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Lasting effects on literacy skills with a computer-assisted learning using syllabic units in low-progress readers

Jean Ecalle *, Annie Magnan, Caroline Calmus

Laboratoire Etude des Mécanismes Cognitifs (EA 3082), Université Lyon(2), 5 av, Mendès-France, 69676 Bron Cédex, France

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ABSTRACT

This study examines the effects of a computer-assisted learning (CAL) program in which syllabic units were highlighted inside words in comparison with a CAL program in which the words were not segmented, i.e. one requiring whole word recognition. In a randomised control trial design, two separate groups of French speaking poor readers ($2 * 14$) in first grade were constituted. They were matched on a range of reading measures and non verbal intelligence and trained intensively over a short period (10 h over a period of 5 weeks). Three tasks were proposed using a classical pre-test/training/post-test design, written word recognition, word reading aloud and word spelling. In addition, three post-test sessions were conducted: one just after training, one after 4 months, and a last one after 9 months. The experimental group trained with the CAL using syllabic units outperformed the control group using CAL with whole word recognition in all the three tasks and there were important lasting effects. The results are discussed in the light of the self-teaching hypothesis and phonological recoding.

1. Introduction

Computer-assisted learning (CAL) has already proven its effectiveness in educational programs designed for young children (MacArthur, Ferretti, Okolo, & Cavalier, 2001; Torgesen & Barker, 1995; Troia & Whitney, 2003). Many researchers have suggested that computer-assisted reading support can be effective in helping children at risk of reading failure (Magnan & Ecalle, 2006; Nicolson, Fawcett, & Nicolson, 2000). Blok, Oostdam, Otter, and Overmaat (2002) conducted a meta-analysis of 42 studies published between 1990 and 2000 that examine the effectiveness of CAL on the acquisition of beginning reading skills in students aged 5–12. They found a positive effect of computer-assisted beginning reading instruction compared to instruction without CAL.

The general question raised in such studies is: What kind of exercise is able to provide the most compelling evidence of the effectiveness of CAL in low-progress readers? And under what conditions? The simple view of reading (Tunmer & Hoover, 1992) defines reading ability as a function of decoding and comprehension skills, namely written word identification and text comprehension. In this paper, we focus only on the first of these which constitutes a basic and essential low-level process in reading.

Word recognition involves two general and interdependent processes (see Morais (2003) for a review), particularly in young readers, the phonological recoding (or simply decoding) of new words and the visuo-orthographic processing of familiar words. Learning to read may be described as a progression from phonological recoding using different sub-lexical units (grapho-phonological process) to direct and automated word identification using unconscious mappings between orthographic and phonological segments. According to the self-teaching hypothesis (Share, 1999), phonological recoding provides the essential and fundamental basis for the storage of well-specified orthographic representations which are indispensable to good readers (Cunningham, 2006; Kyte & Johnson, 2006; Nation, Angell, & Castles, 2007). The main objective of this paper is to provide low-progress readers in grade 1 with a CAL program intended to help promote the phonological recoding process.

The most extensive work in this area has been conducted by Wise and colleagues. Olson, Foltz, and Wise (1986), Olson and Wise (1992) and Wise, Ring, and Olson (2000) have explored the use of synthetic computer speech as a remedial tool for dyslexic children's deficits in printed word recognition. In their initial studies, these authors selected children in 3rd to 6th grade who were in the lower 10% of their classes in reading. The children read stories on the computer for a half an hour each day. When they encountered difficult words in the stories, they could click on the words with a mouse to make the computer highlight and pronounce the words. During the session, the children answered occasional multiple-choice comprehension questions about the stories they were reading on the computer. At the end of the

* Corresponding author. Tel.: +33 478772437.
E-mail addresses: Jean.Ecalle@univ-lyon2.fr, ecalle.jean@wanadoo.fr (J. Ecalle).

