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CRITICAL REVIEW

Neuropsychological Profile of Intellectually Gifted Children: A Systematic Review

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Abstract

Objective: The term *intellectually gifted* (IG) refers to children of high intelligence, which is classically measured by the intelligence quotient (IQ). Some researchers assume that the cognitive profiles of these children are characterized by both strengths and weaknesses, compared with those of their typically developing (TD) peers of average IQ. The aim of the present systematic review was to verify this assumption, by compiling data from empirical studies of cognitive functions (language, motor skills, visuospatial processing, memory, attention and executive functions, social and emotional cognition) and academic performances. **Method:** The literature search yielded 658 articles, 15 of which met the selection criteria taken from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses model. We undertook a qualitative summary, to highlight any discrepancies between cognitive functions. **Results:** IG children exhibited better skills than TD children in a number of domains, including attention, language, mathematics, verbal working memory, shifting, and social problem solving. However, the two groups had comparable skills in visuospatial processing, memory, planning, inhibition, and visual working memory, or facial recognition. **Conclusion:** Although IG children may have some strengths, many studies have failed to find differences between this population and their TD peers on many other cognitive measures. Just like any other children, they can display learning disabilities, which can be responsible for academic underachievement. Further studies are needed to better understand this heterogeneity. The present review provides pointers for overcoming methodological problems and opens up new avenues for giftedness research.

Keywords: Gifted, High ability, Neuropsychology, Cognitive function, Systematic review

INTRODUCTION

The definition of *giftedness* is still a matter of debate. Many forms of giftedness have been described and theorized. Among them is *intellectual giftedness* (IG), which is related to theories of intelligence, and historically based on the psychometric approach (Mandelman et al., 2010; Sternberg, 1981). *IG* refers to a high ability level, which was defined almost a century ago by Spearman (1904) as the *g factor*. Standardized measures of general cognitive ability are widely used to identify IG children (Cao et al., 2017), based on the intelligence quotient (IQ; McCoach et al., 2001). Children are therefore considered to be IG when their full scale intelligence quotient (FSIQ) reaches a particular threshold (Geake, 2009), generally equal to or above 130 on a test such as the Wechsler Intelligence Scale for Children (WISC; Caroff, 2004; Grégoire, 2012; Terriot, 2018). If this rigorous criterion is applied, gifted children represent 2.2% of a given age group.

Over the past decades, the increased availability of data on brain and cognitive functions in IG children has allowed neuropsychologists to gain a better understanding of how these children function. Many studies point to a unique

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neurodevelopmental trajectory in IG children. Intelligence is known to be supported by an extensive neuronal network in which frontal and parietal areas play a major role (Jung & Haier, 2007). The resolution of complex tasks, usually underpinned mainly by frontal areas (Jin et al., 2006; Lee et al., 2006), elicits a different pattern of activation in highly intelligent individuals, involving more posterior areas. In general, the functioning of IG children's brain networks is characterized by less segregation, less modularization, and more global integration (Luders et al., 2007; Solé-Casals et al., 2019; Westerhausen et al., 2018).

At the cognitive level, it has been suggested that IG children do not necessarily excel across the whole spectrum of performance measures. Their performances may be on a par with, or only slightly ahead of, their peers in a number of areas (Schofield & Ashman, 1987). They may also have weaknesses in their cognitive functioning, with learning difficulties and/or disabilities (Brody & Mills, 1997). Some authors have postulated that IG children undergo *asynchronous development*, with some cognitive and social aspects lagging behind their general ability (Silverman, 1997; Terrassier, 2009). Meanwhile, other studies have suggested that some cognitive functions, such as attention or executive functions (EFs), play a key role in the development of intelligence. We would therefore expect IG children to perform better on these functions than TD children. So far, however, studies have failed to confirm this suggestion (Montoya-Arenas, Aguirre-Acevedo, Díaz Soto, & Pineda Salazar, 2018; Viana-Sáenz, Sastre-Riba, Urraca-Martínez, & Botella, 2020).

Intelligence scales (e.g., Wechsler scales) were initially developed to obtain a single measure (FSIQ) of an ability (g), calculated from a range of cognitive subscores. Since then, however, researchers have identified several segmented domains of intelligence, evidenced by factor analyses and supported by neuropsychological theories (Wechsler, 2016). To measure these domains, subtests probing particular sets of cognitive functions, some sharing a common variance, are clustered into indices. For example, the Wechsler Intelligence Scale for Children–5th edition (WISC-V) includes seven *primary* subtests used to calculate the FSIQ, and these, together with a further three primary subtests, are used to produce the following five indices: Similarities and Vocabulary (Verbal Comprehension Index, VCI), Block Design and Visual Puzzles (Visual Spatial Index, VSI), Matrix Reasoning and Figure Weights (Fluid Reasoning Index, FRI), Digit Span and Picture Span (Working Memory Index, WMI), and Coding and Symbol Search (Processing Speed Index, PSI). These indices necessarily correlate with IQ, but their loadings differ, ranging from .81 (VCI), .87 (VSI), 1.00 (FRI), and 87 (WMI) to .57 (PSI). This explains the large discrepancies and increased variability in indices and subtest scores among persons with high ability (Binder, Iverson, & Brooks, 2009).

As indicated by the interpretation manual, this scale can be used to test assumptions about neuropsychological deficits. However, in the context of IG, the interpretation of subtest scores and indices may lead to a circular analysis (Makin & Orban de Xivry, 2019), as the variable of interest (index or subscore) is characterized by retrospective data (FSIQ). For example, Vocabulary has a loading of .76 on VCI and VCI and a loading of .81 on FSIQ. Consequently, IG children generally score higher on VCI subtests than on subtests of other indices, such as PSI, which has a loading of .55 on FSIQ. Neuropsychological tests offer a means of overcoming this issue, as they allow researchers to move away from intelligence by focusing on specific neuropsychological domains. Even so, there may be an overlap between some of these measures (Tremont, Hoffman, Scott, & Adams, 1998).

To our knowledge, there has yet to be a study comparing IG children and TD children on overall cognitive performances, measured with neuropsychological tests. This is paradoxical, given that a cognitive characterization would enhance the clinical description of this population. It is important to identify IG children's cognitive strengths and weaknesses, in order to provide suitable care and support at school for those who need it. Greater knowledge about their neuropsychological functioning would allow assessment guidelines to be developed for professionals. However, there are numerous methodological issues that need to be resolved if research is to move forward. At a theoretical level, gathering data on neuropsychological functioning in giftedness may help to refine the definition of this population.

We undertook a systematic review of the literature pertaining to a range of cognitive domains in IG. Research findings were grouped according to the classes of cognitive functions identified by Lezak, Howieson, Loring, and Fischer (2004): receptive (sensory reception and perception) and expressive functions (linguistic and motor skills/praxis), memory, attention and EFs, and social/emotional cognition. Academic skills (reading, writing, mathematics) were also taken into consideration. The neuropsychological tests measuring these domains were selected according to their interpretation manuals, and in accordance with reviews in child neuropsychology (Cassidy et al., 2018; Grealish, Price, & Stein, 2020; Lehtonen, Howie, Trump, & Huson, 2013). The present systematic review summarized the contributions and limitations of each included study and opened up avenues for future research.

