizing problems) because they are phenotypically and genotypically validated constructs of child mental health problems whereas the evidence for the distinctiveness of individual disorders is less strong (Forbes et al., 2016). The study analyzed data from a large sample of 2759 children and adolescents with autism from the SSC cohort. Potential confounders were age and sex (to control for their association with internalizing and externalizing problems in autistic children and adolescents; Oswald et al., 2016; White et al ., 2009), as well as occurrence of seizures, known to impact cognition, mood and behavior (Helmstaedter & Witt, 2017). Based on existing literature (Neuhaus et al., 2018), we anticipated cognitive skills scores would have small, positive associations associated with internalizing problems although no hypotheses were made on whether this association would be replicated when examined separately in participants with co-occurring ID, because of the conflicting findings (e.g., Edirisooriya et al., 2021; Mingins et al., 2021). On the basis of existing evidence of no differences in the levels of externalizing problems between autism and autism with co-occurring ID (Goldin et al., 2014; Totsika, Hastings, Emerson, Berridge, & Lancaster, 2011) we anticipated a similar pattern of associations between cognitive scores and externalizing problems across children with and without ID. We hypothesized a negative association between adaptive behavior and both internalizing and externalizing problems across cognitive skill levels.

METHODS

Design

The study is a secondary analysis of cross-sectional data drawn from the Simons Simplex Collection (SSC) that is curated by the Simons Foundation Autism Research Initiative (SFARI) Autism with data collected across 12 university-affiliated research clinics in the United States SSC includes 2759 children with autism between the ages of 4 and 18 (Fischbach & Lord, 2010). The SSC recruited families who had only one child with a diagnosis of autism; neither parents nor the child with autism had any known associated disorders such as Fragile X or Down syndrome, pregnancy or birth complications (e.g., less than 36 weeks of gestation and less than 2000 g at birth; born with significant injury or abnormality or disease that affects the brain).

Participants

For this study, data from the full sample of 2759 children were included. The mean age of the participants was nine years (SD = 3.56). Most participants were male (n = 2384, 86.41%). Self-reported racial/ethnic background was reported as White for the majority of participants (n = 2167, 78.5%). An ID was present in 25.7% (n = 709) while 74.1% (n = 2044) did not have ID (see below for definition of ID). More descriptive information can be found in Table 1.

Ethics

Approval for the current study was granted by the Institutional Review Board, King's College London (ethics reference number: PNM/13/14-174). For the primary data collection using SSC, consent was provided by participants parents and assent was also obtained from children where possible (Simons Foundation, 2019).

Intellectual disability (ID) identification

The SSC database did not identify whether participants had a diagnosis of ID. For the purposes of the present study, we identified ID following an approach that mirrors the current guidance in the latest Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013). Children with a VABS-II overall composite standard score two standard deviations below the mean (VABS composite ≤70) who also had an IQ score two standard deviations below the mean (IQ ≤70) were identified as having ID.

Measures

Autism identification

Autism identification was based on: the Autism Diagnostic Interview-Revised (ADI-R) (Rutter et al., 2003), the

T A B L E 1 SSC sample demographic and clinical characteristics.

