19.00 €

vol. LXVIII. January-April 2020

N° 287

Four-monthly Journal
ISSN 0006-6761

BPA

1/3

Bollettino di Psicologia Applicata

APPLIED PSYCHOLOGY BULLETIN

Indexed in PsycINFO® – Scopus Bibliographic Database

Research

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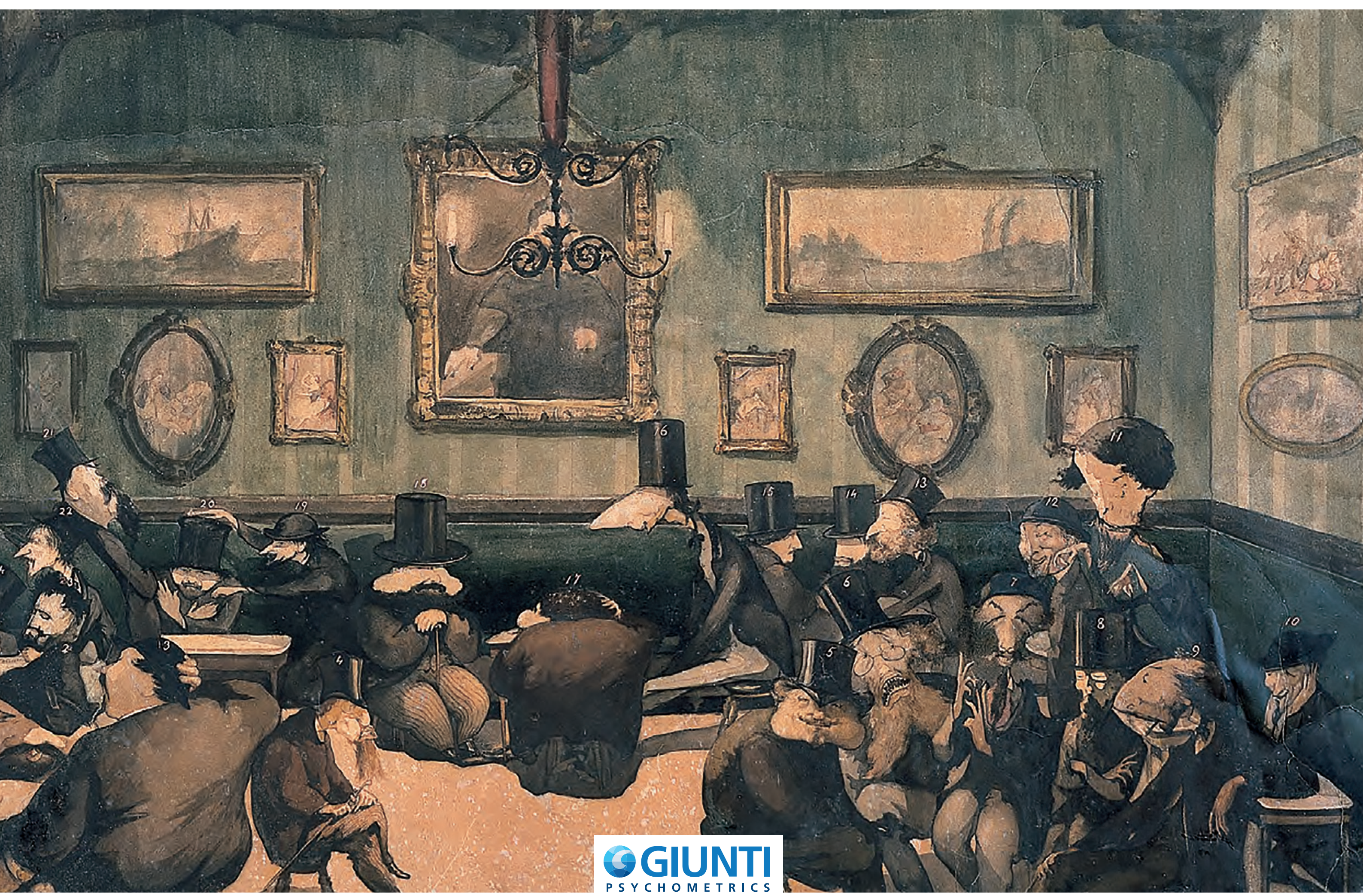

GIUNTI PSYCHOMETRICS

Scientific Director Alessandro Zennaro

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DOI: 10.26387/bpa.287.4

Intelligence profiles of children and adolescents with High functioning autism spectrum disorder

