Ministry of Higher Education and Scientific Research

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Faculty of Arts and Languages

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Dissertation Presented in Partial Fulfilment of the Requirements for a Master's Degree in Linguistics and Didactics

Effectiveness of the Multisensory Approach in Teaching Reading to a Normal Class with Integrated Dyslexic Cases: A Primary School Case Study

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Academic Year: 2019 – 2020

Dedication

In memory of Mme Rahma Mahi and Prof. Mouhamed Tahar Chouchane.

You are remembered dearly forever in our hearts.

To your blessed souls, I dedicate this dissertation.

I know you would have liked to see the fruit of this work.

Rest in peace.

Acknowledgement

First, I would like to express my gratitude to Prof. Bouhania for having accepted to supervise this thesis and guide this work throughout.

I warmly thank Dr. Mayouf-Toumi for his advice and availability. Thank you for making your neuropsychological expertise accessible to me whenever I needed it and for conducting the preliminary testing and diagnosis essential to the making of this work.

I would also like to thank the members of the jury who do me the honour of reading and evaluating this dissertation.

My gratitude is also extended to the inspectors, the schools administrators and the teachers who accepted the realisation of this research despite their professional constraints.

I thank the parents for their active participation and their trust. I also address my thanks to the children without whom this work would not have been possible and whose remarkable desire to learn inspires me to be a better teacher.

I would like to thank my family for having confidently accompanied me in this work. I think particularly and affectionately of my parents who allowed me to stand on my own feet, of my sister Chaimaa whom I admire for her intelligence and strength, and of my brothers for whom I have an affection unwavering.

My best wishes go to my classmate Linda for all the support and encouragement she has given me, and the patience and unfaltering faith she has in me. I am eternally grateful for the generosity of her friendship.

Finally, I thank my friends and all those who directly or indirectly participated in this work and who could not be cited.

Abstract

Developmental dyslexia, which is the focus of this study, has been the subject of much research within the scientific community regarding its aetiology, but to date, there are very few training programs in Algeria designed to integrate dyslexic pupils in normal class settings. This research studies the effects of a multisensory training program requiring haptic (tactile-kinaesthetic), visual and auditory modalities in teaching reading skills to dyslexic and normal pupils together. Three classes participate in the experiment. The first of these (experimental) includes a dyslexic case and benefits from training consisting of exercises designed to develop metaphonological skills, knowledge of letters and letter-sound associations. Writing activities and haptic and visuo-haptic exploration of letters are also offered. The second (placebo) class receives math-focused training while the third (control) class receives no training. Students' performance is measured before and after training by various tests related to reading. The results of the post-test show a greater improvement in the reading of single words, graphics as well as the level of phonological awareness among the pupils in the experimental class. However, the latter does not differ from the other two classes in silent reading comprehension and dictation. On the other hand, a deferred evaluation, carried out more than two months after the interruption of training, makes it possible to highlight the strong impact of this training on the reading level of the pupils in the experimental class. Finally, when assessing the records of most pupils according to a national assessment scale of the reading level at the entrance to CE2, the pupils of this same class obtain, in the topics dealing with reading comprehension and in copying, scores significantly higher than the scores of pupils of the control class.

Keywords: Developmental dyslexia, reading, multisensory approach, haptic, visual, auditory

Résumé

La dyslexie développementale, qui est au centre de cette étude, a fait l'objet de nombreuses recherches au sein de la communauté scientifique concernant son étiologie. Or à ce jour, il existe très peu de programmes de formation conçus pour intégrer les élèves dyslexiques en classe normale. Cette recherche étudie les effets d'une approche de formation multisensorielle nécessitant des modalités haptiques (tactiles-kinesthésiques), visuelles et auditives pour aider les normo-lecteurs et les élèves dyslexiques à développer leurs compétences en lecture. Trois classes participent à l'expérience. La première (expérimentale) intègre un cas dyslexique et bénéficie d'une formation comprenant des exercices destinés à développer des compétences méta-phonologiques, la connaissance des lettres et des associations lettre-son. Des activités d'écriture et d'exploration haptique et visuo-haptique des lettres sont également proposées. La deuxième classe (placebo) reçoit une formation axée sur les mathématiques tandis que la troisième classe (témoin) ne reçoit aucune formation. Les performances des élèves sont mesurées avant et après la formation par différents tests relatifs à la lecture. Les résultats du post-test montrent une plus grande amélioration de la lecture des mots simples, des graphiques ainsi que du niveau de conscience phonologique des élèves de la classe expérimentale. Cependant, cette dernière ne diffère pas des deux autres classes en compréhension de lecture silencieuse et en dictée. En revanche, une évaluation différée réalisée plus de deux mois après l'interruption de la formation permet de mettre en évidence le fort impact de cette formation sur le niveau de lecture des élèves de la classe expérimentale. Enfin, en évaluant les cahiers de la plupart des élèves, selon une échelle nationale d'évaluation de la lecture à l'entrée du CE2, les élèves de cette même classe obtiennent, dans les matières traitant de la compréhension en lecture et en copie, des scores nettement supérieurs aux scores des élèves de la classe témoin.

Mots clés: Dyslexie développementale, lecture, approche multisensorielle, haptique, visuelle, auditive

ملخص

لازال عسر القراءة التنموي ، وهو محور هذا البحث ، موضوعًا للكثير من الدراسات داخل المجتمع العلمي فيما يتعلق بمسبباته، ولكن حتى الآن ، هناك عدد قليل جدًا من البرامج التدريبية المصممة لدمج التلاميذ الذين يعانون من عسر القراءة في بيئة الأقسام العادية. يدرس هذا البحث آثار نهج التدريب متعدد الحواس الذي يتطلب أساليب اللمس (الحركية اللمسية) والطرائق البصرية والسمعية في تعليم التلاميذ الطبيعيين و الذين يعانون من عسر القراءة على حد سواء و تطوير مهارات القراءة لديهم. ثلاث أقسام شاركت في التجربة. يتضمن القسم الأول (التجريبي) حالة عُسر قراءة ويستفيد من التدريب الذي يتكون من تمارين مصممة لتطوير المهارات الميتافونولوجية والتعرف على الحروف و الربط بين الصوت و الحرف، كما يتم تقديم أنشطة الكتابة والاستكشاف اللمسي للحروف. يتلقى القسم الثاني (العرضي) تدريبًا يركز على الرياضيات بينما لا يتلقى القسم الثالث (الشاهد) أي تدريب. يتم قياس أداء التلاميذ قبل وبعد التدريب من خلال اختبارات متنوعة تتعلق بالقراءة. تظهر نتائج إختبار ما بعد التدريب تحسنًا أكبر في قراءة الكلمات المفردة والحروف وكذلك مستوى الوعي الصوتي بين تلاميذ القسم التجريبي. ومع ذلك فإن هذا الأخير لا يختلف عن القسمين الأخرين في فهم القراءة الصامتة والإملاء. من ناحية أخرى ، فإن التقييم الأخير الذي تم إجراؤه بعد أكثر من شهرين من انقطاع التدريب يبرز التأثير القوي لهذا المنهج على مستوى القراءة لدى طلاب الفصل التجريبي. أخيرًا ، عند تقييم سجلات معظم التلاميذ ، وفقًا لمقياس تقييم وطني للقراءة عند مدخل السنة الثانية إبتدائي، يسجل القسم التجريبي تفوق واضح في الموضوعات التي تتناول فهم القراءة والنسخ نظرا لحصول تلاميذه على درجات أعلى بكثير من تلاميذ القسم الشاهد.

الكلمات المفتاحية: عسر القراءة التنموي ، القراءة ، المنهج متعدد الحواس ، اللمسي ، البصري ، السمعي

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Abbreviations and Acronyms

Inserm: Institut national de la santé et de la recherche médicale

DSM-IV: Diagnostic and Statistical Manual of Mental Disorders, fourth edition

WHO: World Health Organisation

CE2: Cours Élémentaire 2eme Année

WISC-IV: Child Wechsler Intelligence Scale

TEA-CH: Test of Everyday Attention for Children

VMI: Developmental Test of Visual-Motor Integration

CMS: Child Memory Scale

BELEC: Written Language and Disorders Assessment Battery Reading Text

NEPSY: Child Neuropsychological Assessment

EG: Experimental Group

CG: Control Group

PG: Placebo Group

General Introduction

According to the Algerian ministry of education, reading can be defined as the process of recognizing, by browsing with the eyes, the graphic signs that transcribe a language, the sounds to which they correspond or the combinations they form, in order to grasp their meaning (Braille can apparently be thought of as indirect eye reading).

If we consider this definition, we can expect several kinds of dysfunctions getting involved in the difficulties that arise while reading. Although the written language may be normally seen by a reader, sign recognition can be disturbed; looking at the said signs can also be a source of difficulty. Similarly, if the recognition of sounds in a given language is impaired, the reading process may also be disrupted.

No one doubts that since man wanted to convey meaning through written signs, some have found it difficult to understand these signs. However, for the expert reader, reading a text seems extremely simple, and even becomes at times almost automatic. Therefore, it is easy to understand that the study of this process (so simple in appearance and which appears so complex when one tries to touch on its operation), as well as associated pathologies, could have interested generations of researchers.

It is therefore also natural that these same researchers were very interested in the genesis of reading, that is to say, how learning children learn to read. Recent advances in neuroscience have made it possible to make visible the cerebral activity constituting reading. All the studies that dealt with this highly complex brain activity have allowed the creation of a neurobiological corpus integrating knowledge from various fields such as linguistics, developmental psychology, neurology, genetics, epidemiology, as well as education. The perspectives that emerge from such multi-level integration, in particular at the level of the

attentional processes that allow deciphering the reading codes, suggest new avenues of scientific exploration and perhaps new therapies and strategies to improve reading.

Learning to read is without question a fundamental step in the education of a child in any culture and has become an environmental factor helping to guide the development of the child's brain through the participation of many cognitive networks working together to allow the child to develop new skills. Most children learn to read and write and achieve a sufficient level of skill. However, a significant part of them (between 4% and 9%) appears to have severe problems in this area. A major portion of these children is dyslexic. According to the collective expertise of Inserm, this specific disorder in learning to read written language affects at least 3% to 5% of 7-year-old children. Even in the most optimistic figures, the incidence of dyslexia exceeds the cumulative incidence of mental retardation, cerebral palsy and epilepsy; as such, it already represents a major public health problem.

A child with dyslexia will spontaneously (consciously or not) try to implement compensatory strategies, but in general this process is very difficult, if not impossible in some cases. It is therefore necessary to integrate these children through a specific training program, the development and effectiveness of which seems to be hampered by the great heterogeneity of the phenotypes encountered in children with dyslexia as well as the polarised learning styles of normal children.

We will say that research on developmental dyslexia is not just a matter of psychology or medicine since the sciences of language, such as psycholinguistics, phonology or neurolinguistics, could also remedy the problem of dyslexia.

In order to carry out our research, we asked the following questions:

- Should we offer differentiated pedagogy adapted to the needs of the dyslexic child as well as those of a normal child?

- Should we focus instead on pupils with specific learning difficulties in trying to reconcile an integrative teaching approach?

A point to emphasize here is that we do not make any anticipated judgments about the effectiveness or not of the methods already used in the teaching/learning of Arabic in Algeria.

Throughout the elaboration of this research, we have managed to formulate and investigate the following hypotheses:

- Understanding the behaviour of the dyslexic child could help us propose an effective teaching method for all readers;
- The use of the multisensory approach, already used in rehabilitating dyslexic pupils could have the same positive effects on the development of the reading skills in normal pupils.
- Finally, the constant solicitation of the dyslexic child in a normal setting would improve the reading performance of the classroom in general.

To validate the effect of the multisensory approach in helping dyslexic children and those who show mild to no reading difficulties an experimental research design with pre-test and post-test is used. The experimental-placebo-control method is also used to ensure the reliability of the results attained throughout a multisensory training program implemented in thirteen teaching sessions during which the progress of learning is assessed on several accounts.

To provide necessary theoretical background, the first chapter tackles the topic of reading and Arabic. It begins by providing relevant definitions and describing the act of reading. It further discusses the main models of learning to read as well as some general

concepts related to the development of reading. General characteristics of Arabic are then reported along with some elements specific to reading in Arabic.

The second chapter of this dissertation is devoted to developmental dyslexia. Different definitions of dyslexia, types and the epidemiology of this disorder are presented. The reasons behind this developmental disorder and its effects on the child are then discussed; and further presented are a set of methods, steps and procedures used in diagnosis.

The third chapter begins by summarising the major skills present in expert reading and describing how the multisensory approach plays a direct role in promoting the acquisition of these skills. It further recommends a series of multisensory strategies englobed in a training program that could be used in helping dyslexic as well as normal pupils learn to read effectively.

The fourth chapter is dedicated to the methodology used in this research. It describes the profile of the participants, the measuring instruments, and the progress of the data collection as well as the experimental plan. Then, the results of the study are presented along with the analysis of data and presentation of various test results as well as the learning scale. Finally, the discussion and conclusion part elaborates on the main findings and the possible shortcomings of the methods used in this study.

Chapter One: Reading and Arabic

1. Chapter One: Reading and Arabic

Introduction

Reading is one of the most important tools for acquiring knowledge, assimilating culture and communicating with the products of the human mind. This activity is the result of several complex knowledge processes that include treating different levels of language and interfering with multiple sensory, motor and mental mechanisms. Pupils are heavily dependent on reading in all subjects, as it is considered an introduction to learning, so teachers focus almost exclusively on promoting reading skills in the first years of schooling. This fundamental human activity is nothing more than an attempt to understand the language produced by others, as the pupils work on analyzing the words and symbols in front of them to obtain the meaning of the written text.

This chapter tries to explain how the child's reading develops; that is to say, how the child relates his or her bank of words (mental lexicon) with the written text. It comprises several definitions of reading, prominent reading models, the components of the reading act, and finally some useful concepts about the reading activity in general. Once a clear picture of the skill of reading is drawn, general characteristics of the Arabic language are then presented and related to the specificities of reading in Arabic.

1.1. Definitions of Reading

The definition of reading in the relevant literature is closely linked to the theoretical approach upon which this definition is based since the activity of reading represents a subject of interest in different disciplines such as cognitive psychology, neuropsychology, pedagogy and speech therapy.

In language teaching, it is often said that ‘to read is to understand’; but on closer inspection, this definition is somewhat reductive of the act of reading which is deeper and more complex.

According to Leu and Kinzer (2011, p. 9), the act of reading constitutes "the product of primary processes" (i.e. correspondence between graphemes and phonemes, partial deciphering of a word, immediate recognition of syllables or words), "and of superior processes" (i.e. intelligence of the language, syntactic-semantic predictions, using context to relate elements).

For Gregoire and Pierart (1994, p. 24), reading is considered "… a complex mental skill". It is not a single skill but rather the result of several distinct, albeit complementary, components, involving both skills specific to the particular field of processing written information and much more general cognitive skills (for example, attention, memorization, intellectual aptitude, and general knowledge) which intervene in many other fields.

These two definitions cited above point to the presence of two complementary and inseparable components: the decoding processes that allow the identification of written words and the syntactic and semantic integration processes related to comprehension. Decoding makes it easier to understand, but one also needs the cognitive and linguistic skills necessary to understand a written message.

In a reading activity, the reader becomes fully involved and mobilizes diverse and interactive skills, because this activity is considered an active search and a construction of meaning. On this point, Gilabert (2001, p. 22) specifies that the act of reading is "the capacity to construct a meaning from what we perceive, according to modalities or strategies of which the reader is master and which he chooses depending on the types of texts and his reading project".

This definition seems relevant for the simple reason that it emphasizes two pillars of reading: the reader and the written material (the text). Furthermore, it defines reading as a relational activity, which connects a reader with a text but also a reader with other readers as in a class where the practice of reading is shared with learners. From this fact, the practice of reading becomes fundamentally social. This activity is omnipresent in school, family life, culture, work, politics, and health. It is therefore ‘everywhere’ to fulfil a crucial function, that of communication in a broader sense.

Reading is also a cultural activity, an activity that represents "a practice, bringing into play knowledge, representations, investments, values as well as complex physical, psychological and cognitive operations, aiming to construct meaning with reference to a written text" (Rondal, 1982).

