Intelligence 98 (2023) 101753

Contents lists available at ScienceDirect

Intelligence

journal homepage: www.elsevier.com/locate/intell

Relations between intelligence index score discrepancies and psychopathology symptoms in the EDEN mother-child birth cohort

Victoria Shevchenko [a,f,*], Ghislaine Labouret [a], Ava Guez [a], Sylvana Côté [b], Barbara Heude [c], Hugo Peyre [a,d,e], Franck Ramus [a]

[a] Laboratoire De Sciences Cognitives Et Psycholinguistique, Département d'Etudes Cognitives, Ecole Normale Supérieure, EHESS, CNRS, PSL University, Paris, France
[b] Research Unit on Children's Psychosocial Maladjustment, CHU Ste-Justine Research Center and Department of Social and Preventive Medicine, University of Montreal, 3175 Chemin de la Côte Ste-Catherine, Montreal, QC H3T 1C5, Canada
[c] Université Paris Cité, Centre of Research in Epidemiology and Statistics, INSERM, Institut national de la recherche agronomique, Paris, France
[d] Centre de Ressources Autisme Languedoc-Roussillon et Centre d'Excellence sur l'Autisme et les Troubles Neuro-développementaux, CHU Montpellier, 39 Avenue Charles Flahaut, 34295 Montpellier cedex 05, France
[e] Université Paris-Saclay, UVSQ, Inserm, CESP, Team DevPsy, 94807 Villejuif, France
[f] Cognitive Neuroanatomy Lab, Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris, France

ARTICLE INFO

Keywords:
Intelligence
IQ
Psychopathology
Mental health disorders
Highly intelligent children
Anxiety
Depression
ADHD

ABSTRACT

The aim of this study was to provide a comprehensive understanding of the potential linkages between intelligence and psychopathology across the full IQ range, while considering both absolute IQ scores and discrepancies between them. We drew data from the EDEN mother-child birth cohort, gathered at two time points: 5.5 and 11.5 years of age. We examined three instruments assessing psychopathology: the Strength and Difficulties Questionnaire, the Child Behavior Checklist, and the Mental Health and Social Inadaptation Assessment for Adolescents. We focused on four distinct scales: internalizing disorder, conduct disorder, social problems, and ADHD symptoms.

Our analyses first examined correlations between Full-scale IQ, Verbal IQ, Performance IQ, and psychopathology scores. Subsequently, we explored correlations between absolute and relative verbal-performance IQ discrepancies and psychopathology scores. In general, we found that relations between intelligence index scores and psychopathology scales were generally null or negative (high IQ associated with fewer psychopathology symptoms). Our results do not lend support to the hypothesis that high intelligence or index score discrepancies are risk factors for psychopathology in children and adolescents.

1. Introduction

Scholars have been intrigued for decades by the possibility of identifying a relation between intelligence and psychopathology (Martin, Burns, & Schonlau, 2010). The question of whether intelligence is a protective factor against psychopathology or a risk factor for certain disorders has been amplified by highly divergent results. While some studies report a negative association between intelligence and mental health (Karpinski, Kinase Kolb, Tetreault, & Borowski, 2018), others observe a protective effect against psychopathology (Rommelse et al., 2017; Williams et al., 2023) or no relation at all (Francis, Hawes, & Abbott, 2016). Some authors also speculate that high discrepancy between different dimensions of intelligence might be a risk factor for psychopathology (Guénolé et al., 2013).

The existing literature has attempted to justify the positive association between psychopathology and intelligence based on the theory called the Theory of Positive Disintegration, proposed by Kazimierz Dąbrowski (Dąbrowski, 1964; Mendaglio, 2008). It posits that personal development is contingent on internal conflicts that arise due to a mismatch between current beliefs and convictions and novel experiences. Dąbrowski emphasized that a child experiences such conflicts when they transition from one developmental stage to another, such as from childhood to adolescence. According to this view, highly intelligent children experience accelerated personality development which is accompanied by emotional upheavals which increase the risk of psychopathology. According to Dąbrowski, the frequency of these

* Corresponding author at: LSCP, Département d'Etudes Cognitives, École Normale Supérieure, 29 rue d'Ulm, 75005 Paris, France.
E-mail address: shevchenko682@gmail.com (V. Shevchenko).

https://doi.org/10.1016/j.intell.2023.101753
Received 24 November 2022; Received in revised form 14 March 2023; Accepted 25 March 2023

transitions depends on overexcitabilities, among other factors (Ackerman, 2009; Schläppy, 2019). Overexcitability refers to intense sensory experiences of stimuli, hypothesized to be caused by the increased sensitivity of neurons (Mendaglio & Tillier, 2006). Dąbrowski differentiated five types of overexcitability: psychomotor, sensual, intellectual, imaginational, and emotional (Dabrowski & Piechowski, 1977; Piechowski, 2006).

Based on this framework, some researchers in the field of gifted education hypothesize that highly gifted children with high overexcitability are at risk of developing psychopathological conditions due to frequent and intense internal crises leading to earlier maturation. Thus, a number of studies have reported higher levels of overexcitability in gifted children compared to their peers of average ability (Ackerman, 1997; Bouchet & Falk, 2001). Additionally, Rinn and Reynolds (2012) reported positive correlations between overexcitability and symptoms of ADHD.

In light of these findings, two hypotheses can be formulated. First, highly gifted children have a higher proclivity for internal crises due to high overexcitabilities, which in turn increases the risk of psychopathology. Second, by extension, one could expect a positive correlation between the severity of psychopathological symptoms and cognitive ability on the whole scale of IQ.

Harrison and Van Haneghan's (2011) tested the first hypothesis by examining the potential links between Dąbrowski's overexcitability and death anxiety and insomnia in gifted children. Their study revealed three major findings. Firstly, gifted students had higher levels of intellectual, imaginational, psychomotor, and sensual overexcitabilities. Secondly, a significant effect of overexcitability (but not of intellectual giftedness) on death anxiety was observed. Thirdly, intellectual giftedness was associated with insomnia and fear of the unknown. In fact, even after adjusting for overexcitability, the authors found a higher prevalence of fear of the unknown, death anxiety, and insomnia in gifted children compared to controls. Many studies have reported an increased prevalence of depressive disorder (Francis et al., 2016; Mendaglio & Tillier, 2006; Messier & Ward, 1998) and anxiety (Kermarrec, Attinger, Guignard, & Tordjman, 2020) in gifted individuals. Moreover, Karpinski et al. (2018) found an increased risk of social anxiety for intellectually gifted adults.

However, Navrady et al. (2017) and Martin et al. (2007) observed opposite trends for neuroticism and anxiety. These studies aimed to confirm a different hypothesis: individuals with lower cognitive ability feel less in control of their environment and consequently are more at risk of developing a psychopathological condition (Lachman & Weaver, 1998; Macklin et al., 1998; Weiss, Gale, Batty, & Deary, 2009). Additionally, the findings of Koenen et al. (2009) indicate that higher cognitive ability in childhood has a protective effect against mental disorders in adulthood. In contrast, Peyre et al. (2016) observed no relationship.

Several studies have also examined discrepancies between IQ indices. These discrepancies have been suggested to be important for identifying performance patterns across different diagnostic groups (Van der Heijden & Donders, 2003). Kaufman (1976) proposed that a significant difference of 30 IQ points or more between verbal and performance IQ scores could indicate that the child's verbal and non-verbal cognitive abilities are not balanced, which may suggest the presence of a cognitive disorder. Others have suggested that this difference may be associated with learning disabilities, which could in turn create behavioral problems (Vaivre-Douret, 2011). Guénolé et al. (2013) found that a significant verbal-performance discrepancy in clinically referred gifted children (IQ > 130) was associated with increased severity of behavioral problems compared to gifted children without the discrepancy (Sweetland, Reina, & Tatti, 2006).

In contrast, studies focusing on the correlation between IQ and psychopathology have rarely reported a positive association. For instance, Dietz, Lavigne, Arend, and Rosenbaum (1997) and Lazaratou et al. (2018) reported a moderate to strong negative correlation between scores on IQ tests and conduct disorder. Rommelse et al. (2017) found a negative correlation between IQ scores and ADHD symptoms in 10–12-year-old children. Moreover, Miller et al. (2016) pointed out that children with conduct disorder often score below average on the verbal part of the WISC-V test.

