ENCEPHALOS 57, 35-43, 2020

Comparison of intellectual profiles among children with different types of neurodevelopmental disorders and typically developing children

Tatiani Mavrea[1], Amaryllis-Chryssi Malegiannaki[2], Nikolaos Apteslis[3], Mary H. Kosmidi[4].

Summary

In the present study, the performance of primary school children with neurodevelopmental disorders (dyslexia, dysgraphia, and ADHD) was compared to that of typically developing children (TD) on the Greek Wechsler Intelligence Scale for Children, 3rd edition (WISC–III). A total of 104 children (85 boys) from the 2nd Center for Differential Diagnosis, Diagnosis and Support in Thessaloniki (26 for each of the three clinical groups and the typically developing group, matched in age) participated in the study. According to the results, children with ADHD demonstrated poorer performance than the children of the other two clinical groups and the TD children on most of the WISC-III subtests (with the exception of the Block Design subtest). On the other hand, the dyslexia and dysgraphia groups did not differ from each other, and on most subtests, they also did not differ from the TD group (with the exception of the Similarities subtest which was lower in the dyslexia than in the TD group). The Verbal Scale and the Full Scale indices were lower among children with ADHD and those with dyslexia than the TD children; the Performance Scale index was lower only in children with ADHD when compared to TD children. In conclusion, attention deficits that characterize ADHD appear to affect a broad range of intellectual functions.

Key words: ADHD, dysgraphia, dyslexia, intelligence, neurodevelopmental disorders, WISC-III.

[1]Primary school teacher. School of Italian Language and Literature, Aristotle University of Thessaloniki

[2]Neuropsychologist, Post-Doctoral Researcher. Lab of Cognitive Neuroscience, School of Psychology, Aristotle University of Thessaloniki

[3]Special Education and Training Teacher. Head of the 2nd Center for Diagnosis, Differential Diagnosis and Support (KEDDY) of Thessaloniki, Regional Directorate of Primary and Secondary Education of Central Macedoni a, Ministry of Education, Research and Religious Affairs

[4]Professor. Lab of Cognitive Neuroscience, School of Psychology, Aristotle University of Thessaloniki

Corresponding author: Tatiani Mavrea

School of Italian Language and Literature, Aristotle University of Thessaloniki
Serron 48, Triandria, Thessaloniki, 55337, tel. 6972479625
t.mavrea@yahoo.gr

1. Introduction

In recent few decades, there has been increased interest from many scientific disciplines (e.g., education, psychology, medicine) regarding the detection, assessment and treatment of Neurodevelopmental Disorders (ND). According to the Diagnostic Statistical Manual of Mental Disorders (DSM-5), ND are defined as a wide range of conditions that occur in the early stages of development and include deficits that affect functioning on an individual, social, academic and professional level. Diagnoses included in this category are Intellectual Disability (ID), Communication Disorders, Autism Spectrum Disorder (ASD), Attention Deficit / Hyperactivity Disorder (ADHD), Motor Disorders, Musculoskeletal Disorders (Tics) and Specific Learning Difficulties (SLD: dyslexia, dysgraphia, dyscalculia)(American Psychiatric Association, 2013). It is, therefore, a group of disorders that have been shown to have a genetic basis and affect brain development, structure and function beginning in childhood (Nisiotou & Vlachos, 2014). Among the main NDs, in terms of frequency in the school population, is dyslexia (with a prevalence rate of 5-15% internationally) and dysgraphia (with a prevalence rate of approximately 10%) (Gabrieli & Norton, 2012; Landerl & Moll 2010; Rosenblum & Dror, 2017. Vlachos et al., 2013) and often coexists with dyslexia by (prevalence of comorbidity 70%) (Mayes, Frye, Breaux & Calhoun, 2018).

Dyslexia is a neurodevelopmental disorder that usually manifests during the first grades of primary school, as an unexpected failure or difficulty in acquiring reading and writing, which is below expectations based on the child's age, intellectual ability and educational opportunities

(Lyon, Shaywitz, & Shaywitz, 2003). Dysgraphia is characterized by difficulties in acquiring writing/spelling skills, which are not the result of inadequate education, sensory problems or low intelligence (Martins et al., 2013). Attention Deficit- Hyperactivity Disorder (ADHD) is another common disorder among school age children (with a prevalence rate of 5-11%) (Sayal, Prasad, Daley, Ford, & Coghill, 2018) and is characterized by inappropriate developmental levels of inattention, hyperactivity and/or impulsivity (Leung & Hon, 2016), which negatively affect the child's ability to control the level of his or her motor activity, focus on the cognitive tasks, focus on relevant and filter out irrelevant stimuli, and think before reacting (Barry, Lyman, & Klinger, 2002).