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ABSTRACT. Nel presente articolo identifichiamo un endofenotipo per soggetti con disturbo dello spettro autistico – livello 1 (Autism spectrum disorder, ASD-1) e normale funzionamento cognitivo, utilizzando la *Wechsler Intelligence Scale for Children – Fourth Edition* con un campione clinico di 80 bambini con diagnosi di ASD-1 senza disabilità intellettiva (con QI>70), e un gruppo di controllo di confronto (*n* = 80) appaiato per età, genere dei bambini e livello di istruzione dei genitori. Dai risultati è emerso che il gruppo clinico con alto funzionamento (High functioning autism spectrum disorder - level 1, HFASD-1) ha ottenuto risultati inferiori rispetto al gruppo di controllo appaiato all'Indice di Velocità di elaborazione e all'Indice della Memoria di lavoro, evidenziando la sensibilità di queste misure sul deterioramento cognitivo generalizzato. Questo risultato è confermato anche dall'assenza di una differenza tra il gruppo HFASD-1 e quello di controllo all'Indice di Abilità generale e dalla grande differenza all'Indice di Competenza cognitiva a favore del gruppo di controllo. Inoltre, il 36% dei bambini HFASD-1 manifestava una grande e rara differenza tra i 4 indici e quindi il QI totale poteva essere considerato non interpretabile come abilità unitaria e coesa. Possiamo sostenere che il profilo cognitivo del HFASD-1 non possa essere interpretato come un'entità unitaria rappresentata semplicemente dal QI, ma si evince che è possibile ottenere una migliore valutazione del loro livello cognitivo utilizzando separatamente l'Indice di Abilità generale e l'Indice di Competenza cognitiva.

SUMMARY. In this paper we identify an endophenotype for individuals with Autism spectrum disorder – level 1 (ASD-1) and normal cognitive functioning using the Wechsler Intelligence Scale for Children – Fourth Edition with a clinical sample of 80 diagnosed ASD-1 children without intellectual disability (with FSIQ>70), and a comparison matched-paired control group (n = 80) combined for age, gender of children and parents' level education. From results emerged that the clinical ASD-1 with High functioning group (ASD-1 HF) performed worse than the matched-paired control group on Processing Speed Index and Working Memory Index, reflecting the sensitivity of these measures to generalized cognitive impairment. This result is also confirmed by the absence of a difference between the ASD-1 HF and control groups in the General Ability Index and the large difference to the Cognitive Proficiency Index in favour of the control group. Again, 36% of ASD children had a rare and large difference between the 4 indices and then the FSIQ could be deemed uninterpretable as unitary and cohesive ability. We argue that the ASD-1's cognitive profile cannot be interpreted as a unitary entity represented from simply FSIQ, but we can obtain a better assessment of cognitive level in ASD subjects using separately the General Ability Index and the Cognitive Proficiency Index.

Keywords: *Autism spectrum disorder, Intelligence, WISC-IV, Cognitive profile, Full Scale Intelligent Quotient*

INTRODUCTION

In the *Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition* (*DSM-V*; American Psychiatric Association, 2013), the autism, Asperger disorder and pervasive developmental disorder not otherwise specified, have been collapsed into a single disorder, the Autism spectrum disorder (ASD) (Kaufmann, 2012). Language abnormalities, repetitive/restricted behaviors and social impairment are the triad of characteristics shared by children with ASD (Zayat, Kalb & Wodka, 2011). As research has often also highlighted intellectual deficits, its assessment in children with ASD is of fundamental importance. In fact, the DSM-5 requires to specify whether ASD is associated with an intellectual disability (American Psychiatric Association, 2013).

Although the new DSM-V classification has unified Asperger syndrome (AS) and High functioning autism (HFA), some studies have suggested that persons with AS possess a distinct profile on tests of intelligence characterized by a high verbal IQ and a low performance IQ, whereas in persons with HFA, the pattern is often reversed (i.e., Ghaziuddin & Mountain-Kimchi, 2004; Mouga et al., 2016).

One of the most commonly used intelligence tests for children is the *Wechsler Intelligence Scale for Children – Fourth Edition* (*WISC-IV*; Wechsler, 2003), and we argue it is a helpful tool that better differentiates and eliminates confounding factors at play in the debate outlined in literature and overcoming the dichotomy of the verbal and performance. The WISC-IV, in addition to Full Scale Intellectual Quotient (FSIQ), implies a the four-factors solution (four indices), i.e. the Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), Working Memory Index (WMI) and Processing Speed Index (PSI) and two additional indices, i.e. the General Ability Index (GAI) and the Cognitive Proficiency Index (CPI). In this way, the WISC-IV allows for better discrimination between abilities on the aggregate level compared to its previous editions. However, only a limited amount of published information is available regarding its utility when assessing clinical samples. In particular, since studies of other clinical groups (e.g., children with traumatic brain injury; children with attention deficit/hyperactivity disorder; children with High functioning autism) have shown profile differences when comparing the WISC-IV to older versions of the WISC (respectively, Donders & Jenke, 2008; Mayes & Calhoun, 2008), it is important to define the WISC-IV profile in children with Autism spectrum disorder of level 1 (according to DSM-V).

