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POOR READERS' PROFILES AMONG GREEK STUDENTS OF ELEMENTARY SCHOOL

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Abstract: Poor readers are characterized by deficits involving word recognition, comprehension, and fluency. Recent studies are examining the performance of poor readers linked to various orthographies with various findings. Despite the special characteristics of the Greek orthography, the profile of specific strengths and weaknesses of poor readers has not been systematically examined in part due to the lack of standardized tests and formal evaluation procedures. This study presents data from a large sample of students in the elementary school (N = 587) on a series of tests assessing single words and pseudowords reading accuracy and sight reading efficiency, spelling, text comprehension, receptive and expressive vocabulary, rapid automatized naming, and non-verbal ability. Results indicated that reading difficulties were accompanied by poor performance on reading efficiency tasks in the majority of students, whereas text comprehension difficulties were much less common.

Key words: Greek orthography, Poor readers, Reading profiles.

In the last three decades research on reading produced significant findings regarding the cognitive and linguistic profiles of experienced and poor readers, the brain mechanisms involved in normal and impaired reading, and effective educational interventions. Although most studies were conducted on English speaking students from USA, Canada, UK, Australia, or New Zealand, recent investigations focusing on readers of other orthographies tend to replicate core findings (Ziegler, Perry, Ma-Wyatt, Ladner, & Schulte-Korne, 2003). Across orthographic systems disabled

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readers are characterized primarily by difficulties in word identification, reading rate, and spelling. The development of efficient lexical access, a prerequisite for rapid word identification, also appears to be lagging, in part due to limited reading experience (Oney, Peter, & Katz, 1997).

Theoretical approaches that guide current research on reading vary in the relative weight they place on different domains that define the function of reading, that is, language, sensory/motor, and speed of processing (MacCardle, Scarborough, & Catts, 2001). A starting point in these approaches is that the ultimate goal of reading is efficient recognition of individual words and rapid access to their meaning(s) facilitating text comprehension. Results from large and well-studied populations with reading disability confirm that reading failure despite proper instruction is associated with impairments in certain linguistic processing skills (Fletcher et al., 1994; Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996; Morris et al., 1998; Ramus et al., 2003; Stanovich & Siegel, 1994). The consensus presently is that the most common profile of reading disability (not accounted for by gross sensory, neurological, or severe psychiatric illness) features deficient skills that prevent efficient processing and recognition of individual printed words. Some of these skills determine sensitivity to individual phonemes in the speech stream and the ability to utilize awareness of the phonemic structure of words necessary for applying the alphabetic principle to learn to read (Schatschneider & Torgesen, 2004). Knowledge of letter-phoneme correspondences and online application of efficient decoding strategies enables readers, after extensive practice, to form a mental lexicon of printed word representations (Schatschneider & Torgesen, 2004). The ability to retrieve these representations in an effortless and automated manner ensures rapid word recognition and accurate spelling.

It should be noted that accurate but laborious decoding of individual words is not sufficient to support fluent reading in the more advanced elementary grades. This type of reading is typically associated with reduced motivation to engage in recreational reading while limited reading practice and restricted experience with print is further associated with poorly developed vocabulary and reading comprehension difficulties (Cunningham & Stanovich, 1998). Accordingly, weaknesses in word decoding not only delay reading but also hinder the formation of orthographic representation of words in memory (Schatschneider & Torgesen, 2004). This is manifested through impaired spelling and very slow reading speed that is seen among the disabled readers (see Table 1).

Table 1. Processes associated with normal and impaired reading

Cognitive/linguistic domains	Related skills	Performance indicators
Phonological and orthographic processing	Phoneme awareness	Phoneme blending, segmentation, etc.
	Decoding skills (sublexical processing)	Pseudoword reading
	Orthographic skills (lexical access)	Sight word reading or irregular word reading
		Spelling of regular and irregular words
General processing speed	Rapid automatic naming	Letter, digit and object naming speed
		Timed word and pseudoword reading
Language comprehension	Listening comprehension skills	Answering questions referring to orally presented material
	Reading comprehension skills	Answering questions referring to text read
	Vocabulary	Receptive and expressive vocabulary

It should be also noted that current definitions of specific reading disability (dyslexia) focus on word level reading skills even though the ultimate goal of reading is to extract and construct meaning from written text. Consistent comparisons between novice and disabled readers indicate that facility in word identification (accuracy and automaticity) is a much stronger predictor of reading comprehension than spoken language comprehension (Vellutino, Fletcher, Snowling, & Scanlon, 2004). According to this notion, inaccurate processing of word meanings hinders the understanding of written language and only timely and effortless execution of lower level processes would allow immediate dispatching of higher thinking processes. In older and more mature readers, language skills, vocabulary size, and wealth of reading experiences, appear to be stronger determinants of reading comprehension than word level skills (Torgesen, 2000).

Identification of reading disabled students

In most English-speaking countries, the identification of children with reading disability (RD) has been limited to those measures that can provide evidence of a discrepancy between the child's aptitude and achievement (IQ and reading achievement tests, respectively). This approach has emerged from the definition of learning disability (LD) by Samuel Kirk in the early 1960s that described LD children as students who fail in school despite their average intelligence (see Cone & Wilson, 1981). Since Kirk's description, the need emerged to identify LD children with valid and reliable criteria that could be used at a federal level (in the USA) to ensure provision of special

services to this population (for an alternative see Speece & Case, 2001). Accordingly, only children with reading achievement scores lower than those predicted by their IQ scores, were identified as dyslexic. Other poor readers who do not meet the discrepancy criterion were not considered reading disabled (dyslexic), and consequently failed to qualify for additional instructional support in reading at their schools.