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session, the computer presented some of the targeted words in a recognition test. The children read with the computer 3 or 4 days a week (30 min per day) for one semester. Globally they spent 10–14 h to a CAL program. The average word-reading gains of the computer-trained children significantly exceeded those of matched poor readers who remained in their regular reading class. However, some of the computer-trained children found it difficult to work alone with the programs. Olson and Wise (1992) found that the children's phonological skills at the start of training were positively correlated with their rate of word-reading improvement during training, thus suggesting that the direct remediation of such children's phonological-processing deficits might make a useful contribution to their reading development.

The benefits of different kinds of speech segmentation (whole word, syllables, onset-rimes and phoneme segmentation) were compared. Subsequently, Olson, Wise, Ring, and Johnson (1997) used a different program and training environment to conduct a longitudinal study. They trained children with reading problems attending 2nd to 5th grade in small groups of 3 or 4 children, each with their own computer and with a teacher always present. The programs included reading stories on the computer with help for difficult words, as in the authors' previous studies. In addition, half of the children spent part of their training time working with programs designed to improve their deficient phoneme awareness and phonological recoding skills. The other children spent all their time accurately reading stories and applying strategies for understanding and remembering the stories. Children in both conditions averaged 18 hours in individualized computer time. The phonological training programs were very effective in improving children's phonological skills, and this improvement was associated with significantly greater gains in several word-reading tests performed by the youngest and less skilled readers. However, the older and more skilled poor readers in the 4th and 5th grades seemed to gain as much or more in terms of word reading measures if they spent all their time accurately reading the stories on the computer and practicing their comprehension strategies (Wise, Ring, & Olson, 1999; Wise et al., 2000).

More recently, Macaruso, Hook, and McCabe (2006) have discussed the findings of an intervention study designed to facilitate the acquisition of word recognition skills in young readers. The computer-assisted instruction contained numerous activities that support the learning and application of phonic word-attack strategies at the letter, word, sentence and paragraph levels in order to enhance automaticity in word recognition. The mean number of sessions (20–30 min each) completed was 64 (range: 37–91); consequently children in the treatment group received about 27 h of CAL. The findings indicate that the very low performing students eligible for Title I services (e.g. they receive additional academic support provided to low-achieving children) who received training made significant reading gains over the school year.

Another question concerns the type of linguistic unit that might be most suitable for promoting the phonological recoding process in French-speaking children. Psycholinguistic and experimental evidence does indeed exist to account for the fact that the size of the sub-lexical units used during learning to read varies across languages as a function of orthographic transparency (for a review, see Ziegler and Goswami (2005)). In French, two main studies have provided evidence of the importance of the syllable as a linguistic unit in beginning readers (Colé, Magnan, & Grainger, 1999; Doignon & Zagar, 2006). Using two different paradigms, it has been shown that children use phonological grapho-syllabic processing.

Colé et al. (1999) provided evidence that good readers at the end of the first grade used a syllabic code to complete a visual word recognition task. This syllabic coding does not seem to become evident until the child has understood and mastered the alphabetic principle which is in turn associated with a certain degree of phonemic awareness. To be precise, syllabic coding will only feature in the reading acquisition of French-speaking children after a certain level of grapho-phonemic mastery has been achieved. In fact, the explicit teaching of GPC allows children to develop connections between letters and sounds. As soon as children apply grapho-phonemic processing automatically, they try to extract units larger than phonemes (e.g., grapho-syllabic processing) on the basis of the early implicit syllable awareness developed during their contact with spoken language (Duncan, Seymour, Colé, & Magnan, 2006; Ecalle & Magnan, 2007; Goslin & Floccia, 2007). The use of syllabic units is not generally possible before the second half of the first year of reading acquisition. Arguably, therefore, it may be better to teach children to focus on links between their explicit awareness of syllables and print, rather than to emphasize the linkage between phonemes and letters (or letter strings), because at this level it will be easier to segment, for example *mardi* (tuesday) into two syllables (mar/di) than into five phonemes (m/a/r/d/i). Doignon and Zagar (2006) tested whether apprentice readers (6–7 to 7–8 years old) and beginner readers (8–9 to 10–11 years old) perceive syllabic units in written words. They used the paradigm of illusory conjunctions because this is able to determine the infra-lexical units identified during the first stages of the written stimuli process. Two experiments were conducted on children during the initial (6–7 years old) through to the final years (10–11 years old) of the process of learning to read. The results indicate that children perceive syllables in letter sequences as early as the end of the first year of learning to read. The authors suggest that the perception of these units is the result of two information sources, syllabic phonology and orthographic redundancy. Consequently, the syllable could be a pertinent unit in the process of learning to read.

