Syllabic Processing in Deaf Readers of French: A Second-Language Question?

D Daigle, A Ammar, R Berthiaume and A-S Besse

Université de Montréal, Département de didactique, Montréal, Canada

M Bastien

Université du Québec à Montréal, Département de linguistique et de didactique des langues, Montréal, Canada

This study aims at investigating syllabic processes in deaf readers \((n=35)\) who were compared to readers of French as a second language \((n=23)\) and to expert readers \((n=40)\). Two experimental tasks varying in their degree of phonological awareness were created: one awareness– task and one awareness+ task. Results show that all participants have knowledge related to some syllabic structures of written French. However, that knowledge is more evident in the awareness– task than in the awareness+ task. The difference between results on both tasks is greater in the deaf group than in second-language readers or the expert readers. These results are discussed in terms of complementarity of syllabic processes in reading and in relation to the status of French for deaf readers.

**KEYWORDS** Deafness, reading acquisition, second language, syllabic processing

**Introduction**

Research has shown over the last few decades that many deaf students encounter great difficulty in learning to read (Marschark, 1999; Transler, et al., 2005). At the end of their schooling, deaf readers will reach, on average, the level of fourth-grade hearing readers (Holt, 1994; LaSasso, 1999). This situation is not related to a particular language, or a specific country. As is well known, a literacy deficit may lead to inequality of personal, social, and professional opportunities for success.

In general, deaf readers’ delay is explained by a phonological deficit (Musselman, 2000). Because reading acquisition is founded on prior oral knowledge and deaf students do not have complete access to oral language, lack of access to its phonology impedes deaf readers’ first steps in literacy acquisition. This situation is known to
endure in deaf adults (Lichtenstein, 1998; Paire-Ficout, 1998). An alternative explanation for deaf readers’ deficit relates to the fact that the language to be read is considered by some as a second language for deaf readers whose first communication mode is a sign language (Lelièvre & Dubuisson, 1998; Mahshie, 1995). This proposal is rooted in studies that showed how written errors made by the deaf were similar to those of second-language writers (Nadeau & Machabée, 1998; Quigley & Paul, 1984) and in correlation studies that revealed links between deaf subjects’ sign language performance and their literacy performance (Padden & Ramsey, 1998; Strong & Prinz, 2000).

Besides Daigle, Ammar, et al. (in press) who tested the second-language explanation with graphophonemic tasks, no one, to our knowledge, has tried to bring forth arguments in favour of this position in relation to syllabic processing involved in reading in deaf adults. The main goal of this study is to evaluate syllabic processing in reading in adult deaf readers of French as a second language.

This study is believed to contribute to our understanding of word recognition processes in deaf readers. More specifically, it will help define the role of phonological processes in reading. In addition, by comparing deaf readers and second-language readers, this study will attempt to test the hypothesis that defines the majority language, French in our case, as a second language for some deaf readers. Finally, the study may affect future practices in the literacy education of deaf adults by allowing reading instructors to build activities that are better adapted to learners’ characteristics and their need to develop specific word recognition abilities essential for expert reading.

Phonological processing in hearing readers

In alphabetic languages, readers, regardless of their hearing status, must acquire and use phonological knowledge and processes efficiently (among many others Colé & Sprenger-Charolles, 1999; Ehri, 1998; Gombert, 1997; Goswami, 2002; Morton, 1989; Share, 1995; Transler, 1999). Phonological processing contributes to the acquisition of word recognition (Ecalle & Magnan, 2002) and fluent word recognition processing is part of expert reading (Stanovich, 1990).

When reading a word, the reader can take advantage of different types of processing among which are found phonological processes and lexico-orthographical processes (Demont & Gombert, 2007; see also Daigle & Armand, 2004, for a more detailed discussion of the role of different sublexical units in word recognition). In the first case, readers will benefit from all prior phonological knowledge, whether that knowledge relates to the graphemic, subsyllabic or syllabic structures of the word. For example, when reading the French word *oiseau* (bird), the reader can reconstitute the word’s pronunciation from assembling all syllables ([wə] + [zo] = [wazo]). In the case of lexico-orthographical processing, the reader would have access directly, without sublexical processing, to the meaning of the word in the mental lexicon. Both expert readers and novice readers benefit from phonological and
lexico-orthographical processing in word recognition (Berent & Perfetti, 1995; Booth, Perfetti, et al., 1999). However, lexico-orthographical processing is founded on prior efficiency of phonological processing (Demont & Gombert, 2007). Indeed, when reading a new word, the reader would first take advantage of phonological processes in order to access word meaning, making then possible the creation of an orthographical representation that can be registered in memory. Among the different phonological units participating in phonological processing, an important body of research has shown, through a variety of paradigms, how hearing readers in their first language benefit from the syllabic structure of words (in English, e.g., Duncan, Seymour, et al., 1997; Goswami, 1993; Goswami & Bryant, 1990; Prinzmetal, Hoffman, et al., 1991; Prinzmetal, Treiman, et al., 1986; Rapp, 1992; and in French, e.g., Colé, Magnan, et al., 1999; Ferrand, Segui, et al., 1996; Taft & Radeau, 1995). In most studies, authors used tasks that did not explicitly ask subjects to manipulate the syllabic structure of written items. For example, the illusory conjunctions paradigm used by Prinzmetal and his colleagues does not explicitly ask subjects to process the syllabic structure of words even though that is what is implicitly expected from them.