METHOD

Search Strategy

We followed the PRISMA guide (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009) and PRISMA protocol (PRISMA-P) (Moher et al., 2015) for this systematic review. An initial search was conducted by the primary author in PROSPERO and Cochrane, to avoid duplication of similar reviews being undertaken. Two researchers independently conducted searches in Scopus, PubMed, PsycArticles (PsycInfo), and Psychology & Behavioral Sciences Collection (PBSCO) between June 2018 and June 2020. No restrictions were applied to publication dates. Searches were performed using combinations of the following terms: “gifted” OR “giftedness” OR “talented” OR “superior intelligence” OR “high abilities” OR “high intelligence” OR “high-IQ” AND “neuropsychology” OR “cognition” OR “attention” OR “executive functions” OR “social cognition” OR “working memory” OR “memory” OR “speech” OR “reading” OR “spelling” OR “visuospatial” OR “perceptual” OR “perceptive” OR “motor” OR “gesture” OR “praxis” OR “coordination” OR “graphomotor” OR “arithmetic” OR “mathematics” OR “learning disabilities” AND “preschooler” OR “children” OR “child” OR “adolescent”. Example of a search string used in the review: “gifted” OR “giftedness” OR “talented” OR “superior intelligence” OR “high ability” OR “high intelligence” OR “High-IQ” AND “attention” AND “preschooler” OR “children” OR “child” OR “adolescent”. A manual search was conducted in the reference lists of retrieved papers to identify further relevant studies.

Article Screening

All studies were collected using a matrix on a spreadsheet in order to help locate duplicate articles, classify them according to inclusion criteria, and register excluded studies. After removing duplicates, the two reviewers independently screened titles, abstracts, and full texts of the remaining 658 articles for eligibility. To be eligible for the current review of neuropsychological findings in gifted children, studies had to fulfill five criteria: (1) only case–control and cross-sectional studies including IG children and a comparison group; (2) scores at least two standard deviations (*SD*s) above the mean on one intellectual measure (e.g., FSIQ) for IG children (see Table 1 for criteria used in each study); (3) for studies focusing on specific subgroups of IG children with attention-deficit hyperactivity disorder (ADHD) or learning disability (LD), cutoff lowered to FSIQ $\geq$ 120, in line with recommendations (see further explanation in section below; criteria for these studies set out in Table 2); (4) use of a valid and reliable cognitive assessment to determine groups’ performances in each cognitive domain considered; and (5) published in English or French in a peer-reviewed journal.

Exclusion criteria were:

- Studies on populations other than IG children (e.g., with autism spectrum disorder) or studies including IG children with neurological disease or neurodevelopmental conditions other than ADHD or LD, such as autism spectrum disorder or premature birth.
- Papers covering other issues, to the exclusion of cognitive functioning (education, neuroimaging).
- Case studies, retrospective studies on IG youth (as these generally focus on predictors of later intellectual level), book chapters, conference proceedings and reviews.
- Studies that did not provide intelligence criteria for the IG group (e.g., only indicating mean IQ) or else used a nonconsensual IQ measure (e.g., IQ based on two subtests of an intelligence scale with no information about prorating method, or inclusion is based on a single quotient such as Verbal IQ or Performance IQ at $\geq$130).
- TD group including children with an intelligence score at least two *SD*s above the mean.
- Participants aged above 18 years.
- Studies that did not sufficiently describe the cognitive tasks, did not use quantitative methods, or did not test the statistical significance of the results.

After applying these criteria, we excluded 643 studies and included 15 (see Figure 1).

Data Extraction

Data were extracted from each study by the first author, using a predefined data extraction form. Information was (1) first author and year of publication, (2) country where study took place, (3) demographic characteristics of each group (IG, TD, and others), (4) intellectual and other inclusion criteria for each group, (5) recruitment method, (6) tool used for cognitive assessment, (7) results of group comparisons for each measure, and (8) main conclusion and study limitations.

As only a few studies were selected for each cognitive domain, and assessment tools were too heterogeneous (for both neuropsychological assessment and IQ measure), a meta-analysis was not appropriate. We therefore undertook a narrative summary of the results and produced a final statement about the main findings for each domain.

RESULTS

Study Characteristics

The 15 articles included in the review provided a combined sample size of 507 IG children (mean age = 11.5 years) and 598 TD children (mean age = 11.6 years). Sample characteristics are summarized in Table 1. Four of these studies included subgroups of IG children and children of average intelligence displaying either ADHD (IG-ADHD: 44; ADHD: 297) or LD (IG-LD: 47; LD: 73).

Most of the participants were recruited from special schools for gifted children (10/15), but some were selected by school professionals (doctor, psychologist) or teachers (3/15) or were recruited through advertisements or selected from a large sample (2/15). Studies were mostly conducted in North America (7), East Asia (3), Latin America (2), Europe (2), and the Middle East (1).

Table 3 summarizes results of comparisons between IG children and TD children on neuropsychological scores. Where available, the statistical significance is reported for each variable. For studies with many statistics, the results of group comparisons are given first. Results concerning specific subgroups of children with ADHD or LD are provided in a separate table and discussed in a specific subsection

Table 1. Sample characteristics of studies comparing IG children with a TD control group (or norms)

Study	Groups	Age or grade	Country	Criteria for IG sample	Group comparison	Recruitment
Arffa et al. (1998)[a]	IG = 26	9–14 y/o	USA	IQ > 130 (WISC-III)	Statistical manual	TD and IG school children
Arffa (2007)	IG = 45 TD_1 = 55 TD_2 = 48	6–15 y/o	USA	IQ > 130 (WISC-III, *M* = 138.8)	TD_1: IQ: 115–129 TD_2: IQ: 90–114	TD and IG school children
Chae et al. (2003)	IG = 106 TD = 71	6–9 y/o	USA	IQ ≥ 130 (WISC, *M* = 138.4)	IQ: 83–127	Children enrolled or not enrolled at the Educational Institute for Gifted Children
Chung et al. (2011)	IG = 22 TD = 26	13–15 y/o	Korea	IQ ≥ 130 (WISC-III)	IQ < 130	Students from a private special education institute who had received prizes for advanced math, or from a local private academy
Harnishfeger & Bjorklund (1990)	IG = 32 TD = 32[b]	*M* = 12.16 *M* = 12.49 y/o	USA	(a) IQ ≥ 130 (WISC), (b) score of ≥ 50% on a gifted checklist completed by the child's teachers, and (c) functioning at least 2 grade levels above assigned grade	TD = 85–118 (OLSAT)	Children from a gifted program
Knepper et al. (1983)	IG = 30 TD = 30	*M* = 11.10 y/o	USA	Standard age scores ≥ 130 (CAT)	90–110	Previously selected to participate in a school program for IG children
Leikin et al. (2013)	IG = 36[c] TD = 46[c]	16–18 y/o	Israel	IQ > 130, RAPM ≥ 27	RAPM ≤ 26	Chosen from classes for gifted students
Minahim and Rohde (2015)	IG = 39[b] TD = 39	Grades 1–5 *uk*	Brazil	IQ > 99th percentile CPM	IQ ≤ 90th percentile	IG: gifted program, previously tested. TD: recruited from the same classes
Montoya-Arenas et al. (2018)	IG = 32 TD_1 = 29 TD_2 = 43	7–11 y/o	Colombia	IQ > 130 (WISC-III)	TD_1:85–115 TD_2:116–129	Selected by their teachers based on academic achievement and an interview
Segalowitz et al. (1992)	IG = 18 TD = 30[b]	*M* = 12.2 *M* = 12.6 y/o	Canada	Screening of top 20% of the cohort on a national achievement test and IQ > 135 (WISC-R)	-	Recruited through an enrichment program. TD: children from home classrooms from which some of the enrichment children came
Shi et al. (2013)[d]	IG = 24 TD = 26	*M* = 10.41 *M* = 10.62 y/o	China	In the top 5th percentile of peers' norms (RAPM)	25–75% (RAPM)	Selected from a large sample (more than 1000 children)
Zhang et al. (2016)	IG = 43 TD = 43	9–10 y/o	China	In the top 5th percentile of peers' norms (RAPM)	25% -90% (RAPM)	Recruited from an experimental primary school class