These and other definitions, despite the differences between them, agree on the complex nature of reading, which represents the outcome of several activities of a different but interconnected nature.

1.2.Reading Models

Reading has long been defined as a visual process by which a reader deciphers words presented on a written medium. This definition existed up until the 1980s, when reading was seen not only as a visual process but also as a cognitive process, as an active and interactive process, as a process of meaning and communication.

1.2.1 Reading is an Active Process

The long-held assumption has been that ‘writing’ is an active process and ‘reading’ is a passive process. Nowadays, reading is considered an active process rather than a visual one. To read the text, the reader processes his or her data by assuming hypotheses that he or she

tries to verify during reading. For Jenkins (1968, p. 219), it is difficult for an adult to understand this process, because it has been automated.

To understand this process, Jenkins proposed a series of exercises presenting altered texts extracted from Alice's work in Wonderland, for example:

Oxxx uxxn a txxx thxxx xxx a lixxxx gxxx nxxxx Axxx.

To read this sentence, the reader calls on his or her knowledge of the language (syntagmatic, semantic and graphic clues). For example, the reader knows that a word starting with a capital letter inside the sentence is a proper noun. This shows that reading is an active process, not a passive one (p.222).

1.2.2 Reading is a Process of Language

For Cunningham and Allington (2007, p. 35), there is a relationship between reading and speaking. The person who speaks a language already has a good knowledge to understand the written form of this language because there are common points between oral and written utterances. The process of reading is very similar to that of speaking.

There are, however, many differences between reading and writing. We can cite, for example, the mode of reception; orally, it is auditory while in writing, it is visual. Thus, the oral mode uses intonation, while the written mode uses typographical elements. Another difference is in terms of structure. Orally, gestures, that is to say the context of the conversation, are often used to understand, while writing is more structured using typographical signs or time to understand. Therefore, writing is decontextualized. It should be noted that the degree of oral contextualization depends on the type of situation (direct communication, telephone communication, etc.).

It is on this idea of contextualized language (orally) and decontextualized language (in writing), that Giasson (2006, p. 12) concludes that "the apprentice reader, who switches from oral to written language, will therefore have to familiarize themselves with the decontextualized nature of reading".

Written language needs to be decontextualized, that is to say, it cannot be anchored in a situation of immediate communication because it must be able to be read and understood by any reader. The reader will have to learn to adjust to the decontextualized nature of the written text in order to be able to decipher meaning more adequately. Children who have more decontextualized oral language experiences, or who are often read to, will already be more aware of the differences between oral and written utterances, and as a result be prone to read more efficiently.

1.2.3 Reading is an Indivisible Process

Giasson (2006) criticized the conventional methods of teaching reading. For her, one cannot teach reading by cutting oral or written language into subcomponents and by proposing activities relating to isolated skills. It is better to have an interaction of all the skills of a reader (comprehension, analysis, knowledge of the language ... etc.) to train a more competent reader.

To better clarify her point of view, she gave the example of a bicycle. "Everyone will agree that a child who has learned holding the handlebars of a bicycle, applying the brakes and pedalling separately does not necessarily know how to ride a bicycle. It’s the interaction of all of these skills that makes up the ability to ride a bicycle" (2006, p. 13).

1.3. The Components of the Act of Reading

According to Harrison and Salinger (1998), the components of the act of reading are the reader, the text and the context.

1.3.1. The Reader (Learner)

The reader travels a long way to become an informed reader. Harrison and Salinger (1998), retrace this journey as follows:

a. **The "Emerging" Reader:** The teaching-learning route begins with the learner's first contact with Arabic in 1st grade (Algerian context). At this stage, according to Harrison and Salinger (1998), the learner cannot read independently because he or she is not yet able to master the alphabetical principle. This principle helps the child to recognize new words. However, if the child stagnates in this stage, he or she will experience enormous difficulties. The transition from the "emerging" reader to the apprentice reader takes place in the first weeks or months of entry into 1st year primary school. If this stage takes longer, the child needs immediate support classes in order to avoid unnecessary struggles for the rest of the school year.
b. **The "Apprentice" Reader:** At this stage, the reader can read a few words thanks to the knowledge of alphabetical principles. Nevertheless, there are still obstacles to overcome as the child attains a considerable level of mastery of the code even if he or she does not always succeed in self-correcting. This trial and error will help the learner improve, but if he or she is not challenged enough at this stage, he or she will not always be able to easily understand what he or she is reading.
c. **The "Beginner" Reader:** The beginner reader is the one who must perfect and mobilize his or her skills so that he or she identifies the words. This identification

allows him or her to read independently. However, the learner must be careful not to fall into the trap of identifying words at the expense of comprehension.

d. The Reader "in Transition": This stage of evolution of reading corresponds to the child's second year of learning. The learner is supposed to decode the words because he or she has a repertoire large enough to recognize words easily. Yet, the evolution of reading does not end at this stage.

1.3.2. The Text (Written Material)

A text can be classified according to its nature (intention of the author and the literary genre, structure of the text and content). It may be in an authentic context, that is to say in an ordinary situation of social life (words printed on cans, on road signs), or out of context (a newspaper, a novel, an art book). When it is contextualized, a written text takes different forms. It may consist of:

- Isolated words (bus, school…)
- Short phrases (principal's office).
- Word lists (science nomenclature).
- Phrases in the form of instruction and slogans (do not speak to the driver).

In a teaching-learning situation, narrative or informative texts are often used, especially with playful characters since children learn better by playing.

1.3.3. The Context

The context includes all the conditions in the text to which the learner is exposed. It may be psychological (intention to read, interest in the text, and desire to read). This factor motivates the reader and pushes him or her to read even if he or she finds it difficult to decipher the meaning. In addition, the context can be social (interaction with the teacher and peers). In this case, the reader is not left alone, but is helped by his or her peers. It may also

be physical (time available) which constitutes a difficulty for teachers (Algerian context) because almost all teachers complain about the time allocated to the reading session being insufficient without forgetting the problem of noise, overcrowded classes, climate and lack of air-conditioning both in winter and summer . All of these factors can hinder the process of learning to read.

1.4 Some Useful Definitions

The evocation of the theme of reading necessarily leads us to use other terms, which are inseparable from this activity. We can summarize them in the following points:

1.4.1. Deciphering

Olson (1996) defines deciphering as the operation by which the novice reader attempts to identify the letters and relate them to the corresponding sounds without necessarily achieving a perception of signifying sets or any kind of understanding. It is the fact that a learner follows with the finger while trying to recognize the letters and translate them into sounds without necessarily arriving at the perception of all words constituting the sentence nor at the comprehension of the text.

1.4.2. Decoding

According to Shea and Ceprano (2017), "decoding is a conscious or unconscious operation that occurs both orally and in writing, and by which the receiver transforms the message into a certain code, into a formulation which he or she can better understand the meaning".

This procedure is the auditory-verbal route that uses grapheme-phoneme conversion. When Children begin to learn to read, they learn to decode words using their knowledge of letters and sounds. In other words, to read a new word, they say it aloud or use a "word

attack" technique to try to identify it mentally. Decoding is an essential skill when learning to read. Although visual word recognition can help improve reading fluency, children need to acquire decoding skills to be able to read texts at a higher language level over the years of their schooling.

1.4.3. Reading Comprehension

Comprehension in general and reading comprehension in particular has been the interest of many linguists: According to O'Malley and Chamot (1990), comprehension is "the aptitude resulting from the implementation of cognitive processes, which enables the learner to access the meaning of a text he or she listens to (oral comprehension) or read (written comprehension) ". Stevens (1982) defines it as more than just a receptive process and recognizes it as a complex process in which the reader identifies essential information in the text and predicts what the writer wanted to say. In other words, reading comprehension is an interaction between the text and the reader's prior knowledge.

This means that comprehension is an aim: if the learner can grasp the overall meaning of the text, this is an important achievement. The remaining difficulties will gradually dissipate, namely: speed, melody, and respect for intonation, etc.

1.4.4. The Alphabetical Principle and the Alphabetical Code

According to Stanovich (1986), the term "alphabetical" refers to the traditional graphic system and not to the modern graphic system. The first designates all the letters or graphemes, which according to the position they take in a word undergo changes in pronunciation. In the second system, the letters often keep the same structure as found in the written text. It is noted that in both cases and whatever the language taught, the emphasis here is on a convention that determines a set of signs called the letters of the alphabet.

a. The Letter of the Alphabet

The letter of the alphabet refers much more to the traditional alphabet than to the phonetic alphabet. It is covered by two elements:

i) The alphabetical principle

This is the principle that allows a human language with a written form to transform its grapheme symbols into elements characterizing this language.

ii) The alphabetical code

This is the set of graphic symbols on which the previous principle is based. For the alphabetical code, the graphic signs combine with each other in a well-defined order to form a larger unit called a syllable. In turn, the syllables join to form words that are used to make sentences or texts. This organizing operation is called "combinatorial" and its memorization process "encoding". "[...] neglecting or refusing to have children study the code in a complete, systematic and regular manner is tantamount to depriving them of a tool which they will need to become true readers" (Weiser & Mathes, 2011, p. 178).

1.5 General Characteristics of the Arabic language

Arabic, a Semitic language, is the official language of 22 countries (250 million inhabitants). It is also present in several non-Arab and predominantly Muslim countries such as Turkey or Iran. There are several varieties of Arabic languages:

- Ancient classical Arabic, which is the language of the Quran, spoken in the 7th century.

- Modern Standard Arabic, which is a slightly differentiated form from classical Arabic, is the variety chosen as the official language in all Arab countries, but it is hardly ever used in daily exchanges. It is practiced in official and formal situations and it is generally reserved for writing, for example: in administrative writings, the majority of television news, political debates, scientific, technical and literary texts, etc.
- Dialectal Arabic, which represents a multitude of different varieties from one country to another or even from one region to another (e.g. Tunisian, Algerian, Moroccan Arabic etc.). Sometimes Arabic dialects vary so much that it is difficult to think of them as one language (Baccouche, 2003).

1.5.1. Characteristics of the Phonetic and Orthographic System of Arabic

Arabic is an alphabetical language consisting of 29 letters (see appendix A), the reading of which is oriented from right to left and where capital letters do not exist. Most letters of the alphabet change shape depending on the position in the word (initial, middle, final) and follow rules for attaching the preceding letter. Apart from six cases (و ز ر د ا ذ), each letter is linked to the one that follows it in the word. Originally, punctuation marks did not exist in Arabic, but Modern Standard Arabic use the same signs as in English but they are usually written backwards to fit the right-to-left orientation of the Arabic script. In addition, according to their place of articulation, a sample of the consonants are (cf. appendix A):

- labial (example: "م" m nasal sound stopper),
- dental (example: "ث" t deaf interdental spirant like English ‘th’ in ‘the’),
- palatal (example: "ك" k deaf stop),
- velars (example: "خ" ẖ deaf fricative reminiscent of the German ‘ch’ of ‘suchen’),
- and laryngals (example: "ح" ḥ dull breath emitted in the position of the whispered voice).

In addition, Arabic has two series of vowels: three short vowels rendered by complementary signs on the letters and three long vowels rendered by the letters (alif, wâw and yâ ’). At the spelling level, it has two writing systems, one vocalized (or vowel), intended mainly for apprentice readers, and the other non-vocalized constituting the standard writing. Vocalized writing is characterized by vowels that are represented by diacritics added to the consonantal skeleton, while the unvocalized form presents only the skeleton of the word made up of consonants and long vowels.

For example: the word "كتب" / k-t-b / refers to / kataba / (كَتَبَ, he wrote), / kutiba / (كُتِبَ, it was written) and / kutubun / (كُتُبٌ, books).

1.5.2. Morphosyntactic Characteristics of Arabic

Arabic is characterized by its consonantal richness and vowel poverty (Blachère & Gaudefroy-Demombynes, 2000) Vowels are only derivative elements, and the morphological system has a two-dimensional structure consisting of a root (usually three consonants) and a template. In fact, words are traditionally classified in the dictionary according to the root. From the root, Arabic constructs its entire vocabulary by derivation. Generally, words that have the same root have a semantic relationship. Arabic is an inflectional language that uses for the conjugation of the verb and for the declension of the name indices of appearance, mode, time, person, gender, number and case which are generally suffixes but which can be in the form of prefixes to express the unfulfilled aspect of the verb (Blachère & Gaudefroy-Demombynes, 2000).

Verbal conjugation in Arabic is relatively simpler compared to that of Indo-European languages (Blachère & Gaudefroy-Demombynes, 2000). The Arabic verb has in fact only two basic conjugation paradigms that distinguish not the time, but the accomplished or incomplete aspect of the action. The expression "accomplished" expresses that the action is

completed while the "unfulfilled" describes an action which is being carried out without specifying whether it took place in the past, the present or the future. For example: [qara'tu] translates into "I have read" while ['aqra'u] can be translated into "I read at the moment ","I usually read "or" I will read ".

There are two grammatical genders in Arabic (masculine and feminine) having a single article. They have a natural value when they concern sexual entities and a conventional value in other cases where the entities are asexual. The masculine does not have a gender mark while the feminine is marked with the addition of a suffix. Arabic has three number categories the singular, which refers to a single entity, the dual, which refers to two entities and the plural. Generally, the personal pronoun is isolated (corresponds to I, you, him, etc. in English) or affix (it attaches to a verb to mark its direct complement).

The order of the elements in the sentence seems to be relatively less important than in other languages (Baccouche, 2003). It is neither free nor fixed. The canonical order of words in verbal sentences is verb-subject-object, but it can vary by the affective turn of the sentence, by the desire to highlight a word or by considerations of rhythm (Blachère & Gaudefroy-Demombynes, 2000). Note that there are other types of simple sentences in Arabic, called nominal sentences, which do not contain a verb. This type of sentence is formed by bringing together two elements (subject + attribute) without being linked by a verb.

1.5.3. The Situation of Diglossia

One of the main characteristics of the Arabic language is the situation of diglossia. This is defined by Ferguson (1959) as a situation in which two languages related by their origin and structure are in use and their functional distributions are complementary.

In the Arab countries, diglossia takes the form of two different registers that are not used in the same contexts: dialectal Arabic, the language of everyday communication, and literary Arabic (standard or classical), the formal variety taught in schools.

The two registers are distinct semantically, syntactically, morphologically and above all phonologically (Albirini, 2015). Dialectal Arabic has a lexicon that is richer in foreign words, it borrows many words from foreign languages (especially French, Castilian, English, etc.). In addition, the phonological system of dialectal Arabic is largely altered compared to that of Standard Arabic. Particularly, vowels, inflectional marks, and syntax are more simplified compared to that of Standard Arabic (Albirini, 2015).

Despite the similarity of words in modern Standard Arabic and in dialectal Arabic that stem from their common linguistic bases, some authors (Baccouche, 2003; Ibrahim, 2006; Saiegh–Haddad, 2004) go so far as to consider dialectal Arabic and Standard Arabic as two different languages, Standard Arabic ultimately corresponding to a foreign language and mastery of both registers resembling bilingualism.

1.6 Specificities of Reading in Arabic

As we have already stated, there are two writing systems in Arabic: one vocalized for apprentice readers and the other unvocalized constituting standard writing. The presence of vocalization creates strict correspondences between graphemes and phonemes and thus provides unambiguous phonological and semantic information that, through a sequential assembly procedure, facilitates reading. Besse (2007) thus shows, with children in 5th grade, that Arabic-speaking readers automate the alphabetical procedure faster than Portuguese-speaking readers do. She explains this result by the transparency of the graphophonological system of vocalized Arabic compared to the complexity of the Portuguese vocalic system. However, in the unvocalized form, only consonants and long vowels are transcribed and the

reader must appeal to the context to read the text correctly. In this type of writing, the word is phonologically and semantically ambiguous (Ammar, 2002).

Learning to read in the Arabic language would require mastering the alphabetic procedure, but the recoding modalities seem different, in particular with regard to the processing of the consonantal root (Facthum-Sainton, 2008). According to Ammar (2002), graphophonological recoding operations take place in the apprentice reader in two phases: a phase in which the processing of consonants is automated fairly quickly and another, which concerns the processing of vowels (diacritics), is slower and requires more developed cognitive resources.