In addition to studies that showed the importance of syllables as reading units, research has also revealed how phonological awareness contributes to reading acquisition (Demont & Gombert, 2007; Gillon, 2004; Troia, 2006). Phonological awareness is generally defined as the capacity to analyse and manipulate voluntarily the phonological structure of words (Gombert, 1990, 2003). Phonological awareness is most often evaluated with tasks requiring subjects to explicitly use phonology in order to succeed. Those tasks must be distinguished from implicit tasks in which subjects are not asked to explicitly manipulate linguistic units (Berthiaume, 2008). For Bialystok (2001), language awareness involves more defined linguistic knowledge and cognitive control. Young readers who manifest a high degree of phonological awareness understand more easily the alphabetic principle (i.e., the segmental structure of written words corresponding, more or less perfectly, to the segmental structure of oral words), and reading level in the first language is very often correlated to the degree of phonological awareness (Demont & Gombert, 1996; Duncan, Seymour, et al., 1997; Hulme, Hatcher, et al., 2002; Wagner, Torgesen, et al., 1997; among many others). These findings have been obtained though the use of different paradigms with tasks that often ask subjects to add, suppress, amalgamate, or permute phonological units. In all cases, the objective is to bring subjects to explicitly process phonological units.

As in their first language, hearing readers need to develop and use efficient word recognition abilities in a second language (Bialystok, 2001; Koda, 2005; Verhoeven, 2000). Indeed, the more efficient word recognition processes are, the more cognitive energy the reader will be able to display for high-level processes linked to reading comprehension. Research in second-language reading has shown that the processes involved in word recognition are comparable to a certain extent to those in first-language word recognition (Akamatsu, 2002; Fitzgerald, 1995; Geva, Wade-Woolley, et al., 1997; Verhoeven, 2000). Among those processes, phonological processes seem
SYLLABIC PROCESSING IN DEAF READERS

Phonological processing in deaf readers

Research in deaf readers has shown that a phonological deficit caused by a lack of access to oral language is often responsible for their reading difficulties (Musselman, 2000). Findings from studies conducted in the deaf population revealed that some deaf readers are capable of phonological processing, although usually to a lesser degree than hearing readers (Colin, Magnan, et al., 2007; Dyer, MacSweeney, et al., 2003; Kyle & Harris, 2006; Transler & Reitsma, 2005), that older deaf subjects are more sensitive to phonology than younger subjects (Daigle & Armand, 2008; Harris & Moreno, 2004), and that better deaf readers use more phonology than less skilled deaf readers (Harris & Moreno, 2006). However, other studies did not show clear phonological processing in deaf readers (Chincotta & Chincotta, 1996; Merrills, Underwood, et al., 1994; Waters & Doehring, 1990). In this last case, authors usually put forward the idea that deaf readers who participated in their studies favoured non-phonological processes, more specifically lexico-orthographical processes. As has been explained, however, non-phonological processes cannot guarantee normal word recognition development and could impede success in reading comprehension (Demont & Gombert, 2007). Finally, among studies aiming to evaluate phonological processing in deaf readers, a few yield an effect for the syllabic structure of items to be read (Daigle & Armand, 2008; Olson & Nickerson, 2001; Sterne & Goswami, 2000; Transler, Gombert, et al., 2001; Transler, Leybeart, et al., 1999). None of those studies tried to distinguish implicit and explicit processing. In fact, all used implicit tasks where subjects did not have to manipulate explicitly the syllabic structure of written items.

