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Intellectual profile in school-aged children with borderline intellectual functioning

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Abstract

Background: Little is currently known about borderline intellectual functioning (BIF), a condition characterized by an intelligence quotient between one and two standard deviations below the average, that affects about 14% of the population.

Aims: The present study aimed to analyze the intellectual profile of school-aged children with BIF.

Method and Procedure: The WISC-IV was administered to 204 children with BIF attending Italian primary and lower secondary school, and their profile was compared with that of a control group of typically developing (TD) children.

Results: The WISC-IV profile of the children with BIF differed from that of the TD children, and the former's performance was worse than the latter's in all the measures considered. The children with BIF also showed significant differences between the four main factor indices, scoring lowest for working memory, while the TD control group's profile was flat (as expected on the grounds of standardization criteria). No differences were found between the profiles of children with versus without a comorbid neurodevelopmental disorder.

Discussion: Our results support the hypothesis that individuals with BIF have a characteristic profile with specific weaknesses.

What this paper adds

This paper contributes to our knowledge of the cognitive profile of individuals with borderline intellectual functioning (BIF) by focusing specifically on this condition. BIF is a complex and pervasive condition that may influence a person's overall functioning. Despite

its far from negligible prevalence and the problems often associated with it, BIF remains a relatively unknown phenomenon in both research and clinical and educational settings. The present study analyzed the intellectual profile of school-aged children with BIF using the WISC-IV. The findings showed an uneven profile, characterized by significant discrepancies between almost all the indices - with the sole exception of the comparison between Verbal Comprehension and Processing Speed. Specifically, our sample obtained its highest scores on the visuo-perceptual index and its lowest scores for the Working Memory component. These results point to a profile that differs from that of the typically-developing population, and also from the picture seen in previous studies on other neurodevelopmental disorders.

Keywords: Borderline intellectual functioning; WISC-IV profile; working memory

Highlights

- Borderline intellectual functioning shows a characteristic, spiky, cognitive profile.
- Working memory seems to be the component most severely impaired.
- Highest scores are obtained on the Perceptual Reasoning Index.

Intellectual profiles in school-aged children with borderline intellectual functioning

1. Introduction

Borderline intellectual functioning (BIF) is a complex condition characterized by an intellectual functioning below the normal range, but above the cut-off for a diagnosis of intellectual disability (ID). This corresponds to an IQ ranging between one and two standard deviations below the mean (DSM-IV-TR, American Psychiatric Association, APA, 2000; ICD-10, World Health Organization, WHO, 1992). Several authors have suggested that the impaired intellectual functioning has to be associated with impairments in adaptive functioning for a "clinical" condition of BIF to be considered (e.g. Ninivaggi, 2009; Vianello, Di Nuovo, & Lanfranchi, 2014).

In recent decades, BIF has been distinguished from ID (e.g. Ferrari, 2009; Wieland & Zitman, 2016), and come to be seen as a "marginal" condition, with no clear definition or classification. This emerges clearly from the description of BIF in the DSM-5 (APA, 2013), which suggests no specific criteria for defining the condition. Little attention has been paid to this condition in the literature and, even when it was considered, it was often not the main focus of the research (Peltopuro, Ahonen, Kaartinen, Seppala, & Narhi, 2014).

BIF nevertheless seems to affect a sizable proportion of the population (e.g. 12.1%, according to Emerson, Einfeld, & Stancliffe, 2010).

It has been shown that individuals with BIF experience learning problems more often than their peers with typical intellectual functioning (e.g. Karande, Kanchan, & Kulkarni, 2008). Such problems are due, for instance, to their weak executive functions, and short-term and working memory, in comparison with their typically developing (TD) peers, in both verbal and visuo-spatial components (e.g. Alloway, 2010; Bonifacci & Snowling, 2008; Schuchardt, Gebhart, & Maehler, 2010; but see Henry, 2001 and Kortteinen, Närhi, & Ahonen, 2009 for two exceptions regarding visual and spatial memory).

Without adequate support, individuals with BIF may be vulnerable or at risk of negative outcomes, such as school dropout, behavioral and social problems, and psychiatric disorders, throughout their lives (e.g. Emerson et al., 2010; Fernell & Ek, 2010; Jankowska, 2016; Hassiotis et al., 2008; Masi, Marcheschi, & Pfanner, 1998; Peltopuro et al., 2014).

