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REVISITING THE ROLE OF VISUAL PERCEPTION ON THE READING SKILLS OF STUDENTS WITH LEARNING DISABILITIES: SOME EDUCATIONAL PLANNING CHALLENGES

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Abstract:
Students with learning disabilities often struggle with reading skill acquisition, due to the nature and complexity of the reading process (Brown, 2009). In addition, it has been documented that students experiencing reading disabilities, have problems with the basic cognitive skills of visual perception (Stokes, Matthen & Biggs, 2015). The purpose of the present study was to investigate the role of the cognitive parameters of visual perception, assessed by the Developmental Test of Visual Perception-2nd Edition (DTVP-2, Hammill, Pearson & Voress, 1993) on the reading ability of students with learning disabilities, assessed by Test A (Panteliadou & Antoniou, 2007, Standardized test for reading disabilities in Greek). The sample consisted of 73 children (N=73) attending the 4th and 5th grade of Primary school, diagnosed with learning disability in reading. The results indicated that visual perception was a predictive factor for reading performance. Implications of these findings are discussed in terms of developing early detection programmes as well as effective educational interventions for pre-school and primary school students.

Keywords: learning disabilities, reading disabilities, visual perception skills, DTVP-2, educational challenges, primary school students

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1. Introduction

Reading is a complex cognitive skill that is gradually developed, by collecting and processing information extracted from written discourse (Tracy & Morrow, 2012). Moreover, to successfully decode written words, children also need to develop sufficient visual-perception skills. This skill presupposes the satisfactory functioning of the brain neurons associated with the areas of vision, hearing, speech and memory, while its mechanism is based on understanding the relationship between the letters and the phonemes of the language. Additionally, reading requires the differentiation and recognition of visual stimuli. Apart from developing satisfactory linguistic skills, reading also requires a visual analysis of a uniquely ordered array of letters such as a familiar word and retrieval of the word representation from memory (Bellocchi et al., 2017).

Indeed, it is a visual action that involves the visual processing of the written language. The latter is also justified by the fact that reading disability has been attributed to problems with visual perceptual function independently of phonological skills (Huestegge et al., 2009; Valdois et al., 2011). Besides, research related to the perception and processing of stimuli has focused on the study of visual perception, confirming its relationship with reading disabilities (Stokes, Matthen & Biggs, 2015).

Given the lack of differences in the sensory recorders of visual information between students with learning disabilities and their typically developing peers, research on the causes of learning disabilities has focused on the perception and processing of incoming information through the visual pathway, where relative differences between the two groups have been observed (Smith, 2004). In fact, the main areas of visual perception, where deficits are observed, seem to be the perception of spatial relations, visual recognition, discrimination and identification of forms and shapes, visual memory, visual integration and visual sequence. The appearance of the afore mentioned deficits may function as a predictor of the existence of learning disabilities (Lane, 2005). Thus, the ability for fine visual perceptual discrimination becomes vital for reading skills acquisition (Inhoff et al., 2011).

Additionally, the control and perception of body orientation and motion are served by multiple sensory and motor mechanisms. Thus, the contribution of the balance system and audio-visual stimuli to body orientation is recognized (Donaldson & Zager, 2010; Lackner & DiZio, 2005). In a related study, Raberger & Wimmer (2003) explored the relationship between learning disabilities and balance problems. The results showed that balance problems (static as well as dynamic) are not related to learning disabilities. On the contrary, Jongmans et al. (2003) showed that students with learning disabilities experienced very low rates in dynamic balance as well as in hand skill tests compared to the control group.

Thereafter, visual discrimination concerns the discrimination of objects based on their particular characteristics, as well as the discrimination of an object from its environment. It is considered to be an important factor for the identification of common objects and symbols (Richmond & Waugh, 2009). The deficits in visual discrimination

may explain the mirror writing (strephosymbolia) in copying forms and symbols (Szucs et al., 2013) that appears in the writing of children with reading disabilities. Subsequently, visual memory refers to the coding process, storage and retrieval of visually acquired information (Baddeley, 2007), while visual integration is related to the ability to identify a symbol or object, when its entirety is not visible (Jiang et al. 2015). In particular, research findings suggest that people with reading disabilities exhibit deficits in the visual-spatial perception and more specifically they are unable to distinguish and identify visual details and relationships between objects or forms (Facoetti et al., 2010). In a recent study, Lima, Salgado-Azoni & Ciasca (2013) compared various variables of executive functions in students with and without reading disabilities. According to their findings, students with reading disabilities differed and had difficulty in maintaining the visual-spatial attention (Wang & Gathercole, 2013).