First, from the literature review, we cannot put forward the idea that deaf readers can become expert without having developed efficient phonological word recognition processes. Second, the literature review does not provide arguments in favour of, or against, the hypothesis stating that written language can be considered as a second language for deaf readers who have a sign language as their first communication.
mode. Third, from past studies, the respective roles of implicit and explicit reading processes in deaf readers cannot be determined, as in hearing readers for that matter, since research has not usually taken this variable into account. It is not because people manifest some knowledge, phonological knowledge in this case, that it can be assumed they can use it explicitly when needed. Sensitivity to written units does not imply consciousness of those units. Considering the well-documented role of phonological awareness in reading development, it seems important that readers, whatever their hearing status, be sensitive not only to phonological units, as measured with implicit tasks, but also be aware of those units, as explicit tasks can help demonstrate. In order to do so, one would have to evaluate processes involved in reading using tasks varying in their degree of phonological awareness. It could be important to select specific knowledge, for example, knowledge of different syllabic structures, and evaluate it through two different tasks, one task aiming at evaluating sensitivity to the language structure and a task that would force subjects to use that specific language structure. This study will address these three points. The questions that we will try to answer are the following: Are deaf readers who have a sign language as a first communication mode able to process syllabic structures in written items, whatever the degree of phonological awareness? How are these deaf readers comparable to second-language readers? How is syllabic processing related to reading performance?

**The present study**

This study falls within the framework of studies aiming to define the role of phonological processing in reading, more precisely in deaf readers. Two tasks were created in order to distinguish different types of syllabic processing. In both cases, the same knowledge is measured — knowledge concerning the rules for syllables in written French. For the first task, the awareness− task, the instructions do not ask subjects to explicitly analyse the syllabic structure of the written items to be read. The second task, the awareness+ task, is considered more explicit because the instructions force subjects to manipulate the syllabic structures of the items to be read.

Three hypotheses have been defined:

- **H1:** Based on the literature review concerning the positive relation between efficient phonological processing and reading, syllabic task results will be related to reading performance
- **H2:** In relation to the second-language hypothesis in deaf readers, deaf readers and second-language readers will have comparable results in the syllabic tasks,

---

1 The implicit/explicit distinction must be considered only in relation to the nature of the task in this study. We are very well aware of the ongoing debate in research considering what can or should be considered as implicit or explicit in reading. For example, some researchers qualify as implicit or explicit the processes involved in reading, other than the nature of the knowledge involved in the different reading processes, and other than the nature of the learning or teaching processes. This debate goes far beyond this study (see however Berthiaume (2008), Bialystok (2001), De Keyser (2003), Ellis (2004), Gombert (1990), or Paradis (2004) for a discussion on those questions).
considering that both groups were matched on reading performance, but had lower results than those of experts readers

- **H3**: Subjects, whatever the group, will obtain lower results for the awareness+ task than for the awareness− task.

**Participants**

Participants were severely or profoundly deaf adults aged 31.4 years on average (n = 35). All became deaf before the acquisition of oral language. They were born in Quebec (Canada) and all used Quebec Sign Language as their first communication mode. All participants were educated in the francophone school system at least through high school. None of the participants had any additional deficit. Participants were recruited in the Montreal area. Deaf participants were compared to second-language readers (n = 23), all recent immigrants from China. Chinese participants were 34.6 years, on average, and all had been educated in their first language at least through high school. Chinese participants had been exposed to French for 18 to 24 months in school (formal French second-language classes) and in their social environment (all lived in Montreal). None of the Chinese participants had a specific deficiency. Chinese participants were selected, first, because the Chinese language was considered to be as far from French as Quebec Sign Language is, and, second, Chinese learners are regarded by second-language teachers as struggling with French phonology. The group of deaf readers and the group of Chinese readers were matched on their results on a computerised reading test\(^2\) and, considering the difficulty in recruiting deaf subjects, as much as possible on age, sex, and the level of education (in first language for the Chinese group). Both groups were compared to a group of expert readers (n = 40) aged 26.2 years, on average. All expert readers were francophone and declared having no reading difficulty. They were all from the Montreal area and all had taken university courses (the criterion for defining expertise in reading). Participants’ characteristics are presented in Table 1.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age (mean in years)</th>
<th>Reading score (mean in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaf</td>
<td>From 19.1 to 53.7 (31.4)</td>
<td>From 52.45 to 98.55 (84.93)</td>
</tr>
<tr>
<td>Chinese</td>
<td>From 21 to 48 (34.6)</td>
<td>From 61.10 to 94.10 (82.93)</td>
</tr>
<tr>
<td>Expert</td>
<td>From 18.1 to 51.7 (26.2)</td>
<td>From 89.35 to 100 (96.71)</td>
</tr>
</tbody>
</table>