Intelligence is one of the most intensively studied constructs in the psychological sciences. There is no single definition of intelligence, but experts tend to agree that it can be considered as individuals' ability to adapt to the demands of their environment and to learn from experience (Sternberg & Detterman, 1986). An individual's intelligence quotient (IQ) is often established by means of tasks that assess different components of intelligence (e.g. verbal, visuospatial, working memory, and processing speed, in the case of the Wechsler scales). Some tests have been developed to assess specific aspects of intelligence, however, such as Raven's Coloured Progressive Matrices (CPM; Raven, Raven, & Court, 1998), or the Logical Operation and Conservation test (LOC; Vianello & Marin, 1998). Individual differences in intellectual functioning go beyond a mere difference in IQ level, however, and it is more appropriate to speak of particular strengths and weaknesses.

Taking this latter approach, numerous researchers have attempted to analyze the cognitive profiles of individuals with neurodevelopmental disorders. Their results have shown, for instance, that individuals with intellectual disabilities of different etiologies may have some characteristics in common, but they perform differently in certain components of intelligence (e.g. Di Nuovo & Buono, 2009; Vianello, 2008). An example comes from research on individuals with Williams and Down syndromes demonstrating almost opposite cognitive profiles (e.g. Paterson, 2001): individuals with Down syndrome often have relatively weak verbal abilities but relatively strong visuospatial abilities, while the opposite is true in the case of Williams syndrome (e.g. Dykens, Hodapp, & Finucane, 2000; Jarrold, Baddeley, & Hewes, 1999).

For BIF too, a clear knowledge of the associated cognitive profile, in terms of strengths and weaknesses, would be useful to shed light on the functioning of the individuals concerned and to allocate resources appropriately to suitable remediation and intervention programs. The aim of the present study was, therefore, to explore the intellectual functioning profile of individual with BIF, based on the WISC-IV indices.

The WISC-IV (Wechsler, 2003) is the most commonly used clinical tool for assessing intelligence in children between 6 and 16 years old (e.g. Bremner, McTaggart, Saklofske, & Janzen, 2011). It is used to obtain a measure of intelligence not only when an ID is suspected, but as part of the diagnostic work-up for specific learning disorders (SLDs), attention-deficit and hyperactivity disorder (ADHD), and other neurodevelopmental problems.

In addition to providing a Full-Scale IQ (FSIQ) measure of overall intellectual ability, the WISC-IV can be used to calculate four main indices (similar to the additional indices found in the WISC-III, Wechsler, 1991) relating to separate cognitive abilities. These include the Verbal Comprehension Index (VCI), the Perceptual Reasoning Index (PRI), the Working Memory Index (WMI), and the Processing Speed Index (PSI). These four indices replace the previously-used Verbal IQ and Performance IQ measures, and the new measures of working memory and processing speed have a greater loading on general IQ (as there are now four subtests instead of two). By replacing the dual verbal versus performance IQ structure of the WISC-III, the WISC-IV enables better estimates of verbal comprehension and perceptual reasoning to be obtained because they are less influenced by working memory and processing speed (Raiford, Weiss, Rolfhus, & Coalson, 2005).

Several authors have suggested that the Full-Scale IQ provides little information on the intellectual functioning of clinical populations (e.g. Fiorello, Hale, Holdnack, Kavanagh, Terrell, & Long, 2007), and that such cases could be assessed more appropriately by using the four main indices and/or two additional global indices that can be calculated on the basis of the WISC-IV subtests, i.e. the General Ability Index (GAI) and the Cognitive Proficiency Index (CPI). The former was first developed for the WISC-III by Prifitera, Weiss, and Saklofske (1998) to provide a measure of general ability uninfluenced by the Arithmetic and Coding subtests. Using the WISC-IV, the General Ability Index is obtained from the Verbal Comprehension and Perceptual Reasoning subtests (i.e. Similarities, Vocabulary, Comprehension, Block Design, Picture Concepts, and Matrix Reasoning) (Raiford et al., 2005). The General Ability Index thus provides a measure of global cognitive functioning that is less influenced by working memory and processing speed (Cheramie, Stafford, & Mire, 2008), while the Cognitive Proficiency Index is obtained from the Working Memory and Processing Speed indices, by including the digit span, letter-number sequencing, coding, and symbol search subtests (Weiss & Gabel, 2008).

Previous studies have analyzed the WISC-IV profile in several clinical conditions identifying specific profiles. For example, the profile of children with specific learning disorders (SLDs) featured a better performance in Verbal Comprehension and Perceptual Reasoning than in Working Memory or Processing Speed (e.g. Cornoldi, Giofrè, Orsini, & Pezzuti, 2014; De Clercq-Quaegebeur et al., 2010; Toffalini, Giofrè, & Cornoldi, 2017). In other words, individuals with SLDs score higher on the General Ability Index than on the Cognitive Proficiency Index (e.g. Giofrè, Toffalini, Altoè, & Cornoldi, 2017; Toffalini et al., 2017). A similarly spiky profile emerged for children with ADHD (e.g. Fenollar-Cortés, Navarro-Soria, Gonzáles-Gómez, & García-Sevilla, 2015).

