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Bilingualism and Learning Disabilities: Untangling the role of executive functions

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ABSTRACT: *Based on the existing research documentation, the role of executive functioning in identifying bilingual students who fail reading skills because of dyslexia, appears promising but not conclusive. Aiming towards identifying non-linguistic factors that could assist in early diagnosis and intervention for bilingual students with dyslexia, we hypothesized that students who do not know the Greek language, but do not face any other limitation in visual perception-memory and executive functions, would be different from students who face limitations in the above functions. Consequently, if these limitations were identified, we could use them to detect reading disabilities before failure.Our goal in the study was to investigate the differences between dyslexic and typical bilingual students in executive functioning. In addition we aimed towards exploring the role of specific executive functions in different reading dimensions. This study involved Albanian-speaking students of Primary and Secondary Education, who were taught Greek as a second language, in support classes for Foreign and Repatriated Students. Of the participants, 48 were boys and 22 girls, 24 were typical readers and 24 were students with reading disabilities. Based on the analysis of our data, it is reported that regarding the differences between typical and dyslexic Albanian-speaking students in visual perception and visual memory, these were not confirmed. All students demonstrated the same level of visual perception and attention and struggled at a similar level on the visual memory task. Further, it was found that visual perception appears to be significant in all reading skills, only for students with LD. The same was true for visual memory, which affected all skills for students with LD and only reading decoding for typical students. Overall, the time it takes students to complete a sequencing task affected all skills for both groups of students. In addition, when students were asked to perform the sequencing task in inhibitory conditions, time affected performance on all skills for typical students but only reading fluency for students with LD.*

KEYWORDS: *bilingual, dyslexia, learning disabilities, executive functions*

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I. INTRODUCTION

Teachers, psychologists and parents often associate the existence of bilingualism in a child with the possibility of school failure. Many suggest that the reason foreign students fail is that they have not developed enough competence in the majority language to be able to cope with school subjects (Porter, 1990, 1998; Rossell & Baker, 1996). Another reason for the failure of bilingual students involves the differences between the family and school environments, both on a linguistic level, as well as on a cultural level (Delgado-Gaitan & Trueba, 1991). Nevertheless, there are many occasions wherein the failure of bilingual children is attributed to socio-economic factors related to the minority language group (Delgado-Gaitan & Trueba, 1991). Finally, the failure of a bilingual child may be due to Learning Disabilities he/she faces leading to some form of special education.

The representation of the group of foreign students in special education and especially in the category of Specific Learning Disabilities, depends on the functional definition of Learning Disabilities and in particular Dyslexia, social discrimination and perceptions, as well as perceptions of special educational needs and the role of special education. Especially in regard to reading disabilities and dyslexia, the majority of bilingual students who fail school, face particular disabilities in reading (Klingner et al., 2006) while 66% of foreign students attending special education are students with learning Disabilities (Zehler et al., 2003).

Despite the above interweave between reading disabilities and bilingualism, research in dyslexia and bilingualism is developed on two parallel levels and often disregard the complex needs of bilingual students with dyslexia. On the one hand, research and good practices in the field of dyslexia have focused more on monolingual students, while, on the other, research on bilingual students has focused on those who do not have special educational needs. When this practice of late assessment and intervention is followed with bilingual dyslexic students, then this may lead to a cumulative deprivation. Late or lack of diagnosis of dyslexia can lead to severe school failure and often to behavioral problems as well as difficulties in social integration. In the case of foreign students who face school failure and social exclusion due to other, systemic factors, the interaction with the existence of specific reading disabilities magnifies all difficulties involved. Finally, the lack of

diagnostic tools in separating dyslexic learners from those who have difficulties in acquiring a second language, does not allow bilingual dyslexics to receive appropriate help, and acquire literacy skills in a second language (Peer, 1999).