\(^2\) The reading test was created with the Zigzag technique developed by Ciesielski and Reinwein (1989) and used in many different studies as an experimental measure or as a control measure, as in the present case (Bastien, 1997; see also http://www.unites.uqam.ca/zigzag). The Zigzag technique consists of a reading activity activated by a segment-by-segment autopresentation of the text to be constructed by the reader. The readers always have the choice between two items — an expected item and a distracter, and must select the expected one in order to activate the following part of the text. The preceding context then appears in a window on the computer. For this study, subjects had to read three texts of about hundred words each. The first one was a practice text. We used the average success rate of the two experimental texts as the reading score for each subject.
In order to investigate the comparability of the Deaf group, Chinese group and Expert group, an analysis of variance (ANOVA) with age and reading score as dependent variables was conducted. Results indicated an age effect and a reading-score effect (respectively, $F(2, 95) = 8.368$, $p < 0.001$ and $F(2, 95) = 28.277$, $p < 0.001$). For age, post-hoc analysis (Tukey) showed that deaf participants did not differ from the Chinese participants ($p = 0.326$), but were older than the expert readers ($p = 0.019$). Chinese readers were also older than the expert readers ($p = 0.001$). The post-hoc analysis on reading score indicated that the deaf participants did not differ from the Chinese participants ($p = 0.632$), but obtained lower scores than the expert readers ($p < 0.001$). Chinese readers also performed worse than the expert readers ($p < 0.001$).

**Experimental material**

Two computerised syllabic tasks were created, one awareness− task and one awareness+ task. In both cases, the material was composed of pseudo-words in order to ensure the prelexical nature of the processes used by the readers and to control for possible discrepancies in lexical knowledge among participants.

In French, liquid consonants may be used alone or be followed by another consonant, the liquids constituting a single coda part of a first syllable (‘r’ in *marteau* (hammer)), or they can be preceded by another consonant to create a complex onset part of a second syllable (‘r’ in *patron* (boss)). Thus, except for double liquids, the orthographic environment of the liquid consonant determines the syllable to which it belongs and whether or not the two consonants are part of the same syllable (the letters ‘rt’ in *marteau* are not part of the same syllable, but the letters ‘tr’ in *patron* are).

The awareness− task is a similarity judgement task similar to those used in other studies (e.g., Daigle & Armand, 2008; Transler, 1999). This task requires subjects to select from two comparison pseudo-words the pseudo-word that most resembles a target pseudo-word. The instructions given to subjects (Which of *carbi* or *cabri* most resembles *capli?*) do not require an explicit processing of the syllable structure of the items read. Only the syllabic structure can lead to selection of the expected item. The experimental material was made up of forty triplets of pseudo-words (see Appendix 1). Pseudo-words of the same triplet had the same number of letters and syllables. Half of the target items followed a liquid-consonant structure (L/C — *morpa*) and the other half a consonant-liquid structure (/CL — *mapli*). The target item was always placed in the centre of the upper third of the computer screen. The two comparison items were placed in the lower third of the screen, one on the left and one on the right. The position of the expected items was randomly selected, but half of the correct answers corresponded to the left item, and half to the right item.

In the awareness+ task, participants had to locate the odd item out of four items (see Appendix 2). This type of task is frequently used in phonological awareness studies. In this task, participants are asked to select the item that starts with a different syllable (e.g., *baflo* — *barto* — *balfé* — *barfî*). All first syllables have the first two
letters in common. In contrast to the implicit task, the instruction (Which items begin with a different syllable?) and the orthographical similarities between first syllables in each trial required participants to manipulate explicitly the syllabic structure of the items read. The experimental material was made up of trials trials. Pseudo-words in each trial had an equal number of letters and syllables. Items in each trial were controlled for phonological and orthographical similarities. Half of the trials targeted a L/C structure and half a /CL structure. All four items were always located in the middle of the computer screen, one beside each other in a row. The position of the expected answer was randomly chosen, but in total, an equal number of expected answers was ensured for each of the four possible positions.