During the identification of words, the Arabic-speaking reader must carry out a morphological analysis allowing him or her to access the lexicon. Thus, a good ability to recognize the pattern of a word is of great help in knowing how this word will behave morphologically and how it should be read when the letters are not vocalized (Gully, Carter, & Badawi, 1990). This finding leads to the hypothesis that an earlier and greater intervention of morphological skills is present in Arabic than in languages with Latin writing.

The work of Besse (2007) shows that Brazilians are more sensitive to rhyme and syllable units at an early stage than Tunisians. This result suggests that the morphological analysis of words plays a more important role than the detection of rhyme in the implementation of word identification strategies in Arabic. Nevertheless, Gully, Carter, and Badawi (1990) find that the contribution of rhyme in learning to read in Arabic is still poorly understood. It requires further research.

In addition, diglossia makes the learning of the Arabic language at school more restrictive for apprentice readers because the Arabic-speaking child must move from oral to written and from the dialect register to the standard register, a register that does not represent

any extension of the spoken language. The novice reader discovers, at the same time, the written form of the word and the sound that corresponds to it. The change of repertoire, from dialect to standard, would thus constitute a potential source of difficulties for learning to read, and result in phonological interference between the two registers during reading (Ammar, 2002).

Ammar shows that at the start of learning, the lexical register reserved for dialectal Arabic gives rise to phonological interference during the reading activity. However, it seems that knowledge in dialectal Arabic is integrated into the learning process and that its contribution is not negligible. The similarities will help learners rely on their implicit knowledge of how dialectal Arabic works in order to perform the phonological and morphological analysis necessary for decoding (Gully, Carter, & Badawi, 1990).

Conclusion

Mastery of language and the development of language skills such as reading have always been the school's priority, especially at the primary level. In fact, reading, writing and communicating orally are essential skills for students to develop adequately in their academic career, in their immediate environment and in society in general.

Reading seems to be at the core of the acquisition of the rest of the skills of language, even that of speaking. More and more research suggests that children can learn to read months before they could speak, and that children who are often read to develop their oral skills faster and more efficiently than those who are exposed to written language at later stages of their cognitive development.

Because learning to read is an integral part of primary schooling, we have attempted in this chapter to define this act of language and describe how it occurs. We have also taken

a look at some of the general characteristics of Arabic followed by some elements specific to reading in this language, all of which is foundational to the present work.

In the Algerian context, reading is increasingly becoming a central concern. Despite the well-defined objectives put in place by the recent reforms of the educational system in this regard, alarming figures show that things are not going so well for the little ones. According to a 2018 report, up to 42% of pupils at the end of primary education do not master the minimum level of so-called basic reading skills. Between 10% and 15% do not manage to read out loud in a decent level of fluency, let alone understand the meaning of what they are reading. By the fifth grade, deciphering texts becomes an effort so intense that the child is left with a serious level of anxiety when taking tests.

While this difficulty is repeatedly documented in the annual reports of literacy made by the Algerian ministry of education, little is said about why it persists despite adaptive didactic measures on the part of the ministry and schools. The second part of this paper explores a reading disorder often neglected in Algeria and explains why it should be taken into account in the teaching methods of reading.

Chapter Two: Developmental Dyslexia

2. Chapter Two: Developmental Dyslexia

Introduction

The field of applied linguistics has come a long way in addressing many a pressing matter in the topic of language learning. Yet, some basic phenomena that interfere with the natural accumulation of language skills remain unidentifiable, and there are many unanswered questions about how they occur.

Among these phenomena, we find dyslexia, a disorder that affects language learning in children, especially in the early stages of learning. The second part of this chapter includes very clear definitions of dyslexia, a neuropsychological description of what goes on in a dyslexic's mind, cognitive disorders that can be associated with different types of dyslexia, and finally the possibility of an adequate diagnosis.

2.1.Definitions of Dyslexia

Researchers classify dyslexia into two main types: Acquired dyslexia, which is a linguistic disorder that occurs as a result of a brain injury, a stroke, dementia or multiple sclerosis, and developmental dyslexia which appears as a result of difficulties in the development of the written language system of analysis.

This part is rather more concerned with the second type of dyslexia since acquired dyslexia is linked to a physiologic conversion reaction causing loss or distortion, which is to say that it does not typically result from genetic, hereditary (developmental) causes. It represents a loss of existing capacity to read, often because of a random incident or other serious health issues such as trauma that affect the left side of the brain (National Institutes of Health, 2019).

Developmental dyslexia can be defined as a specific and lasting disorder of written language acquisition, occurring despite normal intelligence (IQ greater than 85), absence of sensory (hearing or visual) or neurological disorders, adequate school education, and sufficient socio-cultural opportunities (DSM-IV; World Federation of Neurology).

It is a disorder due to a brain dysfunction leading to difficulty in identifying written words (Beaton, 2004). It concerns 2 to 8% (Smythe, Everatt, & Salter, 1997), even 8 to 10% of children (Habib, 1997) and is always accompanied by dysorthographia which is a writing dysfunction due to a persistent learning disability in the acquisition and mastery of spelling, also called impaired acquisition of written expression (Debray-Ritzen & Ritzen, 1997).

To speak of dyslexia, the disorder highlighted must be significant. In other words, that there must be a difference of more than 18 months between the child's reading age and his or her actual age. In addition, the reading disruption must have a significant impact on academic success or activities of daily living that involve reading (DSM-IV, 1996). The notion of durability of the disorder is also essential for establishing the diagnosis of dyslexia. Slow learning in the first months is not sufficient to evoke the diagnosis of dyslexia (Debray-Ritzen & Ritzen, 1997).

2.2.The Neuropsychological approach to Dyslexia (1970-1990)

Advances in cognitive neuropsychology challenge the unitary concept of dyslexia and allow different forms of developmental dyslexia to be distinguished. Studies have demonstrated the existence of developmental dyslexia analogous to acquired dyslexia in brain-damaged adults (Snowling, 1991).

This section will only describe the most frequently encountered types of developmental dyslexia, which are part of central dyslexia (the alteration of which is at the level of systems

involved in post-visual processing of the written word): phonological dyslexia, surface dyslexia, and mixed dyslexia.

2.2.1. Phonological Developmental Dyslexia

This form of dyslexia is characterized by impairment of the phonological route (letter to sound) of reading while the lexical path is preserved.

Reading non-words, pseudo-words, new or unfamiliar words is difficult. The child has numerous phonemic paralexias (three → tree), visual (saw → was) or morphological paralexias (geneticist → genetics), as well as lexicalization errors when reading non-words (odg → dog).

Reading known regular and irregular words is relatively preserved. Yet in writing, the child does not always respect the phonology, which results in non-phonologically plausible errors (garden → jarbin) (Marshall & Newcombe, 1973).

2.2.2. Surface Developmental Dyslexia

This type of dyslexia is defined as a major failure in the lexical route (recognition of words and retrieval of their pronunciation from memory) with predominant use of the phonological route. The performance of children with this type of dyslexia is characterized by a selective disorder in the reading of irregular words, while the reading of new words, regular words, non-words and pseudo-words is preserved. The errors produced on irregular words result from too strict application of the graphic-phonemic conversion rules. This results in many regularization errors in which an irregularly spelled word is mispronounced by incorrect application of regular spelling-sound correspondences (plaid → played).

Other types of errors can be produced such as visual paralexias (dad → bad) and morphological (politician → politics). These children also encounter major difficulties in defining homophone and non-homographic words (male / mail) (Castles & Coltheart, 1996).

What characterizes written production here is the fact that words are written as they are pronounced (ocean → owshen). We then speak of phonologically plausible errors. The errors produced are the direct consequence of the complexities and irregularities of spelling. A more regular language would pose fewer problems for surface developmental dyslexics (Snowling, 1991).

2.2.3. Mixed Developmental Dyslexia

It is characterized by the disruption of two reading paths: the lexical and the phonological paths. A child suffering from this type encounters the reading errors described for phonological dyslexia and surface dyslexia, as well as non-phonologically plausible errors in writing.

2.3. Cognitive Disorders Underlying Dyslexia

According to the neuropsychological approach, dyslexia is secondary to a brain dysfunction that would lead to an underlying cognitive deficit, manifested in poor reading performance (Habib, 1997). A largely prevalent position even today is that one and the same cognitive deficit is at the origin of dyslexia of whatever type: phonological disorder (Snowling, 1981).

However, several studies have shown that these difficulties are not characteristic of all dyslexic cases (Goulandris & Snowling, 1991). The hypothesis of a visual-attentional disorder as responsible for difficulties in learning to read in children without a phonological disorder is currently accepted by a more limited group of researchers (Vidyasagar, 2004).

2.3.1. The Phonological Disorder

a. Phonological Disorder: Difficulty in categorical perception.

The phonological disorder can be defined as a difficulty in processing sounds. From around 6 months, a normal child who had been able up until that point to distinguish the phonetic contrasts of all the languages of the world, will gradually lose this ability. Due to extended contact with his or her mother tongue, he or she will gradually become unable to distinguish irrelevant contrasts from it.

Children with a phonological disorder do not lose this ability and keep a system of allophonic discrimination, that is to say that they will make phonemic distinctions on the basis of contextual variants. They show themselves capable of differentiating acoustic variants of the same phonemic category (distinct sounds in other languages), but fail to differentiate between distinct phonemes in their mother tongue. This is known as a deficit of ‘categorical perception’ (Beaton, 2004).

A phenomenon of over-discrimination of what is not necessary to recognize the word, and of under-discrimination of the phonological differences between the words, seem to prevail in these children.

b. The Repercussions of the Phonological Disorder

The child who has a phonological disorder therefore has difficulty in building the phonological system of his or her mother tongue and, consequently, in establishing stable graphic-phonemic relationships, which disturbs the

acquisition of reading and spelling. This phonological disorder is shown to have direct repercussions on oral language (Beaton, 2004).

The child is indeed unable to repeat phonologically complex words and/or non-words adequately (Snowling, 1981). He or she also presents significant difficulties in accessing the phonological form of the word as well as poor performance in lexical evocation (Frith, 1985).

In addition, these children have short-term verbal memory difficulties, oculomotor difficulties, visual analysis difficulties, difficulties in learning languages both orally and in writing as well as difficulties in phonological awareness (Habib, 1997).

Numerous studies have shown the strong relationships that exist between phonological awareness and learning to read. If certain authors start from the postulate that phonological awareness is a reliable predictor of the acquisition of reading, then phonological awareness deficit hinders the acquisition of reading (Ball & Blachman, 1991), others, on the other hand, believe that awareness of the segmental structure of speech emerges at the same time as the acquisition of reading (Alegria, Pignot, & Morais, 1982).

Currently, some authors agree to speak of a reciprocal relationship between phonological awareness and learning to read. Indeed, Snider (1995), who considers phonological awareness as one of the prerequisites for reading, explains that some skills are predictive of reading, but others are a result of learning.

The existence of a phonological disorder is clearly established in phonological dyslexia. On the other hand, certain forms of developmental dyslexia, including

surface dyslexia, are said to originate from a deficit in visual-attentional treatments (Valdois, 1996).

2.3.2. Visual-attentional Deficit Disorder

a. Visual-attentional disorder: Difficulties with visual attention.

According to Valdois and De Partz (2000), who define visual attention as the ability to distribute attention homogeneously over a sequence of letters, visual-attention skills seem to have a relationship with the reading activity, and could be selectively disturbed in the context of surface developmental dyslexia. Indeed, at the word level, visual-attentional processing comes into play in order to process all the letters of the sequence. In particular, it is necessary for the child to distribute his or her visual attention in an evenly distributed manner over all of the letters that make up the words so that the letters can be processed in parallel and the word correctly identified (Valdois & De Partz, 2000).

Visual-attentional disorder is characterized by a child's difficulty in distributing his or her attention in a homogeneous manner over the sequence of letters (Valdois & De Partz, 2000). Thus, certain letters appear to be more prominent than others and the identification of the written word cannot succeed (for example "house" is first read HoUse, then HouSe). The word is therefore never treated as a whole unit and no stable representation of this word can be reinforced and memorized.

In addition, dyslexic children would suffer from a lack of inhibition of peripheral information when reading text. They would be sensitive to the surrounding information, which can thus interfere with visual processing of the

text (Valdois, 2005). The child is therefore unable to build up a spelling lexicon since he or she cannot match a visual word unit with a sound word unit.

b. The Consequences of Visual-attentional Disorder

Since the child cannot store the orthographic forms of words in memory, he or she is constantly forced to use the phonological path to be able to decipher them. He or she grows to have a slow and very syllabic reading. In addition, his or her usual spelling is deficient: He or she writes as he or she hears and, in the same text, a word can be written on each line in a different but phonologically correct manner. The child also has serious copying difficulties (Perfetti, Rieben, & Fayol, 1997).

4.2The Effects of Dyslexia

Regardless of the type of dyslexia diagnosed, the dyslexic child feels different from the others. Rejected without understanding the reasons, he or she often feels ashamed and guilty. This handicap is not as visible as physical or mental handicaps, but it is responsible for great suffering insofar as the child must continue his or her school learning and meet the requirements of success of adults. The repercussions of dyslexia are considerable both on school efficiency and on the child's behaviour (Debray-Ritzen & Ritzen, 1997).

4.2.1. Effects of Dyslexia on Efficiency

Due to the difficulties it generates in reading and spelling, dyslexia hinders other learning skills of the child which can lead to overall academic failure. Indeed, reading and spelling difficulties will quickly spread to all fields (Bonnelle, 2002).

According to Habib (1997), the brain of a dyslexic child does not have the tools necessary for learning written language. Learning to read will require from the child much greater effort and energy than from an ordinary child. The dyslexic child is a pupil who will constantly have to compensate by actively seeking alternative methods to be able to achieve the same performance as other pupils.

While for the majority of pupils learning takes place naturally, almost automatically, it takes place at the cost of pain and sacrifice for dyslexic children. Their learning becomes a punishment, an ordeal that is rewarded only with poor marks and remarks that are inappropriate for the efforts made.

4.2.2. Effects of Dyslexia on the Child's Behaviour and Experience

a. School Failure and Loss of Self-confidence

Because dyslexia hinders or makes learning difficult and generally leads to overall academic failure, it will therefore have serious consequences for the child's experience.

According to Espinosa (2002), there is a close link between the child's educational status, that is to say his or her level of academic achievement, and the image he or she has of self. To gain self-confidence, to build a positive self-image, each human being needs success. Thus, one can imagine how destructive the experience of failure can be for the individual. School failure affects, on the one hand, the intimate being of the person, the child self-deprecating for not being up to his or her own aspirations, and, on the other hand, his social being, since the child also suffers from the contempt that he or she can see in the eyes of those around him or her (Cordié, 1993).

The clinical study of children in difficulty often reveals that they suffer from a lack of self-confidence linked to a self-deprecating feeling (Mannoni, 1987).

b. School Failure and Learned Helplessness

Frame and Matson (1987) defined the concept of *learned helplessness* as a position of anticipation, habituation and justification of failure. Bonnelle (2002) used this term to describe the behaviour of dyslexic children. Indeed, the latter often tend to attribute their failures to their weakness and not to the difficulty of the task, and to consider their successes as the result of chance, luck and not because of their abilities and their work. The child settles in a painful but somewhat resigned position: Any endeavour is a failure, so it is better to behave in anticipation of failure (Beauchaine & Hinshaw, 2008).

Dweck (1999) has shown that an adaptive response to failure can be learned and that it represents a possible solution for discouraged children. If no response therapy is given to dyslexic children, who already find little reinforcement in their actions, they would give up their efforts, and school failure could be increased by this attitude of resignation, even apathy.

c. School Failure and Behavioural Problems

Psychological, affective and socio-relational disorders are frequent in dyslexic children. The literature distinguishes "active" behavioural disorders, such as agitation, opposition, aggression, indiscipline, provocation with sometimes pre-criminal acts; and "passive" behavioural disorders, including withdrawal, shyness, inhibition and disinterest (Bonnelle, 2002). Other symptoms, such as eating disorders, enuresis, psychosomatic manifestations,

can also be consecutive to the psychological suffering experienced by these children with learning difficulties.