The research on the relationship between psychopathology and intelligence has produced inconsistent results over the years, which can be attributed to methodological issues (Francis et al., 2016; Martin, Burns, & Schonlau, 2009). Firstly, there are variations in the operational definitions of intelligence and intellectual giftedness across studies. While some researchers define intellectual capacities based on academic achievement (Harrison & Van Haneghan, 2011) or affiliation with gifted programs (Bouchet & Falk, 2001), others solely rely on cognitive tests with IQ as the outcome measure. Furthermore, most studies use different cut-off IQ scores to define giftedness (see Table 1).

The operationalization of cognitive ability based on academic achievement may lead to bias by under-representing gifted children who face challenges adapting to the standard education system or lack interest in academic achievements. Conversely, recruitment based on gifted programs may result in a bias by under-representing gifted children who perform well in school and have no need for intellectual assessment programs.

In some studies, the gifted and control groups were not sampled from the same population, which raises concerns about their comparability. For example, Karpinski et al. (2018) compared Mensa members' responses to a questionnaire with national survey data from Kessler, Chiu, Demler, and Walters (2005). The volunteering Mensa members were not representative of high IQ individuals, and the prevalence of disorders was calculated based on different questions asked at different times. Similarly, Guénolé et al. (2013) used data from clinically referred gifted children, while the controls were randomly recruited from the general population. Francis et al. (2016) highlighted these methodological issues in their literature review and concluded that, overall, higher IQ is associated with fewer behavioral deviations. Table 1 provides a summary of the diverging results in the existing literature.

The objective of this study is to contribute to the field by examining a large birth cohort of children drawn from the general population, without selection bias in favor of greater psychopathology, and without selection bias in favor of children who had a reason to take an IQ test. A previous study had examined this cohort, comparing scores in the Strength and Difficulty Questionnaire (SDQ: Bøe, Hysing, Skogen and Breivik, 2016) between high-IQ and normal-IQ 5.5-year-old children, and had found no difference in any SDQ domain (Peyre et al., 2016). We extend this study in several ways: Firstly, we do not just consider full-scale IQ in relation to psychopathology, but also examine Verbal IQ and Performance IQ separately, as well as their absolute difference |VIQ-PIQ| and relative difference (VIQ-PIQ). Secondly, we extend the analysis to follow-up psychopathology measures taken in the same children at 11.5 years of age. Thirdly, we broaden the psychopathology measures beyond the SDQ to include two other instruments: the Child Behavior Checklist (CBCL) and the Mental Health and Social Inadaptation Assessment for Adolescents (MIA), and we analyze four scales: internalizing disorder, conduct disorder, social problems, and ADHD symptoms. Finally, instead of just comparing high-IQ with normal-IQ groups, we analyze the relationship between IQ and psychopathology over the entire IQ range (page 2).

2. Methods

2.1. Participants

In this study, we used the data of the EDEN cohort. EDEN is a longitudinal study that involved follow-ups of women and their children. The participants were recruited at the prenatal stage. The sample comprised 2002 women; at the time of delivery, 1907 of them remained in the cohort. The recruitment followed a random sampling procedure:

Table 1
Summary of the literature review. Articles considering the whole scale of IQ and involving a population-based sample are in italics.

Study	N	Sample description	Assessment of cognitive ability	Definition of giftedness	Dependent variable	Dependent measure	Relation observed
Ackerman, 1997	79	High School students Age: 12–18 Gifted: 42	Gifted program: IQ, academic achievement, creativity, task commitment	IQ ≥ 120[a]	Overexcitability	Overexcitability Questionnaire	Positive
Dietz et al., 1997	*510*	*Population-based* *Age: 2–5 years*	*McCarthy Scales of Children's Abilities, Bayley Scales of Mental Development*	–	*Psychopathology*	*CBCL, RABI,*[b] *play observation*	*Negative*
Messier & Ward, 1998	207	Delinquent juveniles 11 gifted 27 with average IQ 112 below average IQ	Raven's Advanced Progressive Matrices	IQ > 125 (> 95th percentile)	Depression	Children's Depression Inventory	Positive
Bouchet & Falk, 2001	561	College students Gifted: 142 AP[c]: 131 Standard: 288	None	Prior affiliation to gifted/ AP programs	Overexcitability	Overexcitability Questionnaire (II)	Positive
Martin et al., 2007	*689*	*Population-based* *IQ 80–89: 174* *IQ 90–99: 224* *IQ 100–109: 176* *IQ ≥ 110: 115*	*WISC*	–	*Anxiety*	*National Institute of Mental Health Diagnostic Interview* *Schedule (DIS) for the DSM-IV*	*Negative*
Koenen et al., 2009	*1037*	*Population-based*	*WISC-R*[d]	–	*Anxiety, Depression*	*Probability of a diagnosis (Diagnostic Interview Schedule (DIS))*	*Negative*
Harrison & Van Haneghan, 2011	216	Middle & High School students Gifted: 73 Control: 143	Gifted Evaluation Scale-II (for some children)	Gifted Evaluation Scale-II, Academic achievement or Torrance Tests of Creative Thinking	Overexcitability, insomnia, fear of the unknown, death anxiety	Likert scales for insomnia and fear of the unknown, Death Anxiety Questionnaire	Overexcitability: positive Death anxiety: none Fear of the unknown: positive Insomnia: positive
Guénolé et al., 2013	286	Clinical (for gifted only) 143 gifted	WISC-III	IQ ≥ 130	behavioral problems	CBCL (French version)	Positive
Peyre et al., 2016	*1100*	*Population-based* *Gifted: 23 (detected among 5-year-olds in the EDEN cohort)*	*WPPSI-III*	*IQ > 130*	*behavioral, emotional, or social problems*	*SDQ*	*None*
Karpinski et al., 2018	NA	Adults Gifted, American Mensa: 3715 National survey data: 9282 from Kessler et al. (2005).	Predefined as a subject variable due to sampling (Mensa test)	IQ > 130	Mood & anxiety disorders	Self-report on received and suspected diagnoses (for American Mensa only)	Positive
Rommelse et al., 2017	*2216*	*Population-based* *Age: 10–12 years* *IQ 55–70: 65* *IQ 70–85: 318* *IQ 85–100: 805* *IQ 100–115: 721* *IQ 115–130: 268* *IQ 130–145: 39*	*WISC-R*[d]	–	*ADHD,* *internalizing symptoms,* *externalizing symptoms*	*CBCL/6–18* *Youth Self-Report* *Teacher Report Form (short)*	*Negative*
Navrady et al., 2017	*109,729*	*Population-based* *Controls: 77121* *Lifetime major depressive disorder: 32608*	*Multiple tests yielding g factor*	–	*Neuroticism,* *psychological distress,* *Lifetime MDD*	*Eysenck Personality Questionnaire Short 120 Form-Revised, General Health Questionnaire, screening for MDD (SCID-CV*[e]*)*	*MDD: none* *Psychological distress & neuroticism: negative*
Lazaratou et al., 2018	*121*	*Population-based* *Diagnosed with conduct*	*Vocabulary & Block Design of WISC-IV*	–	*IQ*	*Vocabulary & Block Design of WISC-IV*	*Positive*

(continued on next page)

Table 1 (*continued*)

Study	N	Sample description	Assessment of cognitive ability	Definition of giftedness	Dependent variable	Dependent measure	Relation observed
		disorder: 55 *Healthy controls: 66*					
Kermarrec et al., 2020	608	Clinically referred. Gifted: 211 Controls: 397	WISC-IV	IQ ≥130	Anxiety	Parental questionnaire (conducted over the phone by a secretary), child's self-report, psychiatric assessment (for a number of children).	Positive
Williams et al., 2023	*261,701*	*UK Biobank* *High g-factor*[f]*: 16,137* *Average g-factor: 236,273* *Low g-factor: 9291*	*Fluid Intelligence, Matrix Pattern Completion, Tower Rearranging, Numeric Memory, Pairs Matching, Symbol Digit Substitution, Reaction Time, and Trail Making.*	*High g-factor: 2SD above the mean*	*Psychological phenotype (depression, anxiety, etc.)*	*Combination of questionnaires & professional diagnoses*	*Depression: negative*[g] *PTSD: negative* *Anxiety: negative*

[a] Exceptions were made for lower scores if the student had outstanding grades or scored high on other components of the assessment such as creativity or task commitment.
[b] Rochester Adaptive Behavior Inventory
[c] Advanced Placement
[d] Revised Weschler Intelligence Scales
[e] Structured Clinical Interview for DSM- 593 IV Axis I Disorders, Clinician Version
[f] General intelligence factor
[g] As reflected in a lower risk of developing a disorder

Table 2
Results of the power analysis.