In the case of dyslexia and dysgraphia, one of the diagnostic criteria requires reading and/or writing skills achievement below that expected based on intellectual abilities. Yet, difficulties in reading and/or writing may impede the development of a variety of cognitive abilities, such as those assessed in intelligence testing. Given the nature of the difficulties associated with ADHD, this diagnosis, too, may hinder adequate cognitive development and learning. To the extent that cognitive abilities assessed on intelligence tests are related to school-based learning and skills, they may be affected by specific areas of weakness. Therefore, it is important to explore the performance of children with these diagnoses on intelligence testing, as this may clarify potential interplays between specific areas of cognitive impairments and intelligence in children with ND.

Several studies have investigated the intellectual profile of children with developmental dyslexia. A significant number of these have shown that, despite having IQ scores in the normal range, children with dyslexia had lower Full Scale Intelligence Quotients (FSIQ) and Verbal Intelligence Quotients (VIQ) compared to children with typical development (D' Angiulli & Siegel, 2003; Moura, Simões, & Pereira, 2014; Vargo, Grosser, & Spafford, 1995). In contrast, no differences were observed with respect to the Performance Intelligence Quotient (PIQ) (Ashtiani & Ahmadi, 2006; D' Angiulli & Siegel, 2003; Moura et al., 2014; Vargo et al., 1995). However, more recent research has shown that in addition to visuo-spatial skills, which remain intact in children with dyslexia, the data do not appear to support the existence of verbal weaknesses in these children (Da Clercq-Quaegebeur et al, 2010; Poletti, 2014; Toffalini, Giofre & Cornoldi, 2017). More specifically, studies have shown that children with dyslexia have high scores on some WISC subtests, namely, Block Design, Object Assembly, Picture Arrangement and Picture Completion (D' Angiulli & Siegel, 2003; Vargo et al., 1995), but performed particularly poorly on Digit Span, Arithmetic (Ackerman, Holloway, & Youngdahl, 2001; D' Angiulli & Siegel, 2003; Moura et al. 2014), Digit Symbol and Symbol Search (Ackerman et al., 2001; D' Angiulli & Siegel, 2003; Da Clercq-Quaegebeur et al., 2010).

In contrast to the extensive interest in dyslexia, very few studies have explored the intellectual profile of children diagnosed with dysgraphia. Poletti (2014) found no difference between children with dysgraphia (as well as children with dyslexia) and typically developing children with respect to intelligence. In the same study, dysgraphia was not related to any cognitive deficits; when compared with a group of children with dyslexia, there was no difference in the intellectual profile between the two disorders. In contrast, another study found a similar intellectual profile tin dysgraphia and dyslexia, characterized by poor Working Memory (based on Digit Span and Letter-Number Sequencing scores) and Processing Speed indices (based on Digit Symbol/Coding and Symbol Search scores) (Toffalini et al., 2017). Consequently, the researchers suggested that the two disorders may be characterized by a common cognitive profile related to difficulties in the acquisition of written language. It is worth noting that one difference between the two groups was the significantly better Perceptual Reasoning Index (PRI) than Verbal Comprehension Index (VCI) of children with dyslexia, indicating their strong visuo-spatial skills. In contrast, the PRIs and the VCIs of children with dysgraphia were similar to each other.

Finally, the intellectual profile of children with ADHD on the WISC has been found to be poor relative to typically developing children (Schwean & Saklofske, 1998). Many researchers have reported significantly lower FSIQs in children with ADHD, with some studies even reporting differences of up to 20 points between children with ADHD and typically developing children (Assemany et al., 2001; Frazier, Demaree, & Youngstrom, 2004; Mayes, Calhoun, & Crowel, 1998). Regarding the WISC subtest scores, studies concur that children with ADHD have great difficulty on Arithmetic, Digit Symbol/Coding, Digit Span and Symbol Search (Mayes & Calhoun, 2004, 2006; Mayes et al., 1998; Mealer, Morgan & Luscomb, 1996; Prifitera & Dersh, 1993; Saklofske, Schwean, Yackulic, & Quinn, 1995; Snow & Sapp, 2000), indicative of difficulties in attention, processing speed and graphomotor skills (Mayes & Calhoun, 2006), while other researchers have suggested that these difficulties may be explained by emotional, behavioral and learning problems and not necessarily by deficits in maintained attention (Reinecke, 1999; Saklofske et al, 1995). Apart from the aforementioned subtests, weaknesses have also been observed among children with ADHD relative to their typically developing peers on Information (Snow & Sapp, 2000) and, in a series of studies conducted in Greek-speaking population, on all WISC-III verbal subtests (Information, Similarities, Arithmetic, Vocabulary, Comprehension and Digit Span) (Andreou, Agapitou, & Karapetsas, 2005; Andreou, Karapetsas, Agapitou, & Gourgoulianis, 2003). Yet, other studies have found the performance of children with ADHD on Information, Vocabulary, Similarities, Picture Completion, and Picture Ar-

rangement to be comparable to that of children with typical development (Assemany et al., 2001; Mealer et al., 1996).