**Procedures**

Both experimental tasks were computerised with LEA software (Bastien, 2002). This software allows automatic gathering of success rates. Participants were met individually in a quiet room and tests were presented on a portable computer. Three research assistants were first trained in preparation for the data collection to ensure equivalency between instructions since they were given in the participants’ first language. One deaf research assistant had Quebec Sign Language as her first communication mode, another research assistant was originally from China and had been living in Montreal for a few years at the moment of collecting the data, and the third research assistant was a francophone. For the awareness− task, participants were told they would see one pseudo-word in the top of the screen and two in the bottom and that, after reading the three items, they were to select the item in the bottom of the screen that most resembled the one on the top of the screen. To answer, participants had to press one of the two predefined keys on the keyboard. For the awareness+ task, participants were first trained on the concept of syllables in French. This was particularly important for the deaf and Chinese subjects. All subjects were told they would see four pseudo-words on the screen and were asked to choose the item that started with a different syllable. To answer, participants had to press one of the four predefined keys on the keyboard. Keys respected the visual order of the four items.

For both tasks, trials always maintained the same presentation. Items of each trial appeared at once and stayed on the screen until either the subjects answered or for a maximum of 10,000 ms. A series of XXXX then appeared and remained for 1000 ms, followed by another trial. The experimental material was grouped into five trials, and an unlimited pause was planned between each group of trials. The subjects controlled the length of the pause by pressing the spacebar. Each test started with five practice trials.

Statistical procedures were as follows. First, considering the limited response choices, the results were evaluated for difference from chance with Student’s t-test. Second, correlation analyses were run in order to establish relations between the experimental tasks and the reading score (Hypothesis 1). Third, ANOVAs were conducted in order to determine the potential effect of group (Deaf vs Chinese vs Expert) or task (implicit vs explicit), followed if necessary by post-hoc tests (Tukey) for pairwise group comparisons (Hypotheses 2 and 3).
Results

**Syllabic awareness—task**

Results for the syllabic awareness—task are shown in Table 2. Mean scores and standard deviations are presented for each sample. Results from the *t*-tests showed that the groups’ responses were significantly different from the chance level (50 per cent) (see Table 2). In fact, the Chinese and expert groups obtained almost ceiling scores.

In order to verify the first hypothesis related to the positive relation between phonological processing and reading ability, results from the syllabic awareness—task were correlated with those of the reading task. Results of the correlation analysis indicated a positive relation between variables in the deaf group (*r*=0.468, *p*=0.004), but not in the Chinese group (*r*=0.368, *p*=0.084) and the expert group (*r*=0.204, *p*=0.207). Very high scores in the Chinese and expert groups may explain the absence of correlation between syllabic processing and reading performance.

To test the second hypothesis of whether deaf learners having a sign language as a first communication mode should be considered to be second-language learners, an ANOVA was conducted with the groups (Deaf, Chinese, Expert) as a between-subjects factor. The analysis indicated a significant group effect (*F*(2, 95) = 35.833, *p* < 0.001). Post-hoc analyses showed that deaf subjects obtained lower scores than Chinese subjects (*p* < 0.001) and expert readers (*p* < 0.001). The Chinese participants’ results did not differ significantly from those of the expert readers (*p* = 0.591).

**Syllabic awareness+ task**

Results for the syllabic awareness+ task are shown in Table 3. Mean scores and standard deviations are presented for each sample. As for the first task, *t*-test analyses

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean score (%)</th>
<th>Standard deviation</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaf</td>
<td>68.40</td>
<td>21.36</td>
<td><em>t</em>(35) = 5.17**</td>
</tr>
<tr>
<td>Chinese</td>
<td>91.96</td>
<td>11.72</td>
<td><em>t</em>(22) = 17.16**</td>
</tr>
<tr>
<td>Expert</td>
<td>95.75</td>
<td>7.12</td>
<td><em>t</em>(39) = 40.64**</td>
</tr>
</tbody>
</table>

** p < 0.001.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean score (%)</th>
<th>Standard deviation</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaf</td>
<td>43.96</td>
<td>29.98</td>
<td><em>t</em>(35) = 3.79*</td>
</tr>
<tr>
<td>Chinese</td>
<td>74.46</td>
<td>23.90</td>
<td><em>t</em>(22) = 9.93**</td>
</tr>
<tr>
<td>Expert</td>
<td>88.21</td>
<td>16.60</td>
<td><em>t</em>(38) = 23.78**</td>
</tr>
</tbody>
</table>

* p = 0.01
** p < 0.001.
for all groups showed that results for the syllabic awareness+ task were significantly higher than the chance level (25 per cent). Second, results of the correlation analyses indicated that in the deaf group, as well as in the Chinese group, syllabic processing was significantly correlated with reading (respectively, $r = 0.494$, $p = 0.002$ and $r = 0.578$, $p = 0.004$). This was not the case in the group of expert readers ($r = 0.192$, $p = 0.241$).