Effect size (r)	Power: 5.5 years	Power: 11.5 years		
	SDQ, $N = 1032$	CBCL, N = 430	SDQ, N = 430	MIA, N = 412
0.1	0.90	0.55	0.55	0.53
0.14	0.99	0.83	0.83	0.81
0.2	1	0.99	0.99	0.98
0.3	1	1	1	1

all women visiting the maternity clinics of Poitiers and Nancy (France) before the 24th week of amenorrhea were proposed to participate. Women with pre-pregnancy diabetes, French illiteracy or those planning to move out of the region were excluded from the study. The EDEN cohort can thus be qualified as representative of the general population (Heude et al., 2016).

The primary goal of the EDEN project was to collect longitudinal data to examine and identify the most significant nutritional, environmental, and social factors affecting children's pre- and postnatal development (Heude et al., 2016). The study involved several follow-ups of the mothers, fathers, and their children, including clinical examinations at birth and ages 1, 3, and 5. Furthermore, cognitive and psychological tests were administered to the children at ages 3, 5, and 11.

For this study, we focused on two age groups, 5.5 years and 11.5 years, for which cognitive and psychological evaluations were available. We only included participants with the variables of interest present in the database, resulting in a sample of 1032 children at 5.5 years (487 girls; mean age = 67.9 months; SD = 1.8) and varying sample sizes at 11.5 years, with $N = 430$ for CBCL and SDQ (212 girls; mean age = 140.2 months; SD = 6.1) and $N = 412$ for MIA (208 girls; mean age = 140 months; SD = 6 months). Table 2 shows the power analysis results based on the number of participants available, demonstrating that both age groups provide >80% power to observe correlations as low as $r = 0.14$ at $\alpha = 0.05$ (two-tailed).

2.2. Measures

2.2.1. Cognitive tests & variables

At the age of 5.5 years, a psychologist administered the French version of the Wechsler Preschool and Primary Scale of Intelligence 3rd Edition (WPPSI-III; Wechsler, 2004) to the children, resulting in scores for full-scale, verbal, and performance IQ. At 11.5 years, the children underwent an online battery of cognitive tests on their home computer, which included adaptations of subtests from the Wechsler Intelligence Scale for Children (WISC-IV; Wechsler, 2005) such as matrix reasoning, picture concepts, and comprehension (in a multiple-choice version). Additionally, another test evaluating verbal ability, adapted from the *Échelle de vocabulaire en images Peabody*[1] (EVIP; Dunn, Dunn, & Thériault-Whalen, 1993), was administered. As these tests were not conducted in a standardized manner, the official norms were not used. Instead, the scores were standardized relative to the cohort's results. Confirmatory factor analysis was then applied to the scores to derive three scores for full-scale, verbal, and performance IQ. Verbal IQ was calculated from the EVIP and comprehension tests (loadings: 0.69 and 0.53, respectively), while performance IQ was calculated from matrix reasoning and picture concepts (loadings: 0.63 and 0.57, respectively). Full-scale IQ was based on all four scores with similar loadings. The descriptive statistics of the variables of interest are presented in Table 3.

The dependent variables resulting from the tests were full-scale IQ (FSIQ), Verbal IQ (VIQ) and Performance IQ (PIQ). For 5.5-year-old children, we used the standardized IQ measures available in the EDEN

[1] Peabody Picture Vocabulary Test (PPVT)

Table 3
Descriptive statistics of the variables of interest.

Variable	5.5 years: Mean (SD) | *Range*	11.5 years: Mean (SD) | *Range*		
	SDQ (N = 1032)	SDQ (N = 430)	CBCL[a] (*N* = 430)	MIA (*N* = 412)
Age (years)	5.7 (0.15)	11.7 (0.5)	11.7 (0.5)[b]	11.7 (0.5)
Sex (% of girls)	47%	49.3%	49.3%	49%
Full-scale IQ	103.4 (13.5)	100 (15)	100 (15)[c]	100 (14.9)
Verbal IQ	106.8 (14.2)	100 (15)	100 (15)	100 (14.9)
Performance IQ	99.6 (13.8)	100 (15)	100 (15)	100 (14.9)
Absolute Verbal-Performance IQ discrepancy[d]	12.5 (9.9)	7.4 (5.9)	7.4 (5.9)	7.4 (5.8)
Relative Verbal-Performance IQ discrepancy[e]	7.2 (14.2)	0 (9.5)	0 (9.5)	−0.2 (9.4)
Internalizing Disorder	2.1 (1.9) | *0–10*	2.4 (2.1) | *0–10*	3.4 (3.7) | *0–61*	2.6 (1.7) | *0–10*
Conduct Disorder	2.4 (2.1) | *0–10*	1.3 (1.5) | *0–10*	5.4 (5.3) | *0–64*	0.4 (0.8) | *0–10*
Social Problems	1.2 (1.3) | *0–10*	1.3 (1.6) | *0–10*	1.3 (1.7) | *0–15*	1.5 (1.2) | *0–10*
ADHD	3.1 (2.4) | *0–10*	2.6 (2.4) | *0–10*	2.4 (2.6) | *0–16*	2.6 (1.5) | *0–10*

[a] Raw scores.
[b] At the moment of administration of the Peabody Picture Vocabulary Test (PPVT). Age values are missing for 12 participants.
[c] IQ scores were standardized relative to the EDEN cohort, hence the "perfect" mean and standard deviation.
[d] Absolute difference between verbal and performance IQ: |VIQ-PIQ|.
[e] Relative difference between verbal and performance IQ: VIQ-PIQ.

database. For the 11.5-year-olds, the available measures were raw g factors resulting from confirmatory factor analysis. We standardized them relative to the cohort and converted them to an IQ scale (mean 100, SD 15). In terms of discrepancies within cognitive ability, both the absolute and relative differences between verbal and performance IQ were considered. The correlation between the absolute difference (|VIQ-PIQ|) and psychopathology tests whether any gap between IQ indices is associated with psychopathology, regardless of the direction. Conversely, the correlation between the relative difference (VIQ-PIQ) and psychopathology tests whether a gap in a specific direction is associated with psychopathology, while a gap in the other direction is a protective factor.

2.2.2. Psychopathology scales

Regarding the operationalization of psychopathology, specific subscales were selected to represent the conditions of interest. The Strengths and Difficulties Questionnaire (SDQ; Goodman, 2001; Shojaei, Wazana, Pitrou, & Kovess, 2009) was completed by parents when the children were 5.5 and 11.5 years old. This questionnaire assesses emotional and behavioral problems in children aged 3 to 16 and consists of 25 items in the form of statements that parents evaluate in terms of their relevance. The items cover problems related to emotions, conduct, hyperactivity, relationships with peers, and pro-social behavior. Each of these domains is evaluated based on five items rated 0, 1, or 2, resulting in a maximum score of 10. SDQ was the only questionnaire administered at 5.5 years, yielding a maximum score of 10 for each domain.

At 11.5 years, parents additionally completed Achenbach's Child Behavior Checklist (CBCL; Achenbach & Ruffle, 2000; Vermeersch & Fombonne, 1997), and the children themselves completed a shortened version of the Mental Health and Social Inadaptation Assessment for Adolescents (MIA; Côté et al., 2017). The CBCL comprises 113 questions

Table 4
Relation between the 4 psychopathology domains analyzed and the subscales of each instrument.