Thus, these disturbances would be secondary and reactive to the school failure caused by dyslexia (Bonnelle, 2002). These psycho-behavioural disorders largely depend on the reaction of the family and school environment to the child's difficulties. In the absence of information about the disorder, the reactions of teachers and classmates are often negative. Indeed, they wrongly attribute the child's difficulties to a lack of work, willpower, motivation, inattention (Mannoni, 1987).

4.3.Diagnosing Dyslexia

We do not know exactly how each person finds a way to understand how to read. Even if our understanding of how reading takes place in the brain increases, reading differs from one person to another and each person is a single case, so the rules do not apply in the same way to every child. It is, therefore, not possible to have one simple explanation for how dyslexia manifests itself in suspected cases, and thus to affirm that a child suffers from dyslexia is usually the result of serious speculations (Démonet, Thierry, & Cardebat, 2005).

What makes diagnosis difficult is the individual differences and the complex nature of reading.

In addition to the intervention of several fields, it is necessary to use various evaluation tools in order to support children who seem to experience unusual learning difficulties while performing age appropriate reading tasks.

It is preferable to delay affirmations of medical, educational, linguistic and psychological signs of dyslexia after a sufficient period for the child’s learning takes place

in school (Klein, 2003). A large part of children experiences these difficulties in the beginning of their studies, but the difficulties gradually disappear after several weeks of entering school. If, however, these problems in class interfere with the child's daily life and well-being, several types of testing need to take place for a more conclusive diagnosis. This testing includes:

- **Neurological and medical test:** This procedure is necessary in order to remove doubt of any physiological or functional causes of anomaly in the brain, the eye or ear.
- **Tests of speech:** By examining the oral and written language and testing basic concepts and vocabulary.
- **Psychometric tests:** These types of tests determine the degree of intelligence as well as any underlying emotional disorders.

Conclusion

Dyslexia is an inherited complex condition and the WHO registers it as a genetic disorder. This disorder is characterized by a serious difficulty in learning to read, and it occurs independent of the child's age and intellectual ability. It affects between 5% and 10% of schoolchildren. Several countries have recently drawn the attention of teachers to "an epidemic of dyslexia" as more and more adults and children with dyslexia are being registered for speech therapy.

While this disorder is very difficult to diagnose, given that it is often accompanied by other mental disorders, it is worth considering it in the classroom when teaching. In the following chapter, an approach to teaching reading while being mindful of the learning needs of dyslexic children is proposed.

Chapter Three: The Multisensory Approach

3. Chapter Three: The Multisensory Approach

Introduction

After studies demonstrating the effectiveness of multisensory training on learning to read, write and recognize geometric figures, it is only adequate to investigate whether this training can be effective in helping children to overcome the difficulties they encounter when learning to read, especially if they have underlying learning disabilities.

In this chapter, we will examine the concept of phonological awareness and its relation to the multisensory approach. We will also assess the effectiveness of multisensory methods in teaching reading both to normal learners as well as to learners with learning difficulties.

3.1.Early Literacy Skills

To learn to read in an alphabetical writing system, it is necessary for children to understand the alphabetic principle, that is to say that the letters (graphemes) of writing represent the oral sounds (phonemes). To do this, they must also understand that spoken words are made up of phonological units and develop an awareness of oral phonology (i.e., the ability to consciously identify and manipulate the phonological units of spoken words). Acquiring reading therefore presupposes both metalinguistic skills and knowledge of the letters of the alphabet. We are therefore going to focus more specifically on these essential factors in learning to read.

3.1.1. Phonological Awareness

Research focused on the role of phonological awareness in reading acquisition suggests that there is a causal and reciprocal link between phonological awareness and reading skills. Scarborough (1998), in a meta-analysis comprising 27 studies, obtained an average correlation coefficient of .46 using scores in phonological awareness tests collected in

kindergarten as a predictor of later reading level. Thus, children who have a good level of phonological awareness at an early stage show good reading performance later on.

Conversely, children with poor reading skills would also exhibit a low level of phonological awareness (Morais, Cary, Alegria, & Bertelson, 1979) as is the case with some dyslexics (Wallach, Wallach, Dozier, & Kaplan, 1977). In the same sense, it has often been observed that phonological training is effective in facilitating the learning of reading, because it promotes the discovery of the alphabetic principle (Castles & Coltheart, 2004)

However, it is important to stress that the predictive value of phonological awareness on learning to read is essentially due, even if there are still some debates, to the development of so-called phonemic awareness (phoneme-grapheme association). Some researchers suggest (Raz & Bryant, 1990) that awareness of phonological segments, such as syllables and rhymes, would develop more naturally in later stages of schooling and would be an important precursor of phonemic awareness. In contrast, the development of phonemic awareness requires explicit teaching with a more specific orientation of phonological activities towards letter-sound correspondences. Mastery of oral language does not lead directly to awareness of phonemes. Stanovich (1999) uses the term phonological sensitivity, rather than phonological awareness, to emphasize the idea of a continuum ranging from reduced sensitivity (e.g., detection) to large units (e.g., syllables) to deeper processing (eg, suppression) on small units (phonemes).

Learning the alphabetic code would contribute to the development of phonological and particularly phonemic skills, and these same skills would in turn facilitate learning to read (Morais, Cary, Alegria, & Bertelson, 1979). Thus, phonological awareness and learning to read would influence each other, and in many cases would determine a child’s later ability to reach advanced levels.

3.1.2. Knowledge of Letters

Learning letters is a crucial part of developing phonemic awareness. McDowell and Lorch (2008) have shown that Chinese readers who learned to read in a logographic writing system do not develop phonemic skills unlike readers who learn to read in an alphabetical writing. In the same way, a study of illiterate Serbo-Croatian adults show that individuals considered to be "weak literate connoisseurs" (less than 50% of known letters), unlike individuals considered "good" connoisseurs (all the letters known), find themselves in great difficulty when faced with tests of suppression and counting of phonemes (Lukatela, Carello, Shankweiler, & Liberman, 1995).

Castles and Coltheart (2004) hypothesize that the phonemic awareness would develop from knowledge of spelling. According to these authors, learning alphabetic writing would allow the learner to perform phonemic awareness tasks by making it possible to manipulate phonemes using orthographic images of words. Considering for example a classic phoneme removal task, prelectors who have little or no knowledge of the written form of words, will have to solve the task by attempting to segment the sounds in words in order to remove the required phoneme. Children with better spelling skills may also use their knowledge to remove the letter or group of letters that match the target phoneme (Castles & Coltheart, 2004).

However, Carroll (2004) shows that increasing knowledge of letters unevenly affects different tasks of phonemic awareness. For example, knowledge of letters would be more strongly associated with success in a phoneme substitution task than in phoneme removal or identification. Phonemic awareness would therefore not be an all-or-nothing skill, and certain aspects of this knowledge would be more or less strongly linked to spelling knowledge and reading. Yet, conscious access to the phonemes of oral language is not

impossible without knowledge of spelling. It seems that a certain degree of phonemic manipulation can be achieved by children for the phonemes of which they do not know the graphical correspondence (Morais, Cary, Alegria, & Bertelson, 1979).

a. Knowing the Names of the Letters

The knowledge of a letter supposes the recognition of its shape but also that of the name and the sound which correspond to this form. These two types of knowledge, although linked, give rise to a fast development. In addition, the name of the letter would be a better predictor of the level of reading at the start of learning than the sound of letters (Ehri, 1983).

The name of the letter, unlike its phonemic value, is revealed to children very early on, usually through the wording of the alphabetical rhyme and reading alphabet books. Numerous studies demonstrate the determining role of knowing the names of letters in the acquisition of reading. Scarborough (1998) observe an average correlation of 52 in 24 studies between letter naming scores in kindergarten and subsequent reading level. The influence of knowledge of letter names on reading, as the primary medium for learning arbitrary letters associations, has been proven to be very important in teaching to read.

b. Knowledge of the Sound of Letters

Knowing the name of letters would influence the discovery of letter-sound links, in particular because the name of certain letters corresponds to the sound associated with them. For example, the name of single vowels (a, e, i, o, u) is identical to their sound. On the other hand, for consonants several cases arise. Some consonants, like b, whose name is pronounced / bi: /, have their sound at the beginning of their name (consonant-vowel-type consonants). Other consonants, like f, have their sounds at the end of their name (vowel-consonant-type consonant). The name of the letter f / ef / ends with the phoneme / f / that it symbolizes. Finally, some links between the name of the consonants and their sounds are

arbitrary as for the h. The link between the name and the sound of letters (which refers to the different types of letters and the phonological structure of their names) would have direct consequences on the learning of the name itself and on the learning of the sound of the letters. Thus, the names of letters that contain their sound would be learned better than those that do not (Cormier, 2006).

Although knowing the name of a letter is not a necessary condition for learning sound, it facilitates and promotes the use of the letter in question. This is shown by a study in Hebrew where, after the same procedure and the same training time, 5-year-olds were better at connecting graphemes to their phonemic representations than to their names (Levin, Shatil-Carmon, & Asif-Rave, 2006).

In summary, knowledge of letter names exerts an influence on the development of knowledge of letter-sound associations. However, the relationship it maintains with phonemic awareness remains unclarified.

3.2. The Multisensory Approach to Teaching Reading

Letters are represented in memory not only by their visual and auditory component but also by their sensorimotor component. This multisensory representation would take place during simultaneous learning to read and write. Strengthening the links between perceptual and motor skills could then improve memorization of letters and thus promote the understanding of the alphabetical principle in young children. Multisensory learning methods are based on this assumption. Before describing those methods which propose the addition of a third sensory modality (haptic modality), we will take stock of the classic learning methods which call upon visual and auditory modalities.

3.2.1. Classic Auditory and Visual Training

In order to prepare or improve the level of children in reading activity, many researchers have proposed training aimed at improving the various skills closely related to reading and which predict success in its acquisition.

a. Phonological Training

This training program is widely tested . It mainly focuses on the metaphonological skills (the ability to manipulate syllables, rhymes and phonemes of oral language) and their impact on both the understanding of the alphabetic principle and the reading level. It may take place before institutional learning to read (Lecocq, 1991; Byrne, Fielding-Barnsley, & Ashley, 2000); during this learning (Ball & Blachman, 1991); or even after training combining phonology, oral reading and manipulation of the graphophonological code (Chardon, 2000).

More often, the results of this training show an improvement in metaphonological skills and a facilitation in learning to read. They highlight in particular the essential role that phonemic awareness plays in this learning. In addition, if training is combined with the teaching of grapheme-phoneme correspondences and with a work on the knowledge of the letters of the alphabet, as well as promoting a better understanding of the alphabetic principle, the effects are generally stronger. This is underlined by the meta-analysis carried out by Bus and Van Ijzendoorn (1999).

While the development of metaphonological skills (especially metaphonemics) is important for learning to read, it is nonetheless insufficient. Indeed, the pupil will also have to relate two types of distinct units: graphemes (one or more letters in writing) with their oral correspondent phonemes (Troia, 1991). This would be the only shortcoming attributed to this training.

3.2.2. Multisensory Training

Although the training described above effectively prepares learners to read, some children have difficulty understanding the logic of the alphabetic principle and using it properly. Some researchers were therefore looked for aids that could assist in better learnin how to read or to remedy existing reading difficulties. In an attempt to encourage the development of connections between orthographic and phonological representations of words, Bryant and Bradley (1985) advocate the use of plastic letters in their training. By manipulating the letters within the words, the child would discover on his or her own that the words which share the same sound also have a letter or a sequence of letters in common.

We become convinced that the teaching of reading is much better when associated with writing. It is also significantly easier and effective when presented by means of visual and haptic multimedia (Bryant & Bradley, 1985).

a. The First Remedial Methods

The methods of learning to read which call upon the visual, auditory sensory and the manual haptic modality are called "multisensory". Already at the beginning of the twentieth century, Maria Montessori (1912) proposed some educational reading preparation activities consisting of the manual exploration of letters cut from sandpaper. This approach has been widely used, more or less systematically, in the field of remedying reading difficulties. For example, Fernald and Keller (1921) proposed a multisensory method for children with reading delays. A word was written in large script letters and spoken by the teacher. Then, the child was asked to trace it with two fingers while saying each of the syllables. After each stroke, the child had to try to write the word without using the model; if an error was produced, it was not corrected. After a short pause, the procedure was repeated until the child was able to write the word from memory.

Fernald (1988) did not develop an explicit theory to justify her method, but considered the memory of the gestures that made it possible to trace the words as important. She suggests that the kinaesthetic cues from hand movement and lip movement is essential in linking the oral and written form of words. She reports, in her case studies, dramatic improvements in children with severe reading delays. However, the lack of details regarding the participants and the procedure, as well as the absence of a control group, calls for caution regarding the conclusions of these early studies (1988)**.**

b. Multisensory Training for Children with Difficulties

Some studies suggest that the positive effects observed on the reading level following multisensory training are the consequence of better memorization of the letters explored visually and haptically. Hulme and Bradley (1984) led a series of experiments in children 8-10 years of age with normal reading disabilities and reading delays. He invited children to explore sequences of letters and abstract shapes, either visually (condition V) or by simultaneously looking at and tracing each one of them (condition VT). The different results show a positive effect of the VT condition on the number of recognized stimuli.

In another study, Hulme and Bradley (1984) suggested that 5-6-year-olds learn symbols arbitrarily associated with names under either (condition V and VT equally). This means that a key technique in carrying out a multisensory teaching methodology is by employing visual aids that target two or more senses, ideally the visual and the haptic senses. The study also concludes that using auditory and visual aids have no less significance for children with normal learning abilities.

3.3. Implementing the Multisensory Approach in the Classroom

In the early 1930s, Dr Samuel Orton commissioned Anna Gillingham and her group to devise a new way of teaching the phonemic structure of written language to people with

dyslexia. He thus aimed to set up a sequential system that would develop in an almost three-dimensional way the relationship between sounds and letters needed to be clearly illustrated, as well as the role of sounds and letters in words. The system put in place also teaches breaking down a word into several small parts. The method used should be multisensory, because people with dyslexia learn better if all of their senses (visual, auditory, tactile and kinaesthetic) are involved (Gillingham & Stillman, 1956).

The Orton-Gillingham multisensory method differs from other reading methods in two ways, namely in the sub-objectives and characteristics of this method.

- **Sub-objectives**

• Phonemic awareness is a primary sub-objective. The student must be taught to listen to a single word or syllable and to break it down into phonemes.

• The second sub-objective is the grapheme-phoneme association. It is about teaching which letters represent which sounds, and how to integrate those sounds into single syllable words.

• The next sub-objective consists of learning the rules and the various possibilities for writing sounds. Students with dyslexia should be aware of these rules and the various forms of writing correctly.

- **Recommended teaching techniques**

• Simultaneous Multisensory: Instruction is delivered using all associative areas of the brain (visual, auditory, kinaesthetic, and tactile) simultaneously.

• Systematic and cumulative: Each new step should result from the previous well-mastered steps. The sequence should start with the simplest basic elements and continue in a gradual and methodical way until the most complex elements.

• Direct: Each concept must be directly taught. The fact that the concept in question can be learned by simple deduction should not be taken for granted.

• Diagnostic: The teacher should continually adapt the pace and style of his or her teaching in order to respect the needs and abilities of each student.

• Synthetic and analytical: We must teach both synthetically (from parts to the whole) and analytically (from the whole to the parts).

Conclusion

In this chapter, we have seen that in order to effectively prepare or improve the level of children in the reading activity, some researchers have proposed training aimed at improving the skills that predict success in its acquisition (phonemic awareness, knowledge of letters and correspondences between letters and sounds) but also to fully use the visual, auditory and sensorimotor components associated with the units of language.

Most research shows that a haptic or kinaesthetic exploration of letters improves knowledge of letters in their various aspects (form, name, sound or gesture of production) and/or the level of understanding of the alphabetic principle and its use. The multisensory approach, therefore, seems to play a particularly important role, and yet very little taken into account, in teaching to read and write. This is why, promoting the use of multimedia and visual aids cannot be stressed enough in the first and second years of primary schooling and even throughout obligatory education.