The discrepancy criterion, despite the fact that it provided a good means for quantifying underachievement, it implied categorical differences among the low achievers (Stuebing et al., 2002). This hypothesis has been empirically tested extensively in the recent years with results that failed to validate the distinction at the prognostic (Share, McGee, & Silva, 1989), intervention (Aaron, 1997; Hatcher & Hulme, 1999; Wise, Ring, & Olson, 1999), and neurobiological level (Pennington, Gilger, Olson, & DeFries, 1992; Wadsworth, Olson, Pennington, & DeFries, 2000). Moreover, the assumption that poor readers who meet the discrepancy criterion differ from other poor readers who do not meet this criterion, has also failed to find empirical support. For instance, longitudinal data reported by Vellutino, Scanlon, and Lyon (2000) failed to show that intelligence distinguishes between impaired and normal readers or between remediated readers following different intervention efforts. According to them: «when intensive remedial resources are made available to impaired readers representing a broad range on the intellectual continuum, response to remediation is not associated with measured intelligence» (p. 228).

To improve the accuracy in estimating the discrepancy between intelligence and achievement a variety of methods have been used (deviation from grade level performance, expectancy formulas, simple standard score differences, and standard regression analyses). The description of the statistical limitations for each one of these methods is beyond the scope of this discussion and it has been described extensively elsewhere (Berninger & Abbott, 1994) leaving no doubts for the problems associated with them. Over the years limitations of the discrepancy approach have become very prominent in research and in clinical and educational practice while the use of IQ scores for the identification of LD students has been widely criticized (Francis et al., 2005).

Siegel (1989) from very early questioned the validity of the discrepancy model and offered evidence for a bidirectional relationship between IQ and achievement, as intelligence seems to limit school achievement and vice versa. She suggested that for diagnostic purposes «a pseudoword reading test

constitutes the most accurate test of a reading disability ... and word recognition tests are the next best alternative» (Siegel, 1989, p. 476). Stanovich (1991, 1993) has proposed an alternative scheme for identification of reading-disabled students based on their performance on word identification and listening comprehension tasks. This approach focuses on the discrepancy between reading achievement scores and scores on listening comprehension tests and it is justified by evidence showing that listening comprehension correlates strongly with reading comprehension (more than full scale and verbal IQ scores) (Stanovich, 1991). Moreover, the processes tapped by comprehension tasks bear stronger relation to education since children who do not understand written material equally well as when it had been read to them, obviously need help to overcome the difficulties posed by their poor word identification skills (Stanovich, 1991, 1993).

Another approach that is lately gaining increasing support as alternative to the discrepancy-based classification of students with learning disability and students with reading disability is the "treatment-validity" model or "responsiveness to intervention" (RTI). According to this view, less attention is given to underlying causes or neuro-biological correlates of the learning disability in order to focus on extrinsic factors such as the quality of provided instruction and the child's response (Speece et al., 2003). In other words, «students who do not respond to well-designed and implemented instruction in general education classrooms may be considered at risk for reading disability» (Speece & Shekitka, 2002, p. 121).

In this model, curriculum-based measures are utilized for detecting students with learning difficulties as indicated by their lower level of performance and speed. This strategy is helpful to differentiate between experiential and cognitive type deficits as they are manifested through the child's interaction with high quality, systematic and reckonable reading instruction (Vellutino et al., 1996). According to Fuchs, Fuchs, and Speece (2002) the RTI approach overcomes IQ-achievement discrepancy problems, minimizes false negative identification rate at a given point in time, while focusing on the learning growth of the students rather than on performance. However, we should also note that RTI is not simple in its application and it has serious implications and increased requirements for planning curriculum and instruction. It also poses heavier demands on educators who are required to apply rigorous monitoring procedures in their teaching (Mellard, 2003).

In a recent survey of definition criteria for learning disabled students

among 218 editorial board members of four journals on learning disabilities and reading, the majority of experts stated clearly that (a) reading achievement, (b) phonemic awareness, and (c) treatment validity should be featured. Moreover, most experts agreed that IQ-achievement discrepancies should not be included in the definition of reading disabilities (Speece & Shekitka, 2002), opting for an assessment approach that is based on language skills, reading achievement, or both. At the same time the issue of the effect that a reader's orthography has upon the developing or impaired reading abilities has been examined carefully because of its implications on RD identification. This issue has led many to search for potential differences among the dyslexic populations in different orthographies with interesting findings.

Reading disability and orthography

Research on the potential impact of orthographic transparency (namely the consistency of spelling to sound correspondences characteristic of a particular writing system) upon the development of reading skills may have theoretical implications leading to a better understanding of the reading process itself. Along these lines, several recent investigations have focused on studying reading in languages that vary widely on levels of orthographic transparency (i.e., Finnish, Spanish, Portuguese, Italian, Greek, Turkish, French, Welsh, and German). Finnish is considered as one of the most "transparent" (or "shallow") and English as one of the most "opaque" (or "deep") orthographies (featuring very low consistency in phoneme to grapheme associations). Findings suggest that more transparent orthographies facilitate earlier development and more efficient use of sublexical processes for reading such as the processes that utilize involvement of the phonological processor and serial recoding of graphemic input to their phonemic counterparts in order to synthesize the written word in its oral equivalent. It appears that novice readers acquire reading in a more effortless and timely manner in orthographies with a higher degree of consistency among grapheme-phoneme correspondences (Seymour, Aro, & Erskine, 2003).

However, important questions regarding the effect that orthographic transparency has upon disabled readers have not been answered conclusively. Early findings indicate that transparency may mask the appearance of disabled reading by permitting a higher degree of decoding accuracy, as readers may rely to a greater extent on serial decoding strategies for word iden-

tification (Botsas & Padeliadu, 2003). Also, in many orthographically transparent European languages reading is taught through synthetic phonics-based approaches that emphasize phoneme segmentation and syllable formation through direct instruction of grapheme-phoneme correspondences and phoneme blending (Wimmer, 1993). This type of instruction may reinforce the use of the phonological route for reading and enhance serial decoding ability even for students who are at risk for developing reading disability. As postulated by Share and Stanovich (1995), systematic and successful use of sublexical processes, facilitates the registration of orthographic conventions and finally leads to fast and accurate word reading and spelling.