Little is known as yet about the WISC-IV profile of individuals with BIF. In a previous study, Cornoldi et al. (2014) explored the WISC-IV profile of individuals with SLDs, comparing them with a group of individuals with ID, and a group of individuals with BIF (who all had a diagnosis of SLDs too). They found the BIF group's WISC-IV profile more similar to that of the group with SLDs, with higher scores on the Verbal

Comprehension Index and Perceptual Reasoning Index than on the Working Memory Index or Processing Speed Index, whereas individuals with ID had a flat profile, with no differences between the four indices. These results may have been influenced by the sample selection criteria adopted, however, because all participants in the BIF group had been selected because they had a diagnosis of SLDs too, and this comorbidity may have influenced their WISC-IV profile.

Given these findings, the aim of the present study was to explore the WISC-IV profile - in terms of the four indices - in individuals with BIF. In particular, we explored whether their cognitive profile more closely resembled that of individuals with TD or individuals with ID. In the case of individuals with TD, based on standardization criteria, there should be no differences between the four indices because the scores for each of them are given on a distribution with a mean of 100 and a standard deviation of 15. In the case of individuals with ID, the profiles could be expected to feature a general, homogeneous weakness in all indices (e.g. Cornoldi et al., 2014). Alternatively, BIF might coincide with a profile similar to the one seen in SLDs, which is generally characterized by significantly stronger verbal comprehension and perceptual reasoning abilities, but weaker working memory and processing speed (Cornoldi et al., 2014). Finally, BIF may have a specific profile with its own particular features.

Several authors have suggested that working memory is impaired in individuals with BIF (e.g. Alloway, 2010; Bonifacci & Snowling, 2008; Mäehler & Schuchardt, 2009). For example, Alloway (2010) compared children with BIF and typically-developing children matched for chronological age, and found the former had a worse performance in both verbal and visuo-spatial short-term and working memory. Similar results were reported by Schuchardt et al. (2010), who found a worse performance in children with BIF than in typically-developing children matched for chronological age, while the BIF group outperformed their peers with mild intellectual disability. Focusing on the WISC-IV cognitive profiles, the above-cited study by Cornoldi et al. (2014) found lower scores on the Working Memory Index than on the other WISC-IV indices (particularly Verbal Comprehension and Perceptual Reasoning) in a subsample of participants with SLDs and borderline intelligence. Based on this evidence, given a general weakness intrinsic in BIF, the WISC-IV profile of individuals with BIF might be expected to reveal a relatively more impaired Working Memory index.

In line with research on the WISC-IV profiles associated with clinical conditions, we also considered the additional scores that can be calculated from the WISC-IV subtests, i.e. the General Ability Index and the Cognitive Proficiency Index. On average, we expected the General Ability Index to be higher than the Cognitive Proficiency Index in individuals with BIF, due largely to their expected working memory impairment.

2. Method

2.1 Participants

Children with BIF. Data were collected by the Italian mental health services by means of WISC-IV assessments on 204 children and adolescents attending mainstream public and private primary and lower secondary schools (i.e. grades 1-8). All participants were assessed from 2013 to 2016, either for screening or for diagnostic purposes: in the vast majority of cases because of difficulties reported by parents and/or teachers.

The inclusion criteria for our sample were: a complete WISC-IV assessment (with the 10 core subtests administered); a Full-Scale IQ between one and two standard deviations below the mean, i.e. from 70 to 85 (standard error was not considered in order to reduce overlaps); and attendance at primary or lower secondary school (i.e. grades 1-8). It was necessary to consider the participants' Full-Scale IQ rather than their diagnosis because BIF is often either not diagnosed, or not labelled as a clinical diagnosis (i.e. in many cases it had not been classified diagnostically as ICD-10 code R41.83).

Participants were between 6 and 15;6 years of age (mean age = 9;11, SD = 28 months), and included 138 males and 66 females. This discrepancy between males and females is not surprising, and in line with other evidence to suggest that intellectual disabilities (e.g. APA, 2013) and other clinical conditions such as ADHD (Nøvik et al., 2006; Willcutt, 2012) have a male predominance. Most participants were Italian and both their parents were Italian too (n= 131); 10 were first-generation immigrants (children born abroad and subsequently migrating to Italy with their parents), or had been adopted by native Italians (n = 4); and 53 were second-generation immigrants, i.e. born in Italy from either immigrant parents, or mixed Italian-immigrant parents. Information about nationality was missing for 6 participants.