One final question needs to be answered: what is the best format in which to present the syllabic unit? Meta-analyses of experimental training studies (Bus & van IJzendoorn, 1999; Ehri et al., 2001) have demonstrated a causal impact of phonemic training on reading skills which is more consistent and robust when letter knowledge training is also included. Moreover, when phonological units are presented with their orthographic counterparts, success in reading acquisition seems to be facilitated. For example, Harm, McCandliss, and Seidenberg (2003) used the connectionist model of reading development, which is intended to simulate detailed aspects of developmental dyslexia (Harm & Seidenberg, 1999), to examine why certain types of interventions designed to overcome reading impairments are more effective than others. Their simulations replicate the patterns of success and failure found in the developmental literature, and provide explicit computational insights into exactly why the interventions that include training on spelling-sound regularities are more effective than those focusing on phonological development alone. More, such methods which emphasize orthographic-to-phonological mappings have also been shown to benefit dyslexic children trained over a short period. With only 10 h of training, young dyslexic children aged between 9 and 11 years improved their performance in a word reading task (Magnan, Ecalle, Veuillet, & Collet, 2004). These results have been replicated in older dyslexic children aged between 11 and 14 years (Ecalle, Magnan, Bouchafa, & Gombert, 2008).

This study presents the effects of audio-visual training based on the matching of phonological syllabic units and orthographic syllabic units on literacy skills in poor readers at the beginning of learning to read. We tested the effect of a CAL program in which syllabic units were highlighted inside words (experimental group) compared to a CAL program without any segmentation of the words, i.e. one which focused on whole word recognition (control group). Our hypothesis was that training with syllabic units would be more efficient than whole word training. More specifically, whatever the kind of word (regular or irregular) and whatever the task involved (word reading or word spelling), the experimental group should outperform the control group because we expected the word segmentation condition to boost the phonological recoding process and consequently facilitate the storage of well-specified orthographic representations.

2. Method

A traditional pre-test, training phase, post-test design was used with a randomised control trial design. Two groups of children (experimental and control) received two different computer-assisted types of training. The post-tests were administered over three sessions to examine the expected persistent effect in the experimental group.

2.1. Participants

Twenty-eight poor readers in first grade were selected from a large population of 90 children attending 4 primary schools in an urban area. All children were French-speaking. They were from various SES and had no specific problems. They had normal or corrected-to-normal vision and no neurological deficits or overt physical handicaps. For the selection, a standardized test of word reading (Timé2; Ecalle, 2003; see below for a description) was administered to the 90 children and only one-third was retained. These selected children obtained the lower scores (from 10 to 26/36) on a composite score involving the orthographically correct word and the pseudoword homophone. This composite score has the advantage to take into account both the level of orthographic lexicon and the ability to use the phonological procedure in case the correct response was not given.

The 28 selected children were separated into two equal groups, i.e. an experimental group (5 girls and 9 boys; mean age: 6 years 9 months) which received syllabic segmentation training and a control group (10 girls and 4 boys; mean age: 6 years 11 months) which was exposed to whole word training. The two subgroups were strictly matched on reading and cognitive levels just before the training phase thanks to the application of a standardized word recognition test (Timé2) and a non-verbal intelligence sub-test, similar to the well-known Raven matrices, taken from an academic achievement battery (ECS-2; Khomsi, 1997).