A recent study of literacy acquisition in 16 European countries highlighted the difficulty in learning to read English compared with other transparent orthographies (Seymour et al., 2003). Results show that more complex word-syllable patterns were associated with lower accuracy and fluency rates, while nonword decoding was slower in deeper orthographies (such as English). The authors linked delayed reading acquisition with deficient development of word level processing for reading irregular words common in deep orthographies. While sub-word ability (or sublexical processes) involving application of grapheme-phoneme correspondences can be used to read orthographically regular words, word-level processes are necessary in order to support recognition of irregular words. While both reading processes have to be used for reading in a deep orthography such as Portuguese, French, Danish, and English, a single process is capable of sustaining accurate word recognition and naming in a transparent orthography. The additional reading mechanism requires the reconstruction of the cognitive mechanisms already occupied for reading and it is initiated when a particular threshold of orthographic complexity has been encountered. Therefore, rates of learning to read are affected, explaining the later development of skillful reading in deep orthographies (Seymour et al., 2003). Other studies have noted differences in the use of sublexical processes between English speaking children and German (Goswami, Ziegler, Dalton, & Schneider, 2001), English and Welsh (Spencer & Hanley, 2003), Portuguese and Spanish (Defior, Martos, & Cary, 2002), and Turkish and English (Oney et al., 1997). Finally, it should be noted, that the close association between impaired phonological processing skills and disabled reading has been documented in both deep and transparent orthographies such as Spanish (Gonzalez & Valle, 2000; Lopez & Gonzalez, 1999), Finnish (Holopainen, Ahonen, & Lyytinen, 2001), and Greek (Porpodas, 1993).

Reading difficulties in Greek students

Characteristics of Greek reading disabled (RD) students have not been described adequately by large scale studies in part due to the lack of standardized assessment tools and identification procedures. Typically, the diagnosis of RD students is made in private or public institutions that vary widely not only on resources and personnel training but also in assessment tools and criteria used. Furthermore, normative data regarding reading achievement of impaired and non-impaired readers are scarce and they are not used extensively.

In the present study, we adopted Fletcher et al.'s (1994) proposal for identifying severely poor readers (PR) based on a single dimension (reading achievement). This notion is based on both educational and empirical grounds, and does not differentiate between IQ discrepant and non-discrepant poor readers and therefore does not exclude any students from remedial services. This particular approach by not implicating neurobiological factors in the identification of RD students (through definitional criteria) shifts the focus from specific etiologies to ensuring universal access to educational interventions. Children identified solely on the basis of reading achievement (usually those who score below the 25th percentile) have been found to compose a rather homogeneous group in terms of their reading and cognitive profiles (Bailey, Manis, Pedersen, & Seidenberg, 2004; Joanisse, Manis, Keating, & Seidenberg, 2000; Manis, Seidenberg, Doi, McBride-Chang, & Petersen, 1996). Specifically, phonological processing deficits are considered today to be the core deficit in most disabled readers despite some variability in individual profiles. Therefore, this approach utilizes current theory of reading disability as a language-based impairment that is manifested primarily through poor word identification skills and does not discriminate between dyslexic and other poor readers.

The plausibility of the above proposal has been examined in a large epidemiological sample by comparing estimates of developmental changes in reading from three different groups of children (discrepant, low achievement, and non-deficient). No growth differences were noted between the two groups of poor readers (discrepant and low-achievement) (Fletcher et al., 1994). More recent meta-analytic studies offer concrete evidence that IQ discrepancy-based classification of RD students has weak validity (Fuchs, Fuchs, Mathes, Lipsey, & Eaton, 2000; Hoskyn & Swanson, 2000; Stuebing et al., 2002). This dimensional definition is free of statistical limitations that

emerge with the use of different scores (i.e., measurement error, regression to the mean, correlations between ability and achievement measures), and only depends upon the decision made about the cut-off criterion. More importantly it does not exclude from intervention services students who do not meet the discrepancy criterion because of their lower IQ that can often be attributed to a disadvantaged environment that limits educational opportunities.

The present study is an initial attempt to address some of the issues mentioned above based on a comprehensive assessment of developing reading skills in a large population of Greek students. Participants were tested on a variety of reading and reading-related measures, for which there is evidence that differentiate good and poor readers in languages with both transparent and opaque orthographies. Our primary purpose was to investigate differences in reading achievement between typically performing and very poor readers and to determine if the profile of severe reading difficulty emerging from the Greek student population features any unique characteristics.

A relatively strict, but widely acceptable cut-off criterion was used to identify PR, excluding those who were suspect for mental retardation, and ensuring that students included were facing severe reading difficulties that very likely indicated reading disability. In this work, the term "reading disability" has been used interchangeably with the terms "reading impairment" and "reading disorder" and is considered, according to the evidence reviewed above, a language-based impairment that is manifested primarily through poor word identification skills. Even though current literature tends not to discriminate between dyslexic and other very poor readers, we avoid characterizing the very PR in our sample as reading disabled or dyslexic given the absence of a formal diagnosis. A secondary goal of the study was to obtain an initial estimate of the prevalence of severe reading difficulties in the Greek student population of elementary school.

METHOD

Participants

Participants were 587 students (304 girls and 283 boys) in the 2nd (n = 209), 3rd (n = 192), and 4th grades (n = 186) from 17 Greek elementary schools in Crete, Attica and the Ionian islands. All students were selected from 17 school units which were selected using a stratified randomized approach.

Based on the "area" strata, school units were representative of urban (seven schools), rural (three schools) and semi-urban areas (seven schools). Students were selected randomly from each class and only those whose parents provided written permission for participating in the study completed the assessment tasks. The students were fluent speakers of the Greek language, and to our knowledge did not suffer from any mental or emotional impairment that prohibited their participation in general education settings, as indicated by the school records. All children were tested individually in two 40-minute sessions by trained undergraduate and graduate research assistants. The data collection took place during the first three weeks of March 2005. Examiners had undergone rigorous training and were closely monitored by the study's coordinator (first author) in order to standardize administration procedures and attain high levels of inter-rater reliability.

