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Dyslexics' Profile on the Working Memory Test Battery for Children, Phoneme Awareness and Literacy Measurements

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***Abstract*—This study aims to present Greek dyslexics' cognitive profile on literacy, Working Memory and phoneme awareness tasks. The reported studies in the Greek language so far, focus on pre-literate or emerging literate students, but dyslexics' spelling and reading deficits are prominent in early adolescence. In order to provide a good account of the spelling and reading difficulties experienced by dyslexics, twelve dyslexic children were tested at the end of Grade 6 and eighteen months later, on a series of phoneme awareness, phoneme perception, word and nonword reading and spelling tasks, as well as on the Working Memory Test Battery for children. Subjects exhibited degraded phoneme representation with regard to phoneme awareness, and speech perception abilities, which remained constant over time 1 & 2 testing. Moreover, reading and spelling of words did not improve between time 1 & 2 testing, whereas phonological implausible errors of words were the only literacy measurement which reached statistical significance. With regard to WM components, as measured by the WMTB-C tasks, the phonological loop spans and the Mazes Memory span improved over time 1 & 2 testing. These findings are discussed in light of the double deficit hypothesis for dyslexics' profile [1].**

Keywords-;working memory, WMTB-C, reading spelling, phoneme awareness, Greek language, dyslexia

I. INTRODUCTION *(DYSLEXICS' PROFILE1)*

Dyslexia issue came into scene during the '60 and unarguably remains controversial with regard to aetiology and prevalence in general population [2]. Dyslexic children have been reported to experience difficulties in processing written language; reading [3, 4] and spelling [5, 6]. These problems are manifested by dyslexics acquiring literacy skills in languages with different orthographic consistency [7]. Shallow orthographic systems are characterised by a high degree of phoneme-grapheme correspondences and are contrasted to deeper orthographies in which letter strings represent one to many phonemes [8]. Greek orthographic system has been classified as a shallow one, as it maps on-to one phoneme-grapheme correspondence in reading but not in spelling [9]. Moreover, Greek children acquire phoneme-grapheme correspondence by the end of second grade, a time point at which phonological implausible spelling errors are at about 12% [9] and orthographic processing errors 80% [10]. Despite the ease of spelling acquisition, reading problems are persistent in Greek dyslexics with regard to fluency [9, 11]. Thus, children with dyslexia in the Greek language can be classified as double deficit deficient [12]. The latter theoretical approach posits that dyslexics' difficulties arise from two domains· the inferior processing of the phonological information, and the inaccurate automatisation naming of visually presented concrete material [1]. Moreover, Porpodas [9], as well as Nikolopoulos, Goulandris, and Snowling [13], provided further evidence of inferior dyslexics performance in recalling phonological information stored in Short Term Memory.

The last decade, Pickering and Gathercole [14] developed the Working Memory Test Battery for children (WMTB-C), in order to describe the components of the Working Memory Model, proposed initially by Baddeley and Hitch [15], and revised subsequently form the former [16, 17]. The battery of tests was used to validate the WM model in normally developing children [18, 19] and in children within reading disabilities [20].

The aim of the present study was to describe the cognitive profile of dyslexic children in the Greek language. For this purpose, a series of standardised and non-standardised tests were administered in dyslexic and normally developing children. This paper presents the profile of 12 dyslexic children in the first examination (grade 6) and eighteen months later, when they were students at the 2nd grade in high school. To the best of my knowledge, description of the WM profile of Greek dyslexics has not been reported. In addition, dyslexics' phonological awareness, reading and spelling abilities, in the Greek language, have been well documented for kindergarten and first and second grade children, but not for student of the upper elementary Primary School and students attainting the high school.

II. METHOD

A. Participants

Twelve Dyslexic students at the end of sixth grade participated in the study. There were all native speakers of Greek with no history of hearing or neurological problems; and they have received monolingual education. They came from urban areas and all parents are reported to complete at least a twelve-year education. Parents of Dyslexics were informed about the study at the local Diagnostic, Evaluation, and Support Centre, after completing the evaluation procedure. The inclusion criteria for all three groups regarded full scale I.Q. >90 as measured by the Weschel Intelligence Scale III and Reading Comprehension Score >85, as measured by the Triga Reading Ability Test [21].