	Full sample (n = 2759)		Autism only (n = 2044)			Autism & ID (n = 709)
	n	%	n	%	n	%
Sex						
Male sex	2384	86.41	1803	88.20	575	81.10
Female sex	375	13.59	241	11.80	134	18.90
Racial/ethnic background						
African American	111	4.02	64	3.10	46	6.50
Asian	111	4.02	67	3.30	43	6.10
Native American	6	0.22	3	0.10	3	0.40
Native Hawaian	2	0.07	1	0.04	1	0.10
White	2167	78.54	1661	81.3	502	70.80
Other	124	4.49	75	3.7	49	6.90
More than one race/white racial/ethnic background	215	7.79	157	7.70	58	8.20
Not specified	23	0.83	16	0.8	7	1.00
Seizures						
No or possible	2558	92.7	1937	94.8	615	86.70
Yes or likely	201	7.3	107	5.2	94	13.30
	Mean	SD (range)	Mean	SD (range)	Mean	SD (range)
Age (years)	9.02	3.56 (4–18)	8.84	3.47 (4–18)	9.56	3.79 (4–18)
CBCLADHD symptoms						
2–5 years	59.05	7.83 (50–76)	58.38	8.04 (50–80)	61.17	8.01 (50–76)
6–18 years	61.81	8.06 (7–80)	61.82	7.68 (50–76)	61.77	8.13 (7–80)
Cognitive skills (estimated full-scale IQ score)	81.17	27.96 (7–167)	94.01	18.21 (25–167)	44.18	15.33 (7–70)
CBCL						
CBCL externalizing	56.58	10.60 (32–97)	56.44	10.87 (32–97)	56.96	9.81 (33–89)
CBCL internalizing	60.32	9.56 (33–90)	60.88	9.74 (33–90)	58.68	8.80 (33–83)
VABS-II						
Communication skills	77.06	14.57 (30–132)	82.75	11.20 (57–132)	60.78	10.11 (30–103)
Daily living skills	76.38	13.87 (25–127)	81.38	11.57 (39–127)	62.07	9.12 (25–85)
Socialization skills	70.93	12.59 (34–117)	75.26	10.70 (44–117)	58.54	8.82 (34–83)

Note: There were 23 missing values for white racial/ethnic background, 4 for ID diagnosis, 2 for age, 1 for Cognitive skills, 9 for CBCL scores and 2 missing values for each of the VABS-II domains. VABS-II is in standard scores ($M = 100$, SD = 15). CBCL is in T scores ($M = 50$, SD = 10).

Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 2000), and the clinician's best-estimate diagnosis which drew on ADI/ADOS as well as clinical observation and chart review (Simons Foundation, 2019). The ADI-R is a semi-structured parent interview that assesses symptoms in the areas of communication, reciprocal social interaction, and restricted and repetitive behaviors. The ADOS is administered by a clinician and evaluates social–communication impairments and repetitive behaviors. Previous research has shown the reliability and validity of the ADI-R and also of the ADOS (Lecavalier et al., 2011; Lord et al., 1993) when distinguishing children with and without a diagnosis of autism (Gotham et al., 2007). Recent studies have highlighted limitations of ADOS and ADI-R in identifying autism in sex-assigned at birth females (D'Mello et al., 2022). The combination of ADOS, ADI-R, observation and clinical judgment as a method of autism identification represented, at the time of data collection, the gold standard assessment for autism ascertainment. Diagnoses assigned were of either Autism, autism spectrum disorder (ASD), or Asperger's (terms in use before the DSM-5, corresponding to DSM-IV-TR classification). For the purposes of this study, diagnoses of Autism, ASD, or Asperger's syndrome were grouped in one category, autism, in line with DMS-5 recommendations.

Cognitive skills

Cognitive skills were measured using a range of instruments because of the different ages of the participants:

Differential Ability Scales, Second Edition (DAS-II) (Elliott, 2007), Mullen Scales of Early Learning, AGS Edition (MSEL) (Dumont et al., 1995), Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999); and Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV) (Wechsler, 2003). All the aforementioned cognitive measures are validated and are often used in research with autistic children and young people (Ozonoff et al., 2005). Convergent validity has been established between DAS and MSEL scores as well as DAS and Wechsler scores in autistic children (Bishop et al., 2011; Kuriakose, 2014), allowing the comparability of IQ scores derived from these different scales. Cognitive skill measures provide an estimate of overall cognitive ability, including deviation IQs (e.g., IQs derived from standard scores) and ratio IQs (e.g., IQs derived by dividing the averaged mental age by chronological age for individuals who were not able to obtain a full-scale deviation IQ). If a participant had a full-scale deviation IQ, this value was prioritized in the present study.

Adaptive behavior

Adaptive behavior was assessed with the Vineland Adaptive Behavior Scale-Second Edition (VABS-II) (Sparrow et al., 2005), a widely used clinical semi-structured interview that assesses adaptive behaviors across three domains: communication, social competence and daily living skills in children and adults. The VABS-II yields standard scores in three adaptive behavior domains and an overall adaptive behavior composite score, with a mean of 100 and a standard deviation of 15. Its internal consistency and convergent validity have been established for autistic children and other neurodevelopment disorders (Sparrow et al., 2005). In the present study, we used parent-reported scores on communication (comprehension, verbal communication, and use of written language), daily living skills (practical skills and behaviors needed to take care of oneself) and socialization (skills and behaviors required to get along with others and use in leisure activities) (Tassé et al., 2016).