Instruments

All students were tested on word and pseudoword reading accuracy, pseudoword and sight word reading efficiency, text comprehension, rapid automatized naming, spelling, a visual-constructive task for assessing nonverbal ability, and expressive and receptive vocabulary.

Word and pseudoword reading accuracy and text comprehension. Subtests 5, 6, and 13 of the Test of Reading Performance (TORP; Padeliadou & Sideridis, 2000; Sideridis & Padeliadu, 2000) were used to assess word and pseudoword reading accuracy and text comprehension, respectively. Pseudoword reading accuracy tasks are used as indicators of students' mastery of sublexical processes as these processes are mainly utilized in pseudoword decoding. TORP subtests 5 and 6 included lists of 40 words and 19 pseudowords, respectively, in order of ascending difficulty. Responses were scored with 0 = inaccurate item reading, 1 = phonologically correct but inaccurate use of stress, or 2 = phonologically accurate and correctly stressed response. Administration of both subtests was discontinued when students scored 0 on 6 consecutive items.

The TORP subtest 13 evaluated students' *text comprehension* skills. It included 6 passages of ascending length and text complexity that were followed by 2-4 multiple choice questions. Students were asked to read each passage aloud and then to answer all the questions following each passage. Students were allowed to look at the passages while answering the questions. The total number of questions for the 6 passages was 18 and each was scored

with 0 = inaccurate answer or 1 = accurate answer. Administration was discontinued if the student had failed to answer correctly all the questions following a passage or had severe difficulties with word reading (more than 80% reading errors in the first sentence of the passage).

Sight word and pseudoword reading efficiency. These tests were designed to assess efficiency of automatic recognition of high frequency words and speeded pseudoword decoding according to another well known standardized test as is the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999). The original TOWRE contains two subtests: (a) the Sight Word Efficiency (SWE) subtest assesses the number of real printed words that can be accurately identified within 45 seconds, and (b) the Phonetic Decoding Efficiency (PDE) subtest measures the number of pronounceable printed nonwords that can be accurately decoded within 45 seconds (Torgesen et al., 1999). In our Greek version, two cards that included a word list each (Card A = high frequency words, Card B = pseudowords) were constructed. High frequency words were initially selected on the basis of frequency of appearance within a corpus of approximately thirty four million lexical units compiled from a wide selection of texts (mainly popular Greek books published after 1990 and daily newspapers). This corpus is available through the Institute of Language and Speech Processing (ILSP) as Hellenic National Corpus (Εθνικός Θησαυρός Ελληνικής Γλώσσας: retrievable at http://hnc.ilsp.gr/info.htm). All 112 tokens in the word list were among the one thousand most frequent words in the corpus. To further ensure that a sufficient number of words that are visually familiar to the youngest students in the study have been included, approximately 30 high frequency words among those appearing in the basic vocabulary selection of the second grade reading textbook were purposefully included in the list (Card A). Pseudowords were constructed by altering one or two letters in 70 words matched on mean frequency of appearance with those included in the word list (Card A), maintaining some of the phonological and/or morphological characteristics of the original (high frequency) word. (i.e., σλέμμα [slema] vs. βλέμμα [vlema]).

Stimuli words on each list were arranged in four vertical columns (approximately 33 words each) of ascending order of word length. Each student was instructed to read each word as fast as possible without making errors starting from the top of each column and moving to the bottom for 45 seconds. For Card A students were also instructed not to attempt to decode, but to skip words that they did not immediately identify. Students received

one point for each item that they accurately read (phonological decoding and stress).

Spelling. Single-word spelling ability was assessed using a list of 60 words selected from the basic vocabulary selection in reading textbooks used in Grades 1-6. Selection of words ensured representation of key instructional units of grammar and spelling rules taught in each grade (i.e., verb past tense, noun clauses, etc.) and were arranged in ascending order of difficulty based on their grade level appearance and the learning objectives set for word spelling in the national curriculum. Teacher ratings were also used to provide an estimate of their spelling difficulty. During administration the examiner first pronounced each word in isolation and then in context to demonstrate its use. After repeating the word in isolation for a second time, the examiner asked the student to write the word on a numbered form corresponding to each word. Each word was scored with 1 point for accurate spelling. Stress errors or omissions were not scored due to the high frequency of occurrence. The spelling task was discontinued when students scored 0 on 6 consecutive items (6 misspelled words).

Rapid automatized naming. Rapid automatized naming is generally assessed through the administration of Denckla and Rudel's (1976) Rapid Automatized Naming test for letters (RAN-Letters) or numbers (RAN-Digits). This particular task is used to assess the rate at which a verbal label is produced when the individual is asked to name high-frequency visual stimuli. The letters used in the original tasks are high frequency lowercase letters (i.e., a, d, o, s, p) repeated 10 times in random sequences. The child is asked to name each letter or number as quickly as possible. The task assesses the rate at which a verbal label for high-frequency visual stimuli is produced. When an individual is significantly slower than average to name all the stimuli presented is considered to have a naming speed deficit (Vukovic & Siegel, 2006). Test-retest reliability estimates of .77 from Grade 1 to Grade 2 have been obtained in previous studies that used card administration procedures as in this study (Wolf, Bally, & Morris, 1986). We used a RAN digit-task because of the naming differences for Greek letters observed among students (letter names or letter sounds) that they could potentially affect time measurements. Ten random sequences of 5 digits (1, 2, 5, 7, 9) were included in large font on a single card and students were instructed to name each item as fast as they could without omitting any. The total time (in seconds) to name the entire set of 50 items was measured.