In recent years, efforts to identify non language factors that can contribute to valid identification of students with dyslexia, have turned to the hypothesis of attention problems based on the level of executive functions of the student. The term executive functions refers at a set of cognitive processes, which depend on and interact with basic cognitive skills such as memory, perception, attention. The term refers to processes of controlling and regulating cognitive skills (Gilbert, & Burgess, 2008; Van der Sluis, De Jong, & Van der Leij, 2007; Zamarian et al., 2006) that allow the individual to effectively manage intentional behaviors and approach the execution of a task that has not yet been automated (Mahone et al., 2002). In simpler terms, executive functions are the result of a coordinated operation of several cognitive processes, in a flexible manner to achieve a cognitive task (Funahashi, 2001).

In the context of executive functions, emphasis is placed on the area of selective attention (Lehto, Juniarvi, Kooistra, &Pulkkinen, 2003), with 3 basic functions: selective attention, switching focus of attention and management of information from long-term memory, i.e. working memory. Selective attention allows for efficient information processing, without interruptions from unrelated stimuli (Lavie, 2000). It controls when and if the individual should act, it includes planning, and deliberately inhibiting irrelevant stimuli, switching between projects, persisting on a goal, and selecting appropriate strategies (Barkley, 2000). Switching focus of attention refers to the ability of the individual to disengage from a task that ceases to be important and to focus on a new one.

Based on the results of relevant research, Visser, Boden & Giaschi (2004) argued that students with dyslexia have problems switching focus of attention, thus affecting the proper distribution of their attention when trying to decode graphemes in reading. Children with dyslexia have an inefficient allocation of visuospatial attention (Brambati et al., 2004). That is, when they are called upon to perform tasks that require quick execution, students with dyslexia need significantly more time (Facoetti, Paganoni, Turatto, Marzola&Mascetti, 2000). This time delay in the processing of stimuli is likely due to attention problems (Hari & Renvall, 2001).In a recent study in Brazil, Lima, Salgrado-Azoni & Ciasca (2013), compared children with dyslexia and children without learning disabilities to various variables related to attention and other executive functions. According to their findings, students with dyslexia differed and had difficulties both in maintaining visuospatial and auditory attention, as well as in shifting attention and inhibition, presenting a particularly burdened profile.

Indeed in recent years, research has highlighted significant deficits in executive functions compared to typical readers (Altemier, Abbott & Berninger, 2008; Brosnan et al., 2002; Gooch, Snowling & Hulme, 2011; Helland & Asbjornsen, 2000; Menghini et al., 2010; Reiter, Tucha & Lange, 2004; Tiffin-Richerds, Hasselhorn, Woerner, Rothenberger & Banaschewski, 2008). Some of this research has focused on attention problems (Facoetti et al., 2000; Shaywitz & Shaywitz, 2008). In other studies, findings point to difficulties with response inhibition (Brosnan, et al., 2002), working memory (Ackerman & Dyckman, 1993; Helland & Asbjornsen, 2004; Swanson & Ashbaker, 2000), and self- -monitoring (Horowitz-Kraus & Breznitz, 2008, 2009). However, in a study with adolescents with dyslexia, (Horowitz-Kraus, 2012), emphasis was placed on recording the deficit in executive functions and with the help of neurophysiological measurements the source of this deficit. The analysis of the data revealed that students with dyslexia face difficulties with more basic executive functions, such as working memory and attention, and not with the switching function.

A different group of relevant studies has pointed out that executive functions such as planning, may significantly and distinctly affect reading comprehension (Sesma, et al., 2009). In a similar vein, Locascio, Mahone, Eason, & Cutting (2010), examined several executive skills in three groups of students: a) typical students, b) students with reading disabilities in decoding, and c) students with exclusively reading comprehension disabilities. From the analysis of the findings, it emerged that the group of readers with decoding disabilities showed particularly low language memory and planning skills, while students with reading comprehension problems showed a deficit exclusively in planning functions.

Based on the existing research documentation, the role of executive functioning in identifying bilingual students who fail reading skills because of dyslexia, appears promising but not conclusive. Aiming towards identifying non-linguistic factors that could assist in early diagnosis and intervention for bilingual students with dyslexia, we hypothesized that students who do not know the Greek language, but do not face any other limitation in visual perception-memory and executive functions, would be different from students who face limitations in the above functions. Consequently, if these limitations were identified, we could use them to detect reading disabilities before failure.