WISC-IV test score results for some special groups are included in the *WISC-IV Technical and Interpretive Manual* (Wechsler, 2008) and in the *Essentials of WISC-IV Assessment* (Flanagan & Kaufman, 2009), to help provide information about the test's specificity and its clinical utility for diagnostic assessment: the special groups studied include children with autistic disorder and with Asperger syndrome according to DSM-IV. According to the *WISC-IV Technical and Interpretive Manual*, the clinical autistic disorder sample (n = 16) scored significantly lower than the matched control group on all 4 indices and the Full Scale IQ (FSIQ), with large effects sizes. The largest effect sizes were obtained for the Verbal Comprehension Index (VCI), the Processing Speed Index (PSI) and the FSIQ. These results were consistent with other studies indicating that individuals with autistic disorder demonstrate lowered general intellectual functioning, especially on verbal and processing speed tasks, and obtain relatively higher scores on perceptual tasks (Flanagan & Kaufman, 2009; Goldstein, Minshew, Allen & Seaton, 2002; Kuriakose, 2014; Liss et al., 2001; Mayes & Calhoun, 2003, 2004; Nader, Courchesne, Dawson & Soulières, 2016; Nader, Jelenic & Soulières, 2015). In contrast, the 40 individuals in the Asperger disorder group scored significantly lower than the matched control group on the PSI, WMI and the Full Scale IQ with large effect size, and a small effect for the PRI and a negligible effect for the VCI. These results are consistent with other research with individuals with Asperger's disorder, which had lower processing speed performance and maintained verbal ability (Ambery, Russel, Perry, Morris & Murphy, 2006; Cederlund & Gillberg, 2004; Flanagan & Kaufman, 2009; Koyama, Tachimori, Osada, Taked & Kurita, 2007; Nader et al., 2015; Spek, Scholte & Van Berckelaer-Onnes, 2008).

In a study by Mayes and Cahloun (2008) 54 children 6-14 years of age with High functioning autism scored above average at WISC-IV in Perceptual Reasoning Index, Verbal Comprehension Index, and General Ability Index, and scores below average 100 at Working Memory Index and Processing Speed Index. The GAI was significantly higher than FSIQ that doesn't differ significantly from the population mean. In another paper, Oliveras-Rentas and colleagues (Oliveras-Rentas, Kenworthy, Robertson, Martin & Wallace, 2012) administered the WISC-IV to a clinical sample of 22 children with High functioning autism, 22 with Asperger syndrome and 12 with pervasive developmental disorders. Comparing this clinical sample with the normal population the only index score that was significantly lower than the population was the Processing Speed Index (PSI). Most notably, significantly lower scores were found for the *Coding*, *Symbol Search* and *Comprehension* subtests, while the *Similarities* and *Matrix Reasoning* subtests were significantly higher. Hence, these results confirm strengths on WISC-IV structured and motor-free subtests (e.g., *Similarities* and *Matrix Reasoning*) and weakness on subtests with more complex/social language demands (e.g. *Comprehension*). However, the manuscript does not provide us any information about the differences between the three clinical sub-samples and fails to take into account the state variables that could affect their intellectual performance. It may not be methodologically correct to compare the performance of the clinical sample with the population mean when studying such small samples; variables such as the parents' educational level or different clinical diagnoses may create a bias for evaluation. In the end, little is yet known about cognitive strengths or ASD difficulties, and the size of ASD samples has always been very small, but using WISC-IV with a larger ASD sample could be useful to better differentiate and eliminate confusion factors by highlighting possible strengths in verbal abilities and weaknesses in memory, attention, graphomotor and processing speed.

In this research we have analyzed the WISC-IV scores in 80 ASD - level 1 (ASD-1) children and adolescents without verbal and intellectual disabilities to study their specific cognitive profile and to compare the results with previous research discussed above. More in particular, we wanted to study the differences in scores on the subtests, on the four core and two additional indices of the WISC-IV. In addition, we studied the difference Max-Min of four core indices as an expression of the unitarity ability of the IQ of the subject (Flanagan & Kaufman, 2009). Flanagan and Kaufman (2009, p. 143) used to define the unitary ability as "an ability (…) that is represented by a cohesive set of scaled scores, each reflecting slightly different or unique aspects of the ability". To measure the unit skill, then, Flanagan and Kaufman used the difference between the highest score (Max) and the lowest score (Min) obtained by a participant in the four indexes of the latest editions of the Wechsler scales. Therefore, the main criterion to define the non-interpretability, or rather the poor cohesion, of FSIQ is based on the relative infrequency of the Max-Min difference between the 4 indices.

Finally, it is especially important to check whether the differences between FSIQ and two additional indices (GAI and CPI), can discriminate between the clinical group and the control group. Everything is designed to identify any patterns of intellectual efficiency of the group diagnosed with High functioning ASD-level 1. We hypothesize they show relative weaknesses on the WMI and PSI indices of WISC-IV, while performing relatively well on VCI and PRI indices because the WISC-IV subtests measure verbal-language and visual reasoning variables without a confounding motor and memory components.