Receptive vocabulary. In order to assess students' receptive vocabulary

skills a Greek adaptation of the Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn, 1981) was used. The original PPVT-R is a widely used receptive vocabulary test for ages 5 to adult with well established and highly valued psychometric properties. For the Greek adaptation we used the original picture templates but we altered either the order of appearance of some item/words or the items/target words in some templates. These changes were made mainly to address differences in the difficulty that certain words pose in each language. The new item order was based on pilot data from 35 children who were tested with the original stimulus order. In this task, each student was asked to identify one picture out of 4 that best represented the word given by the examiner. Scoring is 0 or 1. Test items/words were arranged in ascending order of difficulty and were administered from an age-appropriate starting point forward. When the student failed to respond correctly to the initial age-appropriate items, new items were administered in backward order (from the age-appropriate to less difficult) until a base of 6 correct answers was established. Once the base of 6 correct responses had been established students then received credit for all lower difficulty items. The test was discontinued when students gave 8 incorrect answers within 10 consecutive items.

Expressive vocabulary. In order to assess students' expressive vocabulary the Vocabulary subtest from the Greek version of Wechsler Intelligence Scales for Children III (WISC-III) was used (Γεώργας, Παρασκευόπουλος, Μπεζεβέγκης, & Γιαννίτσας, 1997). This subtest along with the Greek adaptation of PPVT-R served as indicators of students' (expressive and receptive) verbal skills. The vocabulary subtest includes 30 word items that are given to students for definition and they are scored with 2, 1, or 0 points each depending on the word level of understanding and richness of expression. The subtest was discontinued after 4 consecutive responses of 0. Student answers were recorded verbatim on test protocols and were rescored by the study coordinator and a small team of examiners in order to ensure consistency in scoring criteria. Only the final (corrected) scores were used in the analyses.

Block design. In order to assess students' visual-constructive skills and also general non-verbal abilities the Block Design subtest from the Greek version of WISC-III was used (Γεώργας et al., 1997). This subtest includes 12 designs that students are asked to re-create using a specified number of two-colored blocks (4-9) within a time limit. The subtest is discontinued after 2 consecutive failures. Student attempts are scored for the accuracy and speed

of reproduction. Combined standard scores for the Vocabulary and Block design subtests were used to provide an estimate of Full Scale IQ (Sattler, 1982).

Composite Reading Index. Children were identified as very poor readers (PR) if they scored at or below the 10th percentile ($z < -1.3$) on the Composite Reading Index of standard grade-corrected scores on the word and pseudoword reading accuracy subtests of TORP. Children scoring above the mean of the respective subtests comprised the non-reading impaired group. A conservative cut-off score (corresponding to the 10th percentile) was chosen to avoid student over-identification and to keep false positive errors low, ensuring that children in the PR group were experiencing sufficiently severe difficulties in learning to read, and excluded children who simply scored in the low average range.

RESULTS

The final sample consisted of 558 children after excluding those with estimated total IQ < 80 (corresponding to a combined standard score of 6 points for the Vocabulary and Block Design WISC-III subscales). The sample of PR included 35 children with Composite Reading Index standard scores below -1.3 (that is, children with poor word and pseudoword reading accuracy performance). Twenty one children were boys (7.8% of the final sample) and 14 girls (4.9%) representing a substantial but nonsignificant difference. Nine PR children were 2nd graders, 11 were attending the 3rd grade, and 15 the 4th grade. Combined mean standard scores on the Vocabulary and Block Design subtests of the WISC-III were 8.2 ± 1.8 for the PR group and 9.67 ± 2.3 for non-impaired (NI) readers ($n = 523$), which correspond to Full Scale mean IQ scores of 91 ($z = -.6$) and 98.5 ($z = -.01$), respectively. The difference between the PR and NI groups was significant, $F(1, 546) = 12.26, p < .001$, and the slightly lower performance of PR children on IQ measures is within the range reported previously by several studies (Vellutino, Scanlon, & Lyon, 2000; Vellutino et al., 1996) and it does not invalidate their inclusion in the PR group. There were no significant gender or grade effects on the combined WISC-III subtest scores.

The first set of analyses examined whether students who were significantly impaired in basic reading skills measured by non-timed word and pseudoword reading tasks were also impaired on a number of other skills

Table 2. Mean standard scores (and SD) for the Poor Readers (PR) group (n = 35) and Non-Impaired (NI) group (n = 310) across all measures

	PR group	NI group	$F(1, 329)$*	η^2
Spelling	-1.40 (.77)	.47 (.82)	164.29**	.33
Sight word reading efficiency	-1.35 (.37)	.37 (.90)	109.09**	.24
Pseudoword reading efficiency	-1.20 (.87)	.33 (.92)	89.29**	.21
Rapid automatized naming	.89 (.84)	-.20 (1.00)	36.62**	.10
TORP-13	-.74 (.95)	.24 (.84)	35.33**	.09
PPVT	-.57 (1.20)	.25 (.81)	20.83**	.06
WISC-III Vocabulary	8.08 (2.50)	10.20 (2.70)	14.27**	.04

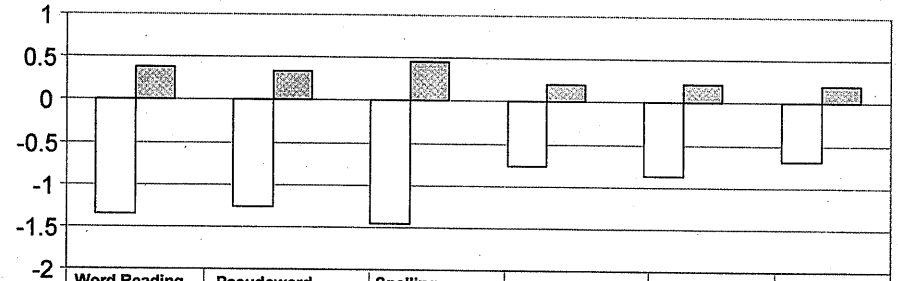
Note. *Standard score on WISC-III Block Design was used as a covariate. **$p < .0001$. PR group = students with standard score of -1.3 or less on word (TORP subtest 5) and pseudoword reading accuracy tests (TORP subtest 6) combined (Composite Reading Index). NI group = students with greater than average scores on the Composite Reading Index.

which are either directly related (e.g., reading speed, spelling, and text comprehension) or indirectly related to reading (i.e., expressive and receptive vocabulary). To ensure that the control group included children with at least average performance on reading accuracy measures, non-reading impaired children in all subsequent analyses were defined as those scoring above the total sample mean on the Composite Reading Index (n = 310, 165 girls and 145 boys).