Var. of interest	SDQ	CBCL	MIA
Internalizing disorder	Emotional symptoms	Anxious/Depressed	(Depression + Anxiety) / 2
Conduct disorder	Conduct problems	Delinquent behavior + aggressive behavior	Conduct disorders
Social problems	Peer relationship problems	Social problems	(Social aggression + Social phobia) / 2
ADHD	Hyperactivity/inattention	Attention problems	(Impulsivity + Hyperactivity + Inattention) / 3

Table 5
Significance thresholds representing three degrees of stringency for each age group. Vp stands for the number of psychopathology variables (4 for 5.5 years and 12 for 11.5 years), and Vc for the number of cognitive variables, i.e., IQ index scores (5).

Threshold	Alpha threshold at 5.5 years	Alpha threshold at 11.5 years
Alpha1 = 0.05	0.05	0.05
Alpha2 = 0.05 / Vp	0.0125	0.004
Alpha3 = 0.05 / (Vp * Vc)	0.0025	0.0008

that yield scores for six areas: anxious/depressed, withdrawn, sleep problems, somatic problems, aggressive behavior, and destructive behavior. The score range for each CBCL domain was different (Table 3). MIA consists of 81 questions and evaluates possible symptoms of social phobias, attention deficits and hyperactivity, general anxiety, eating disorders, conduct disorder, depression, oppositional disorders, psychopathy, and aggression. Higher scores on the aforementioned tests are equated with more severe psychopathology. The subscales involved in the computation of the variables of interest can be viewed in Table 4.

2.3. Data analysis

To address the first question of our study (i.e., is there a relation

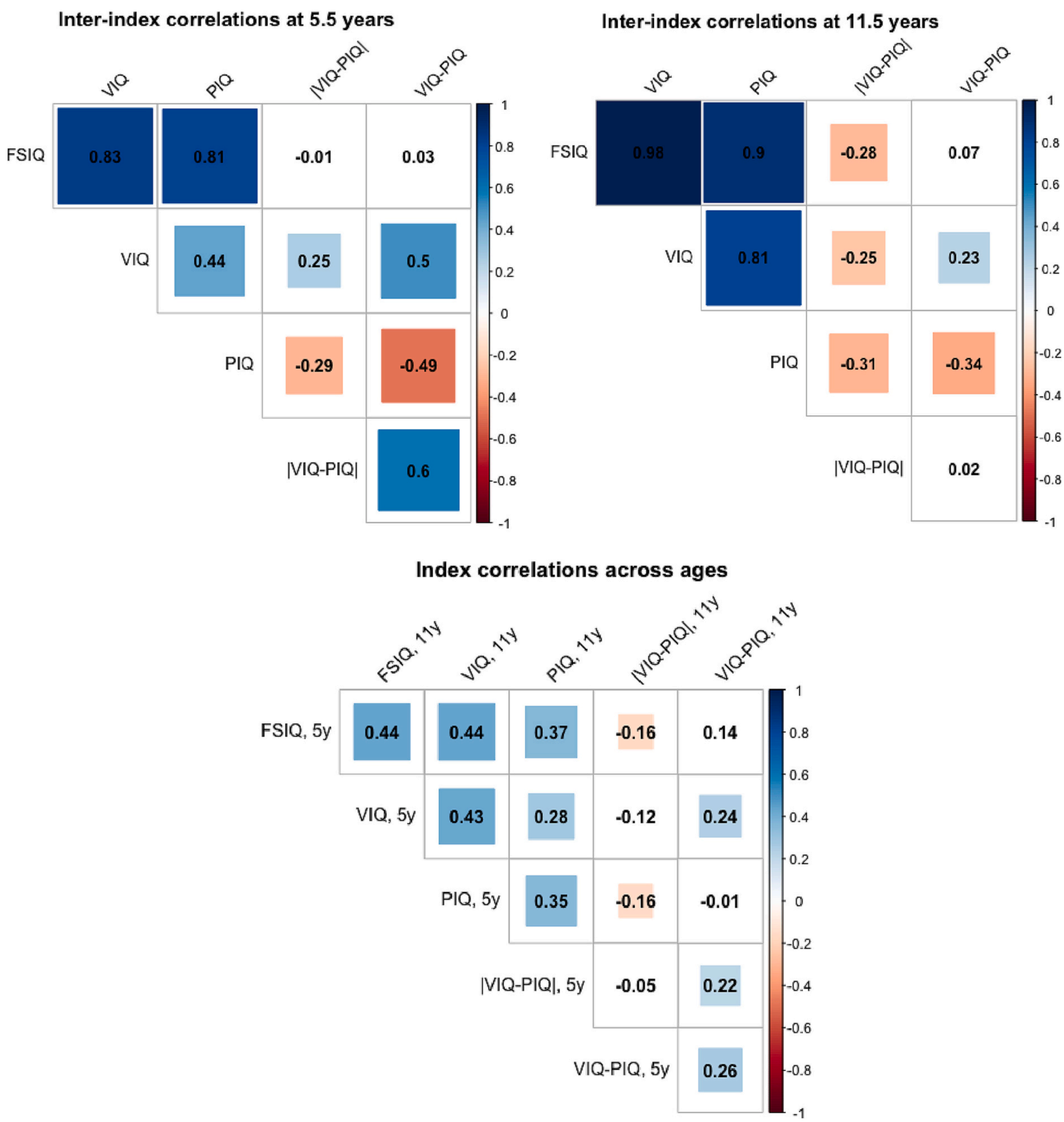

Fig. 1. Correlations (Spearman) of cognitive measures for 5.5-year-olds (upper left), 11.5-year-olds (upper right) and across ages (bottom). Sig. level = 0.05. Significant correlations are highlighted in blue (positive) or red (negative). FSIQ: Full-Scale IQ, VIQ: Verbal IQ, PIQ: Performance IQ, VIQ-PIQ: relative verbal-performance discrepancy, |VIQ-PIQ|: absolute verbal-performance discrepancy. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 6
Spearman's correlation coefficients between IQ index scores and discrepancies, and SDQ scales for 5.5-year-olds.

	Full-scale IQ	Verbal IQ	Performance IQ	|VIQ-PIQ|	VIQ-PIQ
Internalizing Disorder	−0.06	−0.04	−0.08**	0.01	0.04
Conduct Disorder	**−0.13*** **	**−0.13*** **	**−0.10*** **	0.01	−0.02
Social Problems	**−0.14*** **	**−0.13*** **	**−0.12*** **	0.03	0.01
ADHD	**−0.25*** **	**−0.22*** **	**−0.21*** **	0.01	−0.01

Significance thresholds: *$p < 0.05$, **$p < 0.0125$ (0.05 / 4), ***$p < 0.0025$ (0.05 / [4 * 5]). $N = 1032$ participants.

between cognitive ability and psychopathology?), we computed bivariate Spearman's correlations between the cognitive scores and psychopathology symptoms described above. Specifically, we tested correlations between each cognitive variable (FSIQ, VIQ, PIQ, |VIQ-PIQ|, VIQ-PIQ) and each psychopathology score at both ages. We chose a non-parametric test because the scores on psychopathology scales were not normally distributed. Additionally, we conducted exploratory analyses on these variables to examine potential non-linear relationships, particularly for the higher IQ quintile.

