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# READING DIFFICULTIES IN PRIMARY SCHOOL: PRECOCIOUS REMEDIATION

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## Abstract

In France, more than 14% of students entering middle school present written-word identification difficulties. This acutely raises the question of how to help struggling readers. Researchers agree that early intervention is the key to preventing learning difficulties from getting more severe with time. The objective of this research is to assess the effectiveness of a plan, combining written-word identification level evaluation and remediation, to reduce written-word identification difficulties among primary school students. Two experimental sessions were conducted over two school years. The written word identification performance of 913 students from grade 2 to grade 5 was evaluated at the beginning of school year. Then, students identified as having difficulties (408 students) benefited from remediation sessions. Based on double path reading models and depending on the problems identified, students with difficulties in written-word identification attended remedial sessions focusing either on grapho-syllabic conversion abilities (the syllable is a prominent sublexical unit in French) or on building and strengthening the orthographic lexicon. Progress in written-word identification performance made by students who benefited from this program was compared to that of a control group. For the control group, the written-word identification performance of students from grade 2 to 5 was evaluated at the beginning (391 students including 184 students identified as having reading difficulties) and the end of the school year, but none of them took the specific remediation sessions. The results indicate a larger increase in written-word identification performance for students benefiting from the specific remediation program than for students who did not. Thus, accessible solutions exist to address some forms of reading difficulties encountered by students in primary school.

Keywords: reading, written-word identification difficulties, primary school, evaluation, remediation.

## 1 INTRODUCTION

The objective of this research is to assess the effectiveness of a program, combining reading abilities evaluation and remediation sessions, to reduce reading difficulties in written-word identification among primary school students. The results show that solutions accessible to all teachers exist allowing primary school students from 2<sup>nd</sup> to 5<sup>th</sup> grade to reduce their difficulties in identifying written words.

In France, the formal teaching of reading begins around the age of 6 and is one of the basic skills of primary school. Access to reading is a key issue, which will depend on the school career of the child and his social integration. In alphabetic language, learning to read requires students to recognize the graphemes and to create a link between those and spoken language [1]. As suggested by the simple model of reading of Hoover and Gough [2], good reading proficiency requires good skills in identifying written words associated with good skills in understanding spoken language. In this article, we will focus on written-word identification abilities.

Different models have been proposed to account for the mechanisms of written words identification. Among them, dual-path-models are still widely used. These models [3] suggest the existence of two procedures (paths) to identify written words among expert readers: a lexical procedure and an analytical procedure. The lexical procedure allows for the identification of all known words by direct activation of their phonological and orthographic representations in the mental lexicon. Via this procedure, readers can recognize, identify all the words they remembered. The second procedure, called "analytic" (or sublexical procedure), allows for the identification of words that are not registered in the mental lexicon (unknown words, pseudowords...). Identification of written words using this procedure requires to decompose written words into sublexical units and to apply the grapheme-phoneme conversion rules. This procedure requires more attention than the lexical one. In the dual-

path models, when a written word is presented to the system, both procedures are activated in parallel. In the case of a frequently known word, phonological representation of the word is activated quickly via the orthographic representation before the analytical procedure is completed. On the contrary, when an unknown word is presented, its identification is achieved via the analytical procedure.

The first developmental models of reading postulated a development in successive stages, each stage being characterized by the use of different procedures. In Frith's model [4], an initial logographic phase, during which children recognize words based on salient visual and contextual features, is followed by an alphabetic phase in which a letter-to-sound translation strategy comes into play. The final stage is fluent orthographic reading, with the installation of a mental lexicon. In these developmental models, a strict succession of the stages is postulated. Nowadays, this assumption is questioned. Other developmental models, derived from connectionist models of expert reading, focus on early interaction between phonological and orthographic units. Indeed, experimental data suggest a simultaneous development of alphabetic and lexical knowledge when students begin to read [5]. In this context, the acquisition of orthographic knowledge is no longer conditioned by a certain level of alphabetic knowledge, but initiated early, from the moment students start learning to read. However, it does not mean that the two reading procedures are also equally effective at the start of reading development [6]: the analytical procedure develops rapidly whereas the lexical procedure is still little effective. Thus, for beginning readers, though memorizing the words encountered is possible as soon as they start learning, this stock is not sufficient and the large majority of reading is achieved via the analytical procedure.