Moreover, the dyslexics' criteria included an inferior performance on three phonological awareness task of the Athina Test. Reading and spelling ability was tested with two test constructed for the purpose of the present research project. Each test comprised of a 92 word and a 92 nonword list with all possible combinations of consonant-vowel (CV), consonant cluster-vowel (CCV, CCCV), vowel-consonant (VC) of the Greek Language. Particular interest was given to include allophones and letter strings that result in phonological processes observed in spoken language. Test – retest reliability, for the reading tests, after a two months period, was reported 0.94 (word list reading) and 0.95 (nonword list reading). Reliability of the spelling test was somewhat higher 0.96 (word spelling) and 0.97 (nonword spelling).

B. Procedure

All students were tested by the author in the Diagnostic, Evaluation, and Support Centre. The material was presented in a random order.

C. Material.

In order to evaluate dyslexics' cognitive ability, a battery of tests set up the inclusion criteria and aimed to elaborate the cognitive processes involved in reading and spelling. Students completed the four tasks of phonological sensitivity and phonological awareness from the ATHINA test [22]. In the phoneme blending, a 32-item task, subjects have to combine the orally presented phonemes, ranging from 4-7, to a word. The phoneme sensitivity task involves a same/different identification of phoneme strings comprising a pair of nonwords. The grapheme identification is a paper and pencil task in which a pair of nonwords is presented in written form and the subjects had to cross out the different spelling stings without to read the nonwords. Finally, in the word completion task, the subjects listen to a word missing an initial or intermediate phoneme and they have to pronounce it in the correct form. The Reading Ability test is a sentence completion test in which subjects have to choose between four candidates the proper word, to fit the meaning and the syntax. The spelling and reading tests were developed for the purpose a larger project and the criteria used were discussed in the former section. The reading time and the spelling errors were included as best predictors of reading and spelling ability among dyslexics according to the double deficit theory (Wolf & Bowers, 1999).

Finally, the Working Memory Test Battery for Children [14] was translated by the author in the Greek language [23]. The Forward and the Backward Digit Recall, the Mazes Memory and the Block Recall were used unchanged. The Word recall and the Nonword Recall comprised of high frequently, concrete words used in the School Text Vocabulary. The nonwords came from the same pool as words and substitutions of initial and intermediate consonants secured plausibility of phonological, graphotactic and syntactic rules of the Greek language. Words and nonwords were disyllabic, in order to fit to the digit names in the Greek language.

III. Results

A. Phase 1.

Table 1 portrays the results of the phase 1 examination at the end of 6th grade. Phoneme blending and phoneme discrimination were the two tasks in which dyslexics met the inclusion criteria with performance below the 85 percentile. In contrast, dyslexics' profile in the grapheme discrimination task, the word completion task and the Reading Ability Test were similar to the normally developing children's expected standards. Dyslexics recall up to five chunks of phonological information in the form of digits and words (M=3.92, M= 3.75, respectively), a Short Term Memory span, which is reduced by one in the case of nonwords. In the case of visuospatial Short Term Memory, children reproduced successfully a complex diagram with up to six elements (M=5.08) and in three-dimension space they could follow a path with up to five intermediate stops (M=4.42). The Working Memory Span of the Central Executive is developed up to the level of five, as it was measured by the Counting Recall and the Backward Digit Recall (M=3.83, and M=3.38, respectively). With regard to spelling ability, dyslexics made consistently more orthographic processing errors in the stem of the words (M=18.58) and less grammatical errors in suffixes (M=8.43). Overall, the orthographic processing errors were greater in number (M=26.01 for words only), than phonological implausible (M=6.00 for words and M=12.33 for nonwords).