In addition, the lack of visual - spatial perception involves difficulties related to the language process, while the latter involves an interpretation of spatial and causal relationships. Research has shown that students with reading disabilities have deficits in the visual - spatial perception, and more specifically, they demonstrate inability to distinguish and identify visual details and relationships between objects or forms (Mammarella et al., 2006). Those students are unable to perceive differences and similarities between letters, forms, sizes and quantities (Wang et al., 2014).

Consequently, it has been highlighted that students with reading disabilities exhibit deficits in basic cognitive skills of visual perception compared to children without learning disabilities (Gibson, Hogben, & Fletcher, 2006). In particular, the low performance in visual perception tests of a group of students with reading disabilities appeared to be negatively correlated with their reading ability (Joseph et al., 2008).

Furthermore, studies support that the chronological age of children is related to their difficulties in visual perception, since the latter gradually develops. Indeed, there is strong evidence suggesting that the problems experienced by elementary schoolers and older children in learning to read are related to the pre-literacy skills that they bring with them from preschool and kindergarten (Lonigan, 2006). Those studies also support that visual recognition and discrimination skills are the highest predictors of a student's performance in reading (Ouellette & Beers, 2010).

In an effort to determine whether the origin of the reading disabilities is different between boys and girls, Hawke et al. (2006) tested twins (monozygotic and dizygotic) and no evidence was found for sex to influence reading skill acquisition. Thus, it is suggested that the same genetic and environmental factors contribute to these disabilities in both sexes. However, other studies have indicated that sex is an important and relevant factor, influencing students' reading ability (Robinson & Lubienski, 2011). In particular, it has been reported that girls on average tend to excel in a variety of reading task assessments (Below et al., 2010) and the influence of sex increases with age (Logan & Johnston, 2009). Regarding also the effect of sex on the performance in visual perception tests, Halpern and Collaer (2005) found that boys' superiority in visuo-spatial trials, when compared to girls', is due to a combination of factors, such as neurological differences of

organisms, excretion of different hormones, different social stereotypes for both sexes as well as different learning experiences. However, Santos et al (2005), who examined the effect of the independent variables of age, sex and cultural differences on the participants' performance in visual memory tests, found no statistically significant differences in relation to sex. Nevertheless, they found differences in copying and distinguishing forms between students living in rural areas and students living in large cities, which was attributed to the delayed school enrolment of children living in the province, unlike students in the city, who usually attend nursery school and kindergarten before joining primary school.

Extensive research on the memory of children with learning disabilities has shown that these students experience specific difficulties in tasks that include not only spatial and visual elements, but also visual information which can be expressed linguistically (Gathercole & Alloway, 2008). Similarly, in a recent study with Greek-speaking students, differences in visual memory skills have been found between children with and without learning disabilities (Theodoridou et al., 2014). The above-mentioned research findings suggest that the memory assessment is based on visual characteristics and that performance can be negatively affected by the inability to encode these elements (Cornoldi et al., 2003; Luck & Hollingworth, 2008). In addition, according to clinical as well as classroom observations, students with reading deficits are described to wrongly perceive the letters (symbols) or confuse their orientation or sequence. Though, it is necessary to underline that letter visual recognition with the associated typing and word recognition are important skills for comprehension (Schwartz, 2006).

