Reading and Working Memory Skills in Students with Dyslexia and Normal Written Language Development in Lebanon within a Multilingual Society

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ABSTRACT

In Lebanon, as in many multilingual countries, the evaluation of written language is a complicated task due to the absence of standardized tools calibrated on the Lebanese population. In order to help speech pathologists understand the development of second-language reading and to set up effective and adapted care based on a reliable diagnosis, a pilot study was started on the basis of the French ODEDYS battery. This study aims particularly to explore the development of word reading, working memory (WM), as well as their possible links. The study population is made up of a group of dyslexic and normal development children ranging from 8 to 10 years old. The results obtained in the tests show that the identification of written words is not necessarily linked to the development of WM and that multilingualism does not necessarily influence cognitive abilities, more particularly the working memory.

Keywords: *Lebanon – Reading assessment – regular words – non-words – working memory.*

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INTRODUCTION

The assessment, and more particularly of the written language, remains a new task that is little used in multilingual contexts like Lebanon, due to the absence of suitable tools and the lack of data concerning multilingual development standards. The clinician therefore finds himself confronted with uncertain clinical choices, having no tools allowing him in the first place to make a credible diagnosis and therefore to initiate appropriate care. Indeed, the assessment is made from tools from abroad translated into Arabic, or used as is, without calibration or standardization on the Lebanese population, or even by a qualitative clinical observation without recourse to tests. In order to obtain reference data on the development of written language in French as a second language, we chose to work on the ODEDYS battery, aimed at screening for specific disorders of the written language in France. Various pilot studies have been set up around this battery, in order to better understand how the learning of written language takes place in a child with French as a second language.

The act of reading involves various complex and varied cognitive processes, including working memory (WM) which has a role both in identifying words and in understanding a text. However, a lot of research also advances the influence of bilingualism on cognitive capacities, notably WM, by explaining that the use of two or three languages from an early age gives better results to cognitive tasks, both in terms of efficiency and processing speed.

In Lebanon, a country where education is compulsory in two/three languages, children aged 5-6 are subject to learning literary Arabic, different from the spoken dialect, and a foreign language, French or/and English. It then seems interesting to us to discover if the levels of French in written language are offset compared to those of monolingual French children, and if working memory plays its role, which is widely mentioned, in reading words.

The objectives of this study are to obtain knowledge relating to the development of the identification of words and non-words as well as working memory during the primary cycle, and to study their possible link.

In the first part, we will develop the theoretical framework on which we relied to develop our problem. This part will be divided into three chapters in which we will present a synthesis of the available studies respectively concerning the linguistic situation in Lebanon, the acquisition of reading and its evolution, WM and its development, the links between WM and reading. From the data presented in this part, we will elaborate the problem and we will specify the objectives and the general hypotheses of this study.

In the practical part, we will present the results concerning the evolution of the identification of words and non-words and of working memory, and the possible correlations between reading words and WM. We will discuss the results in a final part.

HYPOTHESIS AND OBJECTIVES

The literature shows the close link between working memory and reading skills (Alloway, 2009; Gathercole and Wang, 2012; Pham and Hasson, 2014; Carvalho, 2014) which represent a major determinant

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of academic success (Barrouillet, Camos, Morlaix and Suchaut, 2008). Indeed, to explain certain difficulties in fundamental acquisitions, such as learning new words and reading, we often refer to so-called general deficits in working memory alongside skills specific to the field of acquisition (Alloway, 2009).

However, the mechanism of their interaction is not yet clear: some researchers claim that reading difficulties appear because during the first stages of reading acquisition, the child needs strong attentional resources to establish a connection between phonemes and their graphic representations (Cohen-Mimran and Sapir, 2007); others highlight the role of working memory that develops throughout the first grades of primary school and intervenes in reading procedures (Ben-Yehudah and Fiez, 2007). This last point is supported by the data in functional neuroimaging.

The current linguistic situation in Lebanon, characterized by the expansion of multilingualism, has an impact both on children's oral language development and on written learning. How does reading develop in Lebanese English/French-speaking children? What about working memory?