B. Phase 2.

The phase 2 examination took place eighteen months after phase 1, when students attending the first semester of the second grade in high school. The battery of test re-administered were the same except from the Wechsler Intelligence Test. Dyslexics' performance on the Athina Test were marginally improved about 4% on phoneme blending, word completion, and phoneme identification

TABLE I. DYSLEXICS' PERPHORMANCE ON WORD AND NONWORD READING AND WRITING

	Literacy Measurements		
		Phase 1 (S.D)	***Phase 2 (S.D)***
		Mean	Mean
Spelling of Nonwords	Phonetic Implausible errors	12.33 (5.1)	10.08 (3.99)
Spelling of Words	Phonetic Implausible errors	6.00 (3.43)	5.00 (5.1)
	Orthographic Processing errors	18.58 (5.58)	16.25 (7.5)
	Grammatical errors	8.42 (7.40)	4.67 (3.87)
Reading Time	Words	95.58 (34.24)	80.83 (27.93)
Reading Time	Nonwords	123.33 (43.52)	133.67 (28.01)

tasks, suggesting an equivalence improvement of the phonological awareness and the phonological sensitivity. One sample kolmogorov-Smirnov Test was used to test data

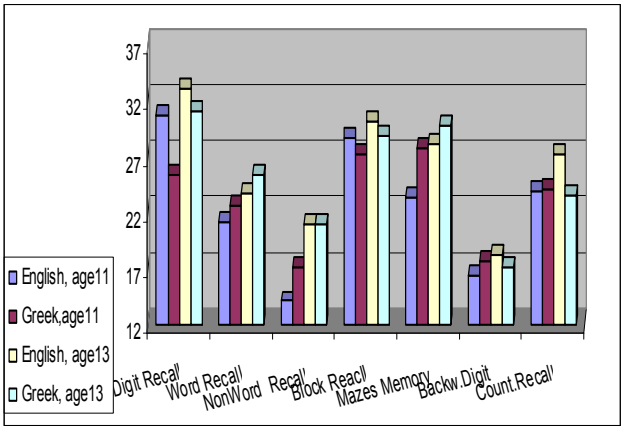
distribution of the four Athina tasks for phase 1 and 2. H0 hypothesis were accepted for all tasks suggesting normally distribution of data. Dyslexics' improvement failed to reach statistical significance on the paired sample T-test ($t(11)=-0.73$, $p>0.05$ for phoneme blending, $t(11)=-0.69$, $p>0.05$, phoneme discrimination, $t(11)=-1.46$, $p>0.05$, word completion and $t(11)=0.45$, $p>0.05$ and letter identification task).

The spelling errors in words and nonwords were coded as phonetic implausible errors, orthographic processing errors in word stems and grammatical errors in word suffixes. All types of errors as well as reading scores met the normally distribution criteria of the kolmogorov-Smirnov Test for phase 1 & 2. Dyslexic's spelling improved considerably only in terms of grapheme-phoneme correspondence in real words $t(11)=-2.83$, $p<0.05$. No other difference was observed ($t(11)=1.3$, $p>0.05$ for phonemic implausible errors in nonwords, $t(11)=1,5$, $p>0.05$ for the orthographic processing errors in word stems, and $t(11)=1.06$, $p>0.05$ for the grammatical errors in suffixes. The same pattern was also observed in dyslexic's decoding ability for words ($t(11)=-1,35$, $p<0.05$) and nonwords ($t(11)=-0.96$, $p<0.05$).

TABLE II. DYSLEXICS' PERFORMANCE ON THE PHONEME AWARENESS TASKS

Phoneme awareness tasks		
Table column subhead	***Phase 1***	***Phase 2***
	Mean (S.D)	Mean (S.D)
Phoneme Blending	102.17 (18.23)	106.08 (17.32)
Phoneme Discrimination	90.58 (17.13)	94.83 (24.2)
Grapheme Discrimination	123.17 (19.16)	118.75 (22.59)
Word Completion	117.75 (15.30)	122.08 (5.82)

Figure 1. Greek dyslexics' and English normally developing children's performance on the WMTB-C