METHOD

Participants

The WISC-IV was administered to 80 individuals (64 males and 16 females), aged 6-16 years of age (*Mean* = 9.81, *SD* = 2.90), who were identified as Autism spectrum disorder of level 1 (ASD-1) (according the DSM-V criteria; APA, 2013), without verbal and intellective deficits. Each child of the clinical group were evaluated following all the requirements for a clinical diagnosis of ASD-1, and they received a comprehensive neuropsychological evaluation by an expert clinician and a multidisciplinary team evaluation that included a detailed medical and developmental history, an extensive diagnostic battery, as well as administration of the *Autism Diagnostic Interview-Revised* (*ADI-R*; Lord, Rutter & Le Couteur, 1994), by a trained research reliable clinician; *Autism Diagnostic Observation Schedule – Second edition* (*ADOS-2*; Lord et al., 2011). Individual diagnosed with Autism spectrum disorder were excluded from this study if they had general cognitive ability scores more than 2 *SD*s below the mean (i.e., FSIQ<70). All participants were evaluated at the Multidisciplinary Unit, Department of Prevention of Public Health ASL2 of Abruzzo, Lanciano-Vasto-Chieti. The Unit consists of a child neuropsychiatry, psychologists and a social worker, operating into the prevention of school medicine. Parents of children gave their authorization, through an informed consent. The research was approved by Ethic Committee of the Child Neuropsychiatry Units. Data were collected between 2017 and 2019. Nine individuals did not agree to participate in the evaluations, and four abandoned the research.

This clinical sample was compared with typically developing children who were part of the Italian WISC-IV standardization sample, matched for gender and age of ASD-1 children and education of both parents. The use of the latter variable is due by results of two studies showed that, while parental influence on children's subtests, FSIQs, indices and GAI of WISC-III and WISC-IV is independent of the parent's gender, it varies as a function of the parent's level of education (Cianci, Orsini, Hulbert & Pezzuti, 2013; Pezzuti, Farese & Dawe, 2019). So, the two groups (i.e., ASD-1 and matched-paired control) included exactly the same numbers of males and females, and were perfectly matched for age in years and months, and education level of both parents.

Instruments

The WISC-IV (Orsini, Pezzuti & Picone, 2012; Wechsler, 2003) was been used. The WISC-IV, in addition to Full Scale IQ (FSIQ), expected four indices, such as the Verbal Comprehension Index (VCI; the subtests are: *Similarities*, *Vocabulary* and *Comprehension*), Perceptual Reasoning Index (PRI; the subtests are: *Block Design*, *Picture Concepts* and *Matrix Reasoning*), Working Memory Index (WMI; the subtests are: *Digit Span and Letter-Number Sequencing*) and Processing Speed Index (PSI; the subtests are: *Coding and Symbol Search*) and two additional indices as General Ability Index (GAI; the subtests are those of VCI and PRI indices) and Cognitive Proficiency Index (CPI; the subtests are those of WMI and PSI indices). The WISC-IV dependent variables studied in this paper are the 10 core subtest scores, the 4 core indices (VCI, PRI, WMI, PSI) and the Full Scale IQ (FSIQ). However, it is possible that the FSIQ to be affected by some variability of four underlying dimensions and this must always be taken into account by the clinicians. So, two optional composite indices have been proposed alongside the FSIQ and these are known as the General Ability Index (GAI) and the Cognitive Proficiency Index (CPI). The GAI, introduced by Prifitera, Weiss and Saklofske (1998), represents a composite measure of cognitive ability comprises the verbal comprehension and perceptual reasoning subtests that, in comparison with FSIQ, minimizes the impact of working memory and processing speed, and reflects reasoning abilities. The CPI, proposed by Dumont and Willis (2001), is therefore an index that summarizes the outcomes of both the working memory and processing speed subtests. The CPI, represented by a quick visual speed, an efficient memory and good mental control, helps fluid reasoning and acquisition of new information, and reduces the cognitive load required by newer or more difficult tasks (Weiss et al., 2006). So, in the present research we used these 2 optional indices (GAI and CPI); differences between indices (FSIQ vs GAI, FSIQ *vs* CPI, GAI *vs* CPI) referring data of Italian WISC-IV standardization (Orsini & Pezzuti, 2014; Orsini & Pezzuti, 2016).

Another WISC-IV dependent variable is the difference between the highest score (Max) and the lowest score (Min) in the four indices of the test as a measure of the unitary ability of FSIQ according to Flanagan and Kaufman (2009). However, as demonstrated in a paper of Orsini, Pezzuti and Hulbert (2014), the statistical method used by Flanagan and Kaufman (2009) to find the threshold 23, didn't really fit for purpose. In the Italian WISC-IV standardization sample the correct statistical method was carried out bringing out the correct threshold of 40. So, when the Max-Min difference score between four core subtests is equal to or greater than 40 scores, then it is considered very rare and it possible to conclude that the FSIQ score cannot be interpreted as one unitary ability of intelligence.