The word recognition test, group-administered, proposed 3 forced-choice tasks: in the first one, the target words were named by the examiner, the second task is composed of pictures and the third one is a semantic categorization task where children have to associate two words. In each task, the target word is in a list of 5 items consisting of the orthographically correct word (e.g., *bateau*, boat), and 4 pseudowords, namely a homophone (*bato*), a visually similar item (*baleau*), an item sharing the same initial letters (*batte*) and an item containing an illegal letter sequence (*btaeua*). Thirty-six target words were given (12 in each task). The children had to find the target in each list. The word recognition test allowed us to match the groups rigorously for reading. Indeed, the five indicators were used. No significant difference between the two groups was observed on chronological age, the scores on the word recognition test and the non-verbal intelligence test (Table 1).

2.2. Material, training and procedure

Two CAL programs were given to the groups. One related to the syllabic segmentation of words. The children saw a printed syllable on the screen and heard a word. They had to indicate the position (initial, medial, final) at which the syllable was located in the word (Fig. 1). If they thought that the syllable did not occur in the word, they responded "no". Following the response – whether it was correct or incorrect – the target word was displayed with the relevant syllable highlighted. The training material contained tri-syllabic words and the structure of target syllable was CV, or CVC or CCV. A bar at the bottom left of the screen indicated the total correct response score. The second CAL program involved whole word recognition. The children heard a word and had to click on the correct word out of a choice of three test words (Fig. 2). In the list, the target word shared the same initial letters with another word. Finally, the same words were used in both programs.

Each program was composed of 12 sessions each containing 32 words; for the experimental group, 24 target words with *yes* response (trou-retrouver) and 8 foils with *no* response (ta-malheureux) and for the control group, 24 target words (retrouver-allumer/retrouver/recueillir) and 8 foils (malheureux-éveiller/généreux/acacia). During a training session, when all the 32 items were seen, children should start again with the same group of items during a training session. Programs were effectively followed in the presence of an adult.

The two groups completed two short sessions of 15 min per day over a period of five weeks during the April and May of the school year. They thus received a total of 10 h of training. All the children were trained individually. During the training period, the children were not trained with any other phonological program.

2.3. Pre- and post-tests

Four sessions were required in order to examine the possible effect of training. A pre-test session (April; t0) just before the training phase, and three post-test sessions: one in May (just after training; t1), one 4 months later in September (t2), and one 5 months after that in February (t3). To compare the experimental vs. control groups before training and across all three post-test sessions, the children were assessed on word reading and spelling. In all the tasks, the words were different from those used in the CAL programs.

Table 1
Mean responses (and standard deviations) for the control and experimental groups.

Age[a]	Word recognition test (/36)					NVI (/15)
	CW	Ho	Vs	Sil	Ils	
Control group						
81.4 (3.2)	11.6 (4)	10.1 (3.1)	5.5 (2.6)	5 (2.5)	3.9 (2.5)	5.3 (2.7)
Experimental group						
82.8 (5.2)	11.7 (3)	10.5 (3.6)	5.6 (1.6)	4.2 (1.6)	4 (4.9)	5.6 (3.6)

Notes: CW: correct word, Ho: pseudoword homophone, Vs: pseudoword, visually similar, Sil: same initial letters, Ils: pseudoword with an illegal letters sequence; NVI: non verbal intelligence.
[a] Chronological age in months at the pre-test phase.