Externalizing and internalizing problems

General problem behaviors were measured with the Child Behavior Checklist (CBCL) (Achenbach & Rescorla, 2001), a widely used 118-item diagnostic screening tool for detecting internalizing and externalizing problems. There are separate versions for younger (2–5 years) and older (6–18 years) age children. Caregivers rate their child's behavior over the previous 6 months and responses are coded on a three-point Likert scale: 0 (not true); 1 (somewhat or sometimes true); and 2 (very true or often true). The current study used CBCL standardized scores on internalizing and externalizing problems, with higher scores indicating higher levels of problems. The measure has strong psychometric properties that have been supported in several research circumstances (Achenbach et al., 2003; Albores-Gallo et al., 2007). It has also been shown to be a meaningful instrument in cases of youth with different functioning levels (Dekker, Koot, et al., 2002; Dekker, Nunn, et al., 2002).

The Cronbach's alpha coefficients in this study were between good and excellent for both versions and scales. For the 2–5 years version, the externalizing problem scale indicates a Cronbach's α of 0.904 and of 0.838 for the internalizing problem scale. Meanwhile, for the 6–18 years version, the externalizing problem scale indicates a Cronbach's α of 0.904 and of 0.848 for the internalizing problem scale.

Analysis plan

Analyses were conducted in SPSS (version 26). In preparation for the main analysis, we first examined the magnitude of bivariate associations between the VABS subscale scores and cognitive skills scores using Pearson r. The correlation between the potential predictors was moderate to high (IQ & VABS-II communication skills $r(2751) = 0.723$; IQ & VABS-II daily living skills $r(2751) = 0.636$; IQ & VABS-II socialization skills $r(2751) = 0.546$). Therefore, each predictor was tested in separate models to avoid multicollinearity in the regression models.

Twelve multiple regression models were fitted (four predictors x three groups) to address the main research question about the association between adaptive behavior and cognitive skills with internalizing and externalizing problems. The four predictors were cognitive skills and the three domains of adaptive behavior (communication, daily living and social skills). The models were fitted separately in three groups, that is, the full sample and in two sub-samples: autistic participants without ID ($n = 2044$) and autistic participants with ID ($n = 709$). We adjusted each of the models with the following control variables: age, sex, white racial/ethnic background, and seizures, to ensure these variables did not distort results. The assumptions for multiple linear regression modeling were largely satisfied. However, outliers were present in models. As a sensitivity analysis, the models were fitted without outliers (Appendix S1). Findings were very similar, so the results section presents the results of the original models, including the outliers. Standardized regression coefficients are presented so the magnitude of the predictor variable coefficients can be compared across models.

RESULTS

Descriptive statistics on cognitive skills, communication, socialization, daily living skills domains, internalizing and externalizing problems are presented in Table 1.

TABLE 2 Regression analyses showing the association of adaptive behavior domains and cognitive skills with externalizing and internalizing problems for full sample ($N = 2759$).

Predictor	Externalizing problems		Internalizing problems	
	β (95% CI)	p	β (95% CI)	p
Model 1				
Cognitive skills	−0.007 (−0.017, 0.012)	0.709	**0.147** (0.037, 0.063)	**<0.001**
Model 2				
Communication skills	**−0.117** (−0.115, −0.056)	**<0.001**	0.009 (−0.021, 0.033)	0.666
Model 3				
Daily living skills	**−0.131** (−0.130, −0.071)	**<0.001**	0.003 (−0.25, 0.29)	0.876
Model 4				
Socialization skills	**−0.228** (−0.225, −0.160)	**<0.001**	**−0.101** (−0.107, −0.47)	**<0.001**