Data analysis

After confirming that assumptions of normality and homogeneity of the variances of the two groups were satisfied using a Levene's test. Various analyses of variance (ANOVA) were used to compare the ASD-1 group with the matched-paired control group. We compared the mean differences between the first and second group (clinical vs control) for each dependent variable of the WISC-IV. Though a *p*-value can determine whether an effect exists, it will not reveal the effect's size. The effect's size provides information regarding its practical significance, whereas the p-value does not assess practical significance. Knowing an effect's magnitude allows one to ascertain the practical significance of statistical significance. Statistical significance can always be reached if there is a large enough sample size, unless the effect size is 0. Even a large effect may not be statistically significant if the sample size is too small. Therefore, according to Cohen (1990, p. 1307), "The primary product of a research inquiry is one or more measures of effect size, not p values". So, we reported also eta-squared as a measure of effect size which can be interpreted using Cohen's (1988) guidelines for determining small (.01), medium (.06), and large (.14) effects.

RESULTS

By comparing the clinical group of subjects with a diagnosis of ASD-1 to the control group on WISC-IV subtests (see Table 1), the eta-squared ranges from .00 (for *Block Design*, *Matrix Reasoning* and *Comprehension*) to .27 (for *Digit Span*), then, from null to very large effect. In particular, *Digit Span*, *Letter-Number Sequencing*, *Symbol Search*, *Coding* and *Cancellation* performances tended to be lower for ASD-1 group than for control group, while for the other subtest there would not be any noteworthy differences. Such subtests are mostly dependent on verbal memory and processing speed abilities.

For what concerns the indices, Table 2 shows a large effect-size for Working Memory, Processing Speed, Full Scale IQ and Cognitive Proficiency indices: the ASD-1 group has a significantly lower mean than the control group.

Analyzing the variability of the indices, that is the difference between the highest (Max) and lowest (Min) of four core indices (VCI, PRI, WMI, and PSI), from the results showed in Table 2, a large effect-size emerges: the ASD-1 group has a significantly higher mean than the control group. In particular, the mean value of the group is next the clinical cut-off, that in the Italian standardization sample (Orsini et al., 2014) it is equal to 40, and 29 ASD-1 subjects (36.2%) have a statistically significant and a rare Max-Min difference, that is greater than cut-off 40 IQs scores (with range difference between 41 to 82); it is rare because it occurs in less than 6.7% on normal subjects. On the contrary, only 3 control subjects (3.7%: with range difference between 41 to 46) have a statistically significant and rare Max-Min difference between four indices. In conclusion, in the ASD-1 group a very wide and rare variability among the 4 indices emerged.

From the study of GAI (General Ability Index) and CPI (Cognitive Proficiency Index), (see Table 2), the ASD-1 group has a mean GAI score (sum of VCI and PRI) of almost 10 points higher than their FSIQ, in the normal group the mean GAI score is almost equal to the FSIQ. This result indicates that WMIs and/or PSIs negatively affect the expression of their general intellectual ability as measured by the FSIQ score in the ASD-1 clinical group. In contrast, the CPI (sum of WMI and PSI) is almost 12 IQ points lower than the FSIQ score in the Autism spectrum disorder group, while this difference is minimal (almost 2 IQ points) in the normal control group. Finally, the average difference between GAI and CPI is in favour of GAI in the clinical group (21.05 IQ points) and is different from the control group which is lower (1.28 IQ points).

Finally, analyses to study the cognitive profiles of the ASD-1 group were carried out. In particular, the subtest performances belonging to the four indices, and the seven indices were compared with each other. The results reported in Table 3 show that, within each of the four indices, there were no relevant discrepancies between the pairs of subtests: the ASD-1 group shows generally homogeneous cognitive profiles between subtests within each index. However, from the results on comparisons between pairs of indices it emerges that both Verbal Comprehension and Perceptual Reasoning indices differ significantly from Working Memory and Processing Speed indices with higher performances in VCI and PRI. On the contrary, there are no differences between Verbal Comprehension and Perceptual Reasoning indices and between the Working Memory and Processing Speed indices. Comparisons between the more general intelligence indices (FSIQ, GAI and CPI) are also all significant, with the highest GAI and the lowest CPI.

DISCUSSION AND CONCLUSION

The diagnostic characterization of ASD patients without intellectual disability is rather difficult because of the milder symptoms and the compensatory abilities (Frith, 2004), which allow the patients to be well adapted in the social environment. Often, they show only secondary symptoms, frequently psychiatric comorbidities with age.

In the present paper, the WISC-IV, administered to children and adolescent to ASD without intelligence deficit, captures their verbal ability and perceptual reasoning strengths, while identifying their memory, attention, grapho-motor and processing speed weaknesses. These results are consistent with some papers (i.e., Mouga et al., 2016; Nader et al., 2016).