[a] The above average group was not taken into consideration in this review
[b] The adult sample was not taken into consideration
[c] Only IG and TD samples nonexcelling in math were taken into consideration
[d] Only Study 1 was taken into consideration
M: mean
Samples: IG: intellectually gifted; TD: typically developing children of average intelligence; Measures: CAT: Cognitive Abilities Test; CPM: Raven's Colored Progressive Matrices; IQ: intelligence quotient; OLSAT: Otis-Lennon School Ability Test; RAPM: Raven's (Advanced) Progressive Matrices; WISC: Wechsler Intelligence Scale for Children.

Table 2. Sample characteristics of studies featuring IG children subgroups (attention-deficit hyperactivity disorder, learning disabilities)

Study	Groups	Age or grade	Country	Criteria for IG sample(s)	Group comparison	Recruitment
Chae et al. (2003)	• IG = 96 • IG_{ADHD} = 10 • TD = 71 • ADHD = *uk*	6–9 y/o (*M* = 7.7)	USA	• IG_{ADHD}: IQ ≥ 130 (WISC) and ADHD diagnosis based on TOVA, CBCL scores, and behavioral observation during test	• IG: IQ ≥ 130 (WISC) • TD: IQ: 83–127 • ADHD	Children enrolled or not enrolled in educational institute for gifted children
Katusic et al. (2011)	• IG_{ADHD} = 34 • $ADHD_1$ = 276 • $ADHD_2$ = 21	6–18 y/o	USA	• IG_{ADHD}: IQ ≥ 120 (WISC-R, WISC-III) with ADHD diagnosis based on DSM-IV criteria, ADHD questionnaires, clinical diagnosis	• $ADHD_1$: children with IQ < 80 and ADHD • $ADHD_2$: children with IQ between 80 and 120 and ADHD	Children attending school in the district with IQ documented in their school and/or medical records
Kraft (1993)	• IG = 40 • IG_{LD} = 21 • LD = 40	*M* = 9.3 *M* = 9.4 *M* = 9.7 (y/o)	USA	• IG_{LD}: IG non able reader (reading at least 1.5 years below grade level at Gray Oral Reading Scores).	• IG: IQ > 130 (CTMM) able reader (reading at or above grade level) • LD: IQ = 90–110 (WISC-R) Non-able reader (same criteria as IG)	Identified by school psychologist as gifted-IQ or gifted-IQ reading impaired
van Vierse-n et al. (2014)	• IG = 31 • IG_{LD} = 26 • TD = 31 • LD = 33	*M* = 100.6 *M* = 108.8 *M* = 103.5 *M* = 113.9 (m/o)	The Netherlands	• IG: IQ > 125 or a 95 % reliability interval tapping at least 130 in the case of a short form (WISC-III). • IG_{LD}: IG with dyslexia[a]	• TD • LD: dyslexic[b]	Participants were recruited through advertisements on the websites of educational magazines and clinical institutions and school psychologists

[a] Criteria for dyslexia: discrepancy between IQ and reading or spelling ability of at least two *SD*s, demonstrated: (a) at most average scores on both reading *and* spelling (standard score ≤ 12), (b) below average scores on reading *or* spelling (lowest 10–15%), and (c) below average performance on at least one of the three cognitive factors thought to underlie dyslexia: phonological awareness, rapid automatized naming, verbal short-term memory.

[b] Criteria for dyslexic group: (a) significant discrepancy between IQ and reading or spelling performance of at least 2 *SD*s and (b) below average scores on reading or spelling (lowest 10–15% or a standard score ≤ 6)

M: mean; *uk*: unknown.

Samples: ADHD: attention-deficit hyperactivity disorder; IG: intellectually gifted; IG_{ADHD}: intellectually gifted with attention deficit hyperactivity disorder, IG_{LD}: Intellectually gifted with learning disability; LD: children with learning disability (with average intelligence); TD: typically developing children (with average intelligence).

Measures: CBCL: Child Behavior Checklist, CTMM: California Test of Mental Maturity; IQ: intelligence quotient; TOVA: Test of Variables of Attention; WISC: Wechsler Intelligence Scale for Children.