Given the linguistic situation in Lebanon characterized by multilingualism (French/English and Arabic) on the one hand and diglossia on the other hand, it is necessary in the field of speech therapy to be able to assess reading and memory of work in order to carry out a reliable screening for specific disorders of written language and to adapt rehabilitation as well as possible. However, there are still no benchmarking and assessment tools for the Lebanese population. The reading and memory tests used with French-speaking children come from tests calibrated on the French population. The assessment then becomes qualitative despite the presence of scores, and the diagnosis is imprecise and undefined.

Among the tests present in ODEDYS, this study relates to the regular word and non-words reading tests and the working memory tests. It was made with normal reader children and dyslexic children. The choice of this test stems mainly from the need for a screening tool for dyslexic children in Lebanon. Similarly, it is a rapid screening test (20 minutes to half an hour) which allows a first assessment of the functionality of the reading procedures and a first approach to the associated cognitive disorders. Added to all this, its good validity and specificity in France.

We would like to propose two main hypotheses which made our thinking progress. They will be confirmed or denied later in the discussion:

H1: The scores in word reading and in working memory improve according to the evolution of the age.

H2: The working memory is linked to the reading performance of regular words and non-words.

MATERIAL AND METHODS

The population studied is made up of 163 bilingual Lebanese children with normal reading skills and dyslexic children, schooled in the primary cycle, from 8 to 10 years old. These children are divided equally by sex. There are seven schools chosen. These are private Lebanese French schools spread over three major regions: North, South and Beirut (capital of Lebanon).

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The recruitment of these children was carried out in French-speaking schools of average socio-cultural level with recruitment conditions:

– Children who have not doubled their class.

– Children with mixed abilities (not only the children who get excellent grades)

Recruitment took place in three stages:

– French-speaking schools have been chosen in different Lebanese regions.

– The directors of the schools chose subjects according to the imposed criteria and sent letters to the parents in order to obtain their agreement.

– The dates for the examinations have been decided with the school directors.

The main objective of this research is to obtain knowledge on the acquisition of reading and working memory in bilingual children and on the link between these two mechanisms. The tests on which we are based, the regular word and non-words reading tests (Annex 1) and the memory backwards (Annex 2), are included in a large protocol including ODEDYS. However, the tests that particularly interest us in this study are the following:

– *Reading of regular words and non-words:* This test is made up of two lists of words: regular words and non-words. It takes approximately 5 minutes to finish it. The word lists are presented to the child one after the other, starting the stopwatch at the start of each column. The child should read the words vertically as quickly as possible, making as few mistakes as possible.

The scores are obtained as follows: a point for the word correctly read by noting the time

in seconds and the success score out of 20 for each column.

– *Working memory (MT):* This test consists of series of numbers spoken verbally to the child, who in turn must repeat them in reverse order.

It shows us the capacity of the child to store, manipulate and evoke elements and makes it possible to determine its span (the maximum number of elements that the subject can recall immediately).

The test is timed and stopped when the child has two successive failures for a sequence of the same number of digits. We note the span which is the number of digits of the longest sequence given correctly and backwards.

Finally, it is important to note that several conditions were followed:

– Respect for the succession of items and tests;

– The use of the same material for all children;

– The adoption of the same instruction for all children;

– The instructions were given in French.

– The tests were individual and took place in a quiet room of the school where the examiner was alone with the child. Assignments were made during school hours: the child left the classroom for the duration of the assessment.

RESULTS

Prior to the results, it seems interesting to show some theoretical aspects regarding dyslexia and working memory, in order to

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have better view of the results and the discussion.

On the first hand, regarding the linguistic context, Lebanon was confronted with several political events, making this country a territory of incursions of several civilizations. Occupied by the Phoenicians, around the 15th century BC, it was soon invaded by a new civilization, which is the Assyrians, followed by the Egyptians, the Seleucids, the Romans and the Byzantines. Finally, Lebanon has opened up to a new political era: that of the French mandate. Since then, France has gradually set up its mandatory administration and has also developed the institutional system of Lebanon. These important adventures as well as the current geographical position of Lebanon, make this country a cross of several languages. The Lebanese is then confronted with multilingualism from an early age allowing him to enrich himself and to develop. However, the official language of the country is the Arabic language but many Lebanese learn English alongside French and consider English and French as a language necessary for their future.