Furthermore, visual motor coordination reinforces eye movement control and hand-eye coordination, thus aiding in the development of the direction sense (top-down, from left to right, etc.) (Radach & Kennedy, 2013; Radach, Huestegge, & Reilly, 2008). In fact, the direction of the left-to-right visual symbols requires sequencing, which is a prerequisite for reading skill acquisition (Shivers, 2007). As noted by Jenkinson, Hyde & Ahmad (2008), Pereira et al. (2011) and Rivard et al. (2011), visual motor coordination is necessary for the development and improvement of all practical skills, including reading. Likewise, Sortor & Kulp (2003), investigated the relationship between reading performance and visual motor coordination, using the Beery VMI battery and two complementary tests of Visual Perception and Motor Coordination. The participants were 155 children, out of which 42 were in 2nd grade, 55 in 3rd grade and 58 in 4th grade of Elementary school. Their findings revealed that the skill of visual perception should be considered as one of the factors significantly associated with reading performance. Similarly, the relationship between visual motor coordination and school performance is also confirmed in a study by Barnhardt et al. (2005), the results of which revealed that the low performance in the Beery VMI battery was related to the difficulty in the spatial organization of a written text. Moreover, Son and Meisels (2006) observed that in early kindergarten, fine motor skills (especially visual motor skills and manual dexterity/hand–eye coordination) predict achievement in reading at the end of first grade.

To sum up, given the well documented influence of visual perception on reading skill acquisition, the evaluation of visual-perceptual and motor processing skills may provide a better understanding of the difficulties that children with reading disabilities face, thus allowing for successful educational intervention programmes to be planned.

The purpose of this study was to investigate the role of the cognitive parameters of visual perception on the reading skills of students, who were all diagnosed with reading disabilities.

2. Material and Methods

The participants of the present study where 73 students (N = 73), attending 4th (19 boys and 18 girls) and 5th grade (17 boys and 19 girls) of mainstream primary schools in the Kozani region of Western Macedonia-Greece in the school year 2017-2018, all diagnosed with reading disabilities by public services and supported by Special Educational Needs (SEN) teacher. The sex ratio in the group was approximately 1:1 (male: female). The selection of schools was based on criteria relating to the representation of urban and semi-urban areas of the region and to the possibility of collecting data from the specific geographical areas. All students were selected to have reading disabilities, to have Greek nationality and to speak Greek fluently. In addition, they did not have any sensory problems or attention deficit disorder with or without hyperactivity.

2.1 Measures

2.1.1 Test-A (Alpha) (Standardized test for reading disabilities in Greek) (Panteliadou & Antoniou, 2007)

A standardized reading comprehension test, well known in Greece as test-A (Panteliadou & Antoniou, 2007), has been developed to assess the reading abilities of children aged 8-15 and identify the reading difficulties they may have. More specifically, it evaluates the following domains: (1) word decoding, (2) fluency, (3) morphology and syntax, and (4) reading comprehension, by providing ten subtests for all of them in total. The first part consists of four groups of five syntactically different but somewhat similar sentences each. Students had to find those two sentences in each group that match semantically. In the second part, there were three reading passages (one narrative and two expository) ranging from 97 to 127 words and followed by 7 multiple-choice items each. This instrument scored one point for each of the 25 items in total. Pearson correlation coefficient that ensures test-retest reliability for this measure is 0.809 (< 0.001) and Cronbach's alpha is placed at 0.81.

2.1.2 Developmental Test of Visual Perception-Second Edition (DTVP-2) (Hammill, Pearson & Voress, 1993)

DTVP-2 (Hammill, Pearson & Voress, 1993) is the second edition of Frostig, Lefever & Whittlesey (1966), well-known, non-verbal Developmental Test of Visual Perception (DTVP). The DTVP-2 is standardised for children aged 4 to 10 years and measures visual

perception as well as visual motor integration skills. The subtests are Eye-hand co-ordination, Copying, Position in space, Spatial Relations, Figure-ground, Visual closure, Visual-Motor Speed and Form Constancy. Eye-hand coordination, Copying, Spatial Relations and Visual-Motor Speed are combined to give a motor-enhanced quotient, which is a measure of visual motor perceptual abilities. The remaining subtests; Position in space, Figure-ground, Visual closure, and Form Constancy are similarly combined to give a motor reduced quotient, which is a measure of visual perception. According to the authors, the DTVP-2 is unbiased relative to race, gender and handedness. Normative statistics were given in terms of subtest standard scores, composite quotients, percentiles and age equivalents. The mean of 10 and the standard deviation of 3 were given for the subtests and a mean of 100 and standard deviation of 15 for composite scores. Age equivalents are to be interpreted with caution as interpolation; extrapolation and smoothing were used to create age equivalents. The average reliability scores of The DTVP-2, are all above the 0.85 level.