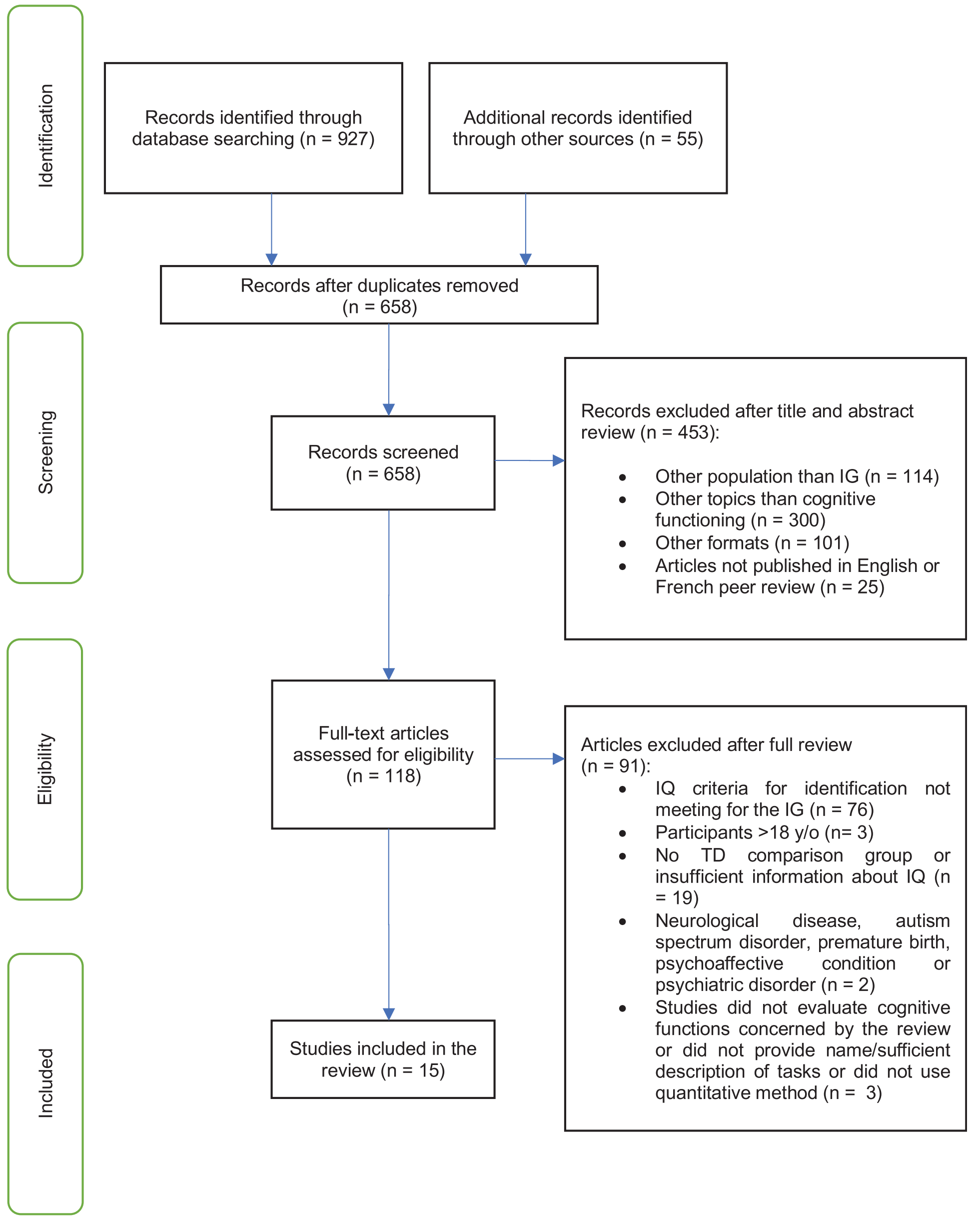

Fig. 1. Flow diagram of selected studies.

(Table 4). A final statement is provided in Table 5, classifying the studies according to their results.

Findings in Neuropsychological Domains

Language

Language ability covers many functions and processes (e.g., comprehension, expression, phonology, lexicon, syntax, pragmatic), and no study has systematically explored all these aspects. Only one of the 15 studies selected for this review dealt with language ability, among other cognitive and electrophysiological measures (Segalowitz, Unsal, & Dywan, 1992). IG children outperformed TD children on the Vocabulary subtest (Wechsler Adult Intelligence Scale-Revised, WAIS-R), indicating better lexical ability in IG children.

Academic skills

Only one of the 15 studies we selected examined the academic performance of IG children (Arffa, 2007). This study addressed the contributions several executive and nonexecutive measures in samples of children with average, above average, or superior intelligence. The author expected to observe significant relationships for all or most of the EF

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Table 3. Main results of studies comparing IG children with TD children on neuropsychological measures

Study	*n*	IQ criteria	Age (years), *M*, range	Tests	Measures	Group comparisons
Academic achievement						
Arffa (2007)[a]	IG = 45	IQ > 130 (WISC-III)	6–15 y/o	Wide Range Achievement Test	Reading	*ns*
	$TD_1 = 55$	IQ: 115–129			Math	$IG > TD_{1,2}$*
	$TD_2 = 48$	IQ : 90–114				
Language						
Segalowitz et al. (1992)	IG = 18	IQ > 135 (WISC-R)	*M* = 12.2 y/o	Vocabulary (WAIS-R)	Raw score	IG > TD***
	TD = 30[b]		*M* = 12.6 y/o			
Visuospatial						
Arffa (2007)[a]	IG = 45	IQ > 130 (WISC-III)	6–15 y/o	Rey Complex Figure Test	Copy	*ns*
	$TD_1 = 55$	IQ: 115–129				
	$TD_2 = 48$	IQ : 90–114				
Verbal memory						
Arffa (2007)[a]	IG = 45	IQ > 130 (WISC-III)	6–15 y/o	Rey Auditory Verbal Learning Test	Score	*ns*
	$TD_1 = 55$	IQ: 115–129				
	$TD_2 = 48$	IQ : 90–114				
Harnishfeger & Bjorklund (1990)	IG = 32	IQ > 130 (WISC)	*M* = 12.16 y/o	Free-recall task (two word lists)	Recall typical words from the adult list	$IG_{boys} < TD_{boys}$
	TD = 32[b]	IQ : 85–118 (OLSAT)	*M* = 12.49 y/o		Recall typical items	*ns*
					Recall atypical items	*ns*
					Typical & atypical latency types	*ns*
					Between-category latencies	IG < TD**
					Global strategy	*ns*
Attention						
Chae et al. (2003)	IG = 10[c]	IQ ≥ 130 (KEDI-WISC)	*M* = 7.7, 6–9 y/o	Test of Variables of Attention visual test	Omission	IG < TD ***
	TD = 71	IQ : 83–127			Commission	IG < TD *
					Response time	*ns*
					Response time variability	IG < TD ***
					Response sensitivity	IG > TD***
					ADHD score	IG < TD **
Minahim and Rohde (2015)	IG = 39[b]	IQ > 99thpercentile	*uk* (Grades 1–5)	MTA-SNAP-IV	Inattention or HI or combined score	*ns*
	TD = 39	IQ ≤ 90th percentile		DSM-IV	Bussing criterion	*ns*
					Positivity	*ns*
Segalowitz et al. (1992)	IG = 18	IQ > 135 (WISC-R)	*M* = 12.2 y/o	Simple reaction time	Mean	IG < TD**
	TD = 30[b]		*M* = 12.6 y/o	Choice reaction time	Standard deviation	IG < TD*
					Coefficient of variation	*ns*
					Mean	*ns*
					Standard deviation	*ns*
					Coefficient of variation	*ns*

(*Continued*)

Table 3. (*Continued*)