In addition, the linguistic situation is further complicated at the level of school education with the phenomenon of "diglossia" of the Arabic language. Diglossia is the use of two varieties of the same language used in different social activities.

On the second hand, learning to read does not develop spontaneously, unlike oral language. It requires formal learning to develop processes and functional components specific to reading. It is a complex activity calling on many cognitive functions and especially information processing.

What differentiates competent readers from others is the fact that their word identification mechanisms are faster than those of bad readers (Plaut & Booth, 2006)

Speaking of reading models, we will develop the model of Frith (1985), which is a model describing three reading strategies acquired successively and which interact together to achieve competent reading. The choice of this model is based on its frequency of use in multiple searches and which explains the mechanism of word identification, the only specific mechanism of reading.

The logographic strategy consists in the global and contextual recognition of words thanks to visual characteristics. The logographic stage constitutes an initial phase during which the child takes into account certain particularities, clues allowing him to "guess" words. These indices can be of several environmental orders or most often visual. But it only allows recognition of a limited number of words and with great uncertainty. At this stage, the linguistic information is treated like an image; the child can never read a new word alone.

The alphabetic strategy, for its part, is based on the identification of letters thanks to the acquisition of the grapheme-phoneme correspondence. The child then uses the correspondences between the graphemes and the phonemes, by assembly strategy and can read the known or rare words but also the pseudo-words. However, he has difficulty reading irregular words and therefore makes frequent regularization errors. Phonology therefore plays a key role in this stage of learning to read, as does working memory, which does storage and manipulation to keep the assembled graphemes in memory.

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Finally, the spelling strategy which allows the child to visually recognize sequences of letters combined to form words, gives him the possibility of recognizing a word as an entity and creating a spelling lexicon, using the global strategy. The child will gradually build up a lexical repertoire of words.

However, for this activity to develop in a harmonious way, several cognitive factors are put in place to facilitate this development. Working memory, one of the fundamental contributors to the learning of new words, reading or other learning has given rise in recent years to many theoretical conceptions and empirical research.

According to Baddeley (1986), the working memory is a "system for the temporary maintenance and manipulation of information, necessary for performing complex cognitive activities, such as comprehension, learning, reasoning".

Likewise, working memory is considered to be a gateway to long-term memory: anything that has been processed and performed in working memory can be transmitted to long-term memory. So called span, which defines the size of the working memory, the longest series of elements capable of being memorized after a single presentation, also called memory span. Working memory can be verbal, visual or visuospatial, but "because of its implications in learning, particularly at school, it is the auditory-verbal working memory that is best known and the most studied" (Mazeau 2013, p.15).

For Alloway, (2010), because of their central role in all academic learning (reading, calculation, comprehension, long-term memorization), performance in working memory is the best predictor of children's academic success. Working memory thus develops continuously according to each age.

In addition, a study made in 2012 shows that bilingual children have a faster processing speed than monolingual children and better handling of elements, which undoubtedly positively affects working memory.

More specifically, a study carried out in 2014 with bilingual Arab children shows that they perform better than monolinguals in all tasks of executive function and in particular working memory (Abdelgafar et al., 2014). This is explained on one hand by their ability to change quickly from one language to another and on the other hand by the use of both languages simultaneously (Rodriguez-Fornells et al., 2006). It is important to note also that Arab children who face diglossia in everyday life have the same functioning as bilingual children who use another language (Moawad, 2006).

Then again, dyslexia is a generic term which indicates the existence of difficulties in the acquisition of written language (Lussier and Flessas, 2009). In DSM-5, learning disorders are now grouped under the general term "Neurodevelopmental disorders" with autism spectrum disorders, psychomotor disorders (ADD / ADHD, TAC, Gilles de la Tourette syndrome and tics), mental impairment, communication disorders. These different disorders are the result of a complex interaction between genetic, environmental and psychosocial risk factors. They interfere with the acquisition and use of one or more of the academic skills of reading, writing, arithmetic or mathematical reasoning.