## **1.1 Children with reading difficulties**

Several studies conducted in France indicate that 14 to 20% of children have reading difficulties when they enter middle school [7]. These studies point to the composite nature of reading difficulties. They show that there is no homogeneous category of struggling readers, but a variety of non-performance. Thus, 5% of students have dyslexia, a neurodevelopmental disorder. According to the dominant hypothesis, this trouble leads to a deficit of the system of phonemic representation disrupting the learning of grapheme-phoneme correspondences, their manipulation in real time while reading and the acquisition of orthographic lexicon [8]. Other children encounter reading difficulties due to environmental causes - leading to difficulty in controlling the decoding, in particular due to non-automatisation which can be related to insufficient practice ... - and / or difficulties in building orthographic lexicon. Finally some children have reading difficulties that are related to other types of disorders.

## **1.2 Difficulties in written words identification and remediations.**

Identifying written words implies acquiring grapho-phonological correspondences (the analytic procedure, decoding). It implies the ability to identify phonemic units in speech and to link them to visual units. In this context, phonological awareness, the ability to orally manipulate the different sound components of words (syllable, attack, rhymes and phonemes) is important. Many studies have shown a link between phonological awareness and reading performance (for a review, see [9]); it is, with the knowledge of letters, one of the best predictors of reading success [10]. At-risk students and students experiencing reading difficulties have more problems than others perceiving and manipulating phonemes [10-11]. Moreover, numerous studies have shown that phonological awareness training improved reading scores [10]. But, most of all, many studies converge on the conclusion that the effect of phonological training is greatly amplified if an explicit work on grapheme-phoneme correspondence is also proposed [12]. For Share [13], developing and mastering grapho-phonological correspondences is a prerequisite for learning to read. This hypothesis is supported by studies showing that good decoder children are those who made the most progress in reading [14]. Consequently, a default in the acquisition and/or the automatisation of grapheme-phoneme correspondence can be a major source of difficulty for beginning readers. In France, studies suggest that training based on syllabic units could also improve word reading [15] and reading speed [16]. Indeed, in French, the syllable is a prominent unit for word recognition [17], and it appears that working on those units, compared to phonemic units will be interesting for poor readers [18]. In summary, it appears that specific work on the acquisition of the correspondences between written and oral units is important for students with difficulties in written-word identification. Moreover, in French, relying on a grapho-syllabic (rather than grapheme-phoneme) procedure seems to be interesting for struggling readers.

Learning to read requires acquiring specific decoding procedures for reading, but above all it requires a certain level of automaticity to ensure that written-word identification does not require too much attention. Automatisations of written-word identification is important because it frees attentional resources which are available for understanding what is read. Thus, as emphasized by Torgesen [19], in addition to learning decoding skills, it is also necessary to increase the stock of words that can be read automatically by the lexical route, a prerequisite for fluent reading (see [20]). Thus, for students mastering the specific decoding procedures, but still having difficulties in written-word identification, work that focuses on fluency appears interesting. One of the most effective techniques to enhance fluency is the repeating reading technique [21] (see [20] for a study on French 6<sup>th</sup> graders).

A significant number of French primary school children have difficulties in written-word identification, and those difficulties may persist in middle school. Thus, it is crucial to find solutions accessible to all teachers to enable these students to acquire reading skills. Considering the researches succinctly presented, it will be interesting to offer those students training on decoding abilities, through the syllable and not the phoneme, and training on fluency. Moreover, as highlighted by several studies, since reading and writing develop in parallel and influence each other, it will be important to propose writing activities. Finally, a consensus exists on training methods to be proposed to struggling readers: the work must be explicit, repetitive, intensive and frequent. It must be proposed to small homogeneous groups of students (3-5) or individually, and it must be rewarding and offer positive reinforcements [22].

The objective of this research is to propose a remediation program to primary school students with difficulties in written-word identification and to study the impact of the remediation program over a control group. Two experiments were conducted over two different school years. For the first experiment, collaboration was established with several schools in the same school district. In those schools, upon request from the National Education inspector, since 4 years, the level of written-word identification of 2<sup>nd</sup> to 5<sup>th</sup> graders is systematically evaluated at the beginning of the school year. Then, students identified as having difficulties receive training focused on decoding and / or fluency depending on the problems they meet. The second experiment consisted in the introduction of our remediation program in new schools to verify its impact and to more deeply explore the results of the first experiment.