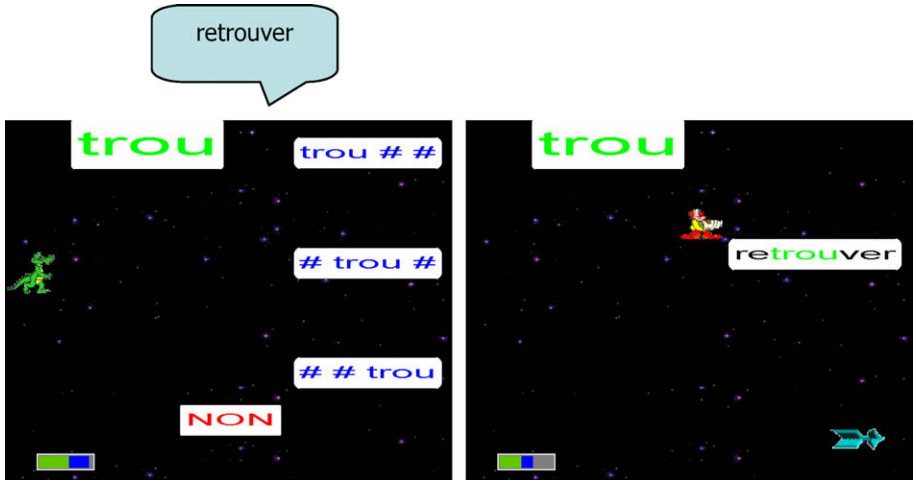

Fig. 1. A computer screenshot of the CAL software with syllabic segmentation training.

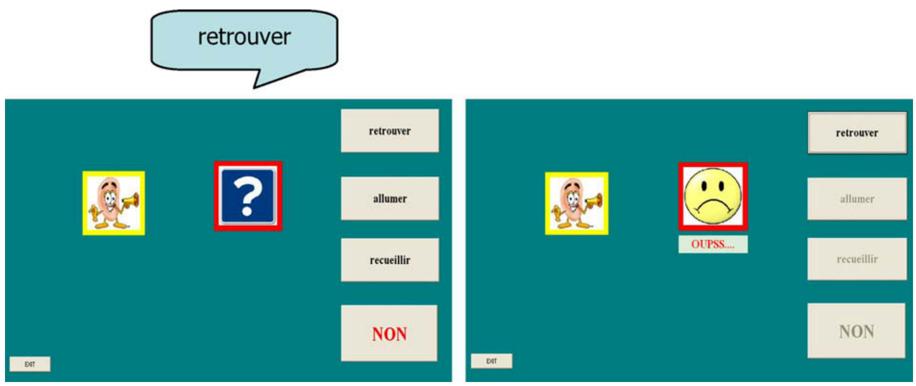

Fig. 2. A computer screenshot of the CAL software with whole word training.

2.3.1. *Word recognition*

This forced-choice task (Timé2) has already been described in the Participants section. The dependent variable used in the analyses was the total of correct responses (max: 36).

2.3.2. *Word reading aloud*

The test was taken from BELEC (Batterie d'Evaluation du Langage Ecrit), a test battery designed to help in the assessment of the cognitive processes involved in the reading and spelling abilities of French-speaking children (Mousty & Leybaert, 1999). In order to get a finer detailed analysis of reading, the children were asked to read aloud 12 regular words and 12 irregular words presented separately in list form. In regular words, the grapheme–phoneme correspondences are consistent where as in irregular words they are more inconsistent. The correct responses were collected (max: 12).

2.3.3. *Word spelling*

The children had to write the word dictated by the teacher. Twenty-four words were presented, 8 with a CV structure in the spoken language (ex: *main,* hand), 8 with a CVCV structure (ex: *lapin,* rabbit) and 8 with a CCVC structure (ex: *fleur*, flower). Half of them were high-frequency and the other half low-frequency words (see Ecalle, Magnan, & Gibert, 2006 for the list of words). The total correct response was considered to be the score (max: 24).

2.4. *Results*

An ANOVA was carried out on the scores on the three tasks with a between-factor Group (experimental *vs* control), and a within-factor Session (pre-test, t0 and post-tests, t1, t2, t3). We expected the Group $*$ Session interaction to provide evidence of a training effect given that we expected the experimental group to progress more than the control group between the pre- and post-tests. In the case of a two-way interaction, the results were further explored using independent samples *t*-tests. The effect size will be presented using the Cohen' *d* (a Cohen's *d* greater .80 is considered as a large effect size).