The results collected following the taking of the Regular (Reg) and Non-words (NW) and MT tests, will be presented and analyzed.

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The children's responses were first entered into Excel. Descriptive statistics were produced and allowed us to obtain total scores for each child, means and standard deviations for each group. Furthermore, since all the scores in our test do not have a normal distribution, and the population is reduced, we used non-parametric tests: the Kruskal Wallis Test (H) for inter-group comparisons and Spearman's Rho test (rs) for correlations. These statistics were produced using SPSS 20 software.

In the first section we will present the evolution of the scores in Reg, NW and MT according to the ages. In a subsequent section, we will examine the correlations between Reg, NW and MT.

Evolution of Reg, NW and MT scores according to ages:

Note that we will use M for Mean and SD for standard deviation. SPSS and Microsoft excel were used for the results.

We note that the degree of significance *p* is represented in the tables and graphs by stars *(p <0.05 *; p <0.01 **; p <0.001 ***).*

The graphs show the evolution of reading scores according to each age. In figure 1, we see that the means for the Reg test change slightly according to the age, going from (M = 17.3; SD = 2.2) for 8 years old to (M = 18.7; SD = 1, 1*, *p <0.05 **) for 10 years old. The scores are also almost equivalent.
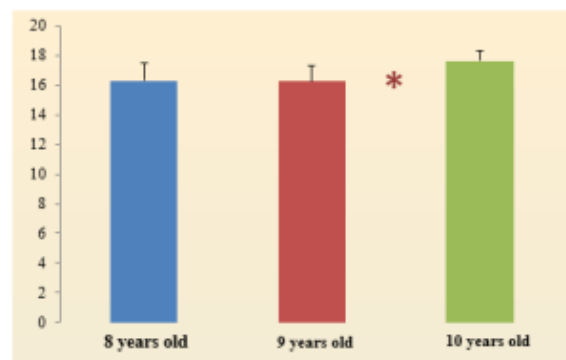
Figure 1:

the evolution of reading regular words
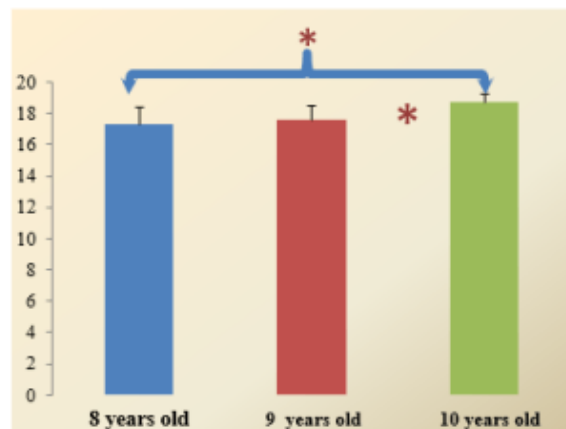
Likewise, figure 2 indicates that the means for the NW test change according to the age, going from (M = 16.3; SD = 2.3) for 8 years old to (M = 17.6; SD = 1, 4*, *p <0.05 **) for 10 years old.

Figure 2:

the evolution of reading non-words

Also, the analysis of the MT results shows a clear evolution of the MT of the age 8 up to age 10 respectively: M = 3.2; SD = 0.8 and M = 3.6; SD = 0.8.

Furthermore, we note that the results suggest that WM did not influence the reading level of the children of the different ages.

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DISCUSSION

Following the exposure of the results obtained, we recall the objective of this study which aims to obtain knowledge as to the development of reading and working memory in the multilingual context encountered in Lebanon and to identify if a link would exist between the two. The goal is to understand normal development in Lebanese children before studying the deviations that may exist in the pathology and to measure if a screening tool like ODEDYS could be used in terms of its scores on the bilingual Lebanese population, without risking lead to false diagnoses.

Below we will discuss the results obtained throughout this study by comparing them with theoretical data.