## **2 EXPERIMENT 1**

### **2.1 Method**

#### *2.1.1 Participants*

Experimental Group: Four schools (including two listed Réseau Éclair - RE, i.e. schools targeted for special help) participated to this experiment. Thus, 237 second graders, 121 third graders, 117 fourth graders and 86 fifth graders took a written-word identification assessment at the beginning of the school year.

Control Group: Four schools (including two listed RE), in which the remediation plan was never implemented, participated to this experiment. Thus, 81 second graders, 117 third graders, 94 fourth graders and 99 fifth graders took a written-word identification assessment at the beginning of the school year.

#### *2.1.2 Procedure*

Performance on written-word identification was evaluated at the beginning of the school year (in October) using the ELFE protocol (Cogni-Sciences, [www.cognisciences.com](http://www.cognisciences.com)) for 2nd, 3rd and 4th graders and with the ROC protocol (Cogni-Sciences, [www.cognisciences.com](http://www.cognisciences.com)) for 5th graders. Students were identified as having written-word identification difficulties when their score was below the 30th percentile. Students had to take a syllable and pseudoword dictation test (2nd graders) or a sentence dictation test (3rd and 4th graders). For 5th graders, a dictation test is included in the ROC protocol. The objective of this dictation exercise was to enable teachers to identify students with difficulties mainly focusing on decoding and those with difficulties mainly focusing on the construction of the orthographic lexicon.

According to their difficulties, students then received training sessions focusing either on decoding or on building / constructing orthographic lexicon (fluency), or both.

For students with decoding difficulties, training sessions were proposed with the Impregnation Syllabic [23]. The objective of these sessions was to consolidate decoding skills through the syllable and not the phoneme [18]. The principle was to propose a progressive training with increasing difficulty adapted to the students: training on simple syllables, and then on more complex spellings (trigraphs - "ian", "ein" for example, contextual spellings - 'g' contextual for example). Activities proposed during the training sessions always combined reading and writing syllables, words and pseudowords containing worked syllables. Immediate feedback was given to the students after each answer for them to assess their knowledge and memorize the correct forms (for more information on feedback, see [24]).

For students with correct decoding abilities, but presenting difficulties in the automatisisation of written word identification, remediation sessions, inspired by Fluence using repeating reading techniques [25], have been proposed. The objective of these training sessions was to increase the orthographic lexicon, then to promote automatisisation to read fluently. The principle was to have students perform repeated and timed readings of texts adapted to their level. The objective of the students was to read the texts fluently, without hesitation and with the correct intonation. After each reading task, feedback was given to the students: while repetition improves reading fluency, it is necessary to give feedback to the students to correct their mistakes, so that the level of word identification improves. Writing tasks were also proposed to strengthen words memorization (flash copy...).

These training sessions, organized in small groups of 3 to 5 students, were proposed by the teacher and took place between the months of November and May. To potentiate the efficacy of the training sessions, the objectives were clearly presented to the students and the sessions were highly structured, short but intense and frequent (2-3 times a week for at least 20 minutes).

At the end of the school year (June), performances in written-word identification were once again evaluated with the same test as earlier in the year.

For the Control Group, written-word identification performances were evaluated at the beginning and the end of school year, but students did not receive our remediation sessions. Indeed, the objective was to evaluate the progress made by the group that received the remediation compared to a group that did not, in order to evaluate the impact of the intervention [26]. However, teachers of the Control Group were informed which students presented difficulties in written-word identification

### Teachers' training course

The Experimental Group's teachers received a 6-hour training course at the beginning of the school year in order to understand the interest of the remediation program and to be able to process the data from the evaluation. Meanwhile, they were presented with an update on theoretical basis about learning to read and its difficulties, followed by a presentation of the remediation program with numerous examples. They were also given practical guidebooks. In this course, we stressed the need to read and write, to give feedback to correct errors and to enhance progress.

## 2.2 Results

Information on the composition of the Experimental and Control groups are presented in Table 1.