In word recognition, we observed a significant Grade $*$ Session interaction, $F(3,78) = 5.65$, $p = .001$. The performance increase was greater in the experimental group than in the control group. No significant difference was observed in the pre-test (t0). In the post-tests, the difference between the two groups was significant, in t1, $t(26) = 2.27$, $p = .03$ ($d = .80$), in t2, $t(26) = 2.36$, $p = .03$ ($d = .82$); in t3, $t(26) = 3.7$, $p = .001$ ($d = 1.15$), with the experimental group outperforming the control group and large effects being observed (Fig. 3).

In the word reading aloud task, we observed a significant G $*$ S interaction for the regular words, $F(3, 78) = 2.83$, $p = .04$. The performance increase was greater in the experimental group than in the control group (Fig. 4a). No significant difference was observed at t0, t1 and t2 ($ps > .10$). However, at t3, the experimental group significantly outperformed the control group, $t(26) = 2.47$, $p = .02$ ($d = .86$). The interaction was also significant in the case of irregular words, $F(3, 78) = 5.25$, $p = .002$ (Fig. 4b). At t0, the difference was at the limit of significance, $t(26) = 1.9$, $p = .07$ ($d = .69$). In the other sessions, the experimental group made significantly more progress than the control group at t1, $t(26) = 4.4$, $p = .0001$ ($d = 1.28$), at t2, $t(26) = 3.95$, $p = .0005$ ($d = 1.2$), and at t3, $t(26) = 4.06$, $p = .0004$ ($d = 1.22$).

In the word spelling task, the G $*$ S interaction was significant, $F(3, 78) = 8.12$, $p = .0001$ (Fig. 5). There was no significant difference at t0 and t1. However, a significant difference was again observed in favour of the experimental group at t2, $t(26) = 2.24$, $p = .03$ ($d = .79$) and at t3, $t(26) = 3.23$, $p = .003$ ($d = 1.05$). The effects were large in these latter two sessions.

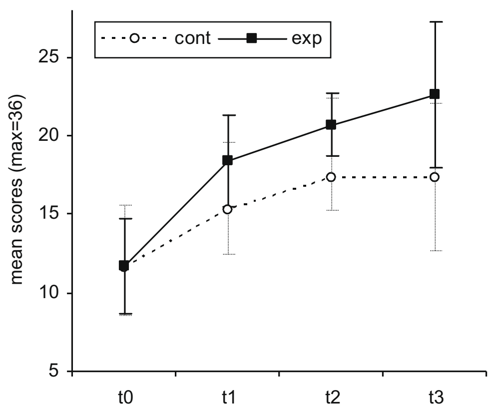

Fig. 3. Mean responses (and standard deviations) for the control and experimental groups in the word recognition test.

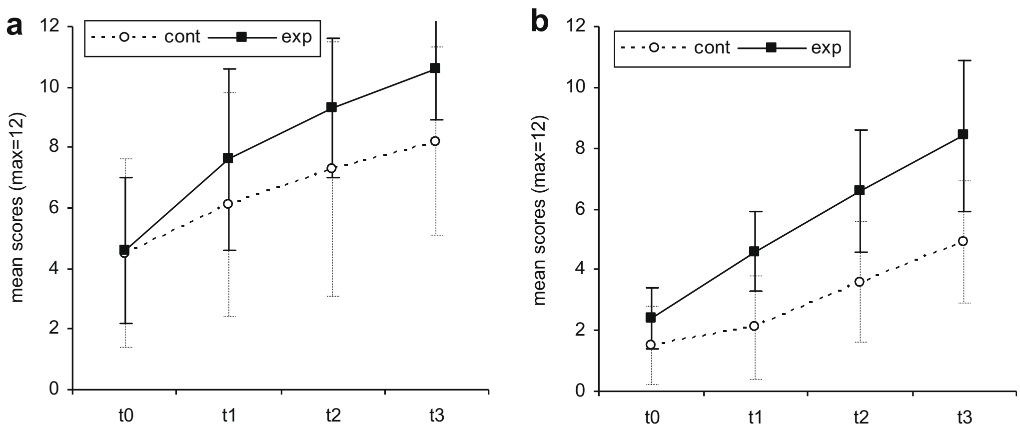

Fig. 4. Mean responses (and standard deviations) for the control and experimental groups in the word reading aloud test for regular words (a) and irregular words (b).