The first hypothesis (H1) admits the presence of an evolution in terms of reading words and working memory according to the ages. As already mentioned in the theoretical part, the child goes through 3 stages to access a competent reading, the logographic, alphabetical and orthographic stage (Frith, 1985). These three reading strategies are acquired successively and interact together to achieve competent reading. Similarly, the capacity of working memory increases during childhood from a quantitative and qualitative point of view (Pross, Gaonac'h, and Gaux, 2008). Returning to the results, we note in the three tests a quasi-equivalence of the results. In the Reg and NW tests, we note slightly significant differences between the ages of 9 and 10, but no significant difference concerning the MT. This hypothesis can therefore only be partially confirmed.

The second hypothesis (H2) presupposes that working memory is linked to the performance of reading regular words and non-words. Indeed, according to the Baddeley working memory model, "the verbal information read by the subject is recorded and stored in the form of a phonetic code in the phonological stock. The more the child manages to mobilize his resources in working memory, the more he will be able to recognize the words and quickly access the lexicon." (Baddeley and Hitch, 1974).

With regard to the results noted in this study, they are being difficult to interpret, and having noted before that the WM does not vary much according to the ages.

So, the link between WM and reading Reg and NW depends largely on the lack of variation in the results, but also on the fact that, the child in the lower age needs WM more than the children in the higher ages. Indeed, "what differentiates competent readers from others is the fact that their mechanisms for identifying words are faster than those of bad readers" (Sprenger-Charolles and Serniclaes, 2003).

However, it would be interesting to confirm the validity of the results by checking their specificity on a larger population, which was not possible in this study, given the reduced number and the time available.

The results obtained can also be explained by two other ideas: first, the correlation of WM with learning to read may appear more in DL children because it is with them that this memory is most impaired. "Dyslexia is characterized by a short-term memory disorder and more particularly short-term auditory-verbal memory" (Pakzad and Rogé, 2004). It is common to observe a reduced verbal span of dyslexic children who cannot memorize a series of numbers or syllables beyond five items. According to Corbin

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Lucie et al. (2012), dyslexic children have a developmental delay in storage capacity. Then, as the executive functions are in great connection with the learning of reading and that they develop continuously, they can intervene more in the activity of reading words, by inhibiting, planning and selecting the relevant elements in a way more skillful, thereby reducing the intervention of WM. "The development of capacities in working memory is very dependent on executive, dynamic, information processing capacities, their management, their distribution between several elements: their effectiveness is therefore essentially constrained by the level of efficiency of executive functions" (Mazeau and Moret, 2013, p.31).

In short, it would be interesting to continue this research by choosing a larger population, to compare according to ages and also studying the written comprehension of which the literature testifies to its important link with WM.

CONCLUSION

Learning written language is a challenge for most children. Access to the written world is often constrained, presenting some of the obstacles in their school life. In addition, good mastery often requires prerequisites that act simultaneously, such as visual, auditory, attentional, memory, executive, etc. However, a dysfunction of these can influence the effectiveness of its development. It is therefore essential to have development standards in order to be able to detect malfunctions early, and effectively provide the necessary care.

Speech therapy in Lebanon faces various obstacles, both in terms of assessment, diagnosis and care, due to a lack of knowledge of the typical development of written language in a bilingual context and of tools to distinguish people with dyslexia sufferers from those in the acquisition phase in a second language. It then seems necessary to pilot tests recognized as reliable in the monolingual population to verify whether the results obtained from the French-speaking Lebanese population are within the standards or not and thus to avoid false diagnoses.

A reproduction of this study with a larger population and more varied memory and reading tests seems particularly interesting to us. Indeed, it would be interesting to also evaluate the visuo-spatial working memory, which according to the literature has a great influence on the acquisition and the efficiency of reading.

Finally, this study allowed us to identify scores for bilingual Lebanese children almost similar to those of French. It would of course be necessary to examine all the results of the battery to see if a calibration is really essential, while also considering the different levels of bilingualism which can have consequences on the reading levels. All of this research should gradually contribute to better knowledge and the establishment of credible tools in speech therapy.

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