3. Results and Discussion

Score performance on the overall reading skill (Test-A) was analyzed with a 2 x 2 between-subjects ANOVA. The main effect of grade on the overall reading skill was significant, $F(1,69) = 10.364$, $p < 0.05$, $n^2 = 0.11$, while the main effect of sex on the overall reading skill was not significant, $F(1,69) = 3.318$, $p > 0.05$, $n^2 = 0.003$. The predicted interaction among sex and grade was significant $F(1,69) = 5{,}778$, $p < .05$, $n^2 = 0.006$. In particular, while boys (mean= 0.531, s.d. = 0.065) and girls (mean = 0.522, s.d. = 0.078) have almost the same performance in 4th grade, boys scored statistically significant higher (mean = 0.604, s.d. = 0.046) than girls (mean = 0.543, s.d. = 0.052) in 5th grade, $t(34) = 3.716$, $p < 0.05$, $d = 1.24$ (see Table 1).

Table 1: Means and Standard Deviations of the students' performance on overall reading skill

Sex	Grade	Means	S.D.	N
Boys	4th	,52289	,077664	19
	5th	,60441	,046357	17
	Total	**,56139**	**,076078**	**36**
Girls	4th	,53133	,065373	18
	5th	,54316	,051900	19
	Total	**,53741**	**,058316**	**37**
Total	4th	,52700	,071079	37
	5th	,57208	,057702	36
	Total	**,54923**	**,068262**	**73**

Moreover, none of the two variables, sex $F(1,69) = 0.106$, $p > 0.05$, $n^2 < 0.001$ and grade $F(1,69) = 0.006$, $p > 0.05$, $n^2 < 0.001$, significantly differentiates performance in reading decoding, since the boys had almost equal performance (mean = 29.86, s.d. = 10.99) with the girls (mean = 28.92, s.d. = 15.77). Correspondingly, with regard to grade variable, the students of the 4th grade demonstrated almost equal performance (mean = 29.32, s.d. =

14.15) with the students of the 5th grade (mean = 29.44, s.d. = 13.08) (see Table 2). Also, there was no predicted interaction between sex and grade $F(1,69) = 3.117$, $p > 0.05$, $n^2 < 0.001$, either.

Table 2: Means and Standard Deviations of the students' performance on reading decoding

Sex	Grade	Means	S.D.	N
Boys	4th	27,11	9,327	19
	5th	32,94	12,127	17
	Total	**29,86**	**10,986**	**36**
Girls	4th	31,67	17,905	18
	5th	26,32	13,421	19
	Total	**28,92**	**15,773**	**37**
Total	4th	29,32	14,150	37
	5th	29,44	13,081	36
	Total	**29,38**	**13,539**	**73**

The main effect of sex variable on reading fluency was significant $F(1,69) = 7.981$, $p < 0.05$, $n^2 = 0.10$, with boys having statistically significant higher performance (mean=34.58, s.d.=17) compared to girls (mean =23.81, s.d.=16), $t(70) = 2.782$, $p < 0.05$, $d = 0.65$. On the contrary, grade does not influence fluency performance $F(1,69) = 0.026$, $p > 0.05$, $n^2 < 0.001$, and there is no interaction between sex and grade $F(1,69) = 2.667$, $p > 0.05$, $n^2 < 0.001$. Besides, none of the abovementioned variables significantly differentiates the performance on morphosyntactic skills, $F \leq 2.220$, $p \geq 0.581$, $n^2 < 0.001$.