Our goal in the study was to investigate the differences between dyslexic and typical bilingual students in executive functioning. In addition we aimed towards exploring the role of specific executive functions in

different reading dimensions, when Albanian students learn Greek as their second language.In particular, the research questions of the study were:

1. Is there a difference between typical and dyslexic children learning Greek as a second language in terms of their visual perception and memory?
2. Is there a difference between typical and dyslexic children learning Greek as a second language in their executive functions?
3. What is the role of visual perception and memory in reading decoding, fluency and comprehension for children learning Greek as a second language?
4. What is the role of executive functions in reading decoding, fluency and comprehension for children learning Greek as a second language?

II. METHODOLOGY

This study involved Albanian-speaking students of Primary (2^{nd}– 6^{th}Grade of Primary School) and Secondary (1^{st} – 2^{nd}grade of Gymnasium) Education, who were taught Greek as a second language, in support classes for Foreign and Repatriated Students. Of the participants, 48 were boys and 22 girls (Table 1). As far as their distribution into classes is concerned, four attended the second grade, 10 in the third grade, nine in the fourth, 11 in the fifth and 10 in the sixth grade, while in the gymnasium, they 10 attended first and 13 second grade of gymnasium.

Table 1

Frequency by category and gender

	Sex		
Category	Boys	Girls	Total
LD	24	11	35
Typical	24	11	35
Total	48	22	70

Students in both groups had an average of 9.77 years of residence in Greece and about 5 years of study in the Greek educational system on average. The level of proficiency in Greek, as assessed with the listening comprehension, was initially for students with Learning Disabilities (LD) 12.36 and 13.15 for typical readers. All students in both groups had a normal Raven index. As for their reading profiles, these are presented in Table2. Students in the two groups had significantly different scores in all reading dimensions tested (Table 3) confirming their reading difficulties.

Table 2

Means and standard deviations for reading dimensions

	Category	Mean	Standard deviations
Decoding	LD	73,43	19,40
	Typical	96,85	11,06
Fluency	LD	58,94	31,31
	Typical	93,83	31,99
Comprehension	LD	8,80	5,57
	Typical	16,00	4,81

Table 3

T-test for differences in reading skills of the two groups

	t	df	Sig.
Decoding	-6,07	66	0,00
Fluency	-4,58	67	0,00
Comprehension	-5,79	68	0,00

Data collection was conducted through the administration of the following tests. 1.*Raven's Coloured Progressive Matrices – CPM*. Adaptation of the English Raven Coloured Progressive Matrices (Raven, 2004). In Greece it has been standardized by Sideridis, Antoniou, Mouzaki & Simos (2015). 2. *Test-A. Reading Test*(Padeliadu& Antoniou, 2007): It consists of a total of 10 exercises, structured in 4 axes (decoding, fluency, morphology and understanding), aiming at the overall assessment of the reading skills of students from third grade to third grade. It is a standardized test widely used in Greece, with very good psychometric characteristics

and no bias for use with foreign students. 3. *Rey-Osterrieth Complex Figure Test (RCFT)* (Osterrieth, 1944).It is a neuropsychological test, widely used to assess mainly visual perception and visual memory as well as executive functions of planning and organization (Baron, 2004;Strauss, Sherman, &Spreen, 2006). It is widely used by the scientific community in both clinical and research settings (Davies, Field, Andersen & Pestell, 2011;Tupler, Welsh, Asare-Aboagye & Dawson, 1995). In 2000 it was rated as the 21st most used neuropsychology test (Boone, 2000), and in 2005 it was ranked 8th out of the top 40 neuropsychological tools and second for executive function assessment tools (Rabin, Barr, & Burton, 2005).4. *Children's Color Trails Test 1 and 2 (CCTT -1 & 2)* (Llorente, Williams, Satz, & D' Elia, 2003). The test is used to assess executive functions (visual attention, ordering skills, psychomotor speed, cognitive flexibility and inhibition). Executive functioning is a broad term that includes response inhibition, working memory, cognitive flexibility, planning, and fluency (Ozonoff & Strayer, 1997). In the first task, visual attention and visual scanning ability is assessed. The second task assesses cognitive flexibility and the ability to switch attention and working memory. It is particularly suitable for children from different cultural backgrounds since no verbal instructions are required. Llorente et al. (2003), argue with their research data that the test can successfully distinguish typical students from students with neurocognitive disorders (ADHD, LD).5. *Language test*. Proficiency in Greek language was measure through the placement tests "Let's speak Greek I, II and III" in 2012-2013 and the performance tests "I am progressing in Greek I, II and III".