An ANOVA with groups (Deaf, Chinese, Expert) as a between-subjects factor was conducted to compare samples in order to test the second hypothesis. Results indicated a significant group effect ($F(2, 95) = 32.801$, $p < 0.001$). Post-hoc analyses revealed that deaf subjects had lower results than Chinese subjects and expert readers ($p < 0.001$ in both cases). However, the Chinese participants’ scores did not significantly differ from those of the expert readers ($p = 0.079$).

**Comparison between results from the awareness− and the awareness+ tasks**

In relation to the third hypothesis, all groups were expected to obtain lower scores on the awareness+ task than on the awareness− task. An ANOVA with groups (Deaf, Chinese, Expert) as a between-subjects factor and tasks (Awareness−, Awareness+) as a within-subjects factor was then conducted. Differences are illustrated in Figure 1.

Results from the ANOVA indicated a main effect of tasks ($F(1, 95) = 50.986$, $p < 0.001$) and an interaction between groups and tasks ($F(2, 95) = 5.435$, $p = 0.006$). As had been hypothesised, all groups obtained scores significantly lower on the awareness+ task than on the awareness− task. However, the difference between scores on those two tasks was not equivalent in all three samples. This explains the interaction between variables. The difference is less important in the expert readers’

![Figure 1](image_url)

**FIGURE 1** Differences between scores for the awareness− and the awareness+ tasks per group.
group than in the two other groups. However, this difference cannot distinguish significantly deaf readers from Chinese readers ($p = 0.310$).

**Discussion**

This study falls within research studies aimed at investigating deaf readers’ difficulties in the light of their use of phonology. Considering the essential role of phonology in reading (Demont & Gombert, 2007) and the deficit exhibited by deaf readers acquiring phonological knowledge (Musselman, 2000), we wanted to define that deficit better by taking into account the degree of phonological awareness — in this case syllabic awareness. Also, we considered the hypothesis sometimes put forward to explain deaf readers’ difficulties: the second-language hypothesis (Padden & Ramsey, 1998; Strong & Prinz, 2000). In order to do so, we built two different phonological tasks targeting syllables as reading units, an awareness− task and an awareness+ task. Three hypotheses guided this study. According to the first one, syllabic processing was expected to be positively correlated to reading performance. The second hypothesis aimed at testing the second-language hypothesis in deaf readers. Finally, we expected the awareness− task to succeed better than the awareness+ task, considering it should require a higher level of language awareness from the participants to process the awareness+ task and taking into account that a higher level of language awareness necessitates more defined linguistic knowledge and cognitive control (Bialystok, 2001).

Results from the syllabic awareness− task revealed that all participants could demonstrate phonological knowledge, at least as evaluated in this task. Indeed, all groups performed above the chance level. These results help define the role of phonological knowledge in deaf readers. If some studies have not reached conclusions in favour of the use of phonology in deaf readers (Merrills, Underwood, et al., 1994; Waters & Doehring, 1990), others have (Colin, Magnan, et al., 2007; Kyle & Harris, 2006; Olson & Nickerson, 2001; Sterne & Goswami, 2000; Transler, Gombert, et al., 2001). This study brings additional support for the use of phonology by deaf readers, even by those who use a sign language as a first communication mode. Moreover, results from the correlation analyses indicated that the awareness− task was related to reading performance in the deaf sample, but not in Chinese readers nor in expert readers. The fact that the last two groups had very high scores on this task impeded the emergence of correlations. Of interest, however, is the fact that, in the early stages of second-language learning, Chinese readers seemed to develop phonological knowledge related to the syllabic structure of written items at a level that was not statistically different from expert readers and were capable of showing this in a task that did not require explicit processing of those syllable units.

Results from the syllabic awareness+ task also indicated that all three groups performed above the chance level. As in the first task, deaf readers obtained lower scores compared to the two other groups. The distinction between results from the Chinese readers and the expert readers was not significant, although a tendency was
observed. This seems to illustrate the limit of Chinese readers in terms of syllabic processing at this stage of their second-language learning. Also, this appears to explain the positive correlation between syllabic processing and reading performance in Chinese readers, as is the case of deaf readers, both groups not being able to reach a high level of success.