Unfortunately, no standardized assessment of adaptive functioning had been conducted for the majority of the sample, but qualitative information was available from interviews with parents. All participants showed adaptive functioning impairments, in terms of academic achievement at least (which was the most common reason for their assessment) or behavioral problems. Other difficulties were described in communication skills, social competence, emotional control and motivation, self-care, and in the ability to organize their own activities and materials.

A clinical diagnosis was found for 186 of the 204 cases examined. In the others, either the diagnostic process was underway at the time of the data collection or no diagnosis was reported in the clinical records. Based on the available information, 32 participants had a diagnosis of SLDs, 13 had a diagnosis of ADHD, 58 had more than one comorbid disorder, and 13 had a comorbid disorder other than SLDs or ADHD. Seventy participants had no comorbid disorders.

Children with typical development (TD). A control group of 60 school-aged children with TD attending Italian primary and lower secondary schools (i.e. grades 1-8) was also included. The inclusion criterion was a Full-Scale IQ above 85 (mean Full-Scale IQ = 100.63; SD = 11.63). Children with a known clinical diagnosis were excluded. This group was selected to distinguish between children with and without BIF (while children with an IQ in the BIF range are also included in the WISC-IV standardization sample). The mean age of the control group was 8 years and 8 months (SD = 21 months; range from 6 years and 4 months to 13 years and 9 months), and it consisted of 29 males and 31 females. These participants were administered the WISC-IV individually in a quiet room at their school by a psychologist on the research team.

2.2 Materials

The Italian standardization of the WISC-IV (Orsini, Pezzuti, & Picone, 2012) was used. This tool is widely used to test intellectual functioning in individuals from 6 to 16 years and 11 months old. The WISC-IV consists of 10 core subtests, and 5 additional subtests; the latter can be administered in addition to the core subtests to obtain more information on a child’s intellectual functioning or be used as a substitute for the core subtests, subject to certain rules (see Manual). The Italian version of the scale confirms its four-factor structure, in accordance with the American standardization (Wechsler, 2003).

Administering the 10 core subtests enables four main indices to be computed for: Verbal Comprehension (core subtests: Similarities, Vocabulary, and Comprehension); Perceptual Reasoning (core subtests: Block Design, Picture Concepts, and Matrix Reasoning); Working Memory (core subtests: Digit Span, and Letter-Number Sequencing); and Processing Speed (core subtests: Coding, and Symbol Search). A Full-Scale IQ can also be calculated, which provides an overall measure of intellectual functioning.

The supplemental subtests were not considered in the present study because they were only available for a small proportion of the children, and because they are not needed to calculate the General Ability and Cognitive Proficiency indices, or the Full-Scale IQ.
The four indices and the Full-Scale IQ are expressed in terms of standard scores with a mean of 100 and a standard deviation of 15. The other two indices (the General Ability Index – derived from the Verbal Comprehension and Perceptual Reasoning subtests – and the Cognitive Proficiency Index – derived from the Working Memory and Processing Speed subtests - used by clinicians to better describe a child's profile) were also calculated and taken into account in the present study.

3. Results

The two groups differed significantly in terms of chronological age, $F(1,263) = 14.62$, $p < .001$, $\eta_p^2 = .05$, so age was controlled for in the subsequent analyses. Gender was also controlled for in the analyses because of the difference in the ratio of males between the two groups.
Figure 1 shows the scores obtained by the two groups in the main and additional indices.

Please insert Figure 1 about here

To identify any differences between the indices, a 4 x 2 mixed ANOVA was run with Index (Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory Index, and Processing Speed Index) as the within-participants factor, and Group (BIF and TD) as the between-participants factor. Interactions were investigated using post hoc analyses, applying Bonferroni's adjustment for multiple comparisons[1].

The main effect of Index, $F(3,780) = 5.78$, $p < .001$, $\eta_p^2 = .022$, was significant. Participants obtained lower scores in the Working Memory Index than in the Verbal Comprehension, Perceptual Reasoning or Processing Speed indices (Mean Difference = -4.512, $p < .001$; Mean Difference = -6.699, $p < .001$; Mean Difference = -5.081, $p < .001$, respectively). No other differences were significant.