Table 3: Means and Standard Deviations of the students' performance on reading fluency

Sex	Grade	Means	S.D.	N
Boys	4th	31,32	13,929	19
	5th	38,24	19,760	17
	Total	**34,58**	**17,045**	**36**
Girls	4th	26,72	15,525	18
	5th	21,05	16,379	19
	Total	**23,81**	**16,007**	**37**
Total	4th	29,08	14,705	37
	5th	29,17	19,803	36
	Total	**29,12**	**17,284**	**73**

The main effect of sex on reading comprehension was not significant, $F(1,69) = 1.818$, $p > 0.05$, $n^2 = 0.02$, while grade $F(1,69) = 8.066$, $p < 0.05$, $n^2 = 0.09$ significantly differentiates the performance on reading comprehension, with the students of the 4th grade having statistically significant higher performance (mean = 41.08, s.d.= 21.70) than the 5th grade students (mean =28.61, s.d.=14.57), $t(71) = 2.874$, $p < 0.05$, $d = 0,67$ (see Table 4). In addition, there was no predicted interaction between sex and grade $F(1,69) = 2.609$, $p > 0.05$, $n^2 = 0.03$.

Table 4: Means and Standard Deviations of the students' performance on reading comprehension

Sex	Grade	Means	S.D.	N
Boys	4th	40,53	26,765	19
	5th	35,29	17,719	17
	Total	**38,06**	**22,781**	**36**
Girls	4th	41,67	15,435	18
	5th	22,63	7,335	19
	Total	**31,89**	**15,246**	**37**
Total	4th	41,08	21,703	37
	5th	28,61	14,571	36
	Total	**34,93**	**19,445**	**73**

Thereafter, linear regression analysis was used to estimate the effect of the students' visual perception performance on their reading skills. It was found that copying (beta = 3,17, t = 2,804, $p < 0.01$) was the only variable that could predict reading decoding (see Table 5). The variables that could predict reading fluency were: a) copying (beta = 2,87, t = 2,005 $p < 0.01$), b) figure-ground (beta = 2,89, t = 2,409, $p < 0.01$), c) visual closure beta = 2,29, t = 2,312, $p < 0.01$) and d) visual motor speed (beta = -3,91, t = -2,362, $p < 0.01$) (see Table 6). Moreover, visual closure (beta = 2,37, t = 2,115, $p < 0.01$) and form constancy (beta = 2,89, t = 2,172, $p < 0.01$) were found to predict morphology-syntax (see Table 7). Predictors of comprehension were found to be: a) position in space (beta = -3,77, t = -2,067, $p < 0.05$) and b) visual closure (beta = 3,26, t = 2,806, $p < 0.01$) (see Table 8).

Table 5: Effect of DTVP-2 subscales on reading decoding

Model	Unstandardized Coefficients		t
	B	Std.Error	
(Constant)	26,74092	23,04921	1,160167
EHC	-0,83923	1,117697	-0,75085
PS	-1,36115	1,233484	-1,1035
COP	3,178732	1,133562	**2,804198***
FG	1,307058	0,951292	1,373981
SR	0,385866	1,584978	0,243452
VCL	1,024496	0,786122	1,303228
VMS	-2,28866	1,310328	-1,74663
FC	-1,45695	0,932927	-1,5617

*$p < 0.01$

Table 6: Effect of DTVP-2 subscales on reading fluency

Model	Unstandardized Coefficients		t
	B	Std.Error	
(Constant)	55,7018	29,14662	1,911089
EHC	-0,6464	1,413372	-0,45734
PS	-2,10844	1,559789	-1,35175
COP	2,874638	1,433433	**2,005422***
FG	2,899048	1,202946	**2,409957***
SR	-2,40796	2,004266	-1,20142

VCL	2,298468	0,994082	**2,312152***
VMS	-3,91484	1,656961	-2,36266*
FC	-1,23397	1,179723	-1,04599

*p < 0.01.

Table 7: Effect of DTVP-2 subscales on morphology-syntax

Model	**Unstandardized Coefficients**		**t**
	B	**Std.Error**	
(Constant)	-31,2016	32,89305	-0,94858
EHC	-0,23073	1,595043	-0,14465
PS	-3,41752	1,76028	-1,94146
COP	2,756984	1,617683	1,70428
FG	-1,2689	1,35757	-0,93469
SR	2,699436	2,261889	1,193443
VCL	2,372997	1,121858	**2,115237***
VMS	0,283969	1,869942	0,15186
FC	2,892559	1,331361	**2,172634***

*p < 0.01.