Chapter Four: Case Study

4. Chapter Four: Case Study

Introduction

After studies demonstrating the effectiveness of multisensory training on learning to read and write, it is necessary to investigate whether this training can be effective in helping children in different settings. The multisensory approach is set to promote, with phonetic and gestural stimulation, the links between sounds and letters. The effectiveness of this method is prevalent with dyslexic pupils, yet its use in an integrated classroom of both normal and dyslexic pupils is not directly established. We attempt in this study to investigate whether the benefits of this method is replicable in the latter setting.

This part presents the methodology used in the context of this research and includes necessary details about participants, measuring instruments, course of the research and plan of the experiment. At the end, a discussion of the findings takes place.

4.1.Methodology

In 2003, Gentaz, Colé and Bara evaluated the effect of multisensory training in preparation for reading with prelector pupils educated in a large nursery section. To this end, two groups of students were formed, each group receiving the same exercises on knowledge of letters, letter-sound associations and phonological awareness. One group, however, would carry out a visuo-haptic and haptic exploration of letters, while in the other group this exploration is only visual. The main result of this research concerns the improvement in pseudo-word reading, which is very important for learners who have had the opportunity to manipulate letters grapho-phonologically. The researchers concluded that the addition of the haptic modality had a beneficial effect on the reading level of the sample.

To explain this effect, it is suggested that when exploring letters, by sharing characteristics with the visual (at spatial level) and auditory (at the level of the sequential processing to be performed) modalities, the haptic modality would favour the establishment of connections between two types of representations: orthographic (at the grapheme level) and phonological (at the phoneme level). This approach of multisensory learning to reading is obviously reminiscent of the work carried out at the beginning of the last century by Maria Montessori (1910-1916), who had already established the positive effect of the multisensory method on the reading rehabilitation of dyslexic pupils.

Thus, by taking inspiration from the main results of the training program presented in the third chapter and with reference to the research findings in the cognitive psychology of reading, we envisaged an experiment with apprentice readers at the second year of primary school. We hypothesize that a reading training consisting essentially of exercises that promote the acquisition of the alphabetical principle and code, phonological skills, knowledge and recognition of letters in visual and haptic modalities as well as their writing, should facilitate learning to read and improve its level at this stage of learning. Let us specify that for us it is not a question of testing the contribution of a particular modality (tactilo-kinaesthetic, visual or auditory), but of knowing if the proposed approach and requesting all of these modalities can have a positive impact on the acquisition of reading among dyslexic or pupils with real underlying learning difficulties.

To test the effects of this training, we have selected three classes of CE2 from two schools in Adrar: a class called experimental will benefit from a planned training in reading, a class called placebo will receive training in the mathematical field and a class called control, not benefiting from any intervention, will serve as a reference group. The choice of classes was based on the psychometric results of each class.

After the purposeful choice of class label, the method chosen to assess the training program is as follows: a pre-test is first carried out on all the classes (end of September); shortly thereafter (in October) the training sessions start for the two classes, experimental and placebo. Finally, a post-test comprising the same assessment as the pre-test is administered (end of December). Pupils are also administered a standardized reading test twice (in January and March, i.e. right at the end and after the training program). Later, the Arabic test results obtained from the national assessment entry to CE2 record are examined. This way of proceeding will make it possible to monitor the effects of training in the short, medium and long term.

4.2.Participants

Eighty-three students in three-second year classes from two primary schools located in the city of Adrar participated in the experiment (see Table 4.2 for average ages, number of students per class and psychometric testing specification). The choice of the two schools is justified by the fact that the pupils belong, in the great majority, to the same socio-cultural backgrounds. The accessibility to these schools was also another reason for their selection. In addition, to test the effect of long-term training, this choice facilitated the retrieval of a record of results from a CE2 national assessment upon entry kept in the archive of one of the schools. We will explain the use of this record in the coming sections.

The three teachers, although having different teaching practices, share the same phonic conception of learning to read, namely explicit teaching of grapheme-phoneme correspondences, systematic copying or dictation exercises, analysis and synthesis. It is therefore, at least at the beginning of learning, a reading by phonological mediation that is sought.

Table 4.2. -Average ages of pupils in the three classes, number of doublers, and psychometric results

	Experimental class (EG, n= 28)	Placebo class (PG, n= 26)	Control class (CG, n=29)
Age (min. and max.)	6; 8 years (6 ; 1 – 7 ; 8)	6; 8 years (6 ; 1 – 8 ; 3)	6; 7 years (6 ; 0 – 7 ; 11)
Number of doublers	3	2	1
No learning difficulties	23	21	27
Mild learning difficulties	4	5	2
Dyslexic	1	0	0

4.3.Measuring Instruments

4.3.1. Psychometric Testing

The targeted classes were evaluated in neuropsychology at a local paediatric clinic employed for this purpose. The school physicians referred the pupils to the chosen local private clinic to facilitate administrative protocols.

The aim of the neuropsychological assessment was to confirm or rule out the diagnosis of any type of dyslexia. The neuropsychological investigation was spread over four evaluation sessions. The psychometric tests used are Child Wechsler Intelligence Scale (WISC-IV), Test of Everyday Attention for Children (TEA-CH), Developmental Test of Visual-Motor Integration (VMI), Child Memory Scale (CMS), The Purdue Pegboard Test, Written Language and Disorders Assessment Battery (BELEC), Reading Text, Child Neuropsychological Assessment (NEPSY), Child Behaviour Check List and Developmental Questionnaire.

A visiting neuropsychologist from Algiers has recommended these tests and has agreed to prepare, carry out and assess and report on the results of these tests. It was very important

for the preliminary study to be performed by a team of experts in order to obtain a reliable outcome. The results attained thereafter determine the purposeful choice of class labels.

4.3.2. Pre- and Post-Tests (Short-Term Evaluation)

The pre-test took place at the end of September, and students in all three classes were assessed collectively using five tests.

a. Reading comprehension (COMP)

Faced with the difficulty of finding a standardized tool likely to assess students' understanding of texts at the very start of learning to read, we chose a test that assessed the understanding of isolated sentences in pictorial situations. We therefore proposed eight items from SCOTLAND, a syntactic-semantic comprehension test developed by Lecocq (1996). Each item has a sentence that appears above four drawings each representing a different scene, only one of which matches the written sentence. After having read it silently, the pupil selects his or her answer from the four drawings offered by checking one of them. The pace is free. The maximum score is eight points.

Example: The sentence "The cats are watching the ball" is accompanied by a sheet of four pictures. In addition to the one corresponding to this statement, three other scenes are proposed: two children playing ball; two cats observe a butterfly; a cat looks at a ball.

b. Metaphonological skills (MPHS)

This test, designed from an analysis of drawings, is taken from a textbook offering training in phonological awareness (Adams, Foorman, Lundberg, & Beeler, 2000). It includes six subtests: rhyme identification, syllable counting, association of initial sounds, phoneme count, and comparison of word length and representation of sounds by letters. Each subtest involves training, followed by a phase during which the experimenter names each of

the drawings whose name will serve as the basis for the phonological analysis, in order to avoid any confusion. The maximum score is five points per sub-test, which gives a total of thirty points. Placing lasts about thirty minutes. Example (initial sound associations sub-test): two lists of five drawings each are proposed. The idea is to relate the drawings in the first list to those in the second when the words represented by those drawings begin with the same sound.

The following three standardized tests are taken from the Batelem R. test (Savigny, Barbier, Coupey-Le Roy, Girard, & Roussel, 2001):

c. Spelling Level and Knowledge of the Graphophonetic Code (SLKGC)

This test, according to its designers, distinguishes three cumulative aspects of a successful transcription: respect for phonetics, customary spelling and application of simple grammatical rules. Phonemes, single syllables and two short sentences are dictated to the pupil. During this experiment, and given the reading level of the pupils, we chose to offer only the first two parts of the test. The maximum mark that can be awarded is twenty-three points (eighteen “phonetic” points, three “usage” points and two “grammar” points).

d. Word Reading (WORD)

Each pupil has a reproduction of a poster, displayed in a large format on the blackboard. The test begins with a collective observation of the poster during which the experimenter has certain details located and has the pupils name them. The objective of this phase is to limit, if possible, errors that may be due to a lack or confusion of vocabulary.

The individual task then consists of connecting, using different coloured pencils, the word tags located around the perimeter of the poster to the corresponding drawings or actions. The first two tracings between word tags and what they represent are done

collectively and serve as a practice. The test lasts ten minutes and the maximum of points that can be obtained is thirty.

e. Graphics (GRAPH)

This test is designed to assess mastery of graphic gesture and the quality of writing using a copy of single words and groups of words. Each student has a sheet on which three rows of patterns are offered: handwriting, script writing, and cursive writing. The task is to copy these models identically on the lines drawn under each row. The maximum of points that can be awarded is thirty: fifteen for legibility, nine for respecting the framing guide lines, stems and jambs and six for making connections between cursive letters. With regards to the test scoring protocols, we called on a second corrector not participating in the experiment. Indeed, despite the standardization, and even if the test manual provides examples of the application of scales (Savigny, Barbier, Coupey-Le Roy, Girard, & Roussel, 2001) the rating is sometimes difficult. When we noted differences, and after consultation, we used the average of the two scores. In December, at the end of the training period, a post-test consisting of the same tests as the pre-test was administered in turn.

4.3.3. Medium and Long-Term Evaluation Tests

In order to follow the evolution of pupils' performance over time, an additional test was administered twice. This is a classic reading test, still very commonly administered in classrooms called the composite reading scale for the preparatory course (Bartout & Inizan, 1972a). This test, made up of eleven subtests exploring various aspects of learning how to read (from phonology to reading comprehension), is calibrated to be administered at two times during the school year, in January and March. It allowed us to know the reading levels reached by the three groups, after the period of training and at the end of the year, two and a half months after the end of training. As for the content of the 2004 national assessment at

entry to CE2, we refer the interested reader to the two documents published by the Ministry of National Education: the test book, intended for pupils (grouping together Arabic and mathematics) the instructions book for teachers (MEN, 2004).

4.4. Training

Each of the three groups (experimental, placebo and control) is made up of all the students in each class. This organization, although not making it possible to rule out a possible "master effect" (Mingat, 1991) avoids causing too much disruption in the use of teachers' time. Indeed, within the framework of a strict experimental approach, it would have been desirable for the size of each group to be made up of students taken, in equivalent numbers, from each of the three classes. However, by choosing this option, during the time slots reserved for training, the teachers would have had to teach only part of their students. Taking into account the number of holidays and other disruptions particular to this year, we did not wish to impose a heavy constraint on the teachers.

Thus, the two groups, experimental and placebo are subjected to a training program specific to each of them and composed of an identical number of thirteen sessions provided by the same experimenter. For the experimental group, each session corresponds to the appropriation of one or two phonemes and the corresponding graphemes (except for the first and the last sessions, which are for one a “start-up” session; for the other, a review session). For the placebo group, the sessions are centred on the understanding of mathematical concepts, the recognition of geometric figures or on measurement activities.

The presence of this group is justified for two reasons: On the one hand, it makes it possible to control the experimental effect, and on the other, it provides information on the increased motivation of the pupils, which may be due to the unusual character of this type of intervention within a school (Hawthorne effect). It should also be noted that the fact of

offering a mathematical activity, more specifically targeted here on geometry, allows students to work in a field that has no direct link with learning how to read or with the content of the examinations offered during the tests, but the content of which will nevertheless be useful to them in class. The spatial environment in which each of the groups work is identical: it is not the usual classroom but an ordinarily unoccupied room, isolated from outside noise and without displays of any kind on the walls. The number of rooms is sufficient for pupils to work alone. These rooms were also used for the taking of the various evaluation tests.

Taking into account the time constraints of the teachers, one or two sessions are offered each week over a period extending from the beginning of October to the end of December. Each session lasts fifty minutes, with the two groups taking over ten minutes apart.

4.4.1. Content and Conduct of Multisensory Training Sessions

The order of presentation of the graphemes studied and the corresponding phonemes was chosen taking into account their relative percentage of use in primary school. Pairs of different graphemes were proposed during the same sessions, to prevent both visual confusion and confusion between elements phonologically.

At the start of the session, the sound and the letter of the day are presented from a short illustrated sentence. Several words in this sentence contain the studied sound corresponding to the target letter. This sentence is read several times, either by the students or by the experimenter if necessary.

When the pupils have identified by themselves the sound and the corresponding letter, they are then asked to write the letter in different cursive large formats on the board. At this time, the direction of rotation of the writing movements of that letter is indicated.

First, standing next to their desks, pupils had to reproduce these movements with their arms and in space. Meanwhile, the experimenter in front of them also performed these same movements in a mirror. This fun exercise for pupils could quickly ensure that everyone had correctly memorized the directions of rotation. Then, the letter of the day, is cut out of sandpaper and glued on cardboard (square of eight centimetres per side or rectangle of eight by twelve centimetres, depending on the size of the stems and legs of the letter), and then it is distributed to each pupil. After a period of observation, the pupil is invited to follow the outline of the letter with his index finger, several times, first with his eyes open, then with his eyes closed. The experimenter explains that in order "to follow the path well, the finger must always feel that it is itchy". "If it is smooth, it is because the fingertip has gone out of the way".

At the end of this phase, the letter remains on the table and the pupil can refer to it during the session. The pupil, then, starts working on an individual exercise sheet: the first exercise consists of writing the target letter, then a word chosen from among those that make up the starting sentence and contain one or more times the target letter. The following exercises can be devoted to locating the sound studied inside written words, recomposing words and writing them using all of their syllables or letters, adding letters missing inside words, collective writing of words using spelling, etc. The experimenter controls the progress of all the steps and the correction immediately follows the end of each exercise.

At the end of the second session and all subsequent sessions, time is set aside for tactile recognition: all the letters studied in previous sessions are placed in the open locker under each desk. The pupil must find, without visual aid, the letter requested by the experimenter. Note that to allow the correct orientation of the card stock and to facilitate the exploration and tactile recognition of the letters, a braille point has been made at the top and to the left of all the cards.

4.4.2. Content and Procedure of the Sessions of the Placebo Training

The number of sessions for this class is identical to the number of sessions carried out with the experimental group, but here the sessions are devoted to mathematical activities (measurement and geometry). The content is as follows: representation and symbolization, situation in space (inside, outside, above, below, between, in front, behind, left, right), recognition and plots of simple geometric shapes (square, round, triangle and rectangle), measurement by ruler, geometry on grid (registration and displacement). To carry out this program, the use of the following material is necessary: coloured pencils, a flat ruler, an eraser, and a squared drawing sheet, individual templates for reproducing circles, squares, triangles and rectangles. It should be noted that a mathematics textbook for second year directly inspires this training and the course of each of its sessions.

4.4.3. Control Group

The pupils of the control group continue the classwork with their teacher, under the usual conditions. The analysis of the results of this group thus makes it possible to assess the the effects of the usual reading exercises provided by the school.

4.5.Results

4.5.1. Psychometric Testing Results

The overall testing done on the pupils of all three classes (n=83) by the visiting neuropsychologist and his team has demonstrated absence of serious learning difficulties for 82 out of 83 of the students. Some pupils (n=11) were said to manifest some mild learning difficulties, all of which were deemed commonly occurring at this age and not indicative of

any health issues. Four out of the five repeater pupils seem to be in this category, the last of whom was a serious case of a mixed type dyslexia.

Presently, we are very interested in the one case diagnosed of dyslexia. We have requested the family not to proceed with treatment until the training program had been administered and we nominated the class in which this case was found to be our experimental group. This request was made after making sure that such decision would not affect the child's wellbeing on the long run. The family of the child was very helpful and agreed to to conform to this request.

For the purpose of this study, we find it appropriate to provide a summary of the expert's report describing this case:

Yasmine, 8 years and 3 months old, is the second child in a family of three girls. Her mother does not work, while her dad is an electrician. During the pregnancy, the mother was in a rather bad psychological state, and only very slowly regained her mental health and her good humour after a year of the child's birth.

Yasmine spoke her first words at the age of three. It was unusual according to her mother but it was not a worry. She was barely 4 years old when a third daughter was born. A sibling jealousy had a massive impact on her, causing her to develop an eating disorder where she would not eat much. At 5 years of age, she went on to develop a severe case of asthma attacks and bronchitis. At the time of the testing, she would have a seizure whenever she cried. With her parents, she is often unassertive and quiet and she seldom expresses herself with others. She expresses overwhelm with her sisters for their 'intelligence' and she demonstrates a significant state of anxiety when she talks about her family.