The Index x Group interaction was significant, $F(3,780) = 6.099$, $p < .001$, $\eta_p^2 = .023$. Subsequent post-hoc comparisons showed that participants in the group with BIF had higher scores for the Perceptual Reasoning Index than for the Verbal Comprehension, Working Memory or Processing Speed indices (Mean Difference = 4.482, $p < 0.001$; Mean Difference = 11.556, $p < .001$; Mean Difference = 5.040, $p < .001$, respectively), and higher scores for the Verbal Comprehension Index and Processing Speed Index than for the Working Memory Index (Mean Difference = 7.074, $p < .001$; Mean Difference = 6.516, $p < .001$, respectively). No significant difference emerged between the Verbal Comprehension and Processing Speed indices ($p = .621$). No significant differences between the four main indices were found for the group with TD.

A further 2 x 2 mixed ANOVA was run: Group (BIF, TD) was the between-participants factor and Index (General Ability Index, Cognitive Proficiency Index) was the within-participants factor.

The Index x Group interaction was significant, $F(1,260) = 19.086$, $p < .001$, $\eta_p^2 = .07$. Participants with BIF obtained higher scores for the General Ability Index than for the Cognitive Proficiency Index (Mean Difference = 9.157, $p < .001$), while no significant

[1]For the interactions, the alpha value for the post-hoc comparisons was set at .003 because 16 comparisons were drawn (.05/16=.003).

differences emerged between these two additional indices in the TD group (*p* = .95).The main effect of Index was not significant (*p* = .19).

The effect sizes with Hedges' correction were calculated on the differences between the four main indices, and between the two additional indices within each group: effect sizes of .20 were classed as small, those of .50 as medium, and those of .80 as large.

In the BIF group, the effect sizes were large for the comparison between the Perceptual Reasoning and Working Memory indices (*g* = .94), medium for the comparisons between the Verbal Comprehension and Working Memory indices (*g* = .63), and between the Processing Speed and Working Memory indices (*g* = .50), and small for all the other comparisons ($g_{(PRI-VCI)}$ = .34; $g_{(PRI-PSI)}$ = .37; $g_{(VCI-PSI)}$ = .07). For the comparison between the two additional indices, the effect size was large ($g_{(GAI-CPI)}$ = .93), confirming substantial discrepancies between the components of the Full-Scale IQ.

In the TD group, the effect sizes were small for all the comparisons between the four main indices ($g_{(VCI-PRI)}$ = -.09, $g_{(VCI-WMI)}$ = .09, $g_{(VCI-PSI)}$ = -.18, $g_{(PRI-WMI)}$ = .17, $g_{(PRI-PSI)}$ = -.09, $g_{(WMI-PSI)}$ = -.28), and between the two additional indices ($g_{(GAI-CPI)}$ = -.01).

Given the presence of participants with one or more comorbid disorders in the BIF group, the profile of children with BIF with comorbidities (n = 116) was compared with that of children without comorbidities (n = 70). These two subgroups did not differ in terms of chronological age (*p* = .848), or Full-Scale IQ (*p* = .657).

A 4 x 2 mixed ANOVA was run with Index (Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory Index, and Processing Speed Index) as the within-participant factor, and Group (with comorbidity and without comorbidity) as the between-participants factor. Interactions were investigated using post hoc analyses, and applying Bonferroni's adjustment for multiple comparisons.

The main effect of Index, $F(3, 552) = 28.68$, $p < .001$, $\eta_p^2 = .14$, was significant. Participants performed better in Perceptual Reasoning than in Verbal Comprehension (Mean Difference = 4.159, $p < .001$), Working Memory (Mean Difference = 10.930, $p < .001$), or Processing Speed (Mean Difference = 4.456, $p = .001$). The scores on the Working Memory Index differed significantly from those on the Verbal Comprehension and Processing Speed indices (Mean Difference = -6.771, $p < .001$; Mean Difference = -6.475, $p < .001$, respectively). No significant differences were found between the Verbal Comprehension and Processing Speed indices ($p = .818$).

Neither the effect of Group ($p = .793$), nor the Group x Index interaction ($p = .093$) were significant.

Partially different results emerged when the two additional indices (General Ability and Cognitive Proficiency indices) were considered. The 2 x 2 mixed ANOVA showed a statistically significant main effect of Index, $F(1,184) = 64.818$, $p < .001$, $\eta^2_p = .261$. Higher scores were obtained for the General Ability Index than for the Cognitive Proficiency Index (Mean Difference= 8.640, $p< .001$). The main effect of Group was not significant ($p = .751$), but the Group x Index interaction was, $F(1,184) = 4.871$, $p = .029$, $\eta^2_p = .026$. Both groups scored higher on the General Ability Index than on the Cognitive Proficiency Index, but the difference was greater for the group with BIF and comorbid disorders (Mean Difference = 11.009, $p < .001$, $g = 1.28$) than for the group with BIF without comorbid disorders (Mean Difference = 6.271, $p < .001$, $g = .74$).