Mean Reading Composite Index standard scores were -2.0 ± .7 (-2.3 ± 1.2 on word and -1.6 ± .44 on pseudoword reading) for the PR group and .6 ± .3 for the NI group (.52 ± .29, and .75 ± .53, respectively). There were statistically significant Group main effects on all measures which were independent of performance on WISC-III Block Design (see Table 2).

As shown in Figure 1, differences in excess of 1.5 standard deviations, which can be considered as clinically significant, were found on spelling, sight word and pseudoword reading efficiency, indicating severe deficits in the rate of decoding and printed word recognition as well as in the effective maintenance of accurate orthographic representations.

Next, we compared PR and NI groups on three latent constructs defined by multiple indicators. These latent variables were: (a) spelling (with four indicators, namely subtotal scores for words of small, medium, large and very large length), (b) reading efficiency (performance on the pseudoword and two sight word reading efficiency lists), (c) text comprehension (indicated by number of correct answers to the comprehension questions of each of three pairs of passages of TORP subtest 13, representing passages of low,



	Word Reading Efficiency	Pseudoword Reading Efficiency	Spelling	TORP subtest 13	RAN	PPVT
PR	-1.349	-1.254	-1.456	-0.768	-0.865	-0.693
NI	0.376	0.342	0.456	0.194	0.21	0.199

Figure 1. Mean differences between the PR group (n = 35) and NI group (n = 310) on all measures.

Note. RAN: Rapid Automatized Naming; PPVT: Peabody Picture Vocabulary Test.

medium, and high difficulty). The null hypothesis tested was that the intercepts of the latent variables are invariant across groups (indicating lack of group differences) by employing a latent means analysis. The added benefit of this analysis is that between-group mean comparisons are based on the latent constructs, which are defined by multiple indicators (in our case, items of varying difficulty). Group membership (PR group and NI group) comprised a dummy variable with 0 defining the group with deficits in reading accuracy and 1 the group of students who were above the mean ($z > 0$) in reading accuracy (based on the Composite Reading Index). The analysis was run with EQS 5.7b (Bentler, 1998) and all variables were standardized prior to the analysis in order to adjust for the unequal number of indicators per construct. Fit indices above .90, significance of b-weights linking indicators to latent variables, and root mean squared error of approximation below .05 were the criteria for determining acceptable model fit (Hu & Bentler, 1995, 1998a, 1998b).

Results indicated that there were significant differences between the two groups across all three latent variables (see Figure 2). Students with deficits in reading accuracy had significantly lower scores on spelling, comprehension, and reading efficiency. Model fit was acceptable given experts' recommendations, $\chi^2(30) = 160.884, p < .001$, CFI = .956, NNFI = .935, IFI = .957, SRMR = .035 (Jaccard & Wan, 1996). All indicators defined their respective latent variables with factor loadings ranging between .73 and .99

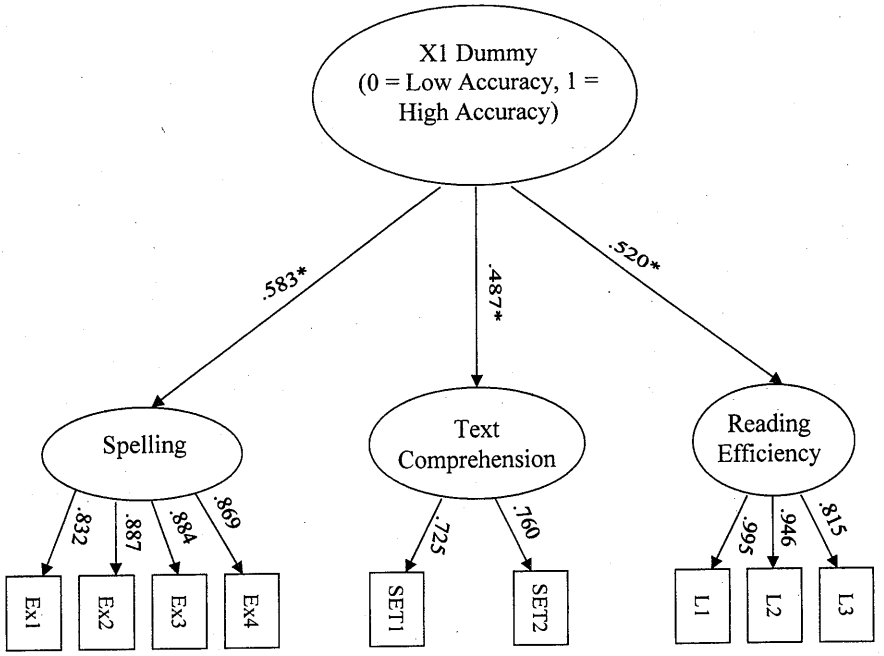


Figure 2. Latent variable means model comparing PR group students with NI group students across spelling, comprehension, and reading efficiency.

Note: PR group = Poor readers: students with standard score of -1.3 or less on word and pseudoword reading accuracy tests combined (Composite Reading Index). NI group = Non-impaired: students with greater than average scores on the Composite Reading Index.
The paths linking the dummy variable to each latent factor are standardized and can be discussed in standard deviation units. Paths that are significant at $p < .05$ are indicated by asterisks. Ex1 to Ex4 in spelling indicates word group based on small, medium, large and very large length (derived from the Spelling task). Comprehension exercises are two clusters of 3 texts (from TORP subtest 13) each representing lower level and higher level of that construct. Reading Efficiency was defined by two lists of words and one list of pseudowords (Word and Pseudoword Reading Efficiency tasks, respectively).

and were significant at $p < .01$. Because variables were standardized prior to the analyses, the effects of the Dummy variable can be interpreted as differences between groups in standard deviation units. Thus, students with deficits in accuracy were .58 *SD* units below the comparison group on spelling, .49 *SD* units below on comprehension, and .52 *SD* units below on fluency. These findings suggest that students with deficits in word reading accuracy "carry" with them deficits in spelling, text comprehension, and reading efficiency as well.