Study	*n*	IQ criteria	Age (years), *M*, range	Tests	Measures	Group comparisons
Shi et al. (2013)	IG = 24	RAPM ≥ 95%	*M* = 10.41	Continuous Performance Test	Rate of omission errors	IG < TD**
	TD = 26	RAPM: 25–75%	*M* = 10.62		Rate of commission errors	IG < TD*
					Sensitivity	IG > TD
					Reaction time	*ns*
					β (judgment criterion)	*ns*
Zhang et al. (2016)	IG = 43	RAPM ≥ 95%	NA, NA, 9–10 y/o	Inattentional blindness paradigm	Susceptible to inattentional blindness	IG < TD**
	TD = 43	RAPM: 25–90%			Mean accuracy (first three trials)	*ns*
					Accuracy in crucial trials	IG > TD**
					Accuracy in divided attentional trials	IG > TD**
Executive functions						
Arffa et al.(1998)[d]	IG = 26	IQ > 130 (WISC-III)	9–14 y/o	Wisconsin Card Sorting Test	Perseverative errors	IG < SM*
Arffa (2007)[a]	IG = 45	IQ > 130 (WISC-III)	6–15 y/o	Wisconsin Card Sorting Test	Perseverative errors	IG < TD_2**
	TD = 103	IQ: 115–129		Stroop Color-Word Test	Nonperseverative errors	IG < TD_2**
		IQ: 90–114		Fluency Test	Word	*ns*
				Trail Making Test	Color	*ns*
				Underlining Test	Color-Word Total	IG > $TD_{1,2}$*
					Controlled Oral Word Fluency Test	IG > $TD_{1,2}$*
					Design Fluency	IG > $TD_{1,2}$*
					Part A	*ns*
					Part B	*ns*
					Total (net correct)	*ns*
Leikin et al. (2013)[e]	IG = 36	RAPM ≥ 27 (QI > 130)	16–18 y/o	Digit span (WISC-III)	Forward digit	IG > TD*
	TD = 46	RAPM ≤ 26			Backward digit	IG > TD**
				Letter-Number Sequencing (WISC-III)	Standard score	*ns*
				Corsi block task	Forward visuospatial	*ns*
Montoya-Arenas et al. (2018)	IG = 32	IQ > 130 (WISC-III)	7–11 y/o		Backward visuospatial	*ns*
	TD_1 = 29	IQ: 85–115		Wisconsin Card Sorting Test	Categories	*ns*
	TD_2 = 43	IQ: 116–129			Perseverative errors	*ns*
					% perseverative errors	*ns*
					Failures to maintain set	*ns*
					% responses at conceptual level	*ns*
				Tower of Hanoi	Moves	*ns*
					Times	*ns*
				Stroop Word Color	Color	*ns*
					Word-Color	*ns*
				Ruff Figural Fluency	Score	*ns*
				Verbal Fluency Test Phonetic	Phonemic	IG > TD_1*
					Semantic	IG > TD_1**

(*Continued*)

Table 3. (*Continued*)

Study	*n*	IQ criteria	Age (years), *M*, range	Tests	Measures	Group comparisons
Segalowitz et al. (1992)[b]	IG = 18 TD = 30	IQ > 135 (WISC-R)	*M* = 12.2 y/o *M* = 12.6 y/o	Wisconsin Card Sorting Test	% perseverative errors	*ns*
				Mazes (WISC-R)	Raw score	*ns*
				Digit span (WAIS-R)	Forward	IG > TD***
					Backward	IG > TD**
				Trigrams		IG > TD**
Social cognition and emotional processing						
Chae et al. (2003)	IG = 106 TD = 71	IQ ≥ 130 (WISC) IQ: 83–127	*M* = 7.7, 6–9 y/o	Korea-Children Behavior Checklist	Social competency	IG < TD***
Chung et al. (2011)	IG = 22 TD = 26	IQ ≥ 130 (WISC-III)	13–15 y/o	Public Good Game	Cooperation Condition 1 (C1) & 3 (C3)	IG > TD**
					Cooperation Condition 2 (C2)	*ns*
					Money earned C1, C2 & C3	IG > TD*/**
					Monetary performance between conditions	IG: *ns* TD: C2 > C1, 3
					Effects of success or failure in preceding trial	*IG, TD: ns*
					Cooperation rates among conditions	*ns*
					Effects of success or failure in preceding trial	*ns*
					Cooperative rate according to number of cooperators in preceding trial:	IG > TD*
					• C1	IG: ns, TD*
					• C2	*ns*
					• C3	IG*
Knepper et al. (1983)	IG = 30 TD = 30	Standard age score ≥ 130 (CAT)	*M* = 11.10 y/o	Means-Ends Problem Solving	Social version	IG > TD*
					Emotional version	IG > TD*
Segalowitz et al. (1992)[b]	IG = 18 TD = 30	IQ > 135 (WISC-R)	*M* = 12.2 y/o *M* = 12.6 y/o	Benton Facial Recognition Test	Score	*ns*

[a] Only comparisons between IG and TD1 or TD2 were taken into consideration
[b] The adult sample was not taken into consideration in this review
[c] Results of IG children with ADHD are documented separately in Table 3
[d] TD were not taken into consideration, as they did not serve as a control group
[e] Only IG and TD samples nonexcelling in math were taken into consideration *M*: mean; *ns*: not significant; *uk*: unknown.
Samples: IG: intellectually gifted; SM: statistical manual (comparison with adult mean); TD: typically developing children of average intelligence;
Measures: CAT: Cognitive Abilities Test; CPM: Raven's Colored Progressive Matrices; DSM(-IV): Diagnostic and Statistical Manual of Mental Disorders (4th edition); IQ: intelligence quotient; MTA-SNAP-IV: NIMH Collaborative Multisite Multimodal Treatment Study of Children with Attention-Deficit Hyperactivity Disorder; OLSAT: Otis-Lennon School Ability Test; RAPM: Raven's (Advanced) Progressive Matrices; WAIS: Wechsler Adult Intelligence Scale; WISC(-R, -III): Wechsler Intelligence Scale for Children.

Table 4. Main results of studies among IG children subgroups (learning disabilities, ADHD) on neuropsychological measures

Study	Samples (n)	Sample description	Test	Measures	Results
Studies among IG children with ADHD					
Chae et al. (2003)	IG = 96	IG: IQ ≥ 130 (WISC)	TOVA	Ommission errors	IG_{ADHD} < ADHD***
	IG_{ADHD} = 10	IG_{ADHD}: IQ ≥ 130 (WISC) and ADHD diagnosis based on TOVA, CBCL scores and behavioral observation during test.		Commission errors	IG_{ADHD} < ADHD*
				Response sensitivity	IG_{ADHD} > ADHD**
	TD = 71	IQ: 83–127		Response time	*ns*
	ADHD = *uk*	ADHD: ADHD children without IG		Response variability	*ns*
				Overall ADHD score	*ns*
			WISC	Subtest score: Coding	IG > IG_{ADHD}**
				Other subtest and IQ	IG = IG_{ADHD}
			CBCL	Social competency	IG > IG_{ADHD}**
Katusic et al. (2011)	IG_{ADHD} = 34 $ADHD_1$ = 276 $ADHD_2$ = 21	• IG_{ADHD}: IQ ≥ 120 (WISC-R, WISC-III) with an ADHD diagnosis based on DSM-IV criteria, ADHD questionnaires, clinical diagnosis • $ADHD_{(1)}$: children with IQ < 80 and ADHD • $ADHD_{(2)}$: children with IQ of 80–120 and ADHD	CAT	Reading score	IG_{ADHD} > $ADHD_{1,2}$ **
Studies among IG children with LD					
Kraft (1993)	IG = 40 IG_{LD} = 21 LD = 40	• IG: IQ > 130 (CTMM) able reader (reading at or above grade level) • IG $_{LD}$: IG non-able reader (reading at least 1.5 years below grade level on Gray Oral Reading Scores) • LD: IQ = 90–110, WISC-R non-able reader (same criteria as IG)	Digit span (WISC) Morse code sequences	*Not specified* *Not specified*	IG_{LD}, LD < IG*** IG_{LD}, LD < IG***
van Viersen et al. (2014)	IG = 31	IG: IQ > 125 or a 95 % reliability interval tapping at least 130 in the case of a short form (WISC-III).	Literacy	EMT, AVI, PI-dictee	LD < IG_{LD} < TD < IG[b]
	IG_{LD} = 26		Cognitive component	FAT, CB&WL, AWNA	LD < IG_{LD} < TD < IG[b]
	TD = 31	IG_{LD}: IG with dyslexia[a]	Working memory	SS, Odd-one-out	LD < TD < IG_{LD} < IG[b]
	LD = 33	TD: typically developing children	Grammar, Vocabulary	CELF	LD < TD < IG_{LD} < IG[b]
		LD: children with dyslexia[a]			