Figure 2 shows the scores obtained by the two groups (BIF with and without comorbid disorders) in the main and additional indices.

Please insert Figure 2 about here

4. Discussion

The present study analyzed the intellectual profile of a sample of children with BIF attending grades 1 to 8 in Italian schools. Apart from a generally below-average intellectual functioning, little is known about the intellectual profile of individuals with BIF. The results of this study confirmed that the profile of individuals with BIF differs from that of typically-developing children. First, as expected, individuals with BIF had lower scores than TD peers in all four WISC-IV main indices. However, the profile of the individuals with BIF was not flat like that of the TD group. It was characterized by higher scores on the Perceptual Reasoning Index, an index based on tasks that primarily measure nonverbal fluid reasoning and perceptual organization abilities (Wechsler, 2003), and lower scores on the Working Memory Index. The presence of impairments in working memory is consistent both with previous specific studies on this cognitive component (e.g. Alloway, 2010; Schuchardt et al., 2010), and with the results of studies based on WISC-IV cognitive profiles (Cornoldi et al., 2014). The same trend emerged for the additional indices: higher scores on the General Ability Index than on the Cognitive Proficiency Index were found in the BIF group, but not in the TD group.

This profile seems peculiar to BIF, although similarities and differences emerge with respect to other clinical conditions. For example, several studies explored the cognitive profile of SLDs, finding particular difficulties in working memory and processing speed (e.g. Giofrè et al., 2017; Peng, Wang, & Namkung, 2018; Poletti, 2016; Toffalini et al., 2017). In studies that used the WISC-IV, SLDs coincided with a profile featuring scores that were higher (to much the same degree) on the Verbal Comprehension and Perceptual Reasoning indices, and lower (again to much the same degree) for the Working Memory and Processing Speed indices (e.g. Cornoldi et al., 2014; Toffalini et al., 2017). In the present study, children with BIF scored lower for Working Memory (like those with SLDs), but (unlike children with SLDs) it was only in Working Memory - not Processing Speed - that they fared worse than in Verbal Comprehension.

The profile that emerged for BIF also seems to differ from that of ID. In previous studies, ID seemed to be associated with an overall impairment in the WISC-IV components, producing an almost flat profile, while our study identified significant differences between the four indices in children with BIF (e.g. Cornoldi et al., 2014).

Moreover, the BIF profile does not seem to depend on the presence of comorbid neurodevelopmental disorders. When participants were grouped by presence or absence of comorbid disorders, a similar profile emerged for the two groups. When the additional indices were considered, however, the group with comorbid disorders showed a greater discrepancy between the two indices, with higher scores on the General Ability Index and lower ones on the Cognitive Proficiency Index.

As for whether the presence of comorbid disorders could be expected to worsen an individual’s cognitive performance, in the present study this was true for the Cognitive Proficiency Index, but not for the General Ability Index. The group with BIF and comorbid disorders scored higher on the General Ability Index and lower on the Cognitive Proficiency Index than the group with BIF but no other comorbid disorders. This result is in line with previous studies on several neurodevelopmental disorders, such as SLDs and ADHD, which found WISC-IV profiles characterized by higher scores on the General Ability Index and lower scores on the Cognitive Proficiency Index (e.g. Cornoldi et al., 2014; Fenollar-Cortés et al., 2015; Toffalini et al., 2017). It is worth adding that most of the individuals in the “comorbid” group had a diagnosis of SLDs and/or ADHD. Unfortunately, due to the large number of children with more than one comorbid disorder, it was impossible to analyze the profiles of subgroups of children with BIF and specific associated disorders. This is an aspect that will need to be investigated in more depth in future research.