The lowest performances of ASD children and adolescents without intellectual deficit were on subtests that make up the Processing Speed Index and Working Memory Index, reflecting the sensitivity of these measures to generalized cognitive impairment. This result is also confirmed by the absence of a difference between the ASD and control groups in the General Ability Index and the large difference to the Cognitive Proficiency Index in favour of the control group. As discussed previously, Saklofske and colleagues (Saklofske,

Table 1 – Comparisons on subtests between Autism spectrum disorder (level 1) group and matched-paired control group

	Autism spectrum disorder (level 1) group (n = 80)		Matched-paired control group (n = 80)				
	Mean	**SD**	**Mean**	**SD**	**F**	***p***	**Eta-squared**
WISC-IV core subtests							
Block Design	10.76	3.92	11.09	3.16	.33	.565	.00
Similarities	11.29	3.86	11.82	2.82	1.01	.316	.01
Digit Span	7.95	2.50	10.97	2.50	58.43	<.001	.27
Picture Concepts	10.35	3.37	10.87	2.39	1.27	.262	.00
Coding	7.26	3.33	10.30	3.25	34.09	<.001	.18
Vocabulary	10.29	3.88	11.34	3.04	3.62	.059	.02
Letter-Number Sequencing	7.71	3.13	10.84	3.05	39.81	<.001	.21
Matrix Reasoning	10.76	3.48	10.79	3.01	.00	.961	.00
Comprehension	10.35	4.65	10.57	2.95	.13	.721	.00
Symbol Search	7.975	3.18	11.20	3.02	43.22	<.001	.21
WISC-IV supplemental subtests							
Picture completion	10.61	3.38	11.60	2.89	3.95	.049	.02
Cancellation	6.86	4.13	10.05	3.19	29.82	<.001	.16
Information	9.59	3.71	11.37	2.56	12.60	<.001	.07
Arithmetic	8.32	3.62	9.81	2.74	8.64	.004	.05
Word Reasoning	9.05	3.40	10.92	3.02	13.59	<.001	.08

Note. Eta-squared values were calculated as a measure of effect size. and results were interpreted using Cohen's (1988) guidelines for determining small (.01). medium (.06). and large (.14) effects.

Table 2 – Comparisons on indices between Autism spectrum disorder group and matched-paired control group

	Autism spectrum disorder (level 1) group (n = 80)		Matched-paired control group (n = 80)				
	Mean	**SD**	**Mean**	**SD**	**F**	***p***	**Eta squared**
Indices							
1. Verbal Comprehension Index (VCI)	103.60	21.54	107.77	14.64	2.05	.154	.01
2. Perceptual Reasoning Index (PRI)	102.70	17.92	105.86	13.49	1.59	.209	.01
3. Working Memory Index (WMI)	86.85	14.52	105.17	14.56	63.55	<.001	.29
4. Processing Speed Index (PSI)	85.14	15.64	104.11	14.64	62.77	<.001	.28
Full Scale Intelligence Quotient (FSIQ)	94.89	15.45	107.84	13.30	32.26	<.001	.17
Diff. Max-Min of 4 indices	38.96	14.66	25.17	9.32	50.38	<.001	.24
Additional indices							
1. General Ability Index (GAI)	104.30	16.82	107.44	13.72	1.66	.199	.01
2. Cognitive Proficiency Index (CPI)	83.25	15.71	106.16	13.87	92.88	<.001	.38
Differences between indices							
FSIQ-GAI	–9.38	7.33	.40	5.66	88.87	<.001	.36
FSIQ-CPI	11.64	13.73	1.67	9.32	28.27	<.001	.16
GAI-CPI	20.85	18.37	1.27	14.64	54.18	<.001	.26

Note. Eta-squared values were calculated as a measure of effect size. and results were interpreted using Cohen's (1988) guidelines for determining small (.01). medium (.06). and large (.14) effects.

Table 3 – Cognitive profiles of the ASD-1 group: comparisons between pairs of subtests within 4 indices. and comparisons between the seven indices of the WISC-IV (n = 80)

Indices	Comparisons between subtests in ASD-1 group	$Mean_{[1]}$	$SD_{[1]}$	$Mean_{[2]}$	$SD_{[2]}$	F	*p*	Eta squared
VCI	$Similarities_{[1]}$ vs $Vocabulary_{[2]}$	11.29	3.86	10.29	3.88	7.82	.006	.09
	$Similarities_{[1]}$ vs $Comprehension_{[2]}$	11.29	3.86	10.35	4.65	3.77	.055	.05
	$Vocabulary_{[1]}$ vs $Comprehension_{[2]}$	10.29	3.88	10.35	4.65	.00	1.00	.00
PRI	Block $Design_{[1]}$ vs Picture $Concept_{[2]}$	10.76	3.92	10.35	3.37	.52	.474	.01
	Block $Design_{[1]}$ vs Matrix $Reasoning_{[2]}$	10.76	3.92	10.76	3.48	.00	.99	.00
	Picture $Concept_{[1]}$ vs Matrix $Reasoning_{[2]}$	10.35	3.37	10.76	3.48	.50	.479	.01
WMI	Digit $Span_{[1]}$ vs Letter-Number $Sequencing_{[2]}$	8.05	2.52	7.71	3.13	1.08	.030	.01
PSI	$Coding_{[1]}$ vs Symbol $Search_{[2]}$	7.26	3.33	7.97	3.18	3.59	.065	.04
	Comparisons between Indices in ASD-1 group							
	$VCI_{[1]}$ vs $PRI_{[2]}$	103.60	21.54	102.70	17.92	.10	.753	.00
	$VCI_{[1]}$ vs $WMI_{[2]}$	103.60	21.54	86.85	14.52	40.10	<.001	.34
	$VCI_{[1]}$ vs $PSI_{[2]}$	103.60	21.54	85.14	15.64	47.22	<.001	.37
	$PRI_{[1]}$ vs $WMI_{[2]}$	102.70	17.92	86.85	14.52	43.92	<.001	.36
	$PRI_{[1]}$ vs $PSI_{[2]}$	102.70	17.92	85.14	15.64	75.02	<.001	.49
	$WMI_{[1]}$ vs $PSI_{[2]}$	86.85	14.52	85.14	15.64	.60	.440	.01
	$FSIQ_{[1]}$ vs GAI$[_{[2]}$	94.89	15.45	104.30	16.82	129.43	<.001	.58
	$FSIQ_{[1]}$ vs $CPI_{[2]}$	94.89	15.45	83.25	15.71	53.91	<.001	.42
	$GAI_{[1]}$ vs $CPI_{[2]}$	104.30	16.82	83.25	15.71	96.67	<.001	.57