Table 1: Characteristics of Experimental and Control groups at the beginning of the school year

| <b>4</b>                                 | <b>2<sup>nd</sup> graders</b> | <b>3<sup>rd</sup> graders</b> | <b>4<sup>th</sup> graders</b> | <b>5<sup>th</sup> graders</b> |
|--|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Nb of students with reading difficulties | 118                           | 66                            | 57                            | 34                            |
| Percentage of the starting group         | 50                            | 55                            | 49                            | 40                            |
| Average Age months (stand. deviation)    | 87,3 (4,3)                    | 100,6 (5,3)                   | 112,7 (5,5)                   | 125,6 (5,4)                   |
| Number of students in RE / no RE         | 70/48                         | 28/38                         | 26/31                         | 15/19                         |
| Number of boys / girls                   | 60/58                         | 35/31                         | 32/25                         | 17/17                         |
| <b>CONTROL GROUP</b>                     | <b>2<sup>nd</sup> graders</b> | <b>3<sup>rd</sup> graders</b> | <b>4<sup>th</sup> graders</b> | <b>5<sup>th</sup> graders</b> |
| Nb of students with reading difficulties | 48                            | 71                            | 40                            | 25                            |
| Percentage of the starting group         | 59                            | 61                            | 43                            | 25                            |
| Average Age months (stand. deviation)    | 88,2 (4,6)                    | 100,5 ( 5,2)                  | 112,7 (5,3)                   | 127,6 (6,2)                   |
| Number of students in RE / no RE         | 27/21                         | 33/38                         | 21/19                         | 16/9                          |
| Number of boys / girls                   | 28/20                         | 43/28                         | 27/13                         | 18/7                          |

Second and third graders evaluated with reading difficulties at the beginning of the school year took training sessions focusing on decoding abilities, based on grapho-syllabic conversion. When they reached a sufficient level of decoding abilities, training sessions on fluency were integrated. Fourth and fifth graders received training sessions focusing on fluency, but also training sessions on decoding abilities, especially for complex graphs when necessary.

The results obtained in written-word identification at the beginning and end of school year for students identified as having difficulties at the beginning of the school year were entered into analysis of variance (ANOVA) with the Evaluation Period (beginning, end of the year) as within-subjects factor, and the Grade (2nd, 3rd, 4th, 5th), the Group (Experimental, Control) and School Category (RE, no-RE) as between-subjects factors.

The significant effect of Grade ( $F(3,443)=124,9$ ;  $p<.001$ ) indicated that written-word identification scores increased when the level of grade increased. The significant effect of the Evaluation Period factor ( $F(1,443)=945.3$ ;  $p<.001$ ) indicated better scores in written-word identification at the end (average of 77.7 words identified in 1 minute, standard error (SE)=1.1) than at the beginning of the year (53.8, SE=0.8). Most importantly, the double interaction Evaluation Period x Group was significant ( $F(1,443)=18,2$ ;  $p<.001$ ). This result revealed that the increase in written-word identification abilities between the beginning and the end of the year was more important for the Experimental group (increase of 27.3 words identified in 1 minute, SE=0.96) than for the Control Group (increase of 20.6, SE=1.11). More precisely, planned comparisons indicated that both Groups did not differ at the beginning of the year – respectively for the Experimental and Control Groups: 52.9 (SE=1.0) vs 54.8 (SE=1.2),  $p=.212$  – but significantly differed at the end of the year – respectively for the Experimental and Control Groups: 80.1 (SE=1.5) vs 75.5 (SE=1.8),  $p<.05$ . The significant interaction Evaluation Period x Grade ( $F(3,443)=12,7$ ;  $p<.001$ ) revealed an increase in written-words identification abilities for the four grade levels (respectively for 2nd, 3rd, 4th and 5th graders an increase of 29.4, 18.6, 25.9 and 21.9), with however a lesser increase for 3rd graders.