The comparison of success rates between the two tasks is interesting. Indeed, even if the two tasks targeted the same knowledge related to specific syllabic structures in French, results indicated that the awareness+ task was more difficult than the awareness− task for all subjects. This brings to light the importance of taking into account the type of task used in reading research. Even if we cannot be certain that subjects did not resort to explicit processes in the awareness− task just because the instructions encouraged them in the direction of implicit processing, it seems that the awareness+ task required a higher level of linguistic knowledge and cognitive control than the awareness− task. Considering that deaf readers may have reached fossilisation in reading — if we accept the conclusions of studies that defined a written language learning cap at the level of hearing fourth graders (Holt, 1994; LaSasso, 1999) — and the fact that Chinese readers are engaged in active learning processes and activities, it is possible to advance that explicit processing characterising language awareness gives a better account of reading performance, as has been suggested by others (Demont & Gombert, 1996; Duncan, Seymour, et al., 1997; Hulme, Hatcher, et al., 2002; Wagner, Torgesen, et al., 1997). Our results suggest that implicit processes that require a lesser degree of linguistic knowledge and control would be related to reading in beginning readers, as it seems to be the case of readers who encounter important difficulties in reading and have reached fossilisation. Past that beginning level, explicit processes would be a better indicator of reading performance. This appears to be the case in Chinese readers. In expert readers, neither type of process would be linked to reading comprehension because of ceiling effects in the experimental tasks, as we observed in this study. Of course, since the distinction between tasks according to the degree of language awareness has not often been investigated, other studies would be needed to support this proposition. However, if this reasoning is acceptable, we could hypothesise for basic word recognition processes such as those involved in treating word reading units (graphemes, syllables, morphemes), a specific developmental pattern in four steps, each characterised by the role of specific processes in reading acquisition. In beginning word recognition in reading, implicit processes would explain reading performance, and then in intermediate readers, implicit and explicit processes would play a role in defining reading. Next, in more advanced readers, only explicit processes would explain reading performance. Finally, in expert reading, all word recognition processes being automated (Gombert, 2003) and performances reaching ceiling scores in experimental tasks, neither implicit nor explicit processes would explain reading performance.

Our results suggest that deaf readers could be considered intermediate in terms of word recognition processes in reading. As for Chinese readers, they could be regarded as more advanced readers. Considering the essential role of phonological
processes in word recognition (Demont & Gombert, 2007), that efficient word recog-
nition processes are required to become expert readers (Colé & Sprenger-Charolles,
1999), and the fact that deaf readers do not have full access to phonology because of
their hearing impairment, deaf readers’ results can be explained by a phonological
deficit. As such, this contributes to the most accepted hypothesis for reading delay in
deaf readers (Musselman, 2000). What this study adds concerns the nature of the
phonological deficit. Indeed, our results indicated that our deaf readers not only had
a phonological deficit, they specifically had a deficit in implicit processing and in
explicit processing. This was not the case for Chinese readers who deaf readers
were compared to. Chinese readers only had a deficit in explicit processing (in fact a
tendency towards it) when compared to expert readers.

Then how can we explain the fact that deaf readers and Chinese readers were, at
first, comparable in terms of reading performance? Phonological processes are only
part of word recognition processes, and word recognition processes are in turn only
part of reading comprehension (Ecalle & Magnan, 2002). Indeed, many more pro-
cesses are involved in reading. Considering that deaf readers in this study had without
any doubt more contact with written French than the Chinese subjects, they had the
chance to develop other knowledge that could be used in the reading comprehension
test (vocabulary, syntax, etc.). They probably took advantage of that knowledge,
using it to compensate for their specific difficulties as other disabled readers do,
notably dyslexic readers (Sprenger-Charolles & Colé, 2003). All together, the results
of this study cannot be regarded to favour the second-language hypothesis to explain
deaf reading deficit (Padden & Ramsey, 1998; Strong & Prinz, 2000). These authors
did not compare deaf readers to second-language readers. Instead, they correlated
deaf subjects’ performances in American Sign Language (L1) to English reading
performances (L2). This difference in paradigms may explain the different conclu-
sions. Another factor that may have had an impact on our results is the fact that our
Chinese readers were already readers in their first language. As sign language is not
written, deaf readers could not develop written competency in their first language and
had to learn the written code of the majority language (French in our case). This is
certainly a limit to this study. To avoid this situation, we would have had to compare
deaf readers to almost illiterate adult learners who have French as a second language.
Obviously, it would have been very difficult to find a homogeneous group of second-
language learners having the same first language and not having attended school. This
situation would also have had the inconvenience of comparing a group of learners
who had access to a school system (the deaf learners) and a group of people who had
not been to school (the second-language learners). This could have created some
misleading interpretations that would not be linked to language status (L2), but to
schooling.