We report results at three two-tailed significance thresholds that represent increasingly stringent correction for multiple tests (Williams, Peyre, Toro and Ramus, 2021). The thresholds are listed in Table 5 along with the corresponding formulas. The only deviation from the

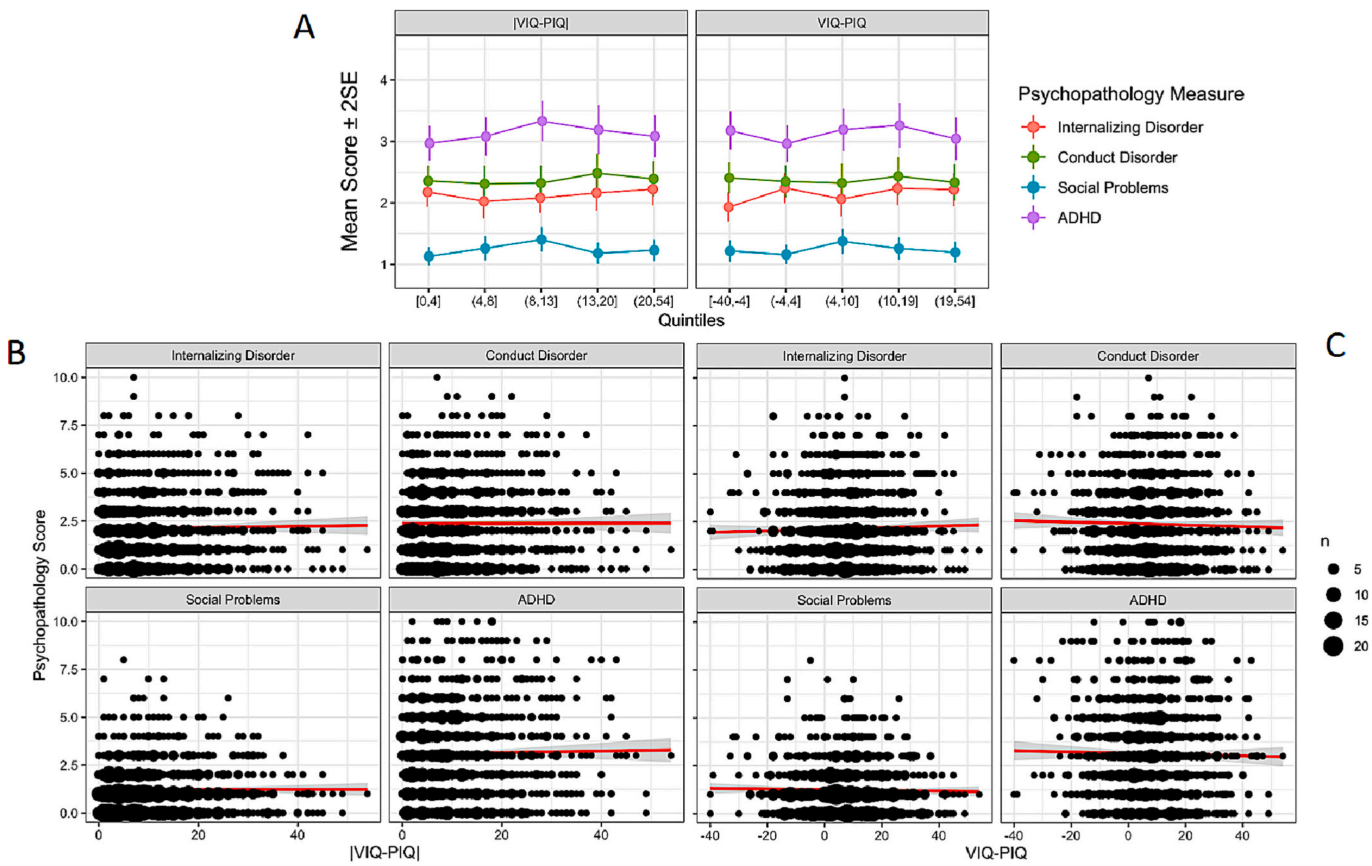

Fig. 2. Relation between verbal-performance IQ discrepancies and SDQ scale scores at 11.5 years old. **A:** SDQ scale scores by quintile of IQ discrepancies. IQ quintile ranges are on the x-axis, mean psychopathology score ± 2SE is on the y-axis **B and C:** Scatterplots of SDQ scale scores (y-axis) as a function of |VIQ-PIQ| in B and VIQ-PIQ in C (x-axis). SDQ: Strength and difficulties questionnaire. N = 1032 participants.

Table 7
Spearman's correlation coefficients between IQ index scores and discrepancies, and psychopathology scales evaluated with CBCL, SDQ and MIA for 11.5-year-olds.

	FSIQ	Verbal IQ	Performance IQ	|VIQ-PIQ|	VIQ-PIQ
Internalizing Disorder, CBCL	**−0.14** **	−0.14*	**−0.14** **	0.01	0.03
Internalizing Disorder, SDQ	**−0.15** **	**−0.15** **	−0.14*	0.02	−0.02
Internalizing Disorder, MIA	−0.11*	−0.12*	−0.06	−0.02	−0.06
Conduct Disorder, CBCL	−0.03	−0.02	−0.04	0.02	0.05
Conduct Disorder, SDQ	−0.05	−0.04	−0.07	0.03	0.05
Conduct Disorder, MIA	−0.13*	−0.13*	−0.11*	0.00	−0.01
Social Problems, CBCL	**−0.15** **	**−0.15** **	−0.13*	0.06	−0.03
Social Problems, SDQ	−0.02	−0.01	−0.05	0.01	0.06
Social Problems, MIA	−0.06	−0.06	−0.05	0.04	−0.04
ADHD, CBCL	−0.07	−0.07	−0.04	0.03	−0.06
ADHD, SDQ	**−0.14** **	**−0.14** **	−0.13*	−0.04	0.02
ADHD, MIA	−0.09	−0.08	−0.07	−0.01	−0.04

Significance thresholds: *$p < 0.05$, **$p < 0.004$ (0.05 / 12), ***$p < 0.0008$ (0.05 / [12 * 5]). $N = 430$ participants.

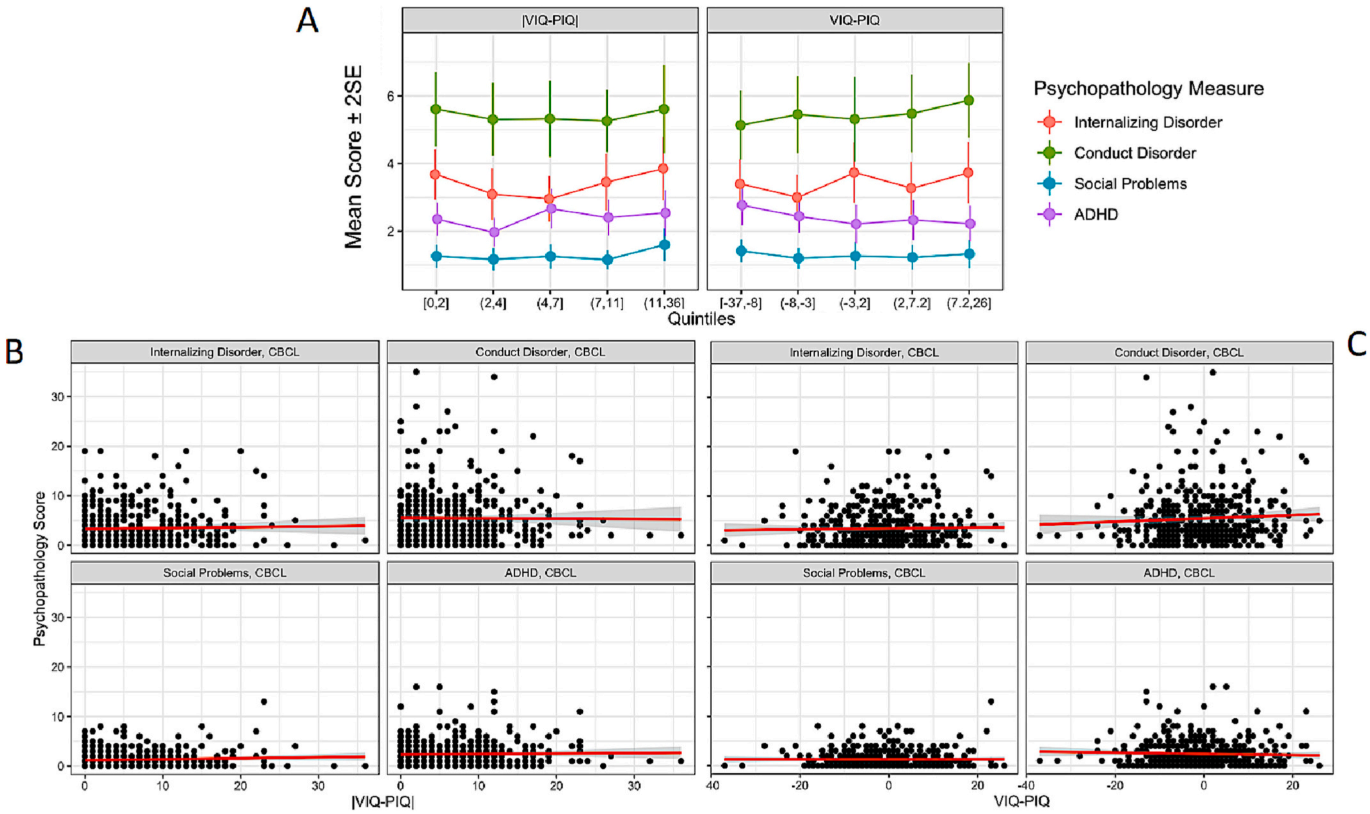

Fig. 3. Relation between Verbal-Performance IQ discrepancies and CBCL scale scores at 11.5 years old**. A:** CBCL scale scores by quintile of IQ discrepancies. **B and C:** Illustration of scatterplots of CBCL scale scores as a function of |VIQ-PIQ| (B) and VIQ-PIQ (C). CBCL: Child behavior checklist. N = 430 participants.