The significant effect of the School Category factor ( $F(1,443)=19,5$ ;  $p<.001$ ) indicated better scores in written-word identification for students in no-RE schools (69.8, SE=1.3) than for students in RE schools (61.8, SE=1.2). Moreover, the interaction School Category x Evaluation Period ( $F(1,443)=4,1$ ;  $p<.05$ ) revealed a larger increase in written-word identification abilities between the beginning and the end of the year for students in no-RE schools (25.5, SE=1.3), than for students in RE schools (22.4, SE=1.0). Planned comparisons indicated that a difference in written-word identification abilities existed between students in RE and no-RE schools at the beginning (respectively, 50.6, SE=1.1 and 57.0, SE=1.1;  $p<.001$ ) and still at the end of the year (respectively, 73.0, SE=1.6 and 82.6, SE=1.7;  $p<.001$ ). However, the double interaction School Category x Evaluation Period x Group was not significant ( $F(1,443)=2,5$ ;  $p=.11$ ). Thus, the effect of the remediation program will not be different in the RE and the no-RE school; only a smaller increase in word identification abilities is observed for the students in RE-schools regardless the Group (Experimental vs Control).

The double interaction Evaluation Period x Group x Grade did not reach significance ( $F(3,443)=1,3$ ,  $p=.271$ ). However, in order to verify that an impact of the remediation program existed in each grade level, for each grade level, we compared the progress in written-word identification scores between the Experimental and the control Groups (Student's t test were used or Mann Whitney test when the homogeneity of variances and / or a normal distribution were not observed).

First of all, for the four grades level, at the beginning of the year, scores in written-word identification test did not differ between the Experimental Group (respectively from 2nd to 5th: 28.3, 47.6, 71.7 and 64.5) and Control Groups (respectively from 2nd to 5th: 25.8, 50.5, 68.8 and 72.8).

However, at the end of the school year, for 2nd, 3rd and 5th graders, comparisons tests attested to a larger increase in written-word identification abilities for the students of the Experimental Group than those of the Control Group. A numerical difference between Experimental and Control Groups for the 4th graders existed, but it did not reach significance (Fig. 1).

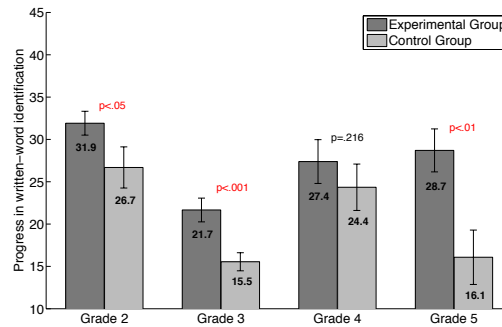


Fig. 1: Progress in written-word identification (difference in scores at the beginning and the end of school year) for Experimental and Control groups according to grade level.

Table 2 indicated the percentage of students from the Experimental and Control groups who are no longer considered as having difficulties in written-word identification at the end of the year whereas their score was below the 30th percentile at the beginning of the year

Table 2: percentage of students no longer considered in difficulty at the end of the school year

|                           | 2 <sup>nd</sup> grade | 3rd grade | 4th grade | 5th grade |
|---------------------------|-----------------------|-----------|-----------|-----------|
| <b>EXPERIMENTAL Group</b> | 50                    | 42        | 40        | 59        |
| <b>CONTROL Group</b>      | 38                    | 17        | 38        | 48        |

### 2.3 Discussion Experiment 1

The results of this Experiment indicate that students who benefit from the remediation program make more progress than students who do not, in the identification of written words. This positive effect is observed among second graders, but also among higher-level graders (third and fifth) indicating that specific work on the identification of written words is possible and beneficial beyond the second year of primary school.

Concerning the fourth graders of the Experimental group, their progress in written-word identification is not significantly better than that of the fourth graders of the Control group. This result is difficult to interpret. One hypothesis is that teachers at this grade level can feel less concerned with reading and thus have followed the proposed protocol less.

Consequently, in order to verify the reproducibility of the obtained results and to understand the results obtained for the fourth graders, a second experiment including new schools was conducted. Schools classified RE and no-RE were inserted into the second experiment, to verify the result of an equivalent effect of the remediation program for RE and no-RE schools

## 3 EXPERIMENT 2

In this second experiment, in order to have a clearer idea of the implementation of remediation during the year, additional exchanges were organized with teachers at the end of the school year. From the information collected, only students whose teachers respected the protocol and actually proposed training sessions at least 2 to 3 time per week were included.