[a] Criterion for dyslexia: discrepancy between IQ and reading or spelling ability of at least two *SD*s, demonstrated (a) at most average scores on both reading and spelling (standard score ≤ 12), (b) below average scores on reading or spelling (lowest 10–15%), and (c) below average performance on at least one of the three cognitive factors thought to underlie dyslexia: phonological awareness, rapid automatized naming, and verbal short-term memory

[b] Results based on Bayesian statistics*uk*: unknown, *ns*: not significant.

Samples: ADHD: attention deficit hyperactivity disorder; IG: intellectually gifted; IGADHD: intellectually gifted with attention deficit hyperactivity disorder; IGLD: intellectually gifted with learning disability; LD: children with learning disability (without IG); TD: typically developing children (average intelligence)

Measures: AVI: text reading time; AWNA: Automated Working Memory Assessment; CAT: California Achievement Test; CBCL: Child Behavior Checklist; CB&WL: Continu Benoemen & Woorden Lezen; CELF-4: Clinical Evaluation of Language Fundamentals; CVLT-C: California Verbal Learning Test-Children's version; EMT: Eén-minuut-test; FAT: Fonemische Analyse Test; SS: spatial span; TOVA: Test of Variables of Attention; WISC: Wechsler Intelligence Scale for Children.

Table 5. Final statement about findings in IG children compared with TD children

	Target ability	Unknown difference	Better functioning	Poorer functioning
Academic achievement	Reading	☐ *Arffa (2007)*		
	Math		☑ *Arffa (2007)*	
Language	Vocabulary		☑ *Segalowitz et al. (1992)*	
Visuospatial	Visuo-constructional skills	☐ *Arffa (2007)*		
Verbal memory		☐ *Arffa (2007)* ☐ *Harnishfeger & Bjorklund (1990)*		
Attention	Prevalence of ADHD	☐ *Minahim & Rohde (2015)*		
	Performance-based measures		☑ *Chae et al. (2003)* ☑ *Shi et al. (2013)* ☑ *Segalowitz et al. 1992* ☑ *Zhang et al. (2016)*	
Executive functions	Shifting	☐ *Montoya-Arenas et al. (2018)** ☐ *Segalowitz et al. (1992)*	☑ *Arffa et al. (1998)* ☑ *Arffa (2007)* ☑ *Montoya-Arenas et al. (2018)**	
	Planification	☐ *Montoya-Arenas et al. (2018)* ☐ *Segalowitz et al. (1992)*		
	Working memory	☐ *Leikin et al. (2013)**	☑ *Leikin et al. (2013)** ☑ *Segalowitz et al. (1992)*	
	Inhibition	☐ *Arffa (2007)*		
Social cognition and emotional processes	Social/emotional skills		☑ *Knepper et al. (1983)*	☒ *Chae et al. (2003)*
	Decision making		☑ *Chung et al. (2011)*	
	Facial recognition	☐ *Segalowitz et al. (1992)*		
Total		12	13	1

*Studies supporting mixed results.

measures. An achievement test (Wide Range Achievement Test Reading and Math) was used as a nonexecutive measure. Regression results indicated that intelligence accounted the most for the achievement measure, with proportions ranging from 14% of the variance for the math score to 28% for the reading score. After controlling for age, significant associations were only found for the math score, as the superior intelligence group scored significantly higher than the other two groups. The author concluded that achievement is more strongly related to IQ than to either executive or nonexecutive measures.

Motor and visuospatial abilities

These abilities have seldom been explored in IG children. The only included study to explore them was the one described in the previous section (Arffa, 2007). Another nonexecutive measure was obtained with the Rey-Osterrieth Complex Figure, assessing visuospatial skills. Regression analysis revealed a significant effect of IQ (WISC-III, perceptual organization composite score) on the copy score. However, after controlling for age, only the above average group scored above average. The authors did not find any differences between the IG group and the average and above average groups. They suggested that a ceiling effect might help explain why differences were not clearly evident. This study did not identify whether IG children had scores above or below those of the average sample.

Verbal memory

Only two of the 15 studies we included explored this domain, and neither of them reported a difference between IG and TD children on the Rey Auditory-Verbal Learning Test. Intellectual level and verbal learning performance seemed to be relatively independent (Arffa, 2007). Intelligence did not account for the variance on the learning test. Post hoc analyses only showed that the above average group performed better than the average group. The IG children did not differ significantly from either of these two groups. The other study found that IG and TD children did not differ significantly on free recall of category-related or not category-related words, whether they were adult-generated or self-generated (Harnishfeger & Bjorklund, 1990). This study did not report all the statistical and significant comparisons between groups and tended to over-emphasize some nonsignificant scores ($p \geq .05$). However, sufficient evidence was collected to conclude that IG children failed to recall more words than TD children and were no more strategic.

Attention

Of all the cognitive domains considered in this review, attentional skills accounted for the greatest number of studies (5/15). Attention is a fundamental process that interacts with every other cognitive function and through it, information processing, orientation, decisional processes, and behavior are controlled (Zimmermann & Leclercq, 2002).

Attention in IG children was assessed with various tools, ranging from reaction times to target detection and the inattentional blindness paradigm. Taken together, studies focusing on performance-based measures (4/5) supported the idea of better attentional functioning in IG children. Only reaction times led to conflicting results. One of three studies reported faster reaction times for IG children in a simple reaction time task (Segalowitz et al., 1992), but the other two studies did not, based on the Test Of Variables of Attention (TOVA)-Visual Test and continuous performance test (Chae, Kim, & Noh, 2003; Shi et al., 2013). These inconsistent results may be explained by the varying nature of the tasks. Nevertheless, variability in response times was lower in IG children than in TD children, in the two studies that measured it (Chae et al., 2003; Segalowitz et al., 1992), suggesting that IG children display fewer fluctuations in attentional skills. Moreover, all the studies that recorded accuracy data (e.g., omission, commission, or accuracy scores) reported better scores for IG children (Chae et al., 2003; Shi et al., 2013; Zhang, Zhang, He, & Shi, 2016). This superiority was also demonstrated using an inattentional blindness paradigm. IG children performed better on this task and were more liable to detect unexpected stimuli (Zhang et al., 2016). These results were interpreted as an additional spare capacity of attention.