The same procedure was used to test students' performance on the WMTB-C tasks at phase 1and 2. Normally distribution of data observed for all tasks on phase 1 and the majority of phase 2 tasks, except for the Nonword List Recall Row Score & Span, the Block Recall Row Score & Span and the Backward Digit Recall Span. A series of paired sample T-test was used to explore any statistical difference on the aforementioned variables that met the normally distribution criteria ($t(11)=-3.09$, $p<0.05$ & $t(11)=-4.00$, $p<0.05$ for the Digit Recall Row score & Span, $t(11)=-2.54$, $p<0.05$ & $t(11)=-2.16$, $p<0.05$ Word List Recall Row score & Span, $t(11)=-1.04$, $p>0.05$ & $t(11)=-2.28$, $p<0.05$ for the Mazes Memory Row Score & Span, $t(11)=-3=0.53$, $p>0.05$ & $t(11)=-20.71$, $p<0.05$ for the Counting Recall Row Score & Span. The nonparametric Wilcoxin Test was used to test the remaining variables. Statistical significance differences were observed for the Nonword List Recall Row Score & Span (W test, N=12, Z=-2.59, $p<0.05$, & W test, N=12, Z=-2.53, $p<0.05$, respectively). No significant difference was found for the Backward Digit Recall Row Score and the Backward Digit Span (W test, N=12, Z=-0.33, $p>0.05$, & W test, N=12, Z=-1.04, $p>0.05$) as well as for the Block Recall span (W test, N=12, Z=-1.633, $p>0.05$).

IV. DISCUSSION

This study aimed to shed light in Greek dyslexic's performance in a series of phoneme awareness and literacy tests, as well as in the Working Memory Battery Test for Children. With regard to phoneme awareness and decoding ability, dyslexics profile is well documented in the literature and results of the present study fits well with current theories. Subjects of the present study were attainting Grade 6 and 8 at the time tested, their performance, however, on the phoneme blending and the phoneme discrimination tests, lagged behind at least three and a half years. On the other hand subject's performance on the word completion and the grapheme identification tasks were affected to a lesser extend. Dyslexic's superior performance on the word completion tasks, compared to the phoneme discrimination tasks, could be explained in terms of the categorical perception strategy. This strategy enables dyslexics to recover speech signal within speech boundaries but not in-between boundaries. The acoustic material of the word completion consists mainly by words with a missing consonant at the beginning of an intermediate CV syllable. The phoneme discrimination task on the other hand, consists of 32 nonword pairs which require acoustic discrimination of items differentiated by one consonant. Consonant pairs differ in voicing, they are either voiced or voiceless (e.g. /r/ & /l/, /h/& /□/), or are allophones of the same consonant (/t/ & /□/ or even consonants which differ in place of articulation / p/ & /t/. This type of acoustic features resembles more to the typical material used to assess the auditory processing deficit in dyslexics. Recently, Pino Magan and Écalle [24]. suggested that poor perception of phonological information may explain degraded phoneme representation in dyslexics' memory, which affects directly Grapheme-phoneme correspondence, a key process in the acquisition of literacy skills [25]. This is in line with the specific auditory processing deficit [26]. The latter is defined as a deficit in discriminating and categorising sounds differentiated by an acoustic feature such as the /ba/ and /da/

syllables. In the present study the phoneme discrimination task can be considered as an alternative version of the material used to test the Auditory Processing Deficit.

More over, the phoneme blending and the word completion tasks have been used to assess phoneme awareness in the Greek and the English language [27, 28, 29]. Validation of the latter task comes from a longitudinal study [30], which demonstrated a correlation of word completion and orthographic processing. Subjects' profile on these two test underlings an inferior phoneme awareness ability, which is persistent over time. Previous research in Grade 4 [13] and Grade 6 [11] Greek dyslexic children, as well as, in 11-12 year English speaking dyslexic children [31], and adolescences [32], revealed a similar profile. Dyslexics' poor phonemic manipulation skills were found commensurate to their spelling and reading ability, as those described in the present study.

Grapheme-phoneme correspondence, as assessed by nonword reading and spelling tasks, showed a considerable deficit in subjects' ability to process unfamiliar written patterns. Children made twice as many phonological implausible errors in nonword writing and reading time of nonwords was one standard deviation below word reading time. Moreover, children's increasing exposure to a variety of written material, such as found in school text books and essay writing, proved beneficial to them only with regard to word processing. There was a considerable decrement in the number of phonological implausible errors and a slight decrement in the grammatical errors and the word reading time, which failed to reach statistical significance. This could be explained by the self-teaching hypothesis which refers to dyslexics' ability to develop a sight vocabulary in order to compensate to deteriorate phonological processing abilities [33].