The present results thus confirm that the BIF population has a specific and distinct profile, and point to the importance of better differentiating BIF from ID or SLDs with average intellectual functioning - both in research and in clinical and educational practice. What are the implications from a clinical and educational standpoint? First, having more details regarding the "specificities" of a given type of intellectual disability could help clinicians, and professionals in general, to devise appropriate training that takes into account the individual's strengths and weaknesses. As mentioned earlier, BIF often goes unrecognized, and is often masked by other clinical disorders. This makes it particularly important to establish whether there are two or more concomitant conditions involved, and whether BIF is the primary cause of the individual's problems, or a comorbid, secondary cause (Ninivaggi, 2009). In other words, we need to know, for instance, whether a child's learning difficulties (which are often the reason why they undergo a clinical assessment, e.g. due to delayed or impaired academic achievement, behavioral problems, attention problems) can be explained by a lower IQ or by the presence of a specific disorder. We might expect children with BIF to have more and/or more severe learning disorders than children with on average intelligence, judging from evidence in the literature on SLDs of children with mixed disorders of scholastic skills having a worse WISC-IV profile than children with a specific disorder in isolation (for example, see Toffalini et al., 2017). Individuals with learning disabilities in higher-order skills (i.e. reading comprehension and applied problem-solving) would also reveal slightly weaker cognitive skills than children with learning disabilities in lower-order skills (e.g. word reading) (e.g. Compton, Fuchs, Fuchs, Lambert, & Hamlett, 2012).

WISC-IV profiling could help us to distinguish individuals with BIF from those with ID, particularly when their Full-Scale IQ is on the lower side of the borderline range (i.e. between 70 and 75).

The present study focused exclusively on individuals with BIF, starting from the hypothesis that they should be considered as a separate population, not as a variant of ID or average intelligence. The literature in this field has been growing in recent years, but BIF is often studied together with mild ID as a single group, despite these populations showing different features (e.g. Nouwens, Lucas, Smulders, & Nieuwenhuizen, 2017). In fact, whether intelligence is a continuum construct - and, from this perspective, ID, BIF, and average intelligence may be considered as lying along this continuum - it is important to bear in mind that global intelligence level is not the only variable characterizing ID and BIF, and distinguishing them from the typical population. The present study goes in the direction of showing that BIF has specific clinical characteristics that differentiate this population from both ID and TD.

Some limitations of this study need to be addressed, however. One limitation concerns the small sample size of the control group. On the other hand, standardized WISC-IV scores could arguably be used to confirm our findings, considering that the mean of each index in a typical population is 100, so the profile is supposed to be flat. Moreover, the sample with BIF was selected on the basis of performance in the WISC-IV, and the same instrument was used to analyze the profile. It might be interesting to analyze the cognitive profile by means of other tests.

The present study could be seen as a first attempt to clarify the cognitive functioning of school-aged children with BIF. It is important to bear in mind, however, that cases of BIF probably cannot be pooled into a single population as well as intellectual disabilities. To gain a thorough understanding of BIF, the variability in this population needs to be borne in mind.

In line with other authors (e.g. Vianello et al., 2014), we would expect to see different subgroups of BIF come to light. Future studies should analyze this issue.

5. Conclusions

Apart from their having an IQ between 1 and 2 standard deviations below average, little is known about the intellectual profile of children with BIF. The results of the present study suggested an uneven profile with significant differences between the various WISC-IV indices, with the sole exception of the Verbal Comprehension and Processing Speed indices, which did not differ. The lowest scores were seen for Working Memory, and the highest for Perceptual Reasoning. This profile differs from the one emerging from previous studies on ID or other neurodevelopmental disorders, as well as from the one seen in typically-developing children. This profile also seems to be uninfluenced by any presence of comorbid neurodevelopmental disorders.

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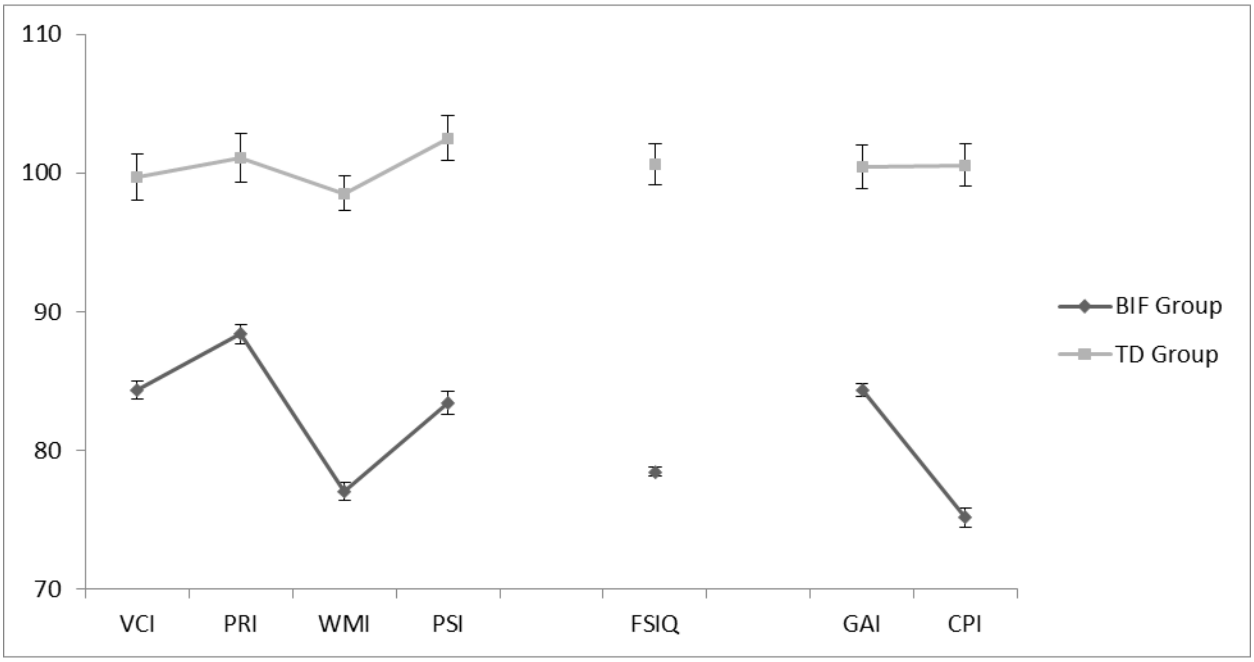
Figure 1