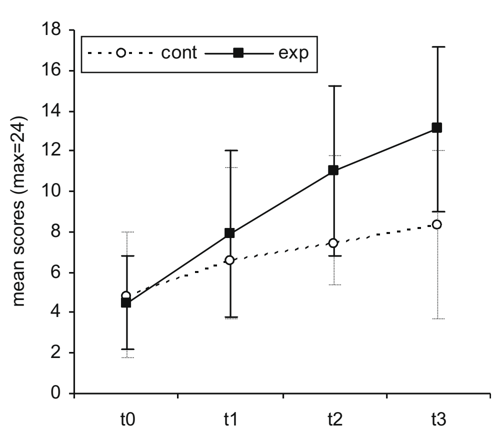

Fig. 5. Mean responses (and standard deviations) for the control and experimental groups in the word spelling task (max: 24).

3. Conclusion and discussion

The aim of this study was to analyse the effect on literacy skills of a CAL program involving word segmentation at the level of syllabic units. Indeed, some researchers have shown that this linguistic unit could be the most important unit in the word recognition process in French readers. In a classical pre-test/training/post-test training design with a randomised control trial, two groups of children experiencing reading difficulties were selected at the end of first grade and trained in word recognition using two CAL programs. One supported the whole-word recognition process (control group) whereas the other encouraged the syllabic segmentation of words (experimental group). Moreover, in this longitudinal study, the possible long-term effect of CAL programs could be tested since performance was measured 9 months after the training phase. Finally, because overall progress was expected in written language processes, various literacy skills were examined on the basis of three tasks: silent word reading, word reading aloud and word spelling.

The results are clear-cut: in reading and spelling, the experimental group outperformed the control group in each post-test session. In the word recognition test (silent word reading), conducted just after the training phase, the effect was significant and the difference between the two groups increased to the experimental group's advantage. The word reading aloud test, distinguished between two types of item. In the regular word condition, a significant effect of CAL with segmentation was observed only at post-test 3, i.e. 9 months after the training. On the other hand, in the irregular word condition, a significant difference emerged just after training and persisted during post-tests 2 and 3. Finally, in the spelling task, a significant effect was again observed in favour of the experimental group. This appeared 4 months after training and could still be observed after 9 months. More generally, the effect of the CAL program with segmentation increased over time for all the tasks when compared to the CAL program using whole-word recognition. In each task, we considered the number of correct responses, i.e. the words which were correctly read or spelled. How can we explain this important and robust effect on orthographic processing?

When syllabic units are presented embedded in a word in the printed form associated with their oral form, children are led to focus their attention on the composition of the word. This means that they are involved in a recoding process. Phonological recoding corresponds to the ability to translate printed words into their spoken equivalents (Share, 1995, 1999). According to the self-teaching hypothesis, phonological recoding is the core method through which orthographic representations are acquired. This process acts as a self-teaching mechanism enabling the child to develop word-specific orthographic knowledge. Numerous experimental studies have provided evidence of the impact of phonological recoding on the storage of well-specified orthographic representations (Cunningham, 2006; Kyte & Johnson, 2006; Nation et al., 2007).

It should be recalled that in this study, none of the words used in the pre- and post-test tasks were seen during the CAL sessions. The question remains to determine why children trained with CAL using the syllabic segmentation of words obtain better performance with lasting effects when required to perform the orthographic processing of new words (not included in the CAL program). We argue that during training, children are stimulated to perform phonological recoding automatically and do so on the basis of syllabic units which are known to be the most relevant linguistic unit in skilled reading in French (Colé et al., 1999; Doignon & Zagar, 2006). Moreover, phonological recoding has an impact on orthographic processing independently of the condition in which it is involved. Research has shown that this process had an effect on orthographic knowledge both in silent reading and reading aloud (Bowey & Muller, 2005; de Jong & Share, 2007).