With regard to dyslexics' performance on the WMTB-C, subjects, on phase 1, have developed to a greater extent the ability to maintain visual information (Mazes Memory Span M= 5.08, S.D.=0.99, Block Recall Span: M=4.42, S.D. 0.79), compared to phonological information (Digit Span: M=3.92, SD=0.8, Word Recall Span: M=3.75, S.D.=0.75, Nonword Span: M=3.02, SD=0.58), or to the ability to process of a concurrent task while maintaining phonological information. These results are commensurate to those reported by Cathercole and Pickering, (2001) with regard to English dyslexics' profile on the development of the WM Span. On phase 2, there was an advantage on phonological loop development over the development of both the visuospatial sketchpad and the central executive. What is of interest is that the latter two components seem to have reached a peak on the time of phase 2 testing, contrary to U.K. general population standards, according to which the visuolspatial skethpad span reaches a peek at the age of fifteen [14]. Moreover, the mazes memory span (M=5.83, S.D.=0.84) is developed to a greater extend than the block recall span (M=4.38, S.D.=0.39) which implies uneven development and, possibly, allocation of different W.M. resources when subjects perform these tasks [14]. It is not clear, however, the status of these resources and to degree that are implicated in word orthographic processing. It may be hypothesized that development of the mazes memory span affects word orthographic processing, with respect to different representation of the /i/, /e/ and /o/ phonemes, which is actually the main source of difficulties in Greek orthography, see table 2.1. for a comparison of Greek Dyslexics' and English normally developing children's performance as reported previously by Gathercole, Pickering, Ambridge, and Wearing, [19].

Uneven development was also observed to tasks that tag the phonological loop. This is getting sharper in phase 2, with dyslexics' span profile to be reduced by one, when it comes to word recall, and by almost two, when it comes to nonword recall, compared to digit recall span. This can be attributed to the material used in these tasks. Digits came from a string pool, and subjects are capable to deploy a range of strategies such as grouping digits to a larger number and subsequently visualising it, or integrating it with information from long term memory. On the other hand, the word recall task was comprised by high frequently and concrete, disyllabic words. These words are a minority with respect to the vocabulary Greek students come up with in school text books and in every day life. Unfortunately, the Greek Language Thesaurus does not provide information about the frequency of disyllabic words compared to tri-syllabic or polysyllabic words which comprise the Greek Vocabulary.

The Central executive on the other hand, is the only component which does not exhibited development between phase 1 and 2. Subjects of the present study are able to maintain less than four pieces of information while performing the Counting Recall and the Backward Digit Recall tasks. These spans are underdeveloped with respect

TABLE III. DYSLEXICS' PERFORMANCE ON THE WORKING MEMORY TEST BATTERY FOR CHILDREN

WORKING MEMORY TEST BATTERY FOR CHILDREN														
	Digit Recall		***Word List Recall***		***NonWord List recall***		***Block Reacll Table***		***Mazes Memory***		***Backward Digit***		***Counting Recall***	
	Row Score	Span	Row Score	Span	Row Score	Span	Row Score	Span	Row Score	Span	Row Score	Span	Row Score	Span
Phase1														
Mean	25.5	3.92	22.83	3.75	17.3	3.02	27.42	4.42	27.83	5.08	17.83	3.58	24.25	3.83
S.D	4.85	0.8	3.62	0.75	2.83	0.58	3.93	0.79	5.86	0.99	4.65	0.9	3.16	0.58

WORKING MEMORY TEST BATTERY FOR CHILDREN														
	Digit Recall		***Word List Recall***		***NonWord List recall***		***Block Reacll Table***		***Mazes Memory***		***Backward Digit***		***Counting Recall***	
Phase 2														
Mean	31.2	5.25	25.5	4.17	21.05	3.5	29.08	4.38	29.92	5.83	17.25	3.67	23.67	3.92
S.D	4.2	0.75	3	0.57	4.03	0.79	2.43	0.39	5.6	0.84	2.38	0.49	3.94	0.67

to those that tag the phonological loop and the visuospatial sketchpad, a profile that fits well to reading disable students [20]. Overall, the reported data demonstrate uneven development of WM components and degrade speech perception which becomes more prominent after the age of eleven. It can be hypothesized that dyslexics failed to improve on a series of reading and spelling measurements due to the limitations they experience on WM, speech perception and phoneme awareness. Unfortunately, this hypothesis can not be tested directly, as the limited number of subjects constrained further statistical analysis. This profile though, is well documented in languages with different orthographic opacity, such as English and German. Moreover, the Phonological Deficit Hypothesis (P.D.H.) postulates that, dyslexics' poor reading and spelling ability results from an imperfect representation of phonological information in long term-memory [34]. A number of studies described dyslexics as exhibiting poor performance in a range of phonological awareness tasks, as well as in storing information in Short –term memory and retrieving information from long term memory [1].