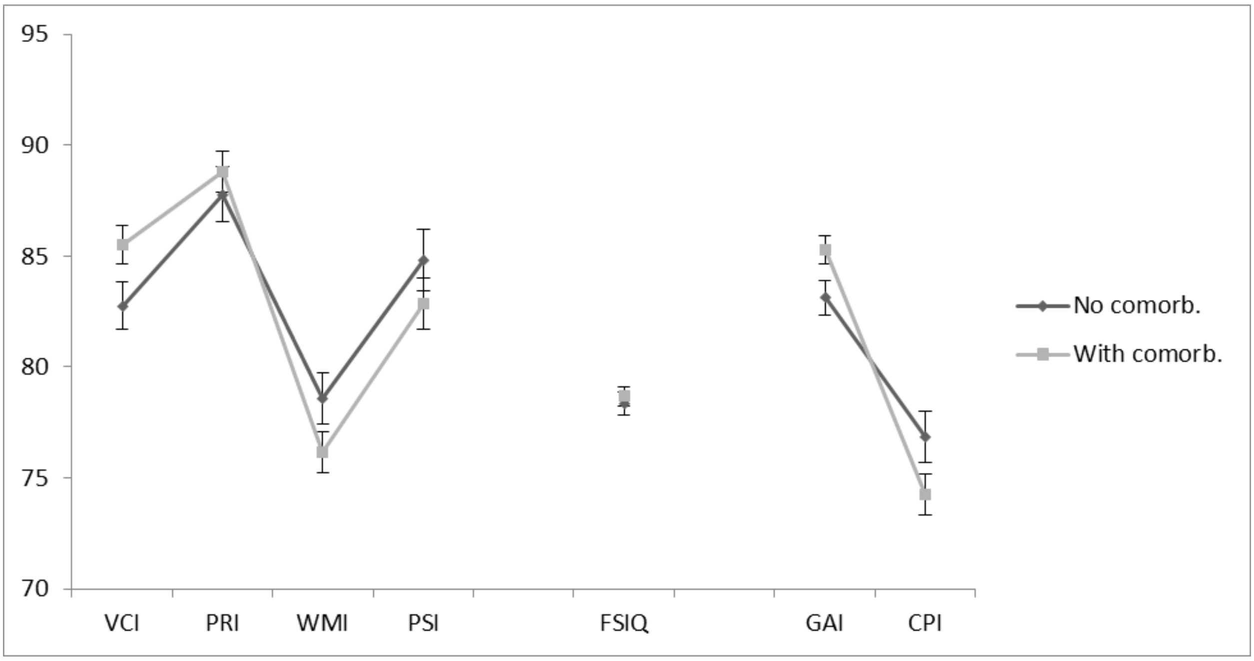
Figure 1 – Mean scores in the main and additional indexes for BIF and TD groups. Bars represent standard errors.



Note. VCI = Verbal Comprehension Index, PRI = Perceptual Reasoning Index, WMI = Working Memory Index, PSI = Processing Speed Index; FSIQ = Full-Scale Intelligence Quotient; GAI = General Ability Index, CPI = Cognitive Proficiency Index

Figure 2

Figure 2 – Mean scores in the main and additional indexes for the group with BIF and comorbid disorders and the group with BIF alone. Bars represent standard errors.



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