Yasmine's attitude in regards to school is a negative one. She would not join kindergarten and she only agreed to join her first primary class at the age of six when the school agreed to admit her younger sister of five at the time.

Her record at her first year of primary school barely amounted to the average required to pass the year, and this result worsened in her second year causing her to have to repeat. Her teacher spoke ill of her, and complained about how inattentive and slow she was, said to refuse to follow instruction or do her homework. It is also worth noting that her mother regularly complained to the school about the teachers' ill treatment of Yasmine. One particular incident documented her teacher at the time of the testing referring to her as ''worse than a donkey''. Her classmates as well as her younger sisters would often bully her. This case was characterised by a delay of two years in reading skills and included the following notes:

- **Motor skills:** good, but no spatial orientation. The child does not recognize the right and the left on herself. There is a delay in the development of the body diagram.
- **Intelligence:** above average according to the results of the test with her psychologist.
- **Language:** still difficulties in expressing herself correctly.
- **Reading:** still syllabic, confusion, inversions, omissions or additions of letters, low voice, monotonous tone.
- **Spelling:** confusion, inversions, omissions, addition of letters.
- **Affection:** important emotional needs, jealousy, reactive aggressiveness, guilt, inferiority, attachment to the mother.

Everything mentioned in the description of Yasmine's case is symptomatic of a severe mixed dyslexia. Two other expert colleagues consolidated the diagnosis of the neuropsychologist.

4.5.2. Training Results

a. Statistical Treatment

The statistical analysis is conducted using the SPSS program. SMA, standard deviation and T test are conducted to calculate the significance of differences between the groups. The size of the effect is calculated by using ETA square (H2). The T test is conducted to learn about the significance of differences between the averages of the experimental, placebo and control groups.

The use of parametric statistical tests assumes three conditions: measurements taken at the interval scale, samples from normal parent distributions and homogeneity of variances (Langouet & Porlier, 1991). However, the small number of our sample and the variation of our observations make the hypothesis of normality of the whole study unlikely. We will therefore use non-parametric tests: tests of Wilcoxon (comparison of two paired groups), Mann-Withney (comparisons of two independent groups) and by Kruskall-Wallis (comparisons of several independent groups).

b. Differences in performance between pre- and post-tests, short-term effect

Before commenting on the results of the evaluations presented in Table 4.5.2.b (1), it should be noted that the three groups, experimental (EG), placebo (PG) and control (CG) present statistically equivalent performance at the end of the pre-test, and for all the tests. This equality of performance, allows us to hypothesize that the teaching practices of teachers have no impact on the reading performance of their pupils. This point constitutes, while not definitively ruling out a possible "master effect", an important element in favour of the specific effect of the sessions, which can be observed subsequently.

Table 4.5.2.b (1). - Average scores (and standard deviations) of the three groups, at pre- and post-tests, EG (experimental group), PG (placebo group) and CG (control group).

In italics, median, minimum and maximum scores

	EG (n=28)						PG (n=26)						CG (n=29)					
	Pre-Test			Post-test			Pre-test			Post-test			Pre-test			Post-test		
WORD/30	2,7 (2,2)			13,7** (10,1)			2,8 (3,8)			8,3** (7,6)			1,3 (1)			5,7** (6)		
Med, min, max	*2*	*0*	*8*	*13*	*2*	*30*	*1,5*	*0*	*15*	*5*	*0*	*26*	*1*	*0*	*3*	*4*	*0*	*19*
COMP/8	1,9 (1,7)			3,7** (2,8)			2,5 (1,8)			4* (2,4)			1,4 (1,4)			3* (2,2)		
Med, min, max	*2*	*0*	*5*	*3*	*0*	*8*	*3*	*0*	*6*	*4,5*	*0*	*8*	*1*	*0*	*4*	*2,5*	*0*	*7*
MPHS/30	12,7 (6,1)			18,4** (6,9)			12,9 (6,7)			15,2** (6,1)			12,3 (4,4)			14,2* (5,7)		
Med, min, max	*13*	*0*	*23*	*17*	*7*	*29*	*12,5*	*4*	*27*	*16*	*7*	*26*	*13*	*6*	*21*	*13,5*	*8*	*26*
SLKGC/23	6,8 (5,6)			13,5** (8,2)			4,7 (5,7)			9,2** (7,2)			4 (3,3)			10,5** (6,8)		
Med, min, max	*7*	*0*	*20*	*16*	*2*	*23*	*3*	*0*	*21*	*6*	*2*	*22*	*4*	*0*	*14*	*13*	*0*	*22*
GRAPH/30	19,1 (5,4)			22,8** (4,7)			21 (5,8)			21,4 (4,3)			20,6 (6,7)			19,3 (5,3)		
Med, min, max	*21*	*9*	*27*	*25*	*11*	*27*	*23,5*	*12*	*27*	*22*	*13*	*27*	*23*	*3*	*30*	*20*	*10*	*26*

* significant at p .05; ** significant at p .01, Wilcoxon test

Most of the differences observed between the pre and post-tests are significant, except for the phonological awareness (CG) and graphics (PG and CG) tests. The other observed advances for these particular groups can be attributed, at least in part, to the regular classroom reading sessions. The results of the control group attest to this, since the pupils of this group progress in three out of the five tests offered.

Furthermore, to judge the specific effect of training, we calculated, for each group and each test, the differences in progress measured by the performance gaps between post- and pre-tests. Comparisons of these differences appear in Table 4.5.2.b (2).

Table 4.5.2.b (2). - Comparison of progress made by the three groups

	WORD		COMP		CSPH		SLKGC		GRAPH	
	Z	p	Z	p	Z	p	Z	p	Z	p
EG-PG	-1,9	.05*	-.3	.79	-2,5	.01**	-1,6	.10	-2	.04*
EG-CG	-2,2	.03*	-.3	.73	-1,9	.05*	-.2	.85	-2,7	.006**
PG-CG	-.4	.67	-.02	.98	-.2	.84	-1,6	.11	-1,4	.16

* significant at p .05; ** significant on p .01, test of Mann and Withney

The results demonstrate clearly, concerning the word reading and graphics tests, that the experimental group is superior to both the placebo and control groups, the latter two groups not being significantly different from each other. Our training therefore has a positive effect on the reading of single words and on the quality of handwriting. It also has a favourable impact on the mastery of the metaphonological skills. On the other hand, the effect is absent when examining the performance obtained in the written comprehension and dictation tests.

c. Deferred Assessment, Medium Term Effects

Following the training period (13 sessions), pupils were tested on the Algerian adaptation of the Composite Reading Scale (Bartout & Inizan, 1972a). This same test was offered again at the end of the school year, more than two months after the end of training, in order to check for the presence of any medium-term effects. If the sub-tests (and the writing conditions) are strictly identical, the weighting of the raw scores obtained is different depending on the month of the test. The results are shown in Table 4.5.2.c (1).

Table 4.5.2.c (1). - Average weighted scores (and standard deviations), on the composite reading scale, in January and March, for the three groups

In italics, median, minimum and maximum scores

EG (n=28)						PG (n=26)						CG (n=29)					
January			March			January			March			January			March		
88,9 (19,1)			103,1** (27,1)			83,8 (16,7)			85,8 (25,2)			79,9 (12,5)			82,9 (14,3)		
83	*70*	*129*	*115*	*53*	*139*	*79*	*60*	*117*	*75,5*	*53*	*126*	*78*	*60*	*105*	*83,5*	*60*	*117*

* significant at $p \leq .05$; ** significant at $p \leq .01$, Wilcoxon test

At the end of the training period in January, the three groups did not stand out statistically ($H = 1.6$; $p = .43$; Kruskall-Wallis test). In other words, we did not notice, on this type of event and on this date, a particular effect of our sessions. On the other hand, looking at the scores from one test to the next, it is not without interest to note that only the

experimental group significantly improves its performance. For this group, this indicates the presence of acquisitions that are greater than the average of the acquisitions generally observed (case of the placebo and control groups, which maintain substantially the same weighted scores between the two applications of the test). This significant progress is confirmed by a statistical differentiation of the three classes at the end of the school year (H = 7; p = .03; Kruskall-Wallis test). At this time, the impact of training seems clear. We find confirmation of this result when comparing the groups two by two (differences observed between the weighted scores for January and March, Table 4.5.2.c (2)). Only the trained group differs from both the placebo group and the control group, the latter two groups not being differentiated.

Table 4.5.2.c (2). - Comparison of progress made by the three groups on the composite reading scale

	Z	p
EG-PG	-2,2	.02*
EG-CG	-2,6	.009**
PG-CG	-.5	.65

(* significant at p .05; ** significant at p .01, Mann's test and Withney)

This late effect is interesting from a didactic standpoint: it highlights the importance of the number of training sessions to be offered in order to observe a positive effect. In our case, if thirteen sessions are not enough to be able to distinguish the groups (with this type of reading test), it may not be the same after adding few more sessions. However, we are not able to say whether the lack of effect at the first assessment is due to a learning defect or whether, as we rather assume, it is more the result of a lack of sensitivity of the instrument of measurement--the test not allowing to apprehend, in our sample, variations of performances still too slight at this stage. The observation of a performance update at the end of the year would argue in this favour and suggest the existence of a threshold

phenomenon. However, the favourable conditions for the occurrence of the latter remain to be determined.

Now regarding the reading levels reached at the end of the year, one remark is in order. As we have just pointed out, the progress of the experimental group seems particularly clear at the end of March. Nevertheless, the average performance of this group remains low even if the score of one hundred and three points corresponds, according to the designers of the test, to "knowing enough to read to pass to second year primary school" (Bartout & Inizan, 1972a).

Indeed, a pupil who has obtained this weighted total of one hundred and three (103) points is in the 8th interdecile of the scale, exceeded by 70% of the approximately five hundred first grade pupils who served as the reference population for the construction of the test. Note, however, that the representative character of this reference population can only be probable.

Finally, let us recall that the overall weakness of the results concerning these three classes of second year school owes nothing to the quality of the education provided by the teachers and their commitment within the school (the high scores obtained by certain pupils in all the evaluations attest to this).

d. National Assessment at Entry to CE2, Long-Term Effects

At the end of the school year, the pupils in our study were subjected to regular institutional assessments organized by the Ministry of National Education as part of an ongoing national project the aim of which is to comprise a reading assessment scale specific to the Algerian context of Arabic. Teachers of each class and level in the primary school are requested to assess the exam, classroom and homework notebooks of each pupil according to a scale proposed by the project directors and write reports about each pupil’s progress. It

should be noted that many records were “lost” or not performed at all compared to the initial population: the experimental group lost seven records out of 28 (the record of the dyslexic pupil was also lost), the placebo group six records out of 26 and the control group seven records out of 29. These losses are due in part to the relocation of certain families leading to a change of school for the pupil. The total number of records is therefore sixty-seven out of the initial eighty-three.

In Table 4.5.2.d (1), the results of a previous but identical national Arabic assessment appear (report found in the archive of one of the schools) and, in Table 4.5.2.d (2), the comparisons of scores between our classes for the elements of this national assessment project.

Given the small size of our sample, we would like to reiterate the caution we must exercise with regard to the results presented here. Looking at the overall scores of the three groups (last two rows of Table 4.5.2.d (1)), we notice that the experimental group achieves the best performance. We also observe, and this without surprise, significant differences between the scores of the national sample and those of our subjects, educated in Adrar, including those of the trained group. A comparison of the three groups two by two will allow us to explore these shifts more precisely.

Table 4.5.2.d (1). - Average scores (and standard deviations) of the three groups and of a representative national sample on Arabic assessment at entry to CE2

	EG (n=21)			PG (n=20)			CG (n=22)			EG, CG, PG (n=63)			National sample
Reading: tools (out of 20)	13,6 (3,4)			12,9 (5,3)			12,9 (2,5)			13,1 (3,9)			15,7
Med, min, max	*14*	*8*	*19*	*14,5*	*3*	*19*	*13*	*9*	*17*	*14*	*3*	*19*	
Writing: tools (out of 18)	10,2 (2,7)			11,9 (4,1)			9,6 (3,3)			10,6 (3,5)			12,6
Med, min, max	*11*	*6*	*14*	*13*	*2*	*17*	*9*	*6*	*14*	*11*	*2*	*17*	

Reading: understand (out of 34)	25 (5)			19,6 (5,9)			18,6 (5,5)			20,9 (6)			25,9
Med, min, max	*25*	*18*	*31*	*19,5*	*12*	*29*	*17*	*11*	*27*	*20*	*11*	*31*	
Writing: produce (out of 15)	10,8 (2,2)			8,6 (2,9)			8,2 (2,9)			9,1 (2,8)			9,8
Med, min, max	*11*	*7*	*13*	*8*	*4*	*13*	*8*	*4*	*13*	*9*	*4*	*13*	
Total score (out of 87)	59,4 (9,3)			53 (15,1)			49,2 (12,1)			53,6 (12,8)			64
Med, min, max	*58,5*	*46*	*71*	*51,5*	*25*	*77*	*43*	*36*	*67*	*53*	*25*	*77*	
Total score (out of 100)	68,3			60,9			56,5			61,6			73,6

Table 4.5.2.d (2). - Comparison of the scores obtained by the three groups on the assessment at entry to CE2 (Arabic)

	Reading: tools		Writing: tools		Reading: understand		Reading: produce		Reading: total	
	Z	p	Z	p	Z	p	Z	p	Z	p
EG-PG	0	1	-1,3	.17	-1,8	.07	-1,5	.12	-9	.35
EG-CG	-.6	.52	-.4	.66	-2,2	.02*	-1,7	.08	-1,8	.07
PG-CG	-.5	.65	-1,4	.16	-.4	.68	-.3	.77	-.9	.36

* significant at p .05; ** significant on p .01, test of Mann & Withney

The control and placebo groups does not differ on any of the elements of the assessment. On the other hand, the experimental group differs significantly from the control group in the comprehension element. More marginally, it differs from this same group on the elements relating to the production of writing (it also obtains a better overall score) and from the placebo group on the semantic elements. The purpose of any reading being to understand what one reads, this is obviously a result to be emphasized here.

In addition, following the observation of the positive effect of our training observed on the graphic design test, we explored the results of a copying exercise found in the classroom notebook. This is an exercise calling on the pupil's attention but also on his or her spelling knowledge, the task consisting in copying, for a period of ten minutes. When looking at the length of the text copied by the pupils, the trained group is significantly

different from the control group with respect to the number of sentences reproduced (Z = -2.1; p <.03; Mann and Whitney test), but not of the placebo group (Z = -1.2; p <.21), control and placebo not otherwise different (Z = -.4; p <.67). Let us add that this additional copied text is not done to the detriment of respect for presentation or punctuation.

Thus, the guided writing and copying exercises, the tactile follow-up of the letters proposed during the training would have allowed an improvement of the graphic gesture (faster execution speed, without consequence on the quality of the spelling).

This result seems important when one considers that copying activities are implemented in all school disciplines (putting together productions of writings, lessons, summaries, poetry, etc.) and that they can be an opportunity to strengthen lexical, orthographic, syntactic acquisitions, etc. Later, in middle school, the speed of the graphic gesture and the good legibility of the trace will also contribute to the pupil's autonomy.

4.6.Discussion and Conclusion

The objective of this research was to evaluate, in the short, medium and long term, the effects of the multisensory method in reading when a multisensory training program was administered to a normal second year class with integrated dyslexic cases. A program, which we hypothesized should facilitate and improve learning capabilities for both normal learners and learners with specific needs, was composed of exercises mainly focussing on knowledge of letters (writing, hearing, visual and haptics), associations between these letters and sounds (grapheme-phoneme correspondence), phonological skills and manipulation of the graphophonetic code. The main results that we will review here attest to the favourable impact of the training provided.

In the short term, pupils in the experimental group performed better than those in the placebo and control groups on the single word reading and graphics tests. The impact of this

training on performance in phonological awareness is also proven, the experimental group also differing from the other two groups. However, no significant difference is observed between the three groups for the comprehension and dictation tests.