REFERENCES

[1] M. Wolf and P. C. Bowers, (1999). "The "Double-Deficit Hypothesis" for the developmental dyslexias", *Journal of Educational Psychology*, vol.91 (3), Sep 1999, 415-438 doi: 10.1037/0022-0663.91.3.415

[2] H.W. Catts, and A.G. Cahmi, "Defining reading disabilities" in Language and Reading disabilities, H.W. Catts & A.G. Camhi, Eds. (2nd ed).,2005, pp50-71 Boston, Pearson pp.

[3] J. P Rack, M. J Snowling and R. K. Olson, "The nonword reading deficit in developmental dyslexia: A review" *Reading Research Quarterly, vol* 27 (1), January 1992 pp28-53.

[4] F.R. Vellutino, J.M. Fletcher, M.J. Snowling, and D.M. Scanlon, "Specific reading disability (dyslexia): What have we learned in the past four decades? ", *Journal of Child Psychology*

[5] *and Psychiatry, vol 45(1)*, Jan2004, pp.2-40. doi: 10.1046/j.0021-9630.2003.00305.x

[6] M. Bruck and R. Treiman, "Phonological awareness and spelling in normal children and dyslexics: The case of initial consonant clusters", *Journal of Experimanta lChild Psychology,* vol.50(1), Augst. 1990, pp.156-178. doi:10.1016/0022-0965(90)90037-9 |

[7] M. Bruck and G. Waters, "An analysis of spelling errors of children who differ in their reading and spelling skills", *Applied Psycholinguistics,* vol.9(1),Mar 1988, pp77-92. doi:10.1017/S0142716400000461 cambridge Journal

[8] N. Goulandris, *Dyslexia in Different Languages: Cross-linguistic Comparison*, London: Whurr Publishers, 2003.

[9] P. H. K. Seymour, M. Aro, & J. M. Erskine, "Foundation literacy acquisition in European orthographies", British Journal *of Psychology,* vol.94(2), May 2003 pp143-174. DOI: 10.1348/000712603321661859

[10] C. Porpodas, (1999). "Patterns of phonological and memory processing in beginning readers and spellers of Greek", *Journal of Learning Disabilities, vol.* 32, pp406-416.

[11] D. Nikolopoulos, N. Goulandris, C. Hulme and M. J. Snowling, "The cognitive basis of learning to read and spell in Greek: Evidence from a longitudinal study", *Journal of Experimental Child Psychology,* vol. 94(1), May 2006 pp1-17. doi:10.1016/j.jecp.2005.11.006 |

[12] A. Grammenou, (2010). "Spelling errors in the Greek Language. Can be described in terms of phonological processes? ", Proc. IALP Cong. International Association of Logopedics and Phoniatrics (IALP 2010), IALP Press, Augst. 2010, pp281-286.,

[13] T.C. Papadopoulos, G.K. Georgiou, and P. Kendou, (2009). "Investigating the Double Deficit Hypothesis in Greek: Evidence from a longitudinal study", J*ournal of Learning Disabilities, vol.*42 (6),Nov/Dec2009 pp.528-547. 10.1177/0022219409338745

[14] D. Nikolopoulos, N. Goulandris, and M. J. Snowling, "Developmental dyslexia in Greek", in *Dyslexia in Different Languages: Cross-linguistic Comparison,* N. Goulandris, Eds. London: Whurr Publishers, 2003, *pp53-67.* 2003.

[15] S.J. Pickering, and S.E. Gathercole, (2001). *The Working Memory Battery Test for Children.* London: the Psychological Corporation, 2001.