Table 3. Concordance between reading accuracy performance and sight word reading efficiency, and text comprehension as a function of group*

Performance		PR group	NI group
Poor	Sight word reading efficiency	89%	4%
	TORP-13	64%	10%
Good	Sight word reading efficiency	11%	96%
	TORP-13	36%	90%

Note. PR group = Poor readers: students with standard score of -1.3 or less on word and pseudoword reading accuracy tests combined (Composite Reading Index). NI group = Non-impaired: students with greater than average scores on the Composite Reading Index. * Based on the Composite Reading Index of Word (TORP subtest 5) and Pseudoword (TORP subtest 6) Reading Tests.

Finally, we examined the concordance between accuracy-based measures of reading ability (TORP subtests 5 and 6) and two other measures, namely sight-word reading efficiency (primarily a rate-based measure) and text comprehension. The same criteria were used across the board (a *z* score below -1.3 indicating significant impairment and a *z* score > 0 above sample average, non-impaired performance). In Table 3 word and pseudoword reading accuracy serves as the criterion classification measure. Overall, the concordance between word and pseudoword reading accuracy (TORP subtests 5 and 6) and a rate measure of reading (word reading efficiency test) was higher than the concordance between word and pseudoword reading accuracy and text comprehension measures. While the vast majority of poor readers (defined by reading accuracy measures) (89%) showed concomitant severe deficits in sight word reading efficiency, only 64% showed severe text comprehension deficits. Conversely, only 4% and 10% of children who scored above average for their grade on reading accuracy measures scored in the impaired range on sight word reading efficiency and text comprehension tests, respectively. It seems that students with poor decoding skills are also not efficient in recognizing high frequency words and they often have reading comprehension problems. In opposition, word reading accuracy skill by itself, is not sufficient in ensuring adequate text comprehension.

The proportion of students who were impaired on single-word type reading tasks which measure primarily accuracy, speed, or both was examined next. Children who had a z score below -1.3 on both the Composite Reading index and the word and pseudoword reading efficiency tests combined, were considered as both accuracy and rate impaired. The overall incidence of this profile in the final sample of 558 children with estimated

Full-Scale IQ scores > 80 was only 3% (4.1% among boys and 2.1% among girls). The distribution of these students was uniform across grades (3, 2.7, and 3.5% in the 2nd, 3rd, and 4th grade, respectively). As expected, the proportion of students with very low performance on either accuracy or reading rate measures was considerably higher (10.8%: 12% among boys and 10% among girls), with similar distributions across grades (9.5, 10.3, and 12.7%, respectively). The proportion of children with very low performance on either word- or text-level tests was even higher. The overall proportion of children with $z < -1.3$ on either the composite reading accuracy index and the reading efficiency index, or the text comprehension subtest of TORP was 18.3% (21.5% for boys and 15% for girls, $p < .037$).

DISCUSSION

Currently, there is growing consensus that reading achievement (Fletcher et al., 1994, 1998), general and more specialized language skills (vocabulary, ability to extract meaning from syntactically complex spoken utterances and phonemic awareness) (Stanovich, 1991, 1993), and response to treatment (Fuchs, Mock, Morgan, & Young, 2003; Speece et al., 2003; Vellutino et al., 1996) should be taken into account in the definition of reading problems.

In the Greek educational system the variety and lack of standardization of diagnostic procedures for learning disabilities has prevented consensus on a skill-based definition of RD students. In addition, the behavioral manifestations of the disability usually feature a variety of psychological, cognitive, and educational characteristics, which are difficult to quantify. As it is observed in other shallow orthographies disabled reading is often masked by the relatively fair performance on reading accuracy tests and it may not be adequately assessed by well established criteria set for readers of the English language. This phenomenon is only exaggerated by parental pressure on specialists for obtaining a formal diagnosis in order to receive special accommodations in the national testing system required for entry to higher education institutions. Under these circumstances both false positive (i.e., overidentification) and false negative (i.e., underidentification) diagnostic errors are expected to be fairly high, the latter depriving students of much needed remedial services (Francis et al., 2005). Only recently, there have been significant advances toward the development of national norm-referenced tests (i.e., TORP and Athena tests). However, the need of a detailed

description of the profile characteristics of Greek RD students remains pressing, given the scarcity of large-scale studies.

The present study examined the psychometric profile of Greek poor readers by adapting the identification scheme proposed by Fletcher et al. (1994, 1998) that is based solely on reading achievement. Our decision was based not only on difficulties inherent to educational research and practice in Greece (i.e., lack of widely used standardized assessments and measurable teaching practices that could lead to "treatment-validity" type of identification approach) but also on the strong theoretical and empirical support this approach has received (Lyon, Fletcher, & Barnes, 2002). For the purposes of the present study, children were identified as very poor readers if they scored below the 10th percentile ($z < -1.3$) on a reading composite score (average of standard scores on the word and pseudoword reading accuracy subtests of TORP) (Padeliadou & Sideridis, 2000). The cut-off criterion was set purposefully lower than the suggested criteria used in other studies (typically at the 25th percentile) to avoid student over-identification and to keep false positive errors low. This classification scheme ensured that children in the PR group experienced sufficiently severe difficulties in learning to read and excluded "garden variety" poor readers who simply scored in the low to average range. Although students in the PR group are most likely facing a disability in reading, we did not use the term because in a research study of this scale the evidence regarding environmental and educational support is very limited and may bias such claims.

The prevalence of poor readers in the general school population of early and middle elementary grades is similar to the rates described in similar studies from English speaking countries. For instance, in a recent report by the Interagency Committee on Learning Disabilities based on epidemiological studies and on the number of school age children receiving special education services for RD in the US, prevalence rates ranged between 5 and 10% (Snow, Burns, & Griffin, 1998). These rates are in agreement to our findings estimating the proportion of students with severe word-level reading accuracy problems to 5.9 % in the elementary school. Gender differences in our sample of PR students follow the ratio of 3:2, favoring boys. This is also in agreement with current research findings that indicate a slight male preponderance among the RD population (Lyon et al., 2002).