The lack of effect on comprehension could be explained by an insufficient level of proficiency in identifying written words. Classically, reading comprehension is considered to require the simultaneous mobilization of two components, on the one hand, the ability to give meaning to language, oral and written, on the other hand, the recognition of written words under the constraint of an information processing system having a limited amount of cognitive resources (Gough, 1996). In this context, too high a cognitive cost of decoding, especially during the learning phase, can hamper understanding, or even lead to its failure by hampering the performance of processing relating to textual integration. The low scores obtained by most pupils on the single word-reading test (including those in the trained group) seem to support this.

Let us also say a few words about the lack of effect observed in the dictation test, recalling first that writing words (or syllables) under dictation can be done in different ways: from orthographic representations stored in memory and using phonological mediation. In the first case, it is a direct and largely automated procedure whereas in the second, a controlled procedure, attention consuming and very frequent during the learning phase (Freedman, 1985). Given the low level of reading of a large number of our pupils, the necessary mastery of the graphic tool still being acquired at this stage of schooling and the control that must be exercised over the writing movements, we can consider dictation a difficult exercise to achieve for them. It is akin to a task of shared attention in which the pupil is required to direct their attention to both the words spoken and what they are writing. At the same time, the pupil must search in memory either fully specified spelling forms (certainly few in number at this stage), or partially specified or absent, which then requires

recourse to phonological mediation (that is to say an analysis of words into phonemes followed by conversion of these phonemes into graphemes). It is therefore probable that our pupils confronted with these multiple tasks found themselves in a situation of cognitive overload.

The positive results observed in the medium term during the deferred evaluation at the very end of the school year (standardized test of the composite reading scale) as well as the favourable improvements noted on the longer term in the comprehension and reading elements (national assessment at entry to CE2) highlight a late incidence of training. Consequently, these results should encourage teachers not to make too hasty judgments about their pupils' abilities to benefit from such sessions. Indeed, the lack of immediate and perceptible progress risks discouraging the teacher; it may then be tempting to interrupt or reduce too early in the school year learning assistance devices, which are still essential for some pupils and over a long period.

By avoiding any prescription and knowing that it is risky to deduce from experimental work procedures that are directly applicable in the classroom, we still believe that we can provide some leads to the teachers in teaching reading. In particular, it is perhaps less the originality of our training that will interest them (apart from the introduction of rough letters) than the methodical, controlled and explicit character of the approach followed. In addition, such training can be addressed within a class to all students regardless of their reading level or specific needs.

Reading training experiments are still infrequent, especially in Arabic, and often focus on phonological activities. In some recent works, devoted to the field of reading (and its disorders) (Verhoeven & Perfetti, 2017; Mahfoudhi, Elbeheri, & Everatt, 2009) the suggestions relating to the implementation of a learning aid take up only a few pages. It

would therefore be advisable to multiply fundamental research carried out in the laboratory field research. The latter should make it possible to verify, if possible, the ecological validity of certain results obtained in a strictly controlled situation. This obviously poses serious problems for the researcher, divided in his or her methodological choices between rigorous control of variables or maintaining the ecological character of the research. However, studies carried out in a school context are essential, on the one hand to maintain a dialogue between practitioner and researcher, on the other hand to offer concrete illustrations to teachers and suggest possible avenues for classroom applications.

General Conclusion

The present research aimed to validate the effectiveness of a multisensory training program in improving reading in a normal classroom with integrated dyslexic cases. The general objectives of the program were to improve perceptual reading processes in children with dyslexia and those demonstrating mild to no learning difficulties.

The evaluation of the use of a multisensory training program relies on two analytical methods. The first method consists of a psychometric testing phase carried out so that proper diagnosis could be made concerning the existence of any type of learning difficulties in the chosen population, and particularly that of dyslexia. This was a preliminary testing done before the training sessions and entirely conducted by a medical professional. The results detect an overall tardiness in the general reading level of all the tested classes, but it is deemed very common at this age. The psychometric testing also detected an extreme case of mixed dyslexia, which was previously unknown to both the teacher and the parents of the child.

The second method used to analyse the results is through a learning scale charter. This method consists of a number of evaluation tests that are carried out throughout the study and took into consideration the immediate, medium and short term effects of the training.

The overall result shows an improvement in the performance of the experimental group and their scores seem to be in favour of the partial achievement of the objectives of this research. Despite this observation, the results obtained by the placebo and the control classes do not allow us to highlight a generalization of favoured use of the multisensory method. Similarly, the results of the dyslexic child do not satisfy the purpose of this study despite it playing a direct influence in choosing the approach in question.

In addition, the duration of the program may have limited the learning of the targeted skills. Everything suggests that a training spread over several months would have consolidated the gains. Furthermore, the learning scale seems to be another variant to be examined in terms of its validity and accuracy.

A low rate of significance between the pre- and post-tests results is also observed and could be explained by three hypotheses. The first concerns the choice of the training exercises, which may not have made it possible to target the objectives of the study. Besides, it was difficult to establish the real level of difficulty for each exercise with regard to the pupils and the selection of exercises likely to improve the performance of the participants in the post-test.

A second assumption concerns the size of the sample. The results obtained allow us to conclude that a larger population would have been necessary in order to obtain an adequate statistical power to detect differences between the two groups. It was indeed very lucky to diagnose an existing case of dyslexia properly in the schools that were chosen.

The third hypothesis concerns the selection of measuring instruments. In short, these tests, not being specifically designed to assess the effectiveness of the program, seem to have had a notable influence on the results. Currently, there is no scientifically validated instrument of measurement that can globally assess the efficiency of a multisensory training program similar to the one used in this study. An attempt to compensate for the lack of specialized tests was made by focusing on tests that assess the reading process as well as the oculomotor stimulus necessary for reading. In vain, would properly designed Algerian tests have made it possible to observe the desired changes? This matter remains perplexing at this point. It is believed that a reading test, regardless of its origin, cannot evaluate the whole of a training program of any kind. It would still be interesting for further research to conduct

the experiment using contextualised reading tests to study the impact of this type of program on the progress of dyslexic second graders and second year pupils in general specifically after the training program to interpret a more conclusive evidence of integration.

This research is original since very few studies aiming to integrate dyslexic children in normal classes have been conducted. It seems important to oversee, in the future, studies with a larger population of dyslexic children in order to understand the implications of such approach better. In addition, it could prove beneficial for subsequent research to test this approach without including a dyslexic element. An interesting avenue for the advancement of research would be to build a specific measuring instrument to assess the real effects of such support. More importantly, it would be useful to carry out longitudinal studies in order to analyse more precisely the impact of such training.

In the Algerian context, it seems now essential that the different stakeholders directly involved in the decision making of reforms in the primary schools take into account dyslexia for a more inclusive classroom. The implementation of concrete actions would make it possible to speed up the *prise de charge* of dyslexic children in their local schools, and not wait until a child is too old to reverse the implications of this disorder.

Multisensory training at the first signs of reading deficits would increase the child's chances of success in treatment and thus reduce the risk of repeated failures both academically and personally. This training can also act as a preventive method before any difficulty manifests itself in later stages of learning.

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Appendix A

Letters of the Arabic Alphabet

Initial	Medial	Final	Alone	Transcription
ا	ـا	ـا	ا	â
بـ	ـبـ	ـب	ب	b
تـ	ـتـ	ـت	ت	t
ثـ	ـثـ	ـث	ث	ṯ
جـ	ـجـ	ـج	ج	j
حـ	ـحـ	ـح	ح	ḥ
خـ	ـخـ	ـخ	خ	ḫ
د	ـد	ـد	د	d
ذ	ـذ	ـذ	ذ	ḏ
ر	ـر	ـر	ر	r
ز	ـز	ـز	ز	z
سـ	ـسـ	ـس	س	s
شـ	ـشـ	ـش	ش	š
صـ	ـصـ	ـص	ص	ṣ
ضـ	ـضـ	ـض	ض	ḍ
طـ	ـطـ	ـط	ط	ṭ
ظـ	ـظـ	ـظ	ظ	ẓ
عـ	ـعـ	ـع	ع	ʿ (ayn)
غـ	ـغـ	ـغ	غ	ǧ
فـ	ـفـ	ـف	ف	f
قـ	ـقـ	ـق	ق	q
كـ	ـكـ	ـك	ك	k
لـ	ـلـ	ـل	ل	l
مـ	ـمـ	ـم	م	m

ذ	ذ	ن	ن	n
ھ	ھ	ـة ، ہ	ة ، ہ	h
و	و	و	و	w
ۑ	ۑ	ي	ي	y

Vowels and Diphthongs

◌َ	A	اَ◌	ā	◌ِ ى	ī
◌ُ	U	◌َ ى	á	◌َ وْ	aw
◌ِ	I	◌ُ و	ū	◌َ ىْ	ay

	1	2	3	4	5	6	7	8	9
Occlusive	b			t ṭ d ḍ		k	q		’
Fricative		f	ṯ ḏ	s ṣ z	š	ḫ ġ		ḥ c	h
Affricate				ǧ					
Nasal	m			n					
Lateral				l					
Vibrant				r					
Glide	w				y				

Classification based on place of articulation

Appendix B

Lesson Plan Example: Experimental Group

1. Discovery of Sound (10 min)

Material: Audio, One letter "ر" per child

• The children and the teacher are seated around a table.

• Give the instruction: “You are going to listen to a rhyme. Pay attention, listen carefully, and try to spot the sound that is repeated often in this story. »Play tracks 1 and 2 of the audio (text with accompaniment then text only), question the children and have them repeat the sound they have identified in turn.

• Give each child a letter "ر". Let the children discover the letter by handling it, then give the instruction: "You are going to tell me what this letter is called". If the children cannot name it, simply give the answer: "This letter is called "ر"and it makes the sound / r / and it goes with the little rounding down." Have the children repeat the sound and let them freely handle the letter for a few moments. Then ask them to place it in front of them in the right direction.

• Ask the children to repeat each line of the rhyme in chorus, giving the instructions:

"Now repeat after me all together: "…إنه يوم رائع". At the end of the repetition, ask the children to name the words in which the sound / r / is heard, then collect the letters.

2. Discrimination of the Initial Phoneme (10 min)

Material: 6 images for the group, 3 starting with the sound / r /, 3 with another sound

• Place the 6 pictures in the middle of the table, naming them so that the children remember the names.

• Give the instruction: "You will silently search for the images that start with the sound / r/, such as **رمان**. Be careful, think carefully. As soon as you find a picture, you will lift your finger, I will come to you, and you will whisper your answers to my ear."

• Walk around the table to collect everyone's suggestions, then take all the pictures again and ask the students to take turns saying whether the sound / r / is heard at the beginning of each word.

3. Discrimination of the Final Phoneme (5 min)

Material: 6 images for the group, 3 ending with the sound / r /, 3 with another sound.

• Place the 6 pictures in the middle of the table, naming them so that the children remember the names.

• Give the instruction: "You will silently search for the images ending with the sound / r /, such as **جدار**. Be careful, think carefully. As soon as you find a picture, you will lift your finger, I will come to you, and you will whisper your answers tom my ear."

• Go around the table to collect everyone's suggestions, then take all the pictures again and ask the students to take turns saying whether the sound / r / is heard at the end of each word.

4. Visuo-Haptic and Haptic Exploration (5 min)

Material: One letter "ر" per child • The arrow "ر" sheet for the group

• Distribute the letters, asking the children to place them the right way up in front of them.

• Present the arrow card of the letter to the group and show with the index finger how to explore the letter in the writing direction by giving the instruction: "You will hold your card with one hand and with the other, you will follow the direction of the letter, going around five times with your eyes open and five times around with your eyes closed."

5. Haptic Discrimination (5 min)

Material: A banner, a letter "ر" and one or more distracting letters per child

• Blindfold each child and place the assembled letter combinations in front of them.

• Give the instruction: "You are going to touch the letters and guess which one is the letter "ر". When you find it, you will keep your right hand on the correct letter and raise the other hand."

• If the child has found the "ر" correctly, let him remove his blindfold to check for himself. If he was wrong, advise him to take the time to explore the letters again.

6. Discrimination of the Initial Phoneme (5 min)

Material: 9 images for the group, 6 starting with the sound / r /, 3 with another sound

• Place the 9 pictures in the middle of the table, naming them so that the children remember the names.

• Give the instruction: "You will think carefully and take, each in turn and in silence, an image which begins with the sound / r /."

• After each child has chosen a picture, have pupils take turns saying the names of the pictures they chose. If one makes a mistake, ask him to put the picture down and choose a new one, allowing him to seek help from others if necessary.

7. Discrimination of the Final Phoneme (5 min)

Material: 9 images for the group, 6 ending with the sound / r /, 3 with another sound

• Place the 9 pictures in the middle of the table, naming them so that the children remember the names.

• Give the instruction: "You will think carefully and take, each in turn and in silence, an image which ends with the sound / r /."

• After each child has chosen a picture, have pupils take turns saying the names of the pictures they chose. If you make a mistake, ask the child to put the picture down and choose a new one, allowing him to seek help from others if necessary.

8. Reinvestment (5 min)

Materials: One "ر" memo sheet per child, Coloured pencils for the group

• Distribute one sheet per child, with the coloured pencils within reach of all.

• Explain the instructions collectively and ensure that they are understood by all.

• Correct the cards before pasting them in the children's notebooks, so that they keep a written record that they can show to their parents.

Lesson Plan Example: Placebo Group

Measurement of Length and Area (Calculating Area)

Material: Cut-outs or small squares, Sheets

Keywords/Vocabulary List: Length, width, area, long, wide

Introduction (10 min):

Teacher introduces the lesson by telling a story relating to area (e.g. land, plantation, etc.)

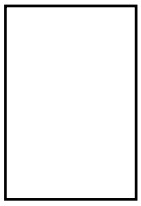
Story:"A farmer walked around his 2 plantations whose shapes are rectangular and said, "I have found the perimeters of my 2 plantations to be the same, so I will harvest the same amount of maize from each of them"

Activities:

Step 1 (5 min)

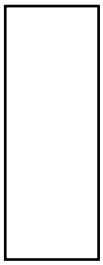
Pupils make 5 or 6 groups. Teacher gives a sheet on which 4 rectangles have been printed with A, B, C, D, and smaller square cut-outs of 1cm by 1cm to each group.

A: 6cm×3cm



B: 4cm×5cm

C: 7cm×2cm



D: 2cm×8cm

Step 2 (15 min)

Pupils cover the rectangles with the smaller square cut-outs of 1cm by 1cm.

Step 3 (15 min)

Pupils complete the table on the chalkboard:

Figure	Total no. of Squares	No. of Squares on the Longer Side	No. of Squares on the Shorter Side
A			
B			
C			
D			

Pupils find the relationship between the total number of squares and the numbers of squares on the sides of the rectangle.

Conclusion (5 min):

The teacher introduces the concept of area by summarizing the pupils' findings and explains the conclusion.

Appendix C

Pre- and Post-Tests

Written Comprehension (COMP):

Note: Before allowing the child to begin the test, exemplify on the board how it is done by conducting example pictures together in class.

Scoring: For each text, check the box corresponding to the answer given by the child. If the child's answer matches the number in bold, score 1. If the child's answer does not match, score 0. For the *Total Score* row calculate the number of correct answers the child received.