### 3.1 Method

#### 3.1.1 Participants

Experimental Group: Initially four new schools (including two classified RE) participated to this experiment. Thus, 174 second graders, 116 third graders, 109 fourth graders and 118 fifth graders took a written-word identification test at the beginning of school year.

However, after interviews with teachers, some classes were eliminated. All classes of a no-RE school, one class of 4th graders in a no-RE school and one class of 2nd graders in a RE school were

eliminated because training sessions were only proposed once a week. Two classes of 3rd graders and one class of 4th graders class in a RE school were eliminated as a theater project was set up from the reading remediation project (students were practiced reading theater texts which were then performed). Finally, results from 102 second graders, 73 third graders, 59 fourth graders and 118 fifth graders were included and analyzed.

Control Group: Same as in Experiment 1.

### 3.1.2 Procedure

Same as in Experiment 1.

## 3.2 Results

Information on the composition of the Experimental and Control groups are presented in Table 3.

Table 3: Characteristics of Experimental Control groups at the beginning of the school year.

| EXPERIMENTAL GROUP                       | 2 <sup>nd</sup> graders | 3 <sup>rd</sup> graders | 4 <sup>th</sup> graders | 5 <sup>th</sup> graders |
|--|-------------------------|-------------------------|-------------------------|-------------------------|
| Nb of students with reading difficulties | 44                      | 31                      | 33                      | 25                      |
| Percentage of the starting group         | 43                      | 42                      | 56                      | 19                      |
| Average Age months (stand. deviation)    | 87,8 (4,0)              | 100,0 (5,4)             | 112,4 (3,5)             | 127,6 (7,5)             |
| Number of students in RE / no RE         | 18/26                   | 13/18                   | 12/21                   | 21/4                    |
| Number of boys / girls                   | 25/19                   | 16/15                   | 19/14                   | 13/8                    |

The results obtained in written-word identification at the beginning and the end of school year for students identified as having difficulties at the beginning of the school year were entered into analysis of variance (ANOVA) with the Evaluation Period (beginning, end of the year) as within-subjects factor and the Grade (2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>), the Group (Experimental, Control) and School Category (RE, no-RE) as between-subjects factors.

The significant effect of Grade  $F(3,301)=97,92$ ;  $p<.001$ ) indicated that written-word identification scores increased when the level of grade increased. The significant effect of the factor Evaluation Period indicated better scores in written-word identification at the end (82.6, SE=1.4) than at the beginning of the year (54.9, SE=0.9). The significant effect of the Group factor ( $F(1,301)=11,0$ ;  $p<.01$ ) revealed better score in written- word identification in the Experimental Group (72.4, SE=1.7) than in the Control Group (65.1, SE=1.4). Most importantly, as in Experiment 1, the double interaction Evaluation Period x Group was significant ( $F(1,301)=49,5$ ;  $p<.001$ ). This result revealed that the increase in written-word identification abilities between the beginning and the end of the year was more important for the Experimental Group (increase of 34.8, SE=1.7) than for the Control Group (increase of 20.6, SE=1.1). More precisely, planned comparisons indicated that both Groups did not differ at the beginning of the year – respectively for the Experimental and Control Groups: 55.0, SE=1.4 vs 54.8, SE=1.1;  $p=.921$  – but significantly differed at the end of the year – respectively for the Experimental and Control Groups: 89.8, SE=2.3 vs 75.4, SE=1.8;  $p<.001$ . The significant interaction Evaluation Period x Grade ( $F(3,301)=3,77$ ;  $p<.05$ ) revealed an increase in written-word identification abilities for the four grade levels (respectively for 2nd, 3rd, 4th and 5th graders an increase of 30.4, 24.6, 31.4 and 24.4).

As in Experiment 1, the interaction School Category x Evaluation Period ( $F(1,301)=9,5$ ;  $p<.01$ ) revealed a larger increase in written-word identification abilities between the beginning and the end of the year for students in no-RE schools (30.8, SE=1.7), than for students in RE schools (24.6, SE=1.2). Planned comparisons indicated that a difference in written-word identification abilities existed between students in RE and those in no-RE schools at the end of the school year (respectively for RE and no-RE schools: 79.0, SE=1.9 and 86.2, SE=2.2;  $p<.05$ ), but not at the beginning (respectively for RE and no-RE schools: 54.4, SE=1.2 et 55.4, SE=1.4;  $p=.58$ ). In this analysis, the double interaction School Category x Evaluation Period x Groups was significant ( $F(1,301)=7,5$ ;  $p<.01$ ). Planned comparisons indicated a training effect (more important progress in written-word identification for the Experimental than the Control group) for students in RE schools ( $p<.001$ ) and students in no-RE schools ( $p<.0001$ ) with a larger effect for students in no-RE schools (progress difference of 19.7 between the



Experimental and Control groups) compared to students in RE schools (progress difference of 8.6 between the Experimental and Control groups).