One study that assessed the frequency of ADHD symptoms, based on teacher ratings and reports (Minahim & Rohde, 2015), found no evidence of a difference in the number of ADHD cases between IG children and their TD peers, suggesting that ADHD is neither more nor less frequent in IG children.

Executive functions

EFs are a set of general-purpose control processes that regulate thoughts and behaviors (Miyake & Friedman, 2012). They "make possible mentally playing with ideas; taking the time to think before acting; meeting novel, unanticipated challenges; resisting temptations; and staying focused" (Diamond, 2013, p. 135). Different EFs can be distinguished, such as working memory (WM), inhibition, cognitive shifting, planning, and problem solving.

Executive functioning received just as much interest as attentional skills as five of the 15 studies we included provided EF measures. Mixed results were reported for WM, depending on the nature of the task and the processes involved. IG children performed better than TD children in both the forward and backward conditions of the digit span task, but not on letter-number sequencing and spatial WM tasks (Leikin, Paz-Baruch, & Leikin, 2013; Segalowitz et al., 1992).

All four studies of the included studies that assessed shifting did so using the Wisconsin Card Sorting Test (WCST). However, they reported contrasting results. When the percentage of perseverative errors was taken into account, half the studies failed to find a difference between IG and TD children (Montoya-Arenas et al., 2018; Segalowitz et al., 1992), while the other half reported lower scores in favor of IG children (Arffa, 2007; Arffa et al., 1998). Performances on other WCST measures differed according to the study. One reported fewer nonperseverative errors for IG children (Arffa, 2007), whereas no difference was found between the groups on the number of categories completed or failures to maintain sets (Montoya-Arenas et al., 2018). In the fluency task, IG children scored higher in the verbal modality (Arffa, 2007; Montoya-Arenas et al., 2018), while conflicting results were reported in the nonverbal modality, with scores either equal to (Montoya-Arenas et al., 2018) or above (Arffa, 2007) those of TD children.

Of the three studies that examined inhibitory ability, only one used a valid measure of inhibition. In this study (Arffa, 2007), IG and TD children did not differ significantly on an underlining test. Montoya-Arenas et al. (2018) also used the Stroop test to assess inhibition. However, the measure required (interference score) to distinguish EF(s) from other cognitive components was not provided. The same problem arose with the Trail Making Test used to assess shifting, as the alternating switch-cost measure was not provided.

Concerning planning skills, no difference was recorded between IG and TD children on either Mazes (Segalowitz et al., 1992) or the Tower of Hanoi (Montoya-Arenas et al., 2018).

Social and emotional processes

Social cognition refers to how people process information within a social context, including perception, causal attributions concerning self and others, social judgments, and decision making.

These abilities were assessed in four of the 15 studies. Only one of them (Chae et al., 2003) highlighted poor social abilities in IG children, based on parents and teachers' responses to the Child Behavior Checklist (CBCL). However, a study conducted with means-ends problem solving (Knepper et al., 1983) showed that IG children outperformed the TD sample on social and emotional problem solving. These results were supported by another study of social decision making in IG adolescents (Chung et al., 2011). These authors showed that IG adolescents were more cooperative and strategic than the others' and demonstrated weak loss sensitivity, but notable greed in a public goods game.

Research on IG Subgroups: Learning Disabilities and Attention-Deficit Hyperactivity Disorder

IG-LD children have received increasing attention over the past few decades. These students are defined as simultaneously having a high general ability and a cognitive deficit (Reis et al., 2014). This results in low achievement in one or more areas, such as reading or writing skills (Maddocks, 2020).

We initially identified two studies that focused on IG subgroups, formed on the basis of an intelligence score two standard deviations above the mean. However, the use of this cut-off is debated. Researchers have suggested that cognitive weaknesses in IG children with LD impact the PSI and WMI, leading to a depressed FSIQ (Maddocks, 2020). Authors therefore recommend either lowering the IQ cut-off or using an alternative measure, such as the General Aptitude Index (Foley Nicpon, Allmon, Sieck, & Stinson, 2011). This led us to consider research on IG-LD children that we had initially excluded, owing to an intellectual level less than two standard deviations above the mean. By setting the IQ cut-off at 120 (Lovett & Sparks, 2013), we were able to include two additional studies in our review (Katusic et al., 2011; van Viersen et al., 2014), bringing the total number of studies on IG subgroups to four (4/15).

Two studies found that children in the IG-ADHD subgroup outperformed peers with ADHD of average IQ on the TOVA (Chae et al., 2003). They made fewer commission and omission errors and had better response sensitivity. They did not differ on either response time, response variability, or overall ADHD score. Compared with their IG peers without ADHD, they scored lower on the Coding subtest of the WISC, but no differences were observed on either the other subtests or the IQ scores. Their social competence, assessed via parental reports (CBCL), was poorer than that of the IG children. IG-ADHD children had better reading performances than children with ADHD of average IQ (Katusic et al., 2011).

The two remaining studies attempted to characterize some of the cognitive functioning of dyslexic IG children, by investigating their WM (Kraft, 1993) and language skills (literacy, grammar, vocabulary, phonology; van Viersen et al., 2014). Although weaknesses were evidenced in some language skills (e.g., phonology), the dyslexic IG children always outperformed their dyslexic peers of average IQ. However, both dyslexic IG children and dyslexic children of average IQ scored lower than IG children on verbal WM tasks (Kraft, 1993). IG children with LD outperformed dyslexic children and TD children on WM and two language skills (grammar and vocabulary), suggesting strengths in their cognitive profile (van Viersen et al., 2014).

DISCUSSION

The twofold aim of this systematic review was to draw up an inventory of studies of the neuropsychological functioning of IG children and to summarize these children's possible cognitive strengths and weaknesses. It was the first to provide a comprehensive understanding of IG children's overall cognitive functioning.

Our study supports the conclusion that IG children generally exhibit average or above average skills, depending on the cognitive area. Only one study found weaker skills in a specific area of functioning (i.e., social competence proxy-reported by parents and teachers).

This review provides evidence that IG children differ from their IQ average peers, with better functioning in some cognitive areas, such as attentional skills, mathematics achievement, some EFs, and social cognition. Their attentional skills are the ones that have been most documented (along with EFs) up to now, and results converge. IG children make fewer errors on attentional tasks and display greater accuracy. Contrary to what has been suggested for many years (by drawing a parallel with ADHD symptomatology), these children seem to be no more concerned by ADHD diagnoses or signs than TD children. These findings are in line with a recent systematic review (Rommelse et al., 2016) suggesting that higher intelligence is actually negatively linked to ADHD and related symptoms.

The executive functioning of IG children has received just as much interest as attention. However, findings in this area are noticeably more heterogeneous. This can be explained by the diverse (nonunitary) nature of EFs, which may lead to patterns of dissociation (Friedman & Miyake, 2017). A recent meta-analysis of EFs in children with high intelligence (criteria not supplied) concluded that they outperform TD children on verbal and visuospatial WM, but not on other EFs (Viana-Sáenz et al., 2020). Our results are partially consistent with this study. IG children appeared to perform better on the verbal component of WM, as well as on shifting, when assessed with a verbal fluency task, probably thanks to their larger vocabulary. Contradictory results were reported by studies using the WCST. Performances of IG and TD children do not differ on the remaining EFs (planning, inhibition, and visual WM).