In the present study, progress was observed both for regular and irregular words. The effects of CAL training were less surprising in the case of the regular words because their highly predictable grapheme–phoneme correspondences were used more efficiently in the experimental group. In the case of irregular words, even though the grapheme–phoneme correspondences were less consistent, the children focused their attention on the letter strings in such words in accordance with the self-teaching mechanism involved in the silent and oral conditions.

Finally, the mechanism used in the CAL training given in this study established a mapping between print and phonology which is known to be best condition for overcoming reading impairments and, in our opinion, for improving phonological recoding. Indeed, this type of training helps children to develop ortho-phonological representations in accordance with a connectionist model of reading development and, more precisely, with the "mapping hypothesis" (Harm & Seidenberg, 1999).

The training intervention avoids some methodological flaws outlined by Troia (1999) in a meta-analysis on 39 studies of metaphonological awareness intervention, in particular a non-random assignment of participants to conditions and failure to control for Hawthorne effects by providing alternate interventions to control group. Moreover, Troia (1999) reported that the number of treatment sessions provided to students varied from 5 to over 100 and with an average of about 32 sessions (sessions often are 15–20 min duration and usually provided twice per week). One characteristic of the program used the present study is the brief period of training. In fact, with a relatively short program in time (10 h compared to 10–27 h in other works; see Macaruso et al., 2006; Olson & Wise, 1992), poor readers in the experimental group made significant progress in literacy skills. Some studies also suggest that long and elaborate training may not be necessary to bring about improvements in reading skills (Agnew, Dorn, & Eden, 2004; Kujala et al., 2001). From an applied perspective, this aspect of the training is very important.

However, some of the limitations in this work deserve further investigation. First, we could observe that exposure to the unit (syllable or word) used differs across interventions on each training trial. Syllables are presented more frequently than the words did[1]. So it could be consider how this confound could have contributed to the pattern of results found. Secondly, word identification is clearly not sufficient for reading. It is also necessary to establish that a functional level of reading has been achieved. Thus, if one cause of failure in reading comprehension lies at the word reading level, future research must address the long-term effects on reading comprehension tasks by means of training in word reading. Moreover, studies with larger samples and involving poor readers in different grades should be conducted to reinforce these results which, to our knowledge, are the first to be obtained with French-speaking children. Finally, even if the syllabic unit seems to be the best candidate for improving the phonological recoding process in French, further research is required in order to examine the question of the most efficient type of unit for training word reading using CAL programs.

[1] One reviewer observed with just cause that when training syllable units with the word "retrouver" the syllable "trou" is given on the screen three times, each in a different location indicated by ###. This contrasts to the training with word units where the word "retrouver" appears just once on the screen in competition with two alternative words "allumer" and "recueillir". The repeated exposure of the syllable units could have contributed to the greater gains found for syllables compared to words, rather than differences in unit size per se, as repeated exposure to words in text and lists is well known to influence new word learning. Ideally, three different syllables (taken from the words used in the word training) would have been presented (e.g. "trou", "lume", and "cuel") so as to control for this.

Very few studies have examined explicit forms of phonological training for French poor readers. Phonological awareness training given in kindergarten (without CAL) had been shown to display a clear positive effect on reading at the end of first grade (Casalis & Colé, in press; Lecocq, 1993). However, to our knowledge, the present study using syllabic units in a CAL program constitutes the first one with French poor readers and more widely with children in semi-transparent orthographies.

The present research is encouraging with respect to both the understanding and remediation of low-progress readers. The possibility that computer-based learning as described here could be used either as part of or in addition to the school curriculum has implications for educational resourcing and teaching methods. Computer-assisted instruction can be used to improve the learning experience and the performance of children with reading and writing difficulties. Nowadays, computers are an integral part of the daily life of many children, and we must ensure that the use of computer-assisted learning in the classroom will prove to be an asset for poor readers and writers. We know that children with reading and writing difficulties are motivated by certain uses of computer technology, and this fact must be exploited to ensure the greatest benefit to struggling readers.

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