As in Experiment 1, the double interaction Evaluation Period x Group x Grade did not reach significance ( $F(3,301)=1,8$ ,  $p=.149$ ). However, in order to verify that an impact of the remediation program existed in each grade level, especially for 4th graders, for each grade level we compared the progress in written-word identification scores between the Experimental and the control Groups (Students' t tests were used, or a Mann Whitney test when the homogeneity of variances and / or a normal distribution were not observed).

First of all, for the four grade levels, at the beginning of the year, scores in written word identification tests did not differ between the Experimental Group (respectively from 2nd to 5th: 29.3, 50.0, 68.9 and 73.7) and Control Group (respectively from 2nd to 5th: 25.8, 50.5, 68.8 and 72.8).

However, at the end of the school year, for 2nd, 3rd, 4th and 5th graders, comparisons tests showed a larger increase in written word identification abilities for students of the Experimental than those of the Control Group (Fig. 2).

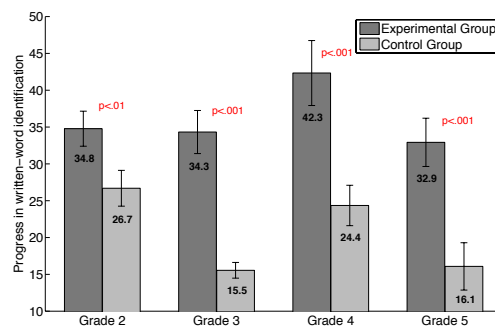


Fig. 2: Progress in written-word identification (difference in scores at the beginning and the end of school year) for Experimental and Control groups according to grade level.

Table 4 indicated the percentage of students from the Experimental and Control groups who are no longer considered as having difficulties in written-word identification at the end of the year whereas their score was below the 30th percentile at the beginning of the school year.

Table 4: percentage of students no longer considered in difficulty at the end of the school year.

|                           | 2 <sup>nd</sup> grade | 3rd grade | 4th grade | 5th grade |
|---------------------------|-----------------------|-----------|-----------|-----------|
| <b>EXPERIMENTAL Group</b> | 52                    | 58        | 52        | 80        |
| <b>CONTROL Group</b>      | 38                    | 17        | 38        | 48        |

Some classes of the Experimental group were deleted because they did not respect the protocol. Analysis of the results of the two 3rd grade classes which included a theater project into the remediation protocol revealed very small progress in written-word identification abilities for the students of these classes (12.6), which is tendentially lower than progress made by the control group ( $p = .051$ ). In those two classes, all students identified as struggling readers at the beginning of the school year are still in the same situation at the end of the year.

### 3.3 Discussion Experiment 2

Results from this second experiment indicate larger progress in written-word identification for students in the Experimental group than for students in the Control group. This result is obtained for all grade levels, including 4th graders. Thus, when the protocol is respected and when training sessions are frequent (2 to 3 times per week) all year long, significant progress in written-word identification is observed for all grade levels.

## 4 GENERAL DISCUSSION

Overall, the results of these two experiments indicate that the implementation of a remediation program, combining an early evaluation of written-word identification abilities followed by training sessions focused on specific difficulties all over the year allows students to make progress in written-word identification. Tables 2 and 4 showed that a significant number of students identified as having difficulties at the beginning of the school year are no longer in difficulty at the end of the year, and this is the case in the Experimental group more than in the Control group.

One characteristic of our research is to propose the remediation program to 2nd graders, but also to older students, up to 5th grade. Indeed, when the various aspects of reading cannot be mastered before the end of the second year of primary school, this learning must be consolidated in the following classes. The results of our study show that our remediation program is still effective for 5th graders. Besides written-word identification training, students should also take advantage of courses aimed at enriching vocabulary and developing comprehension [27] (Pressley, 2006). To support the results of this research, we plan to retest students from a school of the Experimental group to verify that progress in reading is maintained over the long term.