Our results indicate a deficit profile that predominantly features impairment on orthographic knowledge, speeded word recognition, and rapid phonological decoding. Our findings are also in agreement with cross-

linguistic data indicating a similar profile of reading-related deficits in both opaque and transparent orthographic systems. In a recent study of German and English dyslexic children, reading performance was compared to both chronological and reading-age matched controls in terms of their ability to read words and nonwords that differed in overall length and the size of orthographic segments. Dyslexics in both countries showed deficits in reading speed, nonword reading, and phonological decoding skills. There was a tendency, however, for English RD students to make more reading errors than German RD students, a finding interpreted in view of the facilitating effect that a more regular orthography (i.e., German vs. English) may have (Ziegler et al., 2003). Higher than expected accuracy rates among RD students have been noted in another study in which Greek RD students were able under certain circumstances to achieve accuracy rates above 92% on a set of (non-standardized) reading tasks, although still performing at lower levels than the control group (Porpodas, 1999).

In our study, group differences on both timed and untimed pseudoword decoding tasks were somewhat smaller than the differences on similar tasks involving real word stimuli. This preliminary finding may suggest a more severe difficulty in automatic recognition than in phonological decoding. The fact that group differences were especially prominent in spelling is consistent with this view, given that accurate and efficient word recognition and spelling depend upon the maintenance and effective retrieval ability of orthographic representations. Another factor accounting for the prominence of group differences in spelling performance is the complex nature of modern Greek orthography, governed by a set of rules the majority of which remain obscure for the novice reader. Comparable findings have been reported in other transparent orthographies (i.e., German, French) but it should be noted that severe spelling deficits have been documented with dyslexic children in English as well (Caravolas, Bruck, & Genesee, 2003; Treiman, 1997; Vellutino et al., 2004; Wimmer, Mayringer, & Landerl, 1998). Such deficiencies seemed to persist following long lasting successful reading interventions and remain even in adolescence (Shaywitz & Shaywitz, 2003).

Reading rate deficits emerge as another defining characteristic of very poor readers, a finding that is in agreement with previous reports in transparent orthographies such as German, Italian, Dutch, and Greek (de Jong & van der Leij, 2003; Porpodas, 1999; Van der Leij & Van Daal, 1999; Ziegler et al., 2003). In agreement with the previous study of Greek disabled

readers that highlighted speed as a key indicator of reading difficulties (Porpodas, 1999), our findings also support a significantly reduced reading rate, which saliently differentiated impaired from non-impaired readers.

Frequency analyses pertaining to the concomitant presence of different deficits in individual PR students indicate that approximately 10% of students with above-average reading accuracy performance performed poorly on reading comprehension measures, while 36% of the PR group did not seem to have difficulties in reading comprehension. Interpretation of these discrepancies requires a comprehensive account of text-level reading skills. Traditionally, most interpretative approaches focus on the dependence of reading comprehension upon lower level processes such as fast and accurate word identification (Vellutino et al., 2004). However, recent studies argue that higher level processes (i.e., inference-drawing, comprehension monitoring, understanding of text structure) and processing capacity (i.e., working memory) explain a significant proportion of variance in reading comprehension scores independent of the contribution due to lower level skills such as word reading ability (Cain, Oakhill, & Bryant, 2004). The present findings suggest that lower level reading skills may be important but, neither necessary nor sufficient to extract meaning from text (Oakhill, Cain, & Bryant, 2003). In our study, 52 students with adequate word-level reading skills had text comprehension problems and may experience problems with one or more of the higher cognitive skills. Conversely, while 22 out of the 35 poor readers performed poorly on text comprehension measures, the remainder may have been able to overcome obstacles introduced by lower-level skill deficits by relying on compensatory strategies for extracting meaning from text. It should be noted, however, that the nature of the text comprehension task permitted the utilization of such strategies by allowing unlimited time to read each passage before and after having read the comprehension questions.

Findings pertaining to the concordance of deficits underscore the presence of three different levels of reading impairment. Students with both word and pseudoword reading accuracy and rate deficits comprise a very small proportion of the student population (approximately 3% of the student body in middle grades). Students with deficits in either of the two domains represent a considerably larger proportion of the population (10.8%). Finally, a high proportion of students with PR had deficits on either word- or text-level reading skills (text comprehension 18.3%). These figures translate to 4 students with typical intelligence experiencing reading problems of

some kind in any classroom (of approximately 20 students). This may have serious effects upon their academic performance given that reading efficiency has an effect upon achievement of most subject areas (Shaywitz, 2003). However, only one student in every two classrooms is expected to manifest impairments on both rate and accuracy of word recognition and decoding; the remaining poor readers may show difficulties on reading accuracy, fluency, or comprehension.

The above findings should be interpreted with some caution given that (a) the estimation of students' IQ was based on two subtests of the WISC-III (Vocabulary and Block Design) for practical reasons and (b) there was a significant difference in IQ between the two student groups compared in the study. On the other hand, estimated IQ scores for the entire group of PR students were in the normal range (M = 91, range: 80-110), whereas the mean group difference on reading achievement measures was larger than corresponding differences in IQ by a factor of four.

In sum, our findings corroborate previous results to suggest that reading disabled students present consistent but diverse profiles, highlighting the necessity for individualized instructional interventions (Fletcher et al., 2002). Differentiated instruction should be based upon diagnostic assessment that effectively aligns the assessment with curriculum and instruction. According to the current consensus regarding the critical antecedents of both success and failure in learning to read, building blocks of effective instruction include phonemic awareness and phonemic decoding skills, fluency in word recognition and text processing, construction of meaning, vocabulary, spelling, and writing (Foorman & Torgesen, 2001).

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