preregistered analyses was the later addition of the ADHD scale, which led us to update the significance thresholds as indicated in Table 5 (Vp = 4 and 12 instead of 3 and 9).

To address the reviewers' comments, we also fit structural equation models (SEM) on verbal-performance discrepancies and full-scale IQ. The results can be viewed in Supplement 3.

3. Results

3.1. Main results

Before proceeding with the main analyses, we computed Spearman correlations on all cognitive measures at 5 and 11.5 years separately. Performance, verbal, and full-scale IQ were positively correlated in both age groups as expected. Moderate negative correlations were detected between performance IQ and verbal-performance discrepancy (Fig. 1, top). We also assessed correlations between IQ scores to check whether the scores were reliable across time (Fig. 1, bottom). Virtually all IQ scores were positively correlated for the two age groups.

The results of correlation analyses for 5.5-year-olds are presented in Table 6. The correlations between IQ index scores and psychopathology scores were all small and either significantly negative (indicating that high IQ was associated with fewer psychopathological symptoms) or not significantly different from zero. Negative correlations were most evident with ADHD symptoms, moderately present with conduct disorders and social problems, and much weaker with internalizing disorders. On the other hand, the correlations between verbal-performance discrepancy scores and psychopathology scores were all non-significant. These results are depicted in Fig. 2.

Similarly, at 11.5 years, the correlations between IQ index scores and psychopathology scores were all small and either significantly negative (high IQ associated with fewer psychopathological symptoms) or non-significantly different from zero, as shown in Table 7. However, fewer correlations were significant at this age due to the smaller sample size. Notably, the largest correlations were observed for internalizing disorder, in contrast to the results at 5.5 years. For conduct disorder, only the MIA showed significant negative correlations, while for social problems, only the CBCL showed significant negative correlations.

Regarding verbal-performance discrepancy scores at 11.5 years old, all correlations with psychopathology scores were small and non-significant for the CBCL (Fig. 3). Similar non-significant associations were observed for other tests (Supplementary figs. 2.2, 2.3, 2.7, 2.8, 2.17, and 2.18).

3.2. Exploratory analyses

Supplement 1 and 2 provide graphs by quintiles of IQ scores and scatterplots with all the data points to visually examine potential non-linear trends and whether children with the highest IQ scores might escape the general negative or null correlation trend. However, the only hint of a non-linear trend was a slight increase in internalizing disorder scores in the highest quintile of verbal IQ (118–147) in 5.5-year-olds (Supplementary fig. 1.1). To probe this visual trend for reliability, a Wilcoxon rank-sum test was performed on the 4th and 5th quintiles of verbal IQ (4th quintile: $N = 212$, median = 1.5; 5th quintile: $N = 201$, median = 2). The results indicated no significant difference between the two quintiles ($W = 18{,}370$, $r = 0.121$, $p = 0.993$). The rest of the analyses showed small and non-significant correlations between IQ index scores and psychopathology scores at both 5.5 and 11.5 years of age, except for internalizing disorder at 11.5 years of age, which showed the largest correlations.

The Structural Equation Models (SEMs) yielded similar results as the correlation analyses; all associations were negligibly small and rarely statistically significant. For a detailed review of the SEMs, refer to Supplement 3.

4. Discussion

There is no shortage of literature claiming a positive association between cognitive ability and symptoms of mental illness. These studies often rely on Dąbrowski's theory of Positive Disintegration and side with the view that intellectually gifted children experience intense emotional crises due to high overexcitabilities which increase the risk of developing a mental illness. However, based on this theory, one can also propose a different hypothesis: as cognitive ability increases, the risk of psychopathology increases. The goal of this study was to test this hypothesis by investigating potential relationships between IQ index scores and the following psychopathological conditions: internalizing disorder, conduct disorder, social problems and ADHD. We were also interested in testing whether there is a relationship between discrepancies between verbal and performance IQ domains and the aforementioned mental disorders. To this end, we analyzed a large dataset collected in the context of a French longitudinal study named EDEN. We used the participant data collected at two ages: 5.5 and 11.5 years.

Overall, we found that the relations between IQ index scores and psychopathology scales were either small and negative, or null. Furthermore, we found no association whatsoever between verbal-performance discrepancy and psychopathology. It is worth noting, however, that at 5.5 years, the negative correlation between ADHD symptoms and IQ was the most pronounced, amounting to a moderate effect that survived rigorous correction for multiple comparisons. This tendency has been previously observed by Rommelse et al. (2017).

Additionally, we utilized structural equation models (SEM) to test the causal dynamics between IQ and psychopathology scores (SDQ) at both ages. Our findings indicate that there was virtually no effect of cognitive variables on SDQ scores (see Supplement 3). It is important to emphasize that these results cannot be attributed to a lack of statistical power, as our sample was sufficiently large to detect even small effects.

Our findings are consistent with an earlier study on the same cohort (Peyre et al., 2016) and extend its results from the age of 5.5 to 11.5 years, and to two new psychopathology instruments (the CBCL and MIA) which provide more detailed assessments than the SDQ. Our results are also in agreement with other studies conducted on different populations and at various ages (Koenen et al., 2009; Martin et al., 2007; Navrady et al., 2017). Similarly, in a recent study of 236,000 adult participants in the UK Biobank, high-IQ individuals had no higher prevalence of mental health disorders, and a lower prevalence of anxiety disorders and post-traumatic stress disorder (Williams et al., 2023).

We also aimed to test the oft-repeated clinical claim that large discrepancies between index scores might be either a risk factor or a reflection of psychopathology (Guénolé et al., 2013). This claim comes in two versions: i. any discrepancy (VIQ $>>$ PIQ or PIQ $>>$ VIQ) is associated with psychopathology and ii. higher verbal index scores (VIQ $>>$ PIQ) are specifically associated with psychopathology. Our results did not support either claim. We found no relationship between either type of discrepancy scores and any psychopathology scale, with the largest correlation coefficient being 0.06 and $-$ 0.06. Notably, this result was not due to the absence of large discrepancies in our sample. Fig. 2 and supplementary figures demonstrate that even verbal-performance gaps of >40 standard points were not associated with higher psychopathology scores. These results stand in sharp contrast with those of Guénolé et al. (2013), Messier and Ward (1998), Kermarrec et al. (2020), Dietz et al. (1997), and Karpinski et al. (2018). Again, we must observe that those studies that claimed a relation were based on either small samples or involved a sampling bias, with some studies manifesting both. In contrast, the present study was conducted on a large, population-based sample.

The association between discrepancy scores and psychopathology may hold true for clinically referred individuals but is obviously not a valid population-wide generalization. Therefore, it would be unwise to consider discrepancies between IQ index scores as proxies or risk factors of psychopathology in clinical practice without more direct evidence. Moreover, our study raises the question whether high IQ, in general, can be regarded as a risk factor for mental illness. Although this study is not directly related to the gifted literature, it takes it into account and raises the following question: if we observe no relationship between cognitive ability and mental illness across the IQ spectrum, do cognitive tests provide valuable insights into the likelihood that a particular individual develops a specific condition? Our findings support a negative answer.