Table 8: Effect of DTVP-2 subscales on reading comprehension

Model	**Unstandardized Coefficients**		**t**
	B	**Std.Error**	
(Constant)	23,51584	34,08334	0,689951
EHC	0,464279	1,652762	0,280911
PS	-3,77196	1,823979	**-2,06799***
COP	2,075993	1,676221	1,238496
FG	-0,01456	1,406695	-0,01035
SR	-0,41412	2,343739	-0,17669
VCL	3,262726	1,162455	**2,806755****
VMS	-1,46706	1,937609	-0,75715
FC	0,88304	1,379538	0,640099

*p < 0.05, **p < 0.01.

4. Discussion and Conclusions

In addition to the well-documented importance of phonological skills in reading acquisition (Hogan, Catts & Little, 2005; Lonigan et al., 2013; Otaiba et al., 2016; Suggate, 2016) visual perceptual and motor processing also appear to be important factors in learning to read. Recent studies, that have explored the relation between visual mechanisms and reading acquisition, have confirmed that the perception of visual sequences significantly contributes to the reading skill acquisition and spelling (Bellocchi, Muneaux, Huau, Lévêque, Jover, & Ducrot, 2017; Gori & Facoetti, 2015).

In the present study, the performance differences in tasks assessing reading skills between boys and girls with reading disabilities, were investigated. In particular, sex was not found to significantly differentiate the overall score of reading skill performance in Test Alpha. The above finding is in line with previous studies that confirmed the lack of

superiority of boys or girls in reading skills (Hipfner-Boucher et al., 2014; Lepola et al., 2012). Additionally, in the present study, for each subtest of Test Alpha, it was found that sex does not significantly differentiate performance in reading decoding. Our results are consistent with the results of Tan and his colleagues (2007). In contrast, other studies suggest that there are statistically significant differences related to sex, which are linked with interest and effectiveness in reading decoding, with girls outperforming boys in both indices (Below et al., 2010; Mullis et al., 2007; OECD / PISA, 2009). In addition, sex factor has a significant effect on reading fluency, but boys demonstrate a higher performance than girls. This finding contradicts the results of Camarata and Woodcock (2006), who found that boys performed lower than girls in tasks assessing reading fluency and that the degree of the sex influence in processing speed is affected by age.

As far as errors are concerned at a morphological level, there were no differences related to sex. Consequently, the variable sex does not seem to differentiate the frequency of errors at morphological level, a conclusion that other researchers disagree with (Bogdanowicz et al., 2014; Bourassa, Treiman & Kessler, 2006). Indeed, it has been pointed out that girls scored higher in morphosyntactic skills performance than boys (Close & Shiel, 2009).

Another finding of the present study is that sex factor does not significantly affect the performance of reading comprehension. This finding is inconsistent with the findings of Logan & Johnston (2009), who examined 232 ten-year-old boys and girls, and found that girls had a higher performance in reading comprehension tasks than boys. Similarly, other researchers (Griva, Alevriadou & Semoglou, 2012; Poole, 2010) confirmed that girls in elementary school were better than boys of the same age at extracting meaning from a text as well as at drawing conclusions.

Regarding the relationship between performance in Test-Alpha and grade, it was found that 5th grade students showed superiority in the overall score performance, compared to children of the 4th grade. This finding is in line with the findings of other studies, where it has been confirmed that the overall performance in reading skills is related to age (Johnsson-Smaragdi & Jönsson, 2006; Logan & Johnston, 2009). However, other researchers, while expecting students to score higher in reading skills test, when attending a higher grade, they found that 4th grade students surpassed those of 5th grade (Robinson & Lubienski, 2011).