In the present study, we investigated the intellectual profile of children suffering from different types of ND using the Wechsler Intelligence Scale for Children 3rd edition (WISCIII, Georgas, Paraskevopoulos, Bezevengis, & Giannitsas, 1997). Specifically, the performance of primary school children with dyslexia, dysgraphia or ADHD was compared not only to each other but also to children with typical development, in order to explore potential differences among the groups, in terms both of verbal, performance and full scale intelligence, as well as on individual subtests. The choice of the WISC-III, despite the fact that there is a more recent version of the test (WISC-V-GR), was necessary because the data from the clinical samples of the present study were collected at the 2nd KEDDY of Thessaloniki, in which the intelligence assessment is still being carried out with the specific version of the tool. Although the existing literature includes many studies examining the intellectual functioning of children with ND in comparison with typically developing children (Mayes & Calhoun, 2004, 2006; Saklofske et al., 1995), as well as among the subtypes of SLD (Poletti, 2014; Toffalini et al., 2017), only one has attempted to compare intellectual profile patterns in these groups to each other (Mayes & Calhoun, 2004). Additionally, to our knowledge, no studies have directly compared the three aforementioned ND selected for the present study. Apart from its overall contribution, however, the present study also contributes to the Greek literature in particular, as it is focused on the Greek-speaking population (Andreou et al., 2005).

2. Method

Participants

The sample of the present study consisted of 104 primary school children (n = 85 boys), divided into three clinical groups and one group of typically developing children. The clinical samples consisted of 26 children diagnosed with dysgraphia (n = 24 boys), 26 with a diagnosis of dyslexia (n = 25 boys) and 26 with a diagnosis of ADHD combined type (n= 20 boys). The group of typically developing children consisted of 26 participants (n = 16 boys). Pupils in the four groups were matched according to their grade in school when the diagnostic evaluation took place. Although an attempt was made to match these groups on gender, it was not possible in some cases, as can be seen from the numbers of participants in each group (see Table 1). This is because the groups of children with dyslexia and dysgraphia consisted mainly of boys, reflecting the increased prevalence of these disorders in boys relative to girls. The ages of the pupils ranged from 8-12 years and grade in school from 3rd to 6th grade, with the majority of students attending 6th grade (Table 1). The children were assessed at the 2nd KEDDY (recently renamed KESY) of Thessaloniki, which covers the western region of the Prefecture of Thessaloniki (Municipality of Ampelokipi-Menemeni, Municipality of Volvi, Municipality of Delta, Municipality of Kordelio-Evosmos, Municipality of Lagada, Municipality of Neapolis-Sykeon, Pavlou Mela, Municipality of Chalkidona, and Municipality of Oreokastro).

Procedure

The present data were collected from the archive of the 2nd KEDDY of Thessaloniki, after permission was obtained. The individual files of all the pupils were studied and their performance on each subtest of WISC-III was recorded, as well as their Verbal (VIQ), Performance (PIQ) and Full Scale Intelligence (FSIQ) Quotients. As regards the clinical groups, pupils displaying co-morbidity with any disorder (other specific learning difficulties, Autism, etc.) were excluded from the study. Statistical analyses were performed using the Statistical Package for Social Sciences version 25 (SPSS, 2017).

Materials

The WISC was originally developed by the American psychologist David Wechsler in 1949. Its third version (WISC-III) was adapted and standardized for the Greek population in 1997 by the Psychometric Laboratory of the University of Athens (Georgas et al., 1997) and has been in wide-spread use in Greece. It is suitable for children aged 6 -16 years and consists of 13 subtests (10 main scales, 2 complementary and 1 optional), each evaluating a different aspect of intelligence. In the present study, the scores from the ten main scales of were used, as well as the VIQ, the PIQ and the FSIQ (which reflects overall intellectual performance). Of these 10 scales, five use auditory/verbal material, yielding a single score (VIQ) and five use visual/auditory material, yielding another single score (PIQ).

3. Results

In order to explore potential differences among groups regarding their performance on the WISC-III subtests, a one-way analysis of variance was performed with group as the independent variable and performance on each subtest, VIQ, PIQ, and FSIQ as the dependent variables. Partial eta squared (η2) was used, to calculate the effect size of the diagnostic group. Post-hoc Bonferroni comparisons were then applied to explore the particular groups that differed from each other (dyslexia, dysgraphia, ADHD and typically developing children).