We have also observed a certain degree of variability of correlation coefficients with IQ index scores, depending on age (5.5 vs. 11.5-year-olds), specific scale (internalizing, conduct, social problems, ADHD) and instrument used (CBCL, SDQ or MIA). One observation relates to the SDQ, which yielded different results at different ages: at 5.5, conduct and social problems – but not internalizing disorder – correlated negatively with IQ index scores. However, at 11.5 years, just the opposite was observed, with ADHD correlating with cognitive measures at both ages. One could argue that it is due to that fact that conduct disorder symptoms are greatly reduced between 5.5 and 11.5 years (see Table 3), which leaves less variance available to correlate. Yet, the same is not true of social problems. Perhaps the nature of social problems differs between 5.5 and 11.5 years, such that difficulties socializing may be more related to general intelligence in early childhood than in adolescence. Such a hypothesis warrants further analyses on individual questions of the tests. With respect to internalizing disorder, both the absolute scores and the variance slightly increased with age.

Furthermore, internalizing symptoms may be more associated with negative thoughts and ruminations, and therefore more associated with language abilities, in adolescence than at pre-school age when language is less developed. This is consistent with the fact that the negative correlation between Internalizing disorder and VIQ increased slightly more (from $r = -0.04$ to -0.15) than that with PIQ (from $r = -0.08$ to -0.14) (Tables 6 and 7).

Regarding the other two tests administered at age 11.5, the CBCL showed negative correlations with IQ index scores for internalizing disorder and social problems but not for conduct disorder and ADHD. Meanwhile, the MIA showed such correlations with internalizing and conduct disorder but not social problems and ADHD. These correlations do not appear to be solely due to the different sensitivity of these scales, as indicated by the number of questions and range of scores in Table 3. However, one notable difference is that the CBCL (and SDQ) were completed by parents, while the MIA was answered by the children themselves. Parents and children have different knowledge and subjective perceptions of the child's behavior, and they may be sensitive to different symptoms. Therefore, it may be beneficial to conduct additional studies that systematically compare the MIA, SDQ, and CBCL.

Several limitations in this study must be noted. The EDEN cohort suffered from considerable attrition, such that the two age groups had very different sample sizes (1032 at 5.5 and 430 at 11.5 years). Another potential limitation was that, at 11.5 years, cognitive tests were administered online and completed autonomously rather than in standard conditions by a trained professional. Therefore, the recorded instructions may have been insufficient for some children, leading to dropout or underperformance, particularly for the least able ones. Putatively, the attrition driven by differences in cognitive ability may have resulted in slightly different samples in terms of cognitive aptitude. In addition, despite instructions to the contrary, some children may have been helped by their parents or siblings. Overall, these conditions are likely to have made our IQ measures noisier than normal. Nonetheless, the correlation between IQ scores at the two ages was satisfactory (Fig. 1, bottom), and the correlations between IQ and psychopathology scores were not consistently lower at 11.5 than at 5.5 years. Thus, the less-than-ideal testing conditions at 11.5 years do not seem to have excessively damaged the reliability of the IQ tests.

The main conclusion that can be drawn from the present results is that the relations between cognitive ability and psychopathology are at best small. When they seemed reliable, they were always negative: increasing IQ index scores were associated with decreased psychopathological symptoms, with ADHD manifesting the most robust negative correlation with cognitive ability. There was no evidence that high IQ might be associated with more psychopathological symptoms, which is consistent with all previous population-based studies. Rather, low IQ appears to be a risk factor for psychopathology, and psychopathology may have a negative effect on cognitive ability. Finally, discrepancies between IQ index scores were not associated with psychopathological symptoms, casting doubt on their relevance for clinical interpretation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

Acknowledgements

We thank Céline Sardano and Anne Forhan, as well as the EDEN mother-child cohort study group, whose members are I. Annesi-Maesano, J.Y. Bernard, J. Botton, M.A. Charles, P. Dargent-Molina, B. de Lauzon-Guillain, P. Ducimetière, M. de Agostini, B. Foliguet, A. Forhan, X. Fritel, A. Germa, V. Goua, R. Hankard, B. Heude, M. Kaminski, B. Larroquey, N. Lelong, J. Lepeule, G. Magnin, L. Marchand, C. Nabet, F Pierre, R. Slama, M.J. Saurel-Cubizolles, M. Schweitzer, and O. Thiebaugeorges.

The EDEN study was supported by Foundation for medical research (FRM), National Agency for Research (ANR), National Institute for Research in Public health (IRESP: TGIR cohorte santé 2008 program), French Ministry of Health (DGS), French Ministry of Research, INSERM Bone and Joint Diseases National Research (PRO-A), and Human Nutrition National Research Programs, Paris-Sud University, Nestlé, French National Institute for Population Health Surveillance (InVS), French National Institute for Health Education (INPES), the European Union FP7 programmes (FP7/2007–2013, HELIX, ESCAPE, ENRIECO, Medall projects), Diabetes National Research Program (through a collaboration with the French Association of Diabetic Patients (AFD)), French Agency for Environmental Health Safety (now ANSES), Mutuelle Générale de l'Education Nationale complementary health insurance (MGEN), French national agency for food security, French-speaking association for the study of diabetes and metabolism (ALFEDIAM).

We acknowledge additional funding from Agence Nationale de la Recherche (ANR-12-DSSA-0005-01).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.intell.2023.101753. The code (R) used to perform analyses and produce the figures is publicly accessible here: https://github.com/victoris93/intelligence-paper-EDEN.

References

Achenbach, T. M., & Ruffle, T. M. (2000). The child behavior checklist and related forms for assessing behavioral/emotional problems and competencies. *Pediatrics in Review, 21*(8), 265–271. https://doi.org/10.1542/pir.21-8-265

Ackerman, C. M. (1997). Identifying gifted adolescents using personality characteristics: Dabrowski's overexcitabilities. *Roeper Review, 19*, 229–236. Ackerman, C. M.

Ackerman, C. M. (2009). The essential elements of Dabrowski's theory of positive disintegration and how they are connected. *Roeper Review, 31*, 81–95.

Bøe, T., Hysing, M., Skogen, J. C., & Breivik, K. (2016). The strengths and difficulties questionnaire (SDQ): Factor structure and gender equivalence in Norwegian adolescents. *PLoS One, 11*(5), Article e0152202. https://doi.org/10.1371/journal.pone.0152202

Bouchet, N., & Falk, R. F. (2001). The relationship among giftedness, gender, and overexcitability. *The Gifted Child Quarterly, 45*(4), 260–267. https://doi.org/10.1177/001698620104500404

Côté, S. M., et al. (2017). Psychometric properties of the Mental Health and Social Inadaptation Assessment for Adolescents (MIA) in a population-based sample. *International Journal of Methods in Psychiatric Research, 26*(4), Article e1566. https://doi.org/10.1002/mpr.1566

Dąbrowski, K. (1964). *Positive disintegration*. Boston: Little, Brown and Company.

Dabrowski, K., & Piechowski, M. M. (1977). *Theory of levels of emotional development* (Vol. 1). New York: Dabor Science Publications.

Dietz, K. R., Lavigne, J. V., Arend, R., & Rosenbaum, D. (1997). Relation between intelligence and psychopathology among preschoolers. *Journal of Clinical Child Psychology, 26*(1), 99–107. https://doi.org/10.1207/s15374424jccp2601_10

Dunn, L., Dunn, L., & Thériault-Whalen, C. (1993). *Echelle de vocabulaire en images Peabody: Adaptation française du Peabody vocabulary test-revised*. Toronto: Psycan.