It is important to stress once more that in the Control group, following the written-word identification evaluation done at the beginning of the year, teachers were informed about the difficulties of their students. Some teachers had designed activities to address them. However, it seems that the implementation of a clear protocol, taking into account the theoretical knowledge on the acquisition of reading is more effective. This data is supported by the results obtained by the two 3rd grade experimental classes that included a theater project into the protocol program. For the students of these classes, possibly the objective “learning to read” was masked by its inclusion in a theater project. Studies indicate that explicitly learning to read would be more effective than project-based learning, especially for struggling students [28]. Furthermore, in these two 3rd grade classes, no work on decoding abilities were proposed while this work is important, especially for the most disadvantaged students. Teachers of experimental schools were trained prior to the introduction of the remediation program. This is important because it allows teachers to understand the objectives of the program, but also its theoretical foundations. Indeed, applying a device without understanding cannot guarantee its success. Failure by some teachers to follow the protocol raises the question of how to support the implementation of such programs. Possibly, for some teachers, a more personalized follow-up would have been beneficial.

Schools classified RE were included in this research. These schools are located in areas of low socioeconomic level. Children in disadvantaged areas are 10 times as likely to experience reading difficulties as those in wealthier areas [29]. Students in these schools are those in greatest need for their difficulties to be detected and addressed early on, so that they do not last. The results of our study indicate that for schools classified RE, if the results indicate greater progress for students who benefited from the remediation program compared to those who did not (in particular Experiment 2), this progress in written-word identification is smaller than the one observed among students in schools not classified RE. Many hypotheses could be proposed to explain this result. One of them concerns the students' vocabulary level. Various studies indicate that often, children from socioeconomically disadvantaged families know two to three times fewer words than children from privileged families [30]. Yet, a condition for quickly learning to read words is that the student already knows the words and their meaning. Without this, the workload is very important. While in the proposed training sessions, the teacher had to ensure that children knew the proposed language, this variable might have had an impact on the results of our study. However, interviews with teachers conducted at the end of Experiment 2 could bring other elements of understanding. Some teachers of schools classified RE expressed that a lot of projects are implemented in their schools, including cultural projects. But a study by Bautier and collaborators [31] put in question all these projects that would blur priorities on school issues by putting very different skills at the same level, and this is especially the case for students in difficulty. Still, other assumptions could be made to interpret this result. Indeed, data from this study do not allow us to understand the result of a lesser effect of our protocol on students of schools listed RE compared to students in schools not listed RE. To understand this result, it would be necessary to follow students in schools listed RE for one year and to have more data on students, including their linguistic level. This project is underway.

Finally, it is possible that teachers' motivation and the involvement of the school's headteacher played a role. Indeed, it is interesting to note that for one of the schools of Experiment 2 (school not classified RE), students' progress has been particularly important. In this school, the headteacher was heavily involved in the protocol and the teachers were very eager to obtain solutions to allow their students to

improve their reading skills. The remediation program got very good reception and was followed scrupulously. In this school, given the very positive results in reading, it has been decided to place the remediation program at the center of the school's project.

One point of criticism in this study relates to the Control group. Our objective was to evaluate the progress made by the group that benefited from the remediation program compared to a group that did not, in order to evaluate the impact of the intervention [26]. It would be interesting, in future research, to compare our remediation program with another program, especially to check the impact of the management of students in small groups.

## 5 CONCLUSION

The results of this study indicate that solutions accessible to all teachers exist to address some forms of reading difficulties encountered by students in primary school. However, to be efficient, it seems important to provide teachers with specific professional development. Moreover, a significant advantage of the remediation program for students after 2nd grade shows the interest and importance to continue training on written-word identification after this grade. This type of training is already found in international literature, but French language and school specificities required to conduct such experiment in a French environment to prove the effects and limitations of this type of training in France. The generalization of this type of program consisting of an initial evaluation test of reading abilities for all students and then the implementation of remediation sessions, could thus be implemented, just like what is done in Finland for example [32].

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