As can be seen in the results presented in Table 2, the average performance of children with ADHD was significantly lower on all subtests compared to those of children of the other two clinical groups and to those of typically developing children (with exception of Block Design, in which no significant differences were observed).

Performance of children with dysgraphia from typically developing children did not differ on any of the WISC-III subtests, while the performance of children with dyslexia differed from the typical group only with respect to Similarities (meandyslexia = 14.19, meanTD = 17.73). The comparison between children with dysgraphia and children with dyslexia showed that these two groups did not differ from each other on any of the WISC-III subtests.

Finally, children with ADHD showed significantly lower VIQs and FSIQs when compared to typically developing children on (VIQ: meanADHD = 93.92, meanTD = 102.73, while FSIQ: meanADHD= 90.81, meanTD= 103.69); the same pattern was observed in children with dyslexia, who had lower VIQs and FSIQs than the typically developing group (VIQ: meandyslexia= 94.77,meanTD = 102.73 while FSIQ: meandyslexia= 94.46, meanTD= 103.69). Regarding PIQ, only children with ADHD showed significantly lower performance than the typically developing group (PIQ: meanADHD= 89.35, meanTD = 99.85).

4. Discussion-Conclusions

In the present study, we explored the intellectual profile that elementary school children with different neurodevelopmental disorders (Dyslexia, Dysgraphia, and ADHD) present on the WISC-III intelligence scale and compared the performance of each group to that of all of the others, including the typically developed group. Based on the results of these comparisons, children with ADHD performed significantly lower than typically developing children on most WISC-III subtests (with the exception of Block Design). Therefore, difficulties in attention and concentration in these children may be related to their performance in the many areas of intellectual functioning tapped by the WISC-III.

More specifically, children with ADHD, as observed in previous studies (Frazier et al., 2004; Mayes et al.,1998), showed significantly lower FSIQ (13 points difference) than those of typically developing children, suggesting that this disorder is characterized by generalized cognitive difficulties or multiple deficits, which affect several of their cognitive abilities (Malegiannaki et al., 2019). Low VIQ, as well as low scores on particular verbal subtests in children with ADHD is consistent with previous findings (Andreou et al., 2003; Andreou et al., 2005; Casey, Rourke, & Dotto, 1996) and suggest deficient acoustic-language processing, as all verbal scales evaluate verbal intelligence through the auditory-linguistic path. Low performance of children with ADHD on the Information subtest (as observed in the study of Snow & Sapp, 2000) suggests general verbal difficulties and possible difficulties in understanding extensive questions. It is important to note that this subtest assesses a range of general knowledge associated with school learning, which may be affected by their inattention. Difficulties in speech organization, in the formation of verbal concepts and the ability to distinguish essential from non-essential details are associated with low scores on the Similarities subtest, as observed in similar studies (Andreou et al., 2003; Andreou et al., 2005). Low performance of children with ADHD on the Arithmetic subtest has been reported in numerous previous studies (Andreou et al., 2005; Assemany et al., 2001; Mayes & Calhoun, 2004, 2006; Snow & Sapp, 2000), which have argued that this subtest not only assesses skills such as flexibility in manipulating numbers, the ability to serially process information, long-term and short-term memory abilities, but also the ability to concentrate and pay attention (which is deficient in children with ADHD). The verbal administration of the arithmetic problems in this subtest most likely increases the level of difficulty for children with ADHD, given their potential distractibility on oral tasks. The low scores observed on the Vocabulary subtest indicate limited language development and verbal fluency ability in children with ADHD (Hurks et al., 2004). Finally, the Comprehension subtest requires children to give verbal solutions to everyday problems and to show that they understand social rules and concepts (Motti-Stefanidi, 1999). In children with ADHD, however, there is considerable difficulty in both verbal problem solving and social intelligence, as this disorder is closely related to problems in social behavior (Beebe, Pfiffner, & McBurnett, 2000). In addition to their weaknesses on the Verbal scale, the ADHD group also did more poorly than the typically developing children on the Performance scale (with exception of Block Design). The PIQ of children with ADHD was lower by about 10 points in comparison to the typically developing pupils and approximately 12 points on the Digit Symbol subtest, a finding that is consistent with a significant number of previous studies (Andreou et al., 2005; Mayes & Calhoun, 2004; 2006; Mayes et al., 1998; Mealer et al., 1996). The Digit Symbol subtest, which examines the child's ability to find a strategic way to process information that will allow him/her to distinguish and memorize visual symbols, as well as the Picture Completion subtest, which measures the visual ability to distinguish major from minor elements (Motti- Stefanidi, 1999) are influenced by the child's ability to concentrate on specific activities. Since difficulties in concentration and attention are basic features in ADHD, poor performance on these subtests is likely to be the result of deficits in concentration and attention. The Picture Arrangement and Object Assembly subtests evaluate, among other things, cognitive processing speed, which in the case of children with ADHD has been shown to be deficient (Shanahan et al., 2006). It is also worth mentioning that most Performance scale sub-