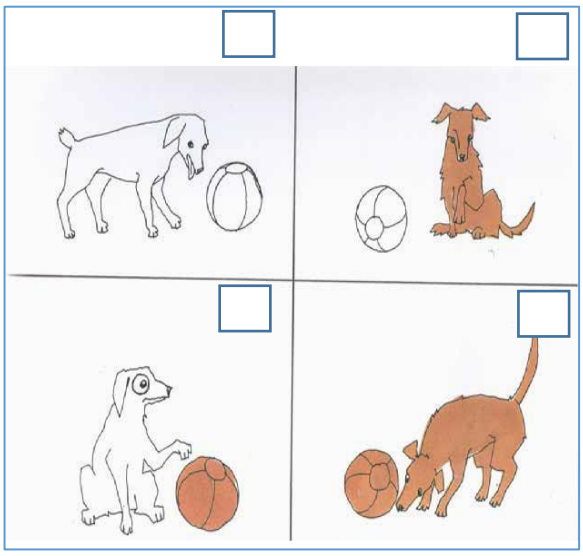
Item	Sentence	Image chosen by the child.				Score (0/1)
1	لا الكلب ولا الكرة لونهما بني.	1 ..	2 ..	3 ..	4 ..	
2	ليس الطائر أبيض فحسب ، بل الزهرة أيضًا.	1 ..	2 ..	3 ..	4 ..	
3	المربع داخل النجمة أزرق.	1 ..	2 ..	3 ..	4 ..	
4	قلم الرصاص على الكتاب الأصفر.	1 ..	2 ..	3 ..	4 ..	
5	الفتاة تلاحق الحصان.	1 ..	2 ..	3 ..	4 ..	
6	الفتاة تجلس على الطاولة.	1 ..	2 ..	3 ..	4 ..	
7	إنهم يقفزون فوق الحائط.	1 ..	2 ..	3 ..	4 ..	
8	قلم الرصاص خلف الصندوق.	1 ..	2 ..	3 ..	4 ..	
Total Score						**/8**

إختبار الفهم الكتابي

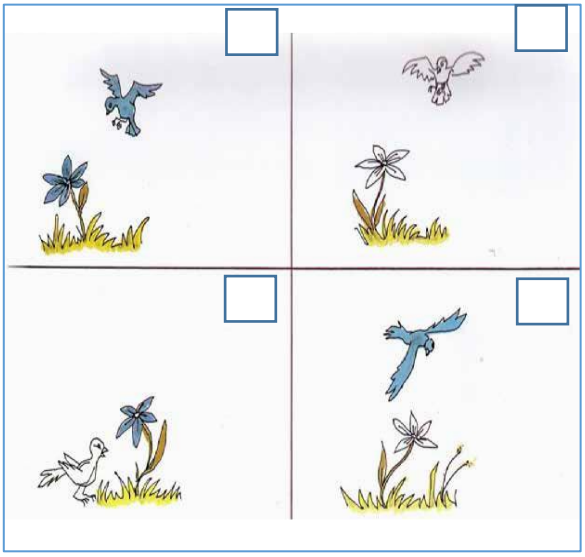
اللقب و الإسم: .....

إقرأ الجملة ثم إختر من بين الصور الأربعة أسفلها الصورة التي توافق المعنى، ضع علامة X في المربع الصغير جنب الصورة الصحيحة:

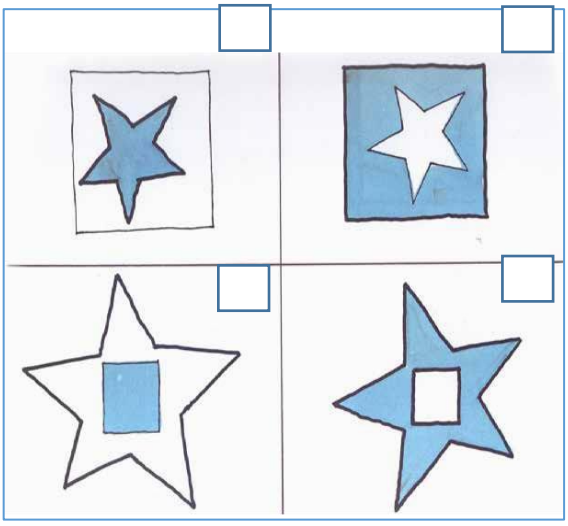
لا الكلب ولا الكرة لونهما بني.



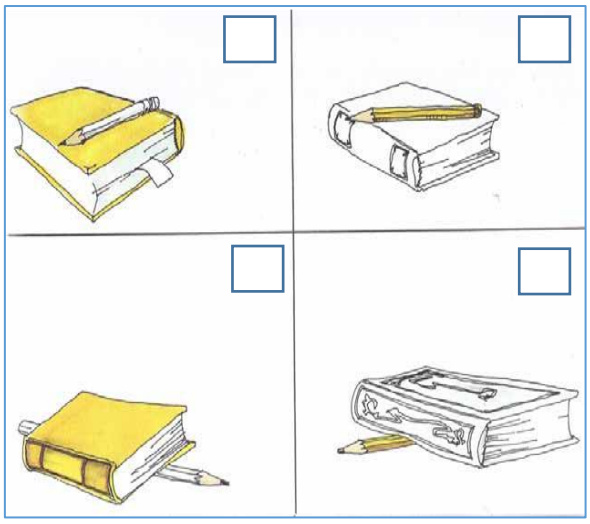
ليس الطائر أبيض فحسب ، بل الزهرة أيضًا.



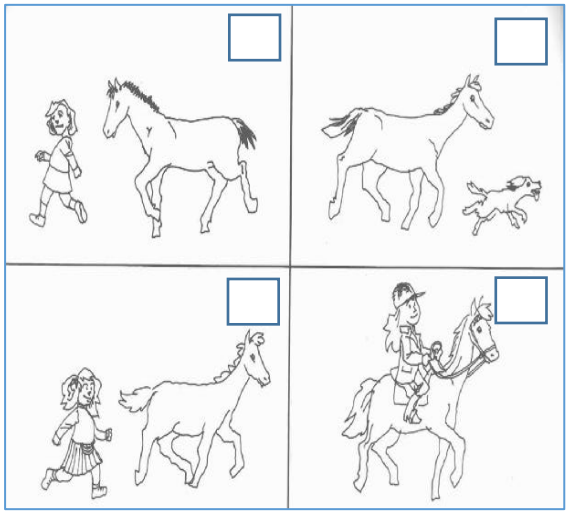
المربع داخل النجمة أزرق.



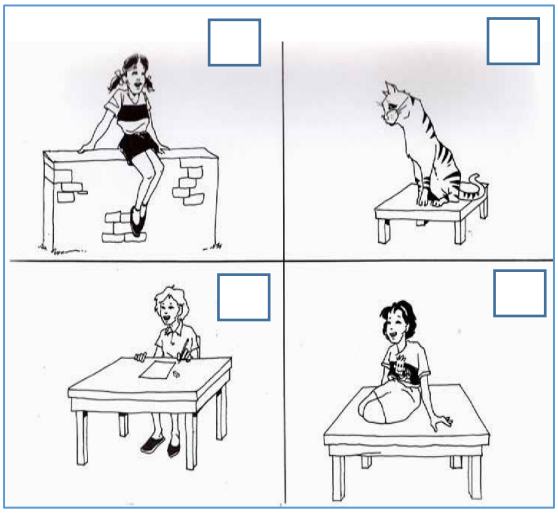
قلم الرصاص على الكتاب الأصفر.



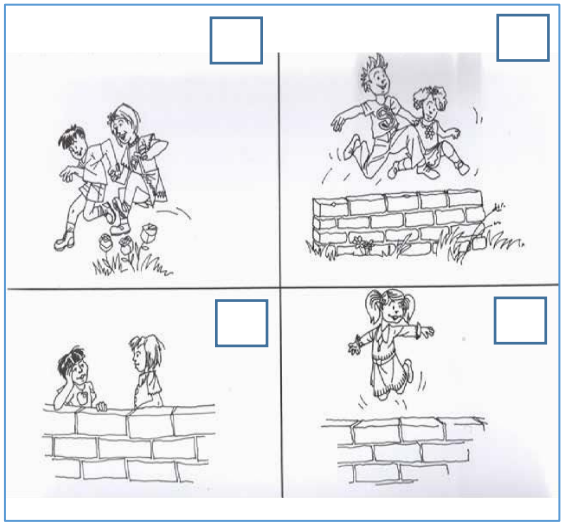
الفتاة تلاحق الحصان.



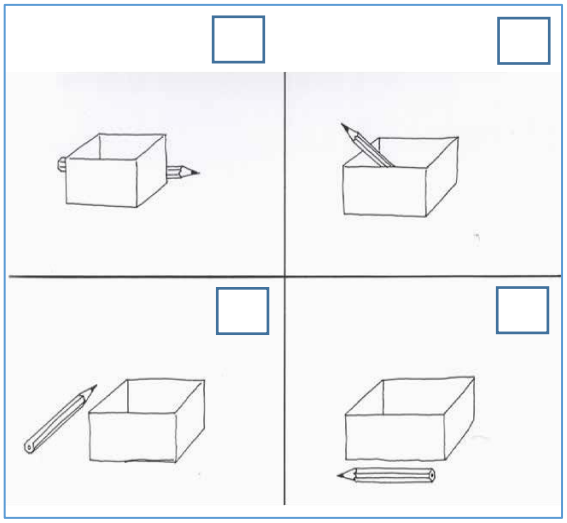
الفتاة تجلس على الطاولة.



إنهم يقفزون فوق الحائط.



قلم الرصاص خلف الصندوق.



أحسنت

Metaphonological Skills (MPHS):

Scoring: Each correct answer receives one point, and the maximum for each sub-test is 5 points.

Sub-Test 1: *Let us Count the Syllables!*

Instructions:

‘’I will say words to you. You will have to count the syllables in the word. For example if I tell you: "نافذة". "نا-ف-ذ-ة" (count at the same time with the fingers for each syllable spoken). How many syllables are in windows? 4, yes there are 4, so I put 4 lines : ////’’

“Now we're going to do the same with apple. Apple (counting with your fingers). How many syllables has "قط" ? Yes, there 2, so I put 2 lines: //’’

“A final example with crocodile. Crocodile. How many syllables has "رمل" ? There are 3, so I put 3 lines: ///’’

“Now you are going to do the same exercise but on your sheet. I tell you the word, you silently count the syllables and you put the number of lines that correspond, if the word has one syllable, you only make one line, if it has 2, you put 2 lines, etc.’’

On the Paper: كراس، طائرة، ديناصور، حلوى، الجزائر

Sub-Test 2: Let us find rhymes!

Instructions:

"You have to connect the words that rhyme. E.g., what word rhymes with "مدرسة" from the following list (رامي، ممرض، مكتبة، كرة)? "مكتبة" , yes.

On the Paper: (Pictures)

رائد	قطار
مقلاة	ذرة
قلم	شاطئء
كرة	علم
منظار	مرساة

Sub-Test 3: *Let us compare the length of words!*

Instructions:

“Which word is the longest between "بقرة" and "ثور" ? Which is the one that contains the most sounds? The first is 4 sounds and the second is 3. Therefore, "بقرة" is the longest word because it has the most sounds.

Now between "يد" and "فأر", what is the longest word? We decompose / ي / - / د /, / ف /- / أ / - / ر /. "فأر" is the longest word.’’

“Now you are going to do the same exercise, you have to find the longest word between:

ثعلب and مسمار,

عظم and فرشاة,

فزاعة and بيض,

ملاكم and هلال,

بالونات and شمس .

Remember to break down the word say each sound in your head; you can help yourself by counting them on your fingers. Circle the longest word.’’

Sub-Test 4: *Let us associate the same initial sounds!*

Instructions:

‘’For this exercise, you will have to find out which words begin with the same sound. For example on your sheet, if you have "بئر", "لعبة" and "بائع". You have to find out which words begins with the same sound as "بئر". You will connect the words that start with the same sound.

“Now you are going to do the same exercise with a few more words, you have to find out which words start the same. They are always in pairs. Listen carefully, I will read them to you once.’’

On the Paper: (Pictures)

نافذة	سرير
سنجاب	صنارة
شاحنة	نجمة
ممحاة	شوكة
صاروخ	مصباح

Sub-Test 5: *Finding the Odd Word!*

"I'll give you some words; you'll find the one that doesn't end the same." For example if I say "خس" , "شمس", "عالم", "فرس". What is the word that does not end the same? It is "عالم", yes. "خس", "شمس" and "فرس" end with the same sound /س / while "عالم" ends with /م /.

"Now you're going to do the same with your exercise. Circle the odd word!"

On the Paper: (Pictures)

نمر، صقر، غزالة، كنغر

تين، عنب، رمان، ليمون

جبل، شلال، سهل، صحراء

قبعة، تنورة، قميص، سترة

طبيب، معلم، رسام، محام

Sub-Test 6: *Let us represent sounds by letters!*

‘’For this exercise, you will have to associate the letters with the words provided. These words will have to include the letter in question in the middle of them. For example, consider the following letters: "غ" ،"و"، "ظ"، "ك". Which of these letters is included in the middle of the word "نظارة"? It is the letter "ظ". Similarly, you will have to connect the words in your exercise with the letter that conveys a middle sound.”

On the Paper: (Pictures)

ثعبان	ل
مضرب	ر
أذن	ذ
عربة	ع
طاولة	ض

اختبار المهارات الميتافونولوجية

لنعد مقاطع الكلمات!

♣ _____

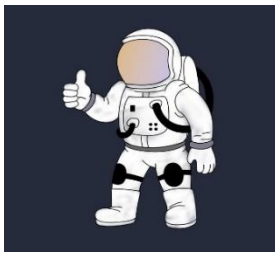
♠ _____

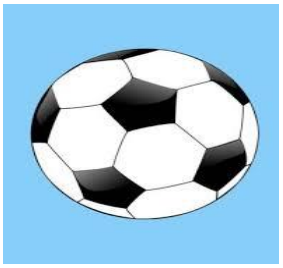
☻ _____

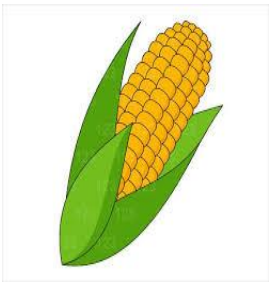
♫ _____

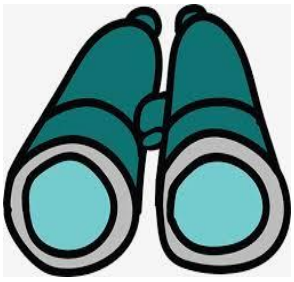
♦ _____

لنشكل القوافي !

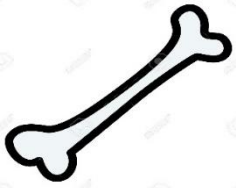








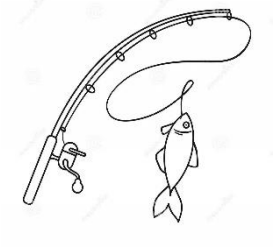
لنقارن طول الكلمات!

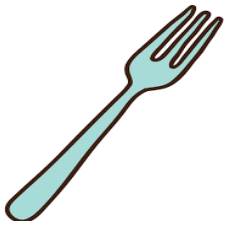



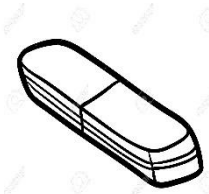


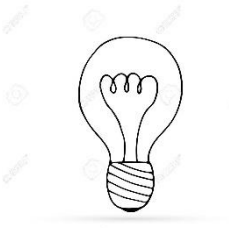


لنربط بدايات الكلمات المتشابهة !









لنشطب الكلمة الدخيلة!





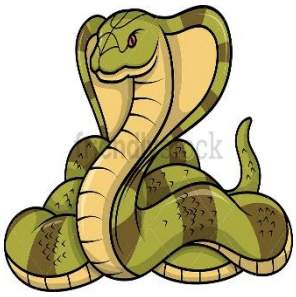




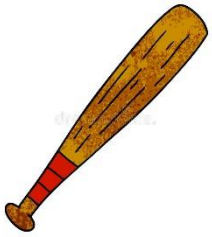




لنربط الكلمات بالحروف !



ل



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Spelling Level and Knowledge of Graphophonetic Code (SLKGC):

Dictation: (23 points (18 Ph. “phonetic” points, 3 Us. “usage” points and 2 Gr. “grammar” points)

ي، ئي، كو، تا، غُ، سً، تحا، لي، ما، لا

رأى ياسين القط الأسود و لعب معه.

Parts	Elements and Text to Dictate	Appreciation: Points		
		Ph.	Us.	Gr.
1	ي، ئي، كو، تا، غُ، سً، تحا، لي، ما، لا	10		
2	رأى يا-سي-ن القط الأسود و لعب معه	8	3	2

Word Reading (WORD)**:**

The test lasts ten minutes and the maximum points that can be obtained is 30, one for each word. The child needs to connect the words to the objects using a pencil.

Graphics (GRAPH):

Copy the following in an identical way.

لعبة الغميضة تفاحة حمراء جميلة مجموعة - قش - قرد

The maximum points that can be awarded is 30: 15 for legibility, 9 for respecting the framing, guide lines, stems and jambs and 6 for making connections between cursive letters. For the scoring of the protocols for this test, we called on a second corrector not participating in the experiment.