III. RESULTS

Results are presented organized around each research question**.**Regarding visual perception, students with reading disabilities had similar performance (M = 27.76) to that of typical readers (M= 28.86), with a maximum possible performance of 38 points (Table 4). In visual memory, students with reading disabilities had lower scores (M = 17.19) than typical readers (M = 19.76) (Table 11) but no difference was statistically significant between the two groups of students, neither for visual perception nor for visual memory.

Table 4

Means and Standard deviations in visual perception and memory

	Category	Mean	SD
visual perception	LD	27,76	6,43
	Typical	28,86	7,22
visual memory	LD	17,19	7,83
	Typical	19,76	5,66

In regard to the differences between typical and dyslexic Albanian-speaking students in terms of their executive functioning, the presentation of the profile of students utilizes 4 indicators. The first two indices relate to the visual scanning and sequencing function and the next two to cognitive flexibility. According to these indicators, as shown in Table 5, students with LD make more errors than their typical peers in the first condition (CCT1), where they are required to connect numbers in sequencer. However, the difference in the number of errors is not statistically significant, and the errors are few. Furthermore, for both groups of students, there was an almost doubling of the time between the first (CCT1) and second conditions (CCT2), confirming the longer time required to process a simple task such as a sequence of the first 20 numbers when an additional factor, such as colour switching, is introduced. Regarding the time needed to process the two tasks, although students with LD took longer in both conditions, the difference in time is statistically significant only for the time needed to plan and implement sequencing (0,024).

Table 5

Means and standard deviations in executive functions

	Category	Mean	Standard deviation
CCT 1 – errors	LD	0,43	0,70
	Typical	0,29	0,79
CCt 1 – time	LD	90,11	39,09
	Typical	68,94	37,75
CCT 2 – errors	LD	1,14	1,28
	Typical	1,37	3,47
CCT 2 – time	LD	161	63,53
	Typical	143,23	65,50

In order to explore the role of visual perception and memory in reading decoding, fluency and comprehensionfor children learning Greek as a second language, linear regression analysis was used to calculate

the effect of visual perception and memory on reading of the students in the two groups. The results are presented separately for visual perception/attention and visual memory.

The visual perception factor had a statistically significant effect on reading decoding (R^2 = 0. 24 p< 0. 003), fluency (R^2 = 0. 35 p< 0. 000), and comprehension (R^2 = 0. 26 p< 0. 002), for students with LD. In contrast, for typical students, there was no statistically significant effect on any reading skill.

The visual memory factor had a statistically significant effect on decoding (R^2 = 0. 27 p< 0. 001), fluency (R^2 = 0. 18 p< 0. 012) and comprehension (R^2 = 0. 22 p< 0. 005) for students with LD. In contrast, for typical students, it had a statistically significant effect only on the skill of reading decoding (R^2 = 0. 19 p< 0. 012).Overall, the role of visual perception appears to be significant in all reading skills and spelling performance, only for students with LD. The same is true for visual memory, which affects all skills for students with LD and only reading decoding for typical students.

In regard to the role of executive functions in reading decoding, fluency and comprehension, linear regression analysis was used to calculate the effect of executive functions on reading of the students in the two groups. The results are presented in terms of 4 indicators: CCT1 errors, CCT1 time, CCT2 errors and CCT 2 time. When we analyzed the prediction based on each of the 4 indicators, the results were different. The error factor in either CCT1 or CCT2 did not appear to significantly predict any skill for any group of students.

In contrast, the factor of execution time had significant effects on the skills of decoding, fluency and comprehension in both groups of students. Specifically, the time to complete the activity in condition CCT1 predicted all skills for both students with LD and typical students, as shown in Table 6.