tests provide a time limit within which the answer must be given, in some cases, bonus points may be received for very speedy completion (i.e., Block Design, Picture Arrangement, Object Assembly). Children with ADHD, due to their impulsiveness, may give incorrect answers very quickly or sometimes because of their distraction, may give delayed answers, resulting in lower scores than the typically developing children on these subtests. Similar performance to that of typically developing children was observed only on Block Design, consonant with the findings of Snow and Sapp (2000).

Similarly, children with dyslexia achieved lower VIQs (with a difference of about 8 points) and FSIQs in children with dyslexia (with a difference of about 9 points), compared to typically developing children, findings that are consistent with previous research (D' Angiulli & Siegel, 2003; Moura et al, 2014). It is worth noting that the differences observed between students with dyslexia and students with typical development were mainly related to lower scores in the dyslexia group on the Similarities subtest. Low score on Similarities has been observed in previous studies (Ackerman et al., 2001; D' Angiulli & Siegel, 2003; Moura et al., 2014) and is assumed to reflect difficulties in organizing speech, word formation, and the ability to distinguish essential from non-essential information. In contrast, the visuo-spatial skills of children with dyslexia remain unaffected, as their performance on all WISC-III Performance scale subtests was similar to that of typically developing children in the present study, as reported in previous studies as well (Da Clercq-Quaegebeur et al., 2010; D' Angiulli & Siegel, 2003; Moura et al., 2014; Toffalini et al., 2017).

In the case of children with dysgraphia, their intellectual profile did not differ from the intellectual profile of typically developing children, as they performed similarly to the control group on all WISC-III subtests. Similar findings pertaining to dysgraphia were observed in a study by Poletti (2014), in which dysgraphia was not found to be associated with any cognitive deficit. It is worth mentioning that dysgraphia may be distinguished into different types (e.g. dyslexic, motor, etc.) depending on the origin of the deficits. In the present study, the lack of differences between the dysgraphia and the typically developing group on the WISC-III may be due to the fact that the diagnosis for dysgraphia in the KEDDY is based largely on criteria of the motor variant of dysgraphia, rather than dyslexic or spatial dysgraphia. However, this does not imply that the other types of dysgraphia are not related to some cognitive deficits. In addition, it is important to note that children with dysgraphia in the present study did not show co-morbidity with dyslexia, as differences in cases with dyslexia-dysgraphia co-morbidity have been observed previously (Ashtiani & Ahmadi, 2006).

Finally, a comparison of the performance of the three clinical groups on the WISC-III to each other showed that the group of children with ADHD had significantly lower scores than those with dyslexia and those with dysgraphia. This leads to the conclusion that the attentional dysfunction that characterizes these children may permeate many levels of information processing, leading children with ADHD to exhibit deficits in the broad range of areas of intellectual functioning examined by WISC-III. On the other hand, it is worth noting that children with ADHD in the present study met criteria for the combined type, which according to recent empirical findings, appears to be responsible for a more diffuse pattern of difficulties than in the inattentive other impulsive type (Malegiannaki et al., 2019; Malegiannaki & Kosmidis, 2018).

Research Limitations - Future Steps

One of the main limitations of the present study was that the matched group samples consisted mostly of boys. This restricts the generalization of the results of the present study to the entire student population, especially girls. For this reason, it would be useful, in the future, to conduct similar research with equal representation of both genders in the clinical samples in order to detect potential gender differences.

A second limitation concerns the cross-sectional nature of the research. Ideally, it would be interesting to reexamine children diagnosed with dyslexia, dysgraphia or ADHD and tested with the WISC-III, as adults with the WAIS, to explore whether their areas of weakness persist into adulthood or if they are restored with education.

A final limitation concerns the fact that a fairly old version of the WISC, the WISCIII, was used. However, to date, it is the diagnostic tool that is widely used in the KEDDY (and for this reason it was used in the present research), while the most recent version, the WISC-V (Stogiannidou, 2017), is now available in Greece. Therefore, it would be worthwhile in the future to conduct research with the latest version of the test, to investigate the intellectual profiles of children with dysgraphia, dyslexia or ADHD, perhaps even additional clinical groups (e.g., autism) and pediatric populations.