Studies did not find any evidence of differences between IG children and TD children on reading, long-term memory, or visuospatial skills. Only one study reported poorer functioning in IG children, and this was for social cognition. Results on this domain were also heterogeneous. It is important to distinguish between different aspects. In low-level social cognition, such as facial recognition, IG children did not differ significantly from their average IQ peers. However, in social/emotional problem solving and social decision making, they demonstrated better skills in performance-based measures. This contrasted with teachers' and parents' ratings, which indicated poorer social abilities in IG children. This is not surprising, as performance-based and rating measures are known to generally yield different types of information (Toplak, West, & Stanovich, 2013).

Our review also indicates that despite a growing interest in IG children with LD or ADHD, few empirical studies have attempted to empirically describe their cognitive profile. Nevertheless, their findings are along the same lines, showing better attentional and reading abilities in IG-ADHD children than in children with ADHD of average IQ. Despite this relative advantage, IG-ADHD children may also encounter difficulties at school (Rommelse et al., 2017) and worrisome psychosocial outcomes requiring diagnosis and treatment, just like any other children (Katusic et al., 2011). Both IG-dyslexic children and average IQ-dyslexic children exhibit poorer WM skills than IG children who are able readers. However, IG-dyslexic children display better WM and language skills (grammar, vocabulary) than average IQ-dyslexic children and even TD children. These better skills may be sources of compensation, but also obstacles to the diagnosis of dyslexia in IG children.

Interestingly, the present systematic review did not provide any support for the assumption that IG children have better overall cognitive functioning, as measured by neuropsychological assessment. For example, although EFs are considered by some to be the fundamental components of intelligence (Ardila, Pineda, & Rosselli,, 2000; Ardila, 2018), our study demonstrated that a higher intellectual level does not necessarily correspond to better executive functioning. Finally, as IG children seem not to outperform TD children in many cognitive domains, we can surmise that intelligence develops in a relatively independent manner from other cognitive functions. Some authors interpret discrepancies between intelligence level and other areas as being clinically specific to IG children and consider them to constitute a vulnerability factor (Terrassier, 2009). However, according to other researchers, discrepancies can be explained by Spearman's law of diminishing returns, which states that there is greater variability across scores and greater dispersion in a higher ability population (Binder et al., 2009; Blum & Holling, 2017; Labouret & Grégoire, 2018), thus refuting any clinical explanation. As neuropsychological measures are generally loosely correlated with IQ, we would not expect all these scores to be at the high level, owing to the regression-to-the-mean effect (Larrabee, 2000). The probability of obtaining an abnormal score is inversely related to intelligence (Binder et al., 2009; McGee, Delis, & Holdnack, 2009). Still others suggest that the lack of difference between samples of IG and TD children on cognitive measures is due to ceiling effects. Moreover, it should be noted that neuropsychological tests are designed with deficits in mind. Their utility for determining above-average abilities is tenuous and controversial.

Although our review offered a new perspective on IG children, by considering their overall cognitive functioning, it had several limitations. First of all, there was a dearth of studies in some domains (e.g., motor or mathematical components). Math abilities are mainly studied in other types of giftedness, notably mathematical giftedness (O'Boyle et al., 2005), with criteria for math achievement rather than a general ability score. This explains why no such data were including in our study. The small number of studies included in this review was the result of a methodological choice to include a well-defined population. Many inclusion and exclusion criteria were applied for this review, in order to avoid limitations encountered in other studies among IG children, including confused definitions and a lack of stringent criteria (Viana-Sáenz et al., 2020). For some domains (e.g., academic achievement, language, and visuospatial ability), the conclusions of this review were based on a single study. Further studies are therefore necessary to generate additional data and make these conclusions more robust. Moreover, more systematic studies are needed to explore all aspects of the domain being considered.

This review also faced methodological issues arising from the studies we selected. The latter generally included children from gifted programs, who are overrepresented in the literature, thus raising the prospect of sampling bias. Moreover, as previously mentioned (Segalowitz et al., 1992), recruitment for these studies was based on the inclusion criteria for the relevant program. It is not clear whether the researchers checked these. Additionally, few studies identified their exclusion criteria, in particular, the presence of medical conditions (e.g., neurological or psychiatric disease). These are important aspects, as they are likely to have an impact on cognitive performance. It should also be noted that descriptions of the TD groups were evasive, and their IQ scores were not systematically provided. Few studies statistically tested the difference in IQ between the two groups, even though the size of this difference and its location in the distribution could have resulted in different effects (Schofield & Ashman, 1987). Researchers should pay attention to these aspects in future studies. Furthermore, our review did not establish exactly how much higher each neuropsychological score was in the IG group, and nor did it ascertain the nature of the nonsignificant results (absence of sufficient evidence or equivalence between groups; Makin & Orban de Xivry, 2019). To answer these questions, effect sizes (or the data required to calculate them) are needed (Ferguson, 2009; Sullivan & Feinn, 2012), but very few of the studies included in this review provided them. Further studies in IG would benefit from reporting effect sizes, in addition to statistical significance, to accurately interpret the results. Lastly, the studies included in this review tended to be old. Current studies tend to focus more on educational issues, even though our knowledge of these children paradoxically remains very limited. Researchers in the neuropsychology field will have an important role to play in enhancing our understanding of these children in years to come.

CONCLUSION AND FUTURES DIRECTIONS

This systematic review provided insight into the cognitive functioning of IG children with skills equal or superior to those of TD children. Strengths were identified in language (vocabulary), math achievement, attention, some EFs (verbal WM, spontaneous verbal shifting), and social/emotional cognition (decision making, emotional/social problem solving). However, the studies included in this review found no evidence of differences between IG children and their TD peers on either reading achievement, visuospatial skills, verbal memory, or other EFs (planning, inhibition, and visual WM). Parents' and teachers' reports identified impaired social competence, but IG children still performed well on performance-based measures in this domain. Further research is needed to explain the gap between what these children are actually able to achieve and adults' perceptions of their skills. At the same time, our review highlighted the need to further investigate the cognitive functioning of IG children in a more systematic way, based on well-defined criteria for the study of IG. Researchers need to pay attention to the tools they use to assess IG children because of potential ceiling effects. It is important to raise the question of these tests' sensitivity to IG people, as they are often constructed for large populations in clinical settings, and not really for individuals of exceptional ability. Further studies are necessary to move forward on this issue.

This review confirmed discrepancies in cognitive measures of IG and put forward several explanatory assumptions. It is an issue of crucial importance that deserves thorough study, in order to improve the characterization of the IG profile and inform the controversial debate about how to identify IG children with learning disabilities (Lyman et al., 2017). Just like their peers, these children may also be concerned by LD, despite cognitive strengths and possible compensatory mechanisms.

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CONFLICTS OF INTEREST

The authors have nothing to disclose.

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