Note: Significant relationships are shown in bold. Control variables: age, sex, white racial/ethnic background and seizures. Model 1-VIF values are as follows for externalizing and internalizing problems- age: 1.029, gender: 1.001, white racial/ethnic background: 1.020, seizures: 1.022 and cognitive skills 0.023. Model 2-VIF values are as follows for externalizing and internalizing problems—age: 1.063, gender: 1.005, white racial/ethnic background: 1.024, seizures: 1.017 and communication skills 1.104. Model 3-VIF values are as follows for externalizing and internalizing problems-age: 1.047, gender: 1.007, white racial/ethnic background: 1.021, seizures: 1.020 and daily living skills 1.077. Model 4-VIF values are as follows for externalizing and internalizing problems—age: 1.112, gender: 1.004, white racial/ethnic background: 1.028, seizures: 1.013 and socialization skills 1.130.

Full sample ($N = 2759$)

Externalizing problems

As shown in Table 2, there was strong evidence of an inverse association between the different domains of adaptive behavior (communication, daily living and socialization skills) and externalizing problems, suggesting that lower levels of communication (Com), daily living (DL) and socialization skills (Soc) were associated with higher levels of externalizing problems. This association was highly significant but small. In contrast, the association between cognitive skills (Cog) and externalizing problems was not significant and near zero.

Internalizing problems

There was strong evidence of a positive association between cognitive skills and internalizing problems, indicating that higher cognitive skills were associated with higher levels of internalizing problems. This association was small. When considering adaptive behavior, there was strong evidence of an inverse association between socialization skills and internalizing problems, suggesting that lower levels of socialization skills were associated with higher levels of internalizing problems. This association was also small. The association between communication and daily living skills and internalizing problems was not significant.

Autism without co-occurring ID ($N = 2044$)

Externalizing problems

As shown in Table 3, the association between cognitive skills and externalizing problems was near zero. In contrast, there was strong evidence of an inverse association between

the three VABS subscales (communication, daily living and socialization skills) and externalizing problems. Lower levels of communication, daily living and socialization skills were associated with higher levels of externalizing problems, although the associations were mostly small.

Internalizing problems

There was strong evidence of a positive association between cognitive skills and internalizing problems. This suggests that higher levels of cognitive skills were associated with higher levels of internalizing problems. On the other hand, there was a negative association between the three domains of adaptive behavior (communication, daily living and socialization skills) and internalizing problems. This suggests that lower levels of adaptive behavior were associated with higher levels of internalizing problems. Associations were small.

Autism with co-occurring ID ($N = 709$)

Externalizing problems

As presented in Table 4, there was strong evidence of an inverse association between daily living and socialization skills and externalizing problems. Lower levels of daily living and socialization skills were associated with higher levels of externalizing problems. Contrary, the association of externalizing problems with cognitive skills and communication skills was near zero.

Internalizing problems

The association between cognitive, communication and daily living skills and internalizing problems was near zero. Contrary, there was evidence of an inverse

TABLE 3 Regression analyses showing the association of adaptive behavior domains and cognitive skills with externalizing and internalizing problems for participants with autism without co-occurring ID ($N = 2044$).

	Externalizing problems		Internalizing problems	
Predictor	β (95% CI)	p	β (95% CI)	p
Model 1				
Cognitive skills	0.038 (−0.003, 0.049)	0.089	**0.126** (0.044, 0.090)	**<0.001**
Model 2				
Communication skills	**−0.145** (−0.187, −0.094)	**<0.001**	**−0.074** (−0.106, −0.023)	**0.003**
Model 3				
Daily living skills	**−0.132** (−0.165, −0.083)	**<0.001**	**−0.064** (−0.091, −0.017)	**0.004**
Model 4				
Socialization skills	**−0.289** (−0.338, −0.249)	**<0.001**	**−0.213** (−0.234, −0.152)	**<0.001**

Note: Significant relationships are shown in bold. Control variables: age, sex, white racial/ethnic background and seizures. Model 1-VIF values are as follows for externalizing and internalizing problems—age: 1.030, gender: 1.003, white racial/ethnic background: 1.015, seizures: 1.009 and cognitive skills 1.038. Model 2-VIF values are as follows for externalizing and internalizing problems—age: 1.233, gender: 1.002, white racial/ethnic background: 1.020, seizures: 1.007 and communication skills 1.235. Model 3-VIF values are as follows for externalizing and internalizing problems—age: 1.043, gender: 1.003, white racial/ethnic background: 1.018, seizures: 1.002 and daily living skills 1.042. Model 4-VIF values are as follows for externalizing and internalizing problems—age: 1.121, gender: 1.001, white racial/ethnic background: 1.021, seizures: 1.002 and socialization skills 1.118.