Note. Eta-squared values were calculated as a measure of effect size. and results were interpreted using Cohen's (1988) guidelines for determining small (.01). medium (.06). and large (.14) effects.

Gorsuch, Weiss, Rolfhus & Zhu, 2005), indicated that more than 60% of the children with diagnoses of ASD in the WISC-IV showed GAIs five or more points greater than their FSIQs. In our result, the clinical group shows GAI mean almost 10 IQ points greater than their FSIQ; at the same time, the FSIQ mean is almost 12 points IQ greater than CPI, and they present a significant difference between GAI and CPI (about 21 points of IQ). These results indicate that Working Memory and Processing Speed indices negatively affect the expression of general intellectual abilities measured by Full Scale IQ.

So, in the ASD children the weaknesses in the WMI and PSI indices and the strengths in VCI and PRI demonstrate an adequate performance in verbal language and visual reasoning, since these indices do not have a confounding motor component and executive processing verbal short-term memory. Motor clumsiness is considered an endophenotype of ASD (Dziuk et al., 2007; Rourke, 2009). In the previous versions of the Wechsler scales, it was related to impaired performance index in both patients with only motor dyspraxia and those with ASD (Rourke, 1989). The WISC-IV profile in the ASD sample provides more elements and is further evidence that clumsiness is caused by a spatial working memory deficit, part of a more general impairment in nonverbal abilities (Klin, Volkmar, Sparrow, Cicchetti & Rourke, 1995), and by the deficit in planning and executing movement, rather than only by a motor skills deficit (Blake, Turner, Smoski, Pozdol & Stone, 2003). Motor planning is directly related to working memory and, therefore, we corroborate the results of Rinehart and colleagues (Rinehart, Bradshaw, Moss, Brereton & Tonge, 2001), who demonstrated a difficulty in maintaining attention and maintaining the appropriate preparatory set in working memory for ASD.

Finally, since Flanagan and Kaufman (2009) stated that a wide and rare variability between indices can be an expression of an IQ that cannot be interpreted as a unitary ability, we studied this variability in the ASD group. Using cut-off value extracted from the Italian standardization sample of WISC-IV (see Orsini et al., 2014), the 36% of ASD children had a rare and large difference between the 4 indices and then the FSIQ could be deemed uninterpretable as unitary and cohesive ability.

There is research that has highlighted how the cognitive profiles of ASD children can be characterized by a fall in verbal tests and therefore a fall in the total IQ of a Wechsler scales (i.e. Flanagan & Kaufman, 2009; Goldstein et al, 2002; Liss et a1., 2001; Kuriakose, 2014; Wechlser, 2008). As well as there are authors concluding that such scales (the WISC-III and WISC-IV) when compared to the *Raven Matrices* or the *Leiter International Performance Scale – 3*, may underestimate the overall level of intelligence of these clinical subjects (i.e., Dawson, Soulieres, Gernsbacher & Mottron, 2007; Giofrè et al., 2019; Nader et al., 2016). However, these conclusions probably have limitations: 1) they are formulated on samples that are almost very small; 2) clinical samples are heterogeneous, in the sense that ASD subjects are not distinguished in with and without intellectual deficit; 3) control samples are rarely perfectly matched. Although in the paper of Giofrè et al. (2019) 31 children ASD with IQ>70 and 19 children with IQ<70 were compared, the first group had a very low mean FSQI score compared to the results of the present research on a group of 80 children ASD with IQ>70. On the other hand, already other research have highlighted as children ASD with higher cognitive abilities and children ASD with lower cognitive abilities, present different cognitive profiles with important differences in the strengths and weaknesses (Mayes & Calhoun, 2003; Mouga et al., 2016). And in part the results of the present paper confirm it, because if children ASD with IQ>70 perform on mean in ICV and IRP that do not differ from those of the paired control group, the profile could be likely to be different from what could emerge with children ASD with IQ<70. This hypothesis has in fact already been confirmed in the research of Mouga et al. (2016) administering the WISC-III to ASD group with normal/high IQ and lower IQ. Therefore, the use of a Wechsler scale with the 4 core indices and the two supplemental ones, will better define the intellectual profile of the ASD clinical group.