References

Ackerman, P., Holloway, C., Youngdahl, P., & Dykman, R. (2001). The doubledeficit theory of reading disability does not fit all. Learn ing Disabilities Research & Practice, 16(3), 152-160. doi: 10.1111/0938-8982.00016

American Psychiatric Association. (2013). Diagnostic and statistical man ual of mental disorders (5th ed.). Washington, London: Ameri can Psychiatric Publishing.

Andreou, G., Agapitou, P., & Karapetsas, A. (2005). Verbal skills in chil dren with ADHD. European Journal of Special Needs Educa tion, 20(2), 231-238. doi: 10.1080/08856250500055743

Andreou, G., Karapetsas, A., Agapitou, P., & Gourgoulianis, K. (2003). Verbal intelligence and sleep disorders in children with ADHD. Perceptual and Motor Skills, 96, 1283–1288.doi: 10.2466/pms.2003.96.3c.1283

Ashtiani, A., & Ahmadi, K. (2006). Verbal and non-verbal intelligence: Dys lexicdysgraphic students and normal students. Archives of Medical Science, 2(1), 42- 46.

Assemany, A., McIntosh, D., Phelps, L., & Rizza, M. (2001). Discriminant validity of the WISC-III with children classified with ADHD. Jour nal of Psychoeducational assessment, 19, 137-147.doi: 10.1177/073428290101900203

Barry, T., Lyman, R., & Klinger, L. (2002). Academic underachievement and Attention-Deficit/Hyperactivity Disorder. Journal of School Psychology, 40(3), 259-283.

Beebe, D., Pfiffner, L., & McBurnett, K. (2000). Evaluation of the validity of the Wechsler Intelligence Scale for Children-Third edition comprehension and picture arrangement subtests as measures of social intelligence. Psychological Assessment, 12(1), 97-101. doi: 10.1111/0938-8982.00016

Casey, J. E., Rourke, B. B.,& Del Dotto, J. E. (1996). Learning disabilities in children with attention deficit disorder with and without hy peractivity. Child Neuropsychology, 2, 83–98.doi: 10.1080/09297049608401354

Georgas, D. D., Paraskevopoulos, I. N., Bezevengis, I. G, & Giannitsas, . D. (1997). Greek WISC-III. Wechsler Intelligence Scale foe Children. Athens: Ellinika Grammata. (In Greek).

Da Clercq-Quaegebeur, M., Casalis, S., Lemaitre, M., Bourgois, B., Getto, M., & Vallée, L. (2010). Neuropsychological profile on the WISC-IV of French children with dyslexia. Journal of Learning Disabilities, 43(6), 563-574. doi: 10.1177/0022219410375000

D' Angiulli, A., & Siegel, L. (2003). Cognitive functioning as measured by the WISCR. Journal of Learning Disabilities, 36(1), 48-58. doi: 10.1177/00222194030360010601

Frazier, T., Demaree, H., & Youngstrom, E. (2004). Meta-Analysis of in tellectual and neuropsychological test performance in Attention-Deficit/Hyperactivity Disorder. Neuropsychology, 18(3), 543-555. doi: 10.1037/0894-4105.18.3.543

Gabrieli, J., & Norton, E. (2012). Reading abilities: Importance of visual-spatial attention. Current Biology, 22(9), R298-R299. doi: 10.1016/j.cub.2012.03.041

Hurks, P., Hendriksen, J., Vles, J., Kalff, A., Feron, F., & Kruse, M. ,et al. (2004). Verbal fluency over time as a measure of automatic and controlled processing in children with ADHD. Brain and Cog nition, 55(3), 535-544.doi: 10.1016/j.bandc.2004.03.003

Landerl, K., & Moll, K. (2010). Comorbidity of learning disorders: Prev alence and familial transmission. Journal of Child Psychology and Psychiatry, 51(3), 287- 294. doi: 10.1111/j.1469-7610.2009.02164.x

Leung, A., & Hon, K. (2016). Attention-Deficit/Hyperactivity Disorder. Ad vances In Pediatrics, 63(1), 255-280.

Lyon, G., Shaywitz, S., & Shaywitz, B. (2003). A definition of dyslexia. An nals of Dyslexia, 53(1), 1-14. doi: 10.1007/s11881-003-0001-9

Malegiannaki, A., Aretouli, E., Metallidou, P., Messinis, L., Zafeiriou, D., & Kosmidis, M. (2019). Test of Everyday Attention for Children (TEA-Ch): Greek normative data and discriminative validity for children with Combined Type of Attention Deficit-Hyperactivity Disorder. Developmental Neuropsychology, 44(2), 189-202. doi: 10.1080/87565641.2019.1578781

Malegiannaki, A. C., & Kosmidis, M. H. (2018). The heterogeneity of At tention Deficit- Hyperactivity Disorder in children and the role of neuropsychological assessment. InF. Vlachos (Eds.), Brain, learning and special education. Athens: Gutenberg. (In Greek) ISBN 9789600119381.