[16] A.D. Baddeley, and G. Hitch,. Working Memory, in *The psychology of learning and Motivation,* G. Bower, Eds. New York: Campridge University Press, 1974, pp.47-90.

[17] A.D. Baddeley, Working Memory, Oxford: Oxford University Press, 1986.

[18] A.D. Baddeley,"The Episodic Buffer: A New Component of Working Memory? ", *Trends in Cognitive Sciences,* vol.11(1), Nov.2000, pp 417-423. doi:10.1016/S1364-6613(00)01538-2 Science Direct

[19] T.P., Alloway, S.J., Pickering, and E. Gathercole, "Verbal and visuospatial short-term memory and working memory in children: Are they separable? ", *Child Development,* vol.77(6), Nov/Dec2006, pp1698-1716. DOI: 10.1111/j.1467-8624.2006.00968.x Wileyinterscience

[20] S.E. Gathercole, S. J. Pickering, B. Ambridge, and H. Wearing, "The structure of Working Memory from 4 to 15 years of age", *Developmental Psychology*, vol.40(2), Mar2004, pp177-190.

[21] S.E. Gathercole, T.P. Alloway, C. Willis and A.M. Adams, "Working Memory in Children with Reading Disabilities", *Journal of Experimental Child Psychology,* vol.93(3), Mar2005, pp265-281. doi:10.1016/j.jecp.2005.08.003 | ScienceDirect

[22] A.tringa. reading Ability Test ,(Τεστ αναγνωστικής ικανότητας), Athens Greek Letters, 2001.

[23] I.N. Paraskevopoulos, A. Kalantzi-Azizi, and N. Giannitsas, "Athina test for the Diagnosis of Learning Disabilities (Αθηνά τεστ δυσκολιών μάθησης) ", Greek Letters Athens: Greece, 2001.

[24] S. J. Pickering, and S.E Gathercole (2001). "*The Working Memory Battery test for Children, translation into the Greek Language by Grammenou*", London: the Psychological Corporation, 2009-2010.

[25] P. Tallal, " Auditory temporal perception, phonics and reading disabilities in children", *Brain and Language,* vol.9(2), Mar1980, pp182-198. doi:10.1016/0093-934X(80)90139-X

[26] G.K. Georgiou, M. Torpa, G. Manolitsis, H. Lyytinnen, and R. Parrilla, "Longitudinal predictors of reading and spelling across languages

varying in orthographic consistency", *Reading and Writing: An Interdisciplinary Journal, in press,* DOI: 10.1007/s11145-010-9271-x

[27] C. McBride-Chang, R. Wagner, and L. Chang, "Growth modelling of phonological awareness", *Journal of Educational Psychology, vol.* 89(4), Dec1997, pp621-630. ScienceDirect.

[28] S.A. Stahl, and B.A. Murray, "Defining phonological awareness and its relationship to early reading", *Journal of Educational Psychology*, vol.86(2), Jun1994, pp221-234 ScienceDirect.

[29] P.E. Bryant, M. McLean, L.L. Bradley and J. Crossland, "Rhyme and Alliteration, Phoneme Detection, and Learning to Read. *Developmental Psychology*", *vol.*26(3), May1990, pp.429-438. Doi: 10.1037/0012-

[30] B. Dodd, N. Sprainger and M. Oerlemans, "The phonological skills of spelling disordered children", *Reading and Writing: An Interdisciplinary Journal,* vol.1(4), Dec1989, pp333-355. DOI: 10.1007/BF00386266

[31] A. J. Fawcett and R. I. Nicolson, "Persistent deficits in motor skill of children with dyslexia", *Journal of Motor Behavior,* vol.27(3),Sept.2005,pp235-240. doi:10.1080/00222895.1995.9941713

[32] E. Cunningham, P. E Kathryn, K. E. Stanovich, and D. L. Share, "Orthographic learning during reading: examining the role of self-teaching", *Journal of Experimental Child Psychology*, vol.82(3), Jul2002, pp185–199. doi:10.1016/S0022-0965(02)00008-5

[33] D. Swan and U. Goswami, "Phonological awareness deficits in developmental dyslexia and the phonological representation hypothesis", *Journal of Experimental Child Psychology*, vol.66 (3), July1997 pp.18-41. doi:10.1016/j.jecp.2007.01.005