Table 6

Effect of time in condition 1 on the reading decoding, fluency, comprehension of students in the two groups

	Category	R^2	B	S.E.	P
Decoding	LD	0,25	-0,25	0,08	0,002
	Typical	0,17	-0,12	0,05	0,017
Fluency	LD	0,33	-0,46	0,12	0,000
	Typical	0,22	-0,40	0,13	0,005
Comprehension	LD	0,23	-0,07	0,02	0,003
	Typical	0,22	-0,06	0,02	0,005

For condition CCT2, the time to complete the activity, (assessing inhibition ability) predicted only fluency for students with LD (R^2 = 0. 16 p< 0. 019), whereas for typical readers it predicted significantly performance in decoding (R^2 = 0. 18 p< 0. 015), fluency (R^2 = 0. 20 p< 0. 007), and comprehension (R^2 = 0. 23 p< 0. 004). Overall, the time it takes students to complete the sequencing task affects all skills for both groups of students. In addition, when students are asked to perform the sequencing task in inhibitory conditions, time affects performance on all skills for typical students and reading fluency for students with LD.

IV. DISCUSSION

The aim of the present study was to investigate the possibility of a valid and early detection of dyslexia in students learning Greek as a second language. This investigation was based on two main hypotheses: a) that native Albanian-speaking dyslexic students have the same basic cognitive characteristics as native Greek-speaking dyslexic students, and b) that native Albanian-speaking dyslexic students differ in basic cognitive indicators from their typical peers with similar proficiency in Greek. Confirming these two hypotheses and identifying the specific cognitive characteristics that distinguish dyslexic students can support the distinction between those bilingual students who fail due to a lack of proficiency in the language of instruction and those who experience intrinsic disabilities and limitations.

Regarding the differences between typical and dyslexic Albanian-speaking students in visual perception and visual memory, these were not confirmed. All students demonstrated the same level of visual perception and attention and struggled at a similar level on the visual memory task. The results of our study do not confirm the findings of earlier relevant research (Fawcett & Nicolson, 1994; Willows, Kruk &Corcos, 1993), which had shown that there were differences between dyslexic and non-dyslexic students in visual and motor activities.

They also do not converge with results from a later study (Everatt, Smythe, Adams & Ocampo, 2000), reporting that bilingual students (who knew English and Sylheti) with poor reading and spelling skills differed from their peers in their ability to recognize shapes. It is possible that the different findings result from the older age of our students, the majority of who were not in the first grades of primary school (Gupta & Garg, 1996), or from the different way of assessing visual perception and memory.

Regarding the role of visual perception in dyslexic non-bilingual students, as argued by Theodoridou, Alevriadou, Semoglou and Anastasiadou (2014), difficulties in visual perception are not a main characteristic of

students with dyslexia. In contrast, for visual memory, the literature is ambiguous. Thus, in some cases significant differences between dyslexics and non-dyslexics are recorded (Koenig, Kosslyn & Wolff, 1991), while others have recorded identical performance for both groups (Bell, 1990;Huba, Vellutino & Scanlon, 1990). In a recent study with Greek students, it was confirmed that there is no difference in visual perception, but there are differences in visual memory skills (Theodoridou, et al., 2014). It is likely that bilingual students in general are not familiar with such complex copying and memorization tasks, and that their overall performance is low.

The role of visual perception appears to be important in all reading skills, but only for students with LD. In this case, visual perception seems to predict more reading fluency and to a lesser extent other skills. It is likely that, for dyslexic students, even a minor difficulty may interact with other more severe deficits, and prevent the use of visual perception to achieve effective reading. Visual memory appears to affect all skills for students with LD while it is only associated with reading decoding for typical students. It is worth pointing out that although the effects of visual memory are statistically significant, they are not large. Evaluating all the results, both visual perception and visual memory appear to be neither key aids nor key barriers for typical bilingual learners.