TABLE 4 Regression analysis showing the association of adaptive behavior domains and cognitive skills with externalizing and internalizing problems for participants with autism and co-occurring ID ($N = 709$).

	Externalizing problems		Internalizing problems	
Predictor	β (95% CI)	p	β (95% CI)	p
Model 1				
Cognitive skills	−0.044 (−0.075, 0.019)	0.236	−0.001 (−0.044, 0.042)	0.981
Model 2				
Communication skills	−0.063 (−0.134, 0.011)	0.098	−0.046 (−0.107, 0.026)	0.234
Model 3				
Daily living skills	**−0.158** (−0.252, −0.092)	**<0.001**	−0.070 (−0.142, 0.006)	0.072
Model 4				
Socialization skills	**−0.104** (−0.204, −0.032)	**0.007**	**−0.099** (−0.179, −0.21)	**0.013**

Note: Significant relationships are shown in bold. Control variables: age, sex, white racial/ethnic background and seizures. Model 1-VIF values are as follows for externalizing and internalizing problems—age: 1.013, gender: 1.012, white racial/ethnic background: 1.006, seizures: 1.020 and cognitive skills 1.014. Model 2-VIF values are as follows for externalizing and internalizing problems—age: 1.046, gender: 1.012, white racial/ethnic background: 1.016, seizures: 1.016 and communication skills 1.053. Model 3-VIF values are as follows for externalizing and internalizing problems—age: 1.046, gender: 1.011, white racial/ethnic background: 1.004, seizures: 1.028 and daily living skills 1.057. Model 4-VIF values are as follows for externalizing and internalizing problems—age: 1.123, gender: 1.011, white racial/ethnic background: 1.011, seizures: 1.014 and socialization skills 1.122.

association between socialization and internalizing problems, where lower levels of socialization skills were associated with higher levels of internalizing problems. This association was small.

DISCUSSION

In this study, we sought to explore the association between cognitive skills and adaptive behavior with internalizing and externalizing problems in a large sample of autistic children and adolescents. Furthermore, we explored whether the patterns of associations were similar in two sub-samples: autistic children and adolescents without co-occurring ID and autistic children and adolescents with co-occurring ID.

Externalizing problems

A consistent finding across the study was the lack of association between cognitive skills and externalizing problems, regardless of ID status. Previous findings examining cognitive scores as an ordinal scale have also found no association with externalizing problems (e.g., aggression; Kurzius-Spencer et al., 2018) whereas studies looking at co-occurring ID as a categorical classification have found association with externalizing problems (e.g., conduct problems; (Totsika, Hastings, Emerson, Berridge, & Lancaster, 2011; Totsika, Hastings, Emerson, Lancaster, & Berridge, 2011). Contrary to our findings, Neuhaus et al. (2018) did find an association between verbal and nonverbal IQ (as continuous variables) and externalizing problems in the SSC cohort

(Neuhaus et al., 2018). This association is complex; positive and significant for verbal IQ across age ranges and negative for nonverbal IQ, with significant findings in just the older age group. Given both verbal and nonverbal scores are used to compute a full-scale IQ or equivalent, it is plausible that (domain specific) IQ effects are 'washed out' in our study via the collapsing of verbal and nonverbal subdomains. Nonetheless, in the context of a lack of association between continuous measures of nonverbal IQ and externalizing problems in younger children (Neuhaus et al., 2018), our finding suggests that support and interventions for reducing externalizing problems should be made available across the spectrum of cognitive skills and not assumed to be required less in more able children.