Francis, R., Hawes, D. J., & Abbott, M. (2016). Intellectual giftedness and psychopathology in children and adolescents: A systematic literature review. *Exceptional Children, 82*(3), 279–302. https://doi.org/10.1177/0014402915598779

Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child & Adolescent Psychiatry, 40*(11), 1337–1345. https://doi.org/10.1097/00004583-200111000-00015

Guénolé, et al. (2013). Behavioral profiles of clinically referred children with intellectual giftedness. *BioMed Research International, 2013*, 1–7. https://doi.org/10.1155/2013/540153

Harrison, G. E., & Van Haneghan, J. P. (2011). The gifted and the shadow of the night: Dabrowski's overexcitabilities and their correlation to insomnia, death anxiety, and fear of the unknown. *Journal for the Education of the Gifted, 34*(4), 669–697. https://doi.org/10.1177/016235321103400407

Heude, B., et al. (2016). Cohort profile: The EDEN mother-child cohort on the prenatal and early postnatal determinants of child health and development. *International Journal of Epidemiology, 45*(2), 353–363. https://doi.org/10.1093/ije/dyv151

Karpinski, R. I., Kinase Kolb, A. M., Tetreault, N. A., & Borowski, T. B. (2018). High intelligence: A risk factor for psychological and physiological overexcitabilities. *Intelligence, 66*, 8–23. https://doi.org/10.1016/j.intell.2017.09.001

Kaufman, A. S. (1976). Verbal-performance IQ discrepancies on the WISC-R. *Journal of Consulting and Clinical Psychology, 44*(5), 739–744. https://doi.org/10.1037/0022-006x.44.5.739

Kermarrec, S., Attinger, L., Guignard, J., & Tordjman, S. (2020). Anxiety disorders in children with high intellectual potential. *BJPsych Open, 6*(4), E70. https://doi.org/10.1192/bjo.2019.104

Kessler, R. C., Chiu, W. T., Demler, O., & Walters, E. E. (2005). Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the national comorbidity survey replication. *Archives of General Psychiatry, 62*(6), 617–627. https://doi.org/10.1001/archpsyc.62.6.617

Koenen, K. C., Moffitt, T. E., Roberts, A. L., Martin, L. T., Kubzansky, L., Harrington, H., … Caspi, A. (2009). Childhood IQ and adult mental disorders: A test of the cognitive reserve hypothesis. *The American Journal of Psychiatry, 166*(1), 50–57.

Lachman, M. E., & Weaver, S. L. (1998). The sense of control as a moderator of social class differences in health and well-being. *Journal of Personality and Social Psychology, 74*(3), 763–773. https://doi.org/10.1037/0022-3514.74.3.763

Lazaratou, H., et al. (2018). Differences in verbal and performance IQ in conduct disorder: Research findings from a Greek sample. *Journal of Psychiatry and Behavioral Sciences, 1*(2). https://doi.org/10.33582/2637-8027/1010

Macklin, M. L., Metzger, L. J., Litz, B. T., McNally, R. J., Lasko, N. B., Orr, S. P., & Pitman, R. K. (1998). Lower precombat intelligence is a risk factor for posttraumatic stress disorder. *Journal of Consulting and Clinical Psychology, 66*(2), 323–326. https://doi.org/10.1037/0022-006x.66.2.323

Martin, L. T., Burns, R. M., & Schonlau, M. (2009). Mental disorders among gifted and nongifted youth: A selected review of the epidemiologic literature. *The Gifted Child Quarterly, 54*(1), 31–41. https://doi.org/10.1177/0016986209352684

Martin, L. T., Burns, R. M., & Schonlau, M. (2010). Mental disorders among gifted and nongifted youth: A selected review of the epidemiologic literature. *The Gifted Child Quarterly, 54*(1), 31–41. https://doi.org/10.1177/0016986209352684

Martin, L. T., et al. (2007). Childhood cognitive performance and risk of generalized anxiety disorder. *International Journal of Epidemiology, 36*(4), 769–775. https://doi.org/10.1093/ije/dym063

Mendaglio, S. (2008). Dabrowski's theory of positive disintegration: A personality theory for the 21st century. *Dabrowski's Theory of Positive Disintegration*, 13–40.

Mendaglio, S., & Tillier, W. (2006). Dabrowski's theory of positive disintegration and giftedness: Overexcitability research findings. *Journal for the Education of the Gifted, 30*(1), 68–87. https://doi.org/10.1177/016235320603000104

Messier, L. P. M., & Ward, T. J. (1998). The coincidence of depression and high ability in delinquent youth. *Journal of Child and Family Studies, 7*, 97–105 (1998) https://doi.org/10.1023/A:1022916231089 (1998).

Miller, J. L., et al. (2016). Issues related to the WISC-V assessment of cognitive functioning in clinical and special groups. *WISC-V Assessment and Interpretation, 287–343*. https://doi.org/10.1016/b978-0-12-404697-9.00010-8

Navrady, L. B., et al. (2017). Intelligence and neuroticism in relation to depression and psychological distress: Evidence from two large population cohorts. *European*

Psychiatry: The Journal of the Association of European Psychiatrists, 43, 58–65. https://doi.org/10.1016/j.eurpsy.2016.12.012

Peyre, H., et al. (2016). Emotional, behavioral and social difficulties among high-IQ children during the preschool period: Results of the EDEN mother–child cohort. *Personality and Individual Differences, 94*, 366–371. https://doi.org/10.1016/j.paid.2016.02.014

Piechowski, M. M. (2006). *Mellow out, they say. If only I could: Intensities and Sensitivities of the Young and Bright*.

Rinn, A. N., & Reynolds, M. J. (2012). Overexcitabilities and ADHD in the gifted: An examination. *Roeper Review, 34*(1), 38–45.

Rommelse, N., et al. (2017). High intelligence and the risk of ADHD and other psychopathology. *The British Journal of Psychiatry: the Journal of Mental Science, 211* (6), 359–364. https://doi.org/10.1192/bjp.bp.116.184382

Schläppy, M.-L. (2019). Understanding mental health through the theory of positive disintegration: A visual aid. *Frontiers in Psychology, 10*, 1291.

Shojaei, T., Wazana, A., Pitrou, I., & Kovess, V. (2009). The strengths and difficulties questionnaire: Validation study in French school-aged children and cross-cultural comparisons. *Social Psychiatry and Psychiatric Epidemiology, 44*(9), 740–747. https://doi.org/10.1007/s00127-008-0489-8

Sweetland, J. D., Reina, J. M., & Tatti, A. F. (2006). WISC-III Verbal/Performance Discrepancies Among a Sample of Gifted Children. In *, (Vol. 50, Issue 1,. Gifted Child Quarterly* (pp. 7–10). SAGE Publications. https://doi.org/10.1177/001698620605000102.

Vaivre-Douret, L. (2011). Developmental and cognitive characteristics of "high-level potentialities" (highly gifted) children. *International Journal Of Pediatrics, 2011*, 1–14. https://doi.org/10.1155/2011/420297

Van der Heijden, P., & Donders, J. (2003). WAIS-III factor index score patterns after traumatic brain injury. *Assessment, 10*(2), 115–122. https://doi.org/10.1177/1073191103010002001

Vermeersch, S., & Fombonne, E. (1997). Le child behavior Checklist: Résultats préliminaires de la standardisation de la version française. *Neuropsychiatrie de l'Enfance et de l'Adolescence, 45*(10), 615–620.

Wechsler, D. (2004). *WPPSI-III, Troisième édition de l'Echelle d'Intelligence de Wechsler pour la période préscolaire et primaire*. ECPA (Editions du Centre de Psychologie Appliquée).

Wechsler, D. (2005). *Échelle d'intelligence de Wechsler pour enfants : WISC-IV*. ECPA (Editions du Centre de Psychologie Appliquée).

Weiss, A., Gale, C. R., Batty, G. D., & Deary, I. J. (2009). Emotionally stable, intelligent men live longer: The Vietnam experience study cohort. *Psychosomatic Medicine, 71* (4), 385–394. https://doi.org/10.1097/psy.0b013e318198de78

Williams, C. M., Peyre, H., Labouret, G., Fassaya, J., Guzmán García, A., Gauvrit, N., & Ramus, F. (2023). High intelligence is not associated with a greater propensity for mental health disorders. *European Psychiatry, 66*(1), e3. https://doi.org/10.1192/j.eurpsy.2022.2343

Williams, C. M., Peyre, H., Toro, R., & Ramus, F. (2021). Neuroanatomical norms in the UK Biobank : The impact of allometric scaling, sex, and age. *Human Brain Mapping, 42*(14), 4623–4642. https://doi.org/10.1002/hbm.25572