With regard to dyslexic students, as mentioned, there is a significant relationship between visual perception and memory with reading skills, but neither variable is significantly involved in detecting dyslexia in bilingual students. Although in the international literature (Smythe &Everatt, 2000) visual skills have been suggested as important factors in the detection of dyslexia in bilingual populations, they alone do not contribute to a reliable detection. On the contrary, their role can be important when they interact with other characteristics of children.

The importance of executive functions in learning and thus in learning disabilities has gained much interest from researchers. However, despite this interest, there are no clear findings on their role in specific reading disabilities, mainly because of the different content attributed to these functions. Based on our investigation, Albanian-speaking students with LD do not appear to have an overall different profile from their typical peers, contrary to several related studies. For example, similar studies have documented differences between typical and dyslexic students in attention (Facoetti et al., 2000; Shaywitz & Shaywitz, 2008); response inhibition (Brosnan et al., 2002) and working memory (Ackerman & Dyckman, 1993; Helland & Asbjornsen 2004; Swanson & Ashbaker, 2000). In a recent study (Horowitz-Kraus, 2012) with adolescents with dyslexia, it was highlighted that students with dyslexia experience difficulties in more basic executive functions such as working memory and attention rather than in the switching function.

Albanian-speaking dyslexic students made more errors than their typical peers, either when asked to follow a known sequence or when asked to inhibit this response by taking another factor into account. In addition, they made more errors and, like their typical classmates, took about twice as long to process a simple task, such as the sequence of the first 20 numbers, when an additional factor, in this case colour change, was introduced. However, they were statistically significantly different from their typical peers only in the time it took them to follow a familiar sequence. It should be pointed out here that if studentsare slow in processing familiar concepts, they are likely to have difficulties in planning their action.It is clear from our datathat dyslexic students seem to lag behind only in planning their action.

The difficulty of bilingual students with dyslexia seems to result from the slow processing and planning required to respond even to cognitive tasks they master (such as sequencing). This interpretation is in line with research suggesting that dyslexic students do not experience significant problems compared to typical students (Barkley, Grodzinsky & DuPaul, 1992;Nyden, Gillberg, Hjelmquist & Heiman, 1999) and with those that point out that executive functions, such as planning, can significantly and distinctively influence reading performance (Sesma, et al. , 2009).

The importance of processing speed is confirmed and extended by the study of its effect on the individual skills of reading decoding, fluency and comprehension. While, overall, the role of executive functions does not appear to be significant for reading skills in either group, the time it takes students to complete the sequencing task affects all skills for both groups of students. As for cognitive inhibition ability, when assessed as response time, it again plays an important role in all skills for typical students and in reading fluency for students with LD.

These findings broaden our understanding of the role of executive functions not only in different groups of learners but also in specific reading skills. In this way, our results add to the findings of Locascio, Mahone, Eason and Cutting (2010), in which they tested a large number of executive skills in three groups of students: a) typical students, b) students with reading decoding disabilities, and c) students with exclusively reading comprehension disabilities. As they pointed out based on their analysis, it emerged that the group of readers with disabilities in decoding showed particularly low language memory and planning skills, while students with problems only in reading comprehension showed a deficit exclusively in planning functions.The different quality of the problems in executive functions faced by students with reading comprehension disabilities and

those with reading decoding disabilities has also been supported by research by Palladino and Ferrari (2013). Thus, problems in reading comprehension seem to be linked to problems in inhibiting irrelevant information, while decoding problems are linked to students' difficulties in processing phonological information. We therefore conclude that, although working memory and automatic response inhibition are important for reading in all bilingual learners, they do not appear deficient in dyslexic learners, who seem to face more basic limitations, such as rapid recall of key data when it comes to even simple, familiar sequences. It is widely accepted that students with learning disabilities experience significant difficulties in executive functions (Borkowski, Estada, Milstead & Hale, 1989; Hooper, Swartz, Wakely, de Kruif & Montgomery, 2002). But if we take into account that executive functions can be divided into two broad subcategories (Denckla, 1996; Reid Lyon & Krasneger, 1996), we can better interpret our findings in relation to the existing relevant literature. It is concluded that the involvement of different executive functions in different reading skills is modified for dyslexic or bilingual learners.

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