Furthermore, in the present study it was found that grade does not significantly affect the performance in reading fluency. In the study of McNorgan, Alvarez, Bhullar, Gayda, & Booth (2011), the research findings suggest that younger children who are more sensitive to higher-order phonological word characteristics may make greater reading proficiency gains, whereas older children who focus more on whole-word orthographic representations may make smaller proficiency gains. Regarding performance in morphology-syntax, no differences were found in relation to grade. Researchers, however, have found that this skill is influenced by school age (Lynn & Mikk, 2009). In addition, it appears that grade significantly influences only the performance in reading comprehension, with 4th grade students showing a higher performance than students in

the 5th grade. Of course, it should be noted that the age variance of the two grades may not allow for differences to be detected.

Since our study aimed at investigating visual perceptual functions and their influence on reading, an attempt was made to examine the effect of visual perception deficits on reading skills, an assumption that has been confirmed by a number of studies (Facoetti et al., 2010; Lima, Salgado-Azoni, & Ciasca, 2013; Ouellette & Beers, 2010; Stokes, Matthen & Biggs, 2015). Besides, reading is primarily a visual function, as it commences with the visual processing of the printed text (Grainger, Dufau, & Ziegler, 2016). Initially, it was found that copying forms is the only variable that can predict reading decoding. Weaknesses in this visual perception skill have been found to be associated with the existence of learning disabilities (Szucs et al., 2013). Visual perceptual dysfunction, which is related to space and in particular to copying forms and images, poses serious difficulties in reading decoding (Mammarella, Lucangeli & Cornoldi, 2010).

Moreover, it was found that the variables that predict reading fluency are copying, figure-ground, visual closure and visual motor speed. Also, the variables involved in predicting morphology-syntax skills are visual closure and form constancy. It has been argued that the visual perceptual deficits associated with visual integration may be noticeable in children of 6 to 11-year old with dysanagnosia, a specific reading disorder which is characterized by the student's reduced performance on accuracy, speed and comprehension. It has also been indicated that students' skills in visual recognition and visual discrimination are the highest predictors of reading performance. In fact, the deficits in visual integration are considered to be the key factors to the aforementioned reading disorder (Stokes, Matthen & Biggs, 2015).

Finally, in our study, the variables involved in the prediction of reading comprehension are position in space and visual closure. Hence, there are spatial associations and figure-ground relations in visual perception, which involve the ability to organize, interpret and give meaning to the information being seen, thus affecting reading comprehension processes (Çayir, 2017).

Consequently, in a general context, the emphasis given to the contribution of phonological awareness to reading skill acquisition in recent years is fruitful and well-founded, but the value and usefulness of visual perception should not be ignored. Therefore, the present study suggesting that visual perception is a predictor of reading disabilities, underlines the need of cultivating and enhancing visual perception skills, as a means of preventing their emergence. For example, the teaching model of the analytical-synthetic method is directly related to the linguistic-visual representations of the students. The principles of this approach give emphasis, through systematic exercise, on the correspondence of phonemes to letters, as well as the fragmentation and re-synthesis of prototype words (Rose, 2006). In this model, reading is perceived as a process that begins with the recognition of the letters, the formation of syllables and finally the synthesis of the prototype word. Later, higher levels of meaningful linguistic organization are involved, such as words or phrases. After teaching several language elements, students will be able to read a pre-structured text (Gustafson et al., 2011).

Concluding, poor visual perceptual skills contribute to perceptual challenges in the classroom, influencing the child's academic proficiency. Diagnosis of perceptual problems facilitates appropriate referrals, recommendations and interventions. This study highlights the need for awareness of visual perceptual difficulties and their important role in learning. Exploring their coexistence could contribute to a deeper understanding of their causal factors, and most importantly in the Greek language, since the research gap that exists, compared to English language, is evident. Further research could take into account the developmental dimensions of reading disabilities, so as to better map the profile of language skills during an individual's developmental course (Ramus et al., 2013).

Several limitations of this study may have affected the overall results and interpretations. Firstly, this study was limited by its small sample size. A larger, diverse sample may have ensured a more representative distribution of the population, allowing for our results to be generalized or transferred. Secondly, the existence of a control group could have provided alternative explanations of our results. Finally, it is also important, studies examining visual perception in students with learning disabilities to be longitudinal, observing and recording the development of formations in reading representations. The same factors may play a different role in students' developmental stages of reading skill acquisition.

About the Authors

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