We found strong evidence of an inverse association between all domains of adaptive behavior and externalizing problems for the whole sample and those without co-occurring ID. In participants with co-occurring ID, adaptive behavior domains were also inversely related to externalizing problems, except for communication. These findings indicate a close relationship between most aspects of adaptive behavior and externalizing problems across all autistic children. Although a causal relationship cannot be inferred, it is conceivable that the interaction of adaptive behavior with the environment may be a significant pathway for the development of externalizing problems. For example, a child who experiences difficulties in social interaction with others may become frustrated, leading to reactive, externalizing behavior. Conversely, Chandler et al. (2022) found an association between ADHD symptoms in early childhood and lower adaptive functioning in adolescence, suggesting a cascading effect of specific externalizing problems on development of adaptive behavior (Chandler et al., 2022). Particular responses to behaviors that challenge may exacerbate aggression and contribute to the maintenance of externalizing problems (Kanne & Mazurek, 2011; Reese et al., 2005) and limited development of adaptive behavior skills.

Internalizing problems

In the full sample, findings indicated that cognitive skills were associated with internalizing problems, and this association was also seen in those with autism without co-occurring ID but not in those with autism and ID. Consistent with findings from previous research (Hallett et al., 2013; Neuhaus et al., 2018; Salazar et al., 2015) the association was positive, suggesting that internalizing problems, such as anxiety or depression, were more likely to be present in people with higher levels of cognitive skills (Mingins et al., 2021). Internalizing problems arise when there is a cognitive appraisal of an event, rather than just the feeling or the negative event itself (Beck & Haigh, 2014). Burrows et al. (2017)

propose a model where cognitive inflexibility and negative self-referential processing increase the risk of repetitive negative thinking (RNT) and lead to high rates of internalizing problems in high-functioning autistic individuals (Burrows et al., 2017). The pattern of associations in the present study highlights that such processes (e.g., cognitive appraisal and RNT) may be more pervasive at higher levels of cognitive skills. However, it must be noted that the CBCL (used in the current study to measure internalizing symptoms) was not designed for use in children with ID, especially children with severe or profound ID, questioning the relevance of some items for these children. Furthermore, sensitivity of the CBCL for detecting affective disorders may well be reduced when parents and carers are responding for children with severely limited language and communication skills (Fynn et al., 2023).

Socialization skills were associated with internalizing problems across all groups, suggesting interdependence of socialization skills and mental health in autistic children, regardless of their ID status and in agreement with existing research (Baker & Blacher, 2020). Other domains of adaptive behavior such as communication and daily living skills were only associated to internalizing problems among participants without ID, suggesting that internalizing problems might be more likely when children without ID struggle with any domain of adaptive behavior.

Although participants with co-occurring ID experience, by definition, more difficulties with communication, there was a lack of an association between communication and internalizing problems in this group. As noted, internalizing problems in this group of children might be more difficult to express or be recognized by parents (Fynn et al., 2023). Another possibility is that children with ID may be more likely to receive support from teachers and carers who are skilled at interpreting the needs and wishes of children with significant communication difficulties. Such specialized support would likely have positive downstream effects on emotional well-being, reducing development of internalizing symptoms that might otherwise arise from impaired communication. This additional environmental support may also be present for daily living skills. Children with autism and ID will be more likely to go to a special school and receive overall more support from the school and home environment to cope with the different demands of daily living, compared to children with autism without ID who – on average – will be more likely to go to a mainstream school and have fewer supports in place to compensate for likely limitations or difficulties in daily living and communication skills (Waddington & Reed, 2017). Future research could explore whether the association between adaptive behavior limitations and internalizing problems is moderated by the extent of environmental adaptation (e.g., attending a special or mainstream school) or the amount of specialist support autistic children receive.

Strengths and limitations of the present study

The present study includes a large, well characterized sample that was assessed with multiple continuous instruments. These findings add to the body of studies using primarily categorical classifications in this field by investigating dimensional associations between cognitive skills and adaptive behavior and internalizing and externalizing problems. The study further adds new knowledge of differential associations between domains of adaptive skills with internalizing and externalizing problems.