Dickerson Mayes, S., Calhoun, S., & Crowell, E. (1998). WISC-III profiles for children with and without learning disabilities. Psychology in The Schools, 35(4), 309-316. doi: 10.1002/(sici)1520-6807(199810)35:4<309::aid-pits1>3.0.co;2-v

Martins, M., Bastos, J., Cecato, A., Araujo, M., Magro, R., & Alaminos, V. (2013). Screening for motor dysgraphia in public schools. Jor nal De Pediatria (Versão Em Portuguese), 89(1), 70-74. doi: 10.1016/j.jpedp.2012.08.008

Mayes, S., & Calhoun, S. (2004). Similarities and differences in Wechsler Intelligence Scale for Children—Third Edition (WISC-III) pro files: Support for subtest analysis in clinical referrals. The Clin ical Neuropsychologist, 18(4), 559- 572. doi: 10.1080/13854040490888530

Mayes, S., & Calhoun, S. (2006). WISC-IV and WISC-III profiles in chil dren with ADHD. Journal of Attention Disorders, 9(3), 486-493. doi: 10.1177/1087054705283616

Mayes, S., Frye, S., Breaux, R., & Calhoun, S. (2018). Diagnostic, demo graphic, and neurocognitive correlates of dysgraphia in stu dents with ADHD, autism, learning disabilities, and neurotypi cal development. Journal of Developmental and Physical Dis abilities, 30(4), 489-507. doi: 10.1007/s10882-018-9598-9

Mealer, C., Morgan, S., & Luscomb, R. (1996). Cognitive functioning of ADHD and non-ADHD boys on the WISC-III and WRAML: An analysis within a memory model. Journal of Attention Disorders, 1(3), 133-145. doi: 10.1177/108705479600100302

Motti–Stefanidi, F. (1999). Evaluation of the intelligence of school-aged children and adolescents.Athens: Ellinika Grammata. (In Greek).

Moura, O., Simões, M., & Pereira, M. (2013). WISC-III cognitive profiles in children with developmental dyslexia: Specific cognitive dis ability and diagnostic utility. Dyslexia, 20(1), 19-37. doi: 10.1002/dys.1468.

Nisiotou, I., & Vlachos, F. (2014). Neurodevelopmental disorders: Is there a common biological basis? Child & Adolescent Psychiatry, 2, 31-41. (In Greek)

Poletti, M. (2014). WISC-IV Intellectual profiles in Italian children with spe cific learning disorder and related impairments in reading, written expression, and mathematics. Journal of Learning Dis abilities, 49(3), 320-335. doi: 10.1177/0022219414555416

Prifitera, A., & Dersh. J. (1993). Base rates of WISC-111 diagnostic sub test patterns among normal, learning-disabled and ADHD sam ples. Journal of Psychoeducational assessment, Wisc-111 Monograph Series, 43-55.

Reinecke, M., Beebe, D., & Stein, M. (1999). The third factor of the WISC-III: It's (probably) not freedom from distractibility. Journal of the American Academy of Child & Adolescent Psychiatry, 38(3), 322-328. doi: 10.1097/00004583- 199903000-00020

Rosenblum, S., & Dror, G. (2017). Identifying developmental dysgraphia characteristics utilizing handwriting classification methods. IEEE Transactions on Human-Machine Systems, 47(2), 293-298. doi: 10.1109/thms.2016.2628799

Saklofske, D., Schwean, V., Yackulic, R., & Quinn, D. (1995). WISC-III and SB:FE performance of children with Attention Deficit Hy peractivity Disorder. Canadian Journal of School Psychology, 10(2), 167-171. doi: 10.1177/082957359501000210

Sayal, K., Prasad, V., Daley, D., Ford, T., & Coghill, D. (2018). ADHD in children and young people: Prevalence, care pathways, and service provision. The Lancet Psychiatry, 5(2), 175-186. doi: 10.1016/s2215-0366(17)30167-0

Schwean, V. &Saklofske, D. (1998). WISC-lll assessment of children with attention deficit/hyperactivity disorder. In A. Prifitera & D. Sak lofske (eds.), WISC-III clinical use and interpretation. (pp. 91-118), San Diego: Academic Press.