Conclusion

This study aimed at investigating phonological processes, more specifically, syllabic
processes, in deaf readers compared to second-language readers. We showed that deaf
readers do not behave as second-language readers. Results of this study reveal that deaf readers do have phonological knowledge related to the syllabic structures of written items and can use it when required to do so. Indeed, they showed a syllabic sensitivity as expressed in the awareness—task. However, their performance is weaker than second-language readers and expert readers. Their phonological deficit can be defined as a deficit in using implicit and explicit processes for treating written items. This probably had an impact on word recognition development, which in turn impeded normal reading comprehension development. Other studies using paradigms allowing for the distinction between reading processes and the degree of language awareness required by the task are needed to explain deaf readers’ difficulties, but more generally to explain all reading deficits in first or second language. To do so, it is important to evaluate specific knowledge and vary the level of linguistic knowledge and control required by the tasks.

Acknowledgements

We would like to thank the Fonds québécois de la recherche sur la société et la culture for a grant made to the first author. We would also like to thank the participants and research assistants who contributed greatly to this study. D Daigle and A Ammar are members of the Center for the Study of Learning and Performance. D Daigle and R Berthiaume are members of the Groupe de recherche sur la langue des signes québécoise et le bilinguisme sourd.

References


Notes on contributors
Ahlem Ammar, Université de Montréal, Département de didactique, CP 6128, Succursale Centre-ville, Montréal, Québec, Canada, H3C 3J7. Email: ahlem.ammar@umontreal.ca

Michel Bastien, Université du Québec à Montréal, Département de linguistique et de didactique des langues, C. P. 8888, Succursale Centre-ville, Montréal, Québec, Canada, H3C 3P8. Email: michel.bastien@microbe.ca
Appendices

Appendix 1: Syllabic awareness– task: some examples

<table>
<thead>
<tr>
<th>Condition <em>/CL</em> condition</th>
<th>Two-syllables items</th>
<th>Three-syllables items</th>
</tr>
</thead>
<tbody>
<tr>
<td>« mapli »</td>
<td>« capli »</td>
<td>« navoplé »</td>
</tr>
<tr>
<td>mapri</td>
<td>cabri</td>
<td>navopré</td>
</tr>
<tr>
<td>marpi</td>
<td>carbi</td>
<td>navorpé</td>
</tr>
<tr>
<td>« vaglu »</td>
<td>« faglu »</td>
<td>« ténucro »</td>
</tr>
<tr>
<td>vagru</td>
<td>fapru</td>
<td>ténuclo</td>
</tr>
<tr>
<td>vargu</td>
<td>farpu</td>
<td>ténulco</td>
</tr>
<tr>
<td>Condition <em>/L/C</em> condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>« morpa »</td>
<td>« forpa »</td>
<td>« dimirba »</td>
</tr>
<tr>
<td>molpa</td>
<td>folga</td>
<td>dimilba</td>
</tr>
<tr>
<td>moplpa</td>
<td>forgra</td>
<td>dimibla</td>
</tr>
<tr>
<td>« palbo »</td>
<td>« salbo »</td>
<td>« tovalbé »</td>
</tr>
<tr>
<td>parbo</td>
<td>sarfo</td>
<td>tovarbé</td>
</tr>
<tr>
<td>pablo</td>
<td>safro</td>
<td>tovabré</td>
</tr>
</tbody>
</table>

Appendix 2: Syllabic awareness+ task: some examples

<table>
<thead>
<tr>
<th>Syllabic structure targeted</th>
<th>Experimental items</th>
<th>Position of the expected answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV</td>
<td>baflo barlo balpé barfi</td>
<td>1</td>
</tr>
<tr>
<td>CV</td>
<td>balpo bapré baldé barni</td>
<td>2</td>
</tr>
<tr>
<td>CV</td>
<td>balnu barco bacla barfa</td>
<td>3</td>
</tr>
<tr>
<td>CV</td>
<td>balsu barna baldo badru</td>
<td>4</td>
</tr>
<tr>
<td>CVC</td>
<td>barco baplo bafi baclu</td>
<td>1</td>
</tr>
<tr>
<td>CVC</td>
<td>badi baldé bagré bablu</td>
<td>2</td>
</tr>
<tr>
<td>CVC</td>
<td>batré bablo barbo baglo</td>
<td>3</td>
</tr>
<tr>
<td>CVC</td>
<td>bacr stupla bafal baltu</td>
<td>4</td>
</tr>
</tbody>
</table>