In summary, in this paper we aimed to identify an endophenotype for ASD with normal cognitive functioning at the WISC-IV evaluation. Results suggest that ASD's with high functioning profile cannot be interpreted as a unitary and cohesive ability, represented from simply FSIQ, but we can obtain a better assessment of cognitive level in ASD subjects using separately GAI and CPI indices. The high discrepancy among the 4 core indices could shape up a characteristic endophenotype of ASD and be used not only for general cognitive assessment, but even as a contribution to differential diagnostic assessment of ASD. We should always ask ourselves what is the advantage of using FSIQ alone with children and adolescent with ASD that does not establish suitability to receive additional services or provide the most useful information for educational planning. In other words, the labelling of intellectual disability to an ASD children with moderate to severe disability can be inaccurate and has no educational function but adds another stigma. An effective assessment for this population should use a functional approach with a differential diagnosis that analyses intellectual profiles and allows psychologists and educators to define the skills that need to be developed and the educational methods most likely to be successful. An assessment of the overall intellectual level of ASD children is less likely to provide life-enhancing progress than an assessment that identifies strengths, weaknesses and ways to address deficits. As such, a cognitive assessment is necessary to measure the level of functioning of an individual in the various domains, specifying whether ASD is present with or without accompanying intellectual or linguistic disabilities, in order to identify appropriate interventions and supports.

The strengths of the present research that distinguish it from previous research are: the use of performance about all 15 WISC-IV subtests (core and supplemental subtests) to get more information on cognitive profiles of ASD group; the greater size, compared to other research, of the clinical sample of 80 children and adolescents diagnosed with Autism spectrum disorder – level 1 (ASD-1) without intellectual disability (with FSIQ>70); and the use of a perfectly matched-paired control sample for age, gender of children and parents' level education, sample very often absent or untreated in pairing for important status variables in other research.

However, this research is not without limits, surely the most important is that we do not have a sample of comparison of ASD children with intellectual disabilities (i.e. with IQ<70). Another limitation, we have not used data on adaptive behaviour (i.e., ADOS-2), although we have already seen how WISC-IV indices can predict the adaptive functioning of children with ASD with high functioning (e.g. Oliveras-Rentas et al., 2012).

Despite these limitations, we believe that this study provides clinicians and researchers with important insights into the intellectual functioning of ASD children with high functioning, demonstrating that the way intelligence is assessed in these children is important and requires careful analysis of cognitive profiles rather than focusing on FSIQ.

However, the future study should be supported by: a) to use other measurements of the average in verbal and visuospatial competences, as the fall in Working Memory and Processing Speed, for example with neuropsychological measurements; b) to know if there are subgroups of ASD children with various levels of functioning, given the variability of cognitive patterns that often emerge in research (e.g. as defined by the DSM-5 severity levels and specifiers; American Psychiatric Association, 2013); c) to compare the profile of ASD children without intellectual deficit and ASD children with intellectual deficit at the WISC-IV, to further information the question if the strengths and deficits are the same in high and low functioning ASD; d) to exam cognitive patterns in ASD children with and without language (receptive and/or expressive) impairment or disorder; e) to deepen how cognition is related to the main characteristics of ASD and adaptive behavior, as well as to the associated psychopathology; f) to compare the ASD-1 profile at the WISC-IV with other diagnoses, e.g. patients with (only) developmental coordination disorder; g) to search for any relationships between motor coordination disorders and CPI indices, also discriminating further between WMI and PSI indices; h) to compare the ASD-1 profile at WISC-IV with than WISC-V not yet available in Italy Regarding this last point, a paper was recently published in which Kuehnel and colleagues (Kuehnel, Castro & Furey, 2019) compared the performance at the Verbal Comprehension Index (VCI) of WISC-IV and WISC-V of ASD and ADHD children. From results the changes in VCI (from WISC-IV to WISC-V) subtest scores were minimal although a statistically significant increase of 5 IQ scores in VCI score occurred. More in particular, for both WISC-IV and WISC-V, the authors found significant differences between pairs of verbal subtests (*Similarities*, *Vocabulary* and *Comprehension*) with *Similarities* subtest was a relative strength and *Comprehension* subtest is weakness. The distint pattern performance (*Similarities* > *Vocabulary* > *Comprehension*) emerged confirming data in literature (e.g., Mayes & Calhoun, 2008; Zayat et al., 2011). These results are partially superimposable to those that emerged in the present research in which our ASD high functioning children and adolescents showed higher performance at the subtest of *Similarities*, while the performance at *Vocabulary* and *Comprehension* subtests are lower but almost similar. We agree with the conclusions of Kuehnel and colleagues (2019) that verbal intellect measurements are particularly important for ASD sufferers, since language disorders are quite common for many individuals across the autistic spectrum and, consequently, their performance on verbal intellect measurements (especially when there is an intellectual disability) is often lower.

Conflict of interest. The Authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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