Shanahan, M., Pennington, B., Yerys, B., Scott, A., Boada, R., & Willcutt, E., et al. (2006). Processing speed deficits in Attention Deficit/Hyperactivity Disorder and reading disability. Journal of Abnormal Child Psychology, 34(5), 584-601. doi: 10.1007/s10802-006-9037-8

Snow, J., & Sapp, G. (2000). WISC—III subtest patterns of ADHD and normal samples. Psychological Reports, 87(3), 759-765. doi: 10.2466/pr0.2000.87.3.759

SPSS (Version 25) [Computer software]. (2017). Chicago: SPSS.

Stogiannidou, A. (2017). WISC-V GR (Wechsler Intelligence Scale for Children - 5th Edition). Athens: Motivo Ekdotiki.

Toffalini, E., Giofrè, D., & Cornoldi, C. (2017). Strengths and weaknesses in the intellectual profile of different subtypes of specific learning disorder. Clinical Psychological Science, 5(2), 402-409. doi: 10.1177/2167702616672038

Vargo, F., Grosser, G., & Spafford, C. (1995). Digit Span and other WISC–R Scores in the Diagnosis of Dyslexia in Children. Perceptual and Motor Skills, 80(3), 1219-1229. doi: 10.2466/pms.1995.80.3c.1219

Vlachos, F., Avramidis, E., Dedousis, G., Chalmpe, M. Ntalla, I., & Gian nakopoulou, M. (2013). Prevalence and gender ratio of dyslexia in Greek adolescents and its association with parental history and brain injury. American Journal of Educational Research, 1, 22-25.

Tables

	ADHD (M, SD)	DYSLEXIA (M, SD)	DYSGRAPHIA (M, SD)	TD (M, SD)
Age (years)	10.38 (.98)	10.42 (1.12)	10.96 (1.54)	10.65 (1.38)
Age range	8-12	8-12	8-12	8-12
Gender (Boys/Girls)	20/6	25/1	24/2	16/10

TABLE 1: DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLEBY GROUP

ADHD=Attention Deficit/Hyperactivity Disorder, TD=Typically Developing, M=mean, S.D.=Standard Deviation

	Diagnostic group				Statistical values		Post-hoc multiple comparisons			
	DYSLEXIA *(n=26)*	DYSGRAPHIA *(n=26)*	ADHD *(n=26)*	TD *(n=26)*			*p*			
WISC-III Subtests	M (S.D.)	M (S.D.)	M (S.D.)	M (S.D.)	F	*P*	DYSLEXIA vs. TD	ADHD vs. TD	DYSLEXIA vs. ADHD	DYSGRAPHIA vs. TD
Verbal Subtests										
Information	15.12 (3.41)	16.50 (4.42)	13.88 (4.27)	17.92 (3.90)	4.89	.003		.003		
Similarities	14.19 (4.61)	15.85 (4.83)	12.92 (5.10)	17.73 (3.57)	5.41	.002	.037	.002		
Arithmetic	16.08 (2.50)	17.85 (3.03)	15.00 (3.34)	17.04 (4.30)	3.49	.019				.017
Vocabulary	26.65 (5.80)	28.73 (7.53)	24.23 (8.68)	30.58 (4.85)	4.10	.009		.007		
Comprehension	19.62 (4.99)	20.31 (4.15)	17.69 (4.44)	21.62 (3.13)	3.88	.011		.007		
Performance Subtests										
Picture Completion	18.54 (2.69)	17.92 (3.86)	15.42 (5.42)	18.42 (3.20)	3.59	.016		.042	.031	
Digit Symbol/Coding	40.38 (7.81)	39.38 (9.28)	37.85 (10.11)	45.46 (7.41)	3.72	.014		.013		
Object Assembly	24.92 (6.12)	22.69 (7.48)	17.46 (9.24)	23.62 (6.53)	5.03	.003		.022	.003	
Picture Arrangement	25.65 (8.99)	28.04 (9.18)	20.12 (9.83)	27.00 (8.38)	3.90	.011		.046		.013
Block Design	35.15 (15.93)	35.77 (12.34)	30.92 (12.41)	39.15 (11.48)	1.72	.169				
Index Scores										
Full Scale IQ	94.46 (9.85)	99.69 (10.27)	90.81 (16.81)	103.69 (10.53)	5.63	.001	.045	.001		
Verbal IQ	94.77 (11.51)	102.96 (12.06)	93.92 (16.05)	102.73 (20.88)	2.59	.057	.008	.008		
Performance IQ	95.38 (11.24)	96.27 (10.08)	89.35 (15.32)	99.85 (11.21)	3.36	.022		.017		

TABLE 2: GROUPCOMPARISONS ON WISC-III SUBTESTS.

ADHD=Attention Deficit/Hyperactivity Disorder, TD=Typically Developing, M=mean, S.D.=Standard Deviation