The study's findings need to be considered in light of design limitations. Environmental variables with well-established associations with child mental health, such as socioeconomic status or parenting (Emerson & Hatton, 2007; Rodas et al., 2017; Totsika, Hastings, Emerson, Lancaster, & Berridge, 2011) were not available in SSC. Medication status was not known and therefore analyses could not control for the potential association with outcomes. Moreover, as the majority of participants identified as White, analyses could not examine whether specific non-white racial/ethnic backgrounds might be associated with outcomes. As values of different cultures vary, the consideration or the judgment over the different behaviors may also change across different environments. For example, what is expected in adaptive behavior varies depending on each culture (Georgiades et al., 2018; Taverna et al., 2011).

Adaptive behavior and internalizing and externalizing problems were reported by the same informant i.e., parents. The pattern of findings may thus reflect common-method variance problems (c.f., Santore et al., 2020). It is, therefore, crucial that future replications draw on different sources of data for the predictor and outcome variables (Podsakoff et al., 2003).

The SSC sample is highly specific, potentially influencing results which may not be representative of the broader autism community. Exclusion criteria for the SSC sample include specific neurodevelopmental conditions (such as Fragile X Syndrome and Down Syndrome) as well as prematurity, low birth weight and brain injury. In addition, parents, and siblings of probands in the SSC sample do not have an autism diagnosis, ID or schizophrenia. Thus, findings may not be directly applicable to a wider group of autistic individuals with co-occurring neurodevelopmental conditions or with familial incidence of autism or other neurodevelopmental or psychiatric conditions.

Dovgan et al. (2019) question the validity of subscale-level CBCL data for intellectually heterogeneous autistic samples. While the CBCL is commonly used in research which children with neurodevelopmental disabilities (Guerrera et al., 2019; Hoffmann et al., 2016), suitability of the CBCL for use with children with severe or profound ID is largely unknown (Halvorsen et al., 2022) and suggested to be less reliable in this population (Koskentausta et al., 2004). If the findings of the Dovgan et al. study are replicated in the future and measurement invariance is not confirmed in this population, it might be likely that CBCL internalizing and externalizing scores reflect different constructs among children with autism with and without ID. Future research might consider, for example, using the Developmental Behavior Checklist, specifically designed to assess emotional and behavioral problems in children and adolescents with developmental and intellectual disabilities (Dekker, Nunn, et al., 2002). Finally, we used a cross-sectional design and findings do not reflect causal associations. Longitudinal studies are needed to understand in a clearer way the direction of the relationship between adaptive behavior and cognitive skills and internalizing and externalizing problems. More studies are also needed in order to explore these links over the lifetime of autistic individuals, as adaptive behavior may change in adulthood (Magiati et al., 2014; Pugliese et al., 2016).

CONCLUSION

Overall, in our sample there was clear evidence of differential associations between adaptive behavior and cognitive skills with internalizing and externalizing problems. Future research on the prevalence of mental health problems in autistic children and adolescents needs to consider the impact of level of functioning beyond a categorical classification of children as having or not having ID. On a more practical level, the systematic association of socialization skills with all mental health outcomes highlights the importance of stimulating socialization skills through early intervention approaches available to all children. Given the likely circularity of the relationship between internalizing problems and socialization skills (Ambrose et al., 2022; de Lijster et al., 2018) addressing internalizing problems, such as anxiety will be critical for enabling and enhancing positive experiences of social interactions. In turn, the fostering of positive friendships plays a beneficial role in ameliorating anxiety and enhancing positive affect. Autistic children without ID who present with high levels of cognitive skills and/or significant limitations across adaptive behavior domains may be at particularly high risk for the development of internalizing problems. Early identification and support can help to address disease burden in this population where internalizing problems and in particular anxiety is the most prevalent mental health difficulty (Chandler et al., 2016; Maskey et al., 2013; van Steensel & Heeman, 2017). Finally, the pattern of associations between externalizing difficulties and adaptive/cognitive skills suggest that externalizing problems might be better addressed by enhancing life skills rather than cognitive or academic attainment, for all children with autism regardless of co-occurring ID.

CONFLICT OF INTEREST STATEMENT

All authors have declared that they have no competing or potential conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ORCID

Javiera Donoso https://orcid.org/0000-0002-6696-0229
Fiona Rattray https://orcid.org/0000-0002-5544-240X

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.