

READING ACQUISITION: CROSS-LINGUISTIC DATA (ENGLISH-, FRENCH-, SPANISH- AND GERMAN-SPEAKING CHILDREN)

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Abstract
We review studies on reading acquisition in English, German, Spanish and French and on the relations between reading and spelling acquisition. These studies show that children mainly rely on decoding skills (grapheme to phoneme relations) when they begin to learn to read and that early decoding skills influence future reading skills. They also show that reading acquisition seems to be easier in languages with shallow orthography (Spanish) than in languages with deep orthography (English), and that significant relations -- but also significant differences -- exist between reading and spelling acquisition. A tentative interpretation of these results is proposed.

Key-words
Reading Acquisition, Spelling Acquisition, Phonological and Orthographic Processing in Reading Acquisition, Grapheme-phoneme correspondences, Deep and Shallow Orthography, Psycholinguistic, Cross-linguistic Studies.

1. PRELIMINARY REMARKS

A young child might be able to understand a text which is read to him but unable to understand the same text when he has to read it by himself. If so, we can say that this subject is experiencing reading difficulties which are not due to a failure in comprehension processing. His/her difficulties appear to be related to other types of mechanisms, that are specific to reading.

In order to imagine what those mechanisms are, we can give the example of walking. It seems difficult to say that a young child is unable to walk because he has not understood the goal of walking (i.e. what could be gained by walking) which is a high level processing. It is obvious that this incapacity is due to the child not having acquired the mechanisms which would permit him to walk without taking into account what he is doing with his feet. In a similar way, we can assume that an adult who has once been able to read, but has lost this capacity as a result of brain damage, has not also lost his understanding of the aim of reading, i.e., comprehension, but only the lower level mechanisms that allowed him to read effortlessly.

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The last point leads us to make a new distinction, i.e. the distinction between automatic, unconscious, processing, on the one hand, and attentional, or controlled, processing, on the other hand. Automatic processing, like word identification, operates without the deliberate intervention of the subject when attentional processing is controlled by the subject. For example, we adjust our level of comprehension to our immediate goal, and we try to get more subtle understanding only when it seems necessary.

In normal adults, low level processing underlying word identification, like low level processing necessary for walking, is fairly automatic. In the case of reading, automaticity of word identification can be illustrated by the so-called stroop effect. A subject is shown the name of colours printed in coloured ink which may or may not correspond to the written word. The subject's task is to say only what colour he 'sees', without taking into account the written words. When the written name and the colour of the ink are different, the subject's response is slowed down, showing that it is difficult and perhaps impossible, not to read words which are automatically processed.

In normal adult reading, word access is mainly automatic and context free. In contrast with a false idea, a lot of experimental studies have shown that expert readers make less use of semantic context to identify a word than less skilled readers (Perfetti, Goldman and Hogaboam, 1979; Stanovich and West, 1981). This is crucial because of the limited capacity of the reader's information processing. Automatic processing is of lower cognitive cost than attentional processing. Moreover, the more the reader uses attentional cognitive resources for word identification (i.e. tries to guess words out of contextual information), fewer are the remaining cognitive resources available to understand the text.

Most reading models assume that two different mechanisms — or routes — allow for word access: a direct route and an indirect one. The first route involves direct connections between a written word and its occurrence in the orthographic lexicon of the subject. This route is generally used to read high frequency words, whether they present regular or irregular grapheme-phoneme correspondences (GPC). The indirect route, which involves GPC, works fine for regular words, like '*table*' in English or in French, but not for words like '*cafe*' in English or '*femme*' in French that violate GPC.

The existence of these two routes was first demonstrated by studies on adults who, after brain damage, became dyslexic. These studies have shown a selective loss of one of these two routes (Ellis, 1984). For example, some subjects were able to read high frequency words by sight, whether they were regular or irregular, but suffered difficulties with unknown words, as well as with non-words. Other subjects were able to use the indirect phonological route. Those subjects could read regular words correctly, whether they were frequent or rare, as well as non-words. On the other hand, their reading of irregular words led to regularization errors, for example, '*have*' read with a long 'a' as in '*gave*'.

2. BEGINNING OF READING ACQUISITION

A feature of most developmental models is that they postulate that, at the beginning of reading acquisition, children can only use 'spelling-to sound knowledge' as their orthographic lexicon is not yet established. Therefore, at the outset, children rely on their speech knowledge to establish a relationship between the spoken and the written language. It is only later that they are able to process words through the direct orthographic route.

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Nevertheless, the weight of the indirect phonological route may depend on the degree to which the different writing systems represent the spoken language they encode. There is a continuum of all writing systems, going from most to least phonological. For alphabetic writing systems, Spanish orthography is one of the most phonological as it reflects relatively faithfully the surface phonology of the language; English orthography is one of the least phonological, with French in between.

The following part of this paper will deal with the way children learn to read in different alphabetic writing systems. If we assume that beginning readers rely mainly on phonological processing, whatever the writing system, we expect regular words to be better processed than irregular words. We also expect an important number of regularization errors, efficiency in pseudoword reading and strong correlations between word and pseudoword reading. On the other hand, we expect no frequency effect (i.e. high frequency words should not be processed better than low frequency ones) and no lexicality effect (i.e. words should not be processed better than pseudowords).

2.1 English-speaking children

Results of studies using reading aloud tasks clearly indicate that younger children give fewer correct responses, with longer latencies, for irregular words than for regular words. For older children, like for mature readers, differences between regular and irregular words are only found for low frequency words (Backman, Bruck, Hebert and Seidenberg, 1984; Waters, Seidenberg and Bruck, 1984). These data suggest that English children pass through a phonological stage but move rapidly to an orthographic stage.

The same results were found in silent reading tasks. In these tasks, sentences that contained an inappropriate homophone word, or a homophone pseudoword were used (Doctor and Coltheart, 1980). These sentences, therefore, sounded right but looked wrong (e.g., "She blue up the balloon", "I have noe time"). Children were asked to say if the sentences were meaningful. Younger children (aged 6 to 8 years) were found to accept these two types of sentences in a majority of cases. The pattern of results was somewhat different for older children (aged 9 to 10 years). The error rate was higher on sentences with a homophone word than on sentences with a homophone pseudoword. This difference between word and pseudoword results in the older group of children was attributed to the fact that they already had an orthographic lexicon and were, thus, able to use the direct orthographic route.

2.2 Studies with Spanish-speaking children

Neither regularity, nor homophony effects can be studied with Spanish subjects as correspondences between graphemes and phonemes are highly regular in this language. Therefore, in order to assess whether children use the phonological route, researchers generally take into account either the accuracy of pseudoword reading, or the difference between words and pseudowords, or the length effect.

Results obtained with young Spanish children clearly suggest an early and long lasting use of phonological processing. For example, a high accuracy level in pseudoword reading has been observed in a study with very young children (5 year-olds). They were able to read (and write) more than 90% pseudowords (Cuetos, 1989). Length effect, without any frequency effect, was

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also reported for Spanish 8 to 13 year-olds (Valle Arroyo, 1989). Spanish children thus seem to rely strongly on the phonological route.

2.3 French longitudinal data

The results of our longitudinal studies (Sprenger-Charolles and Casalis, 1995; Sprenger-Charolles and Siegel, 1998; Sprenger-Charolles, Siegel and Béchennec, 1998, Sprenger-Charolles, Siegel and Bonnet, forthcoming) showed that, in the middle of first grade, children read regular words better than irregular ones which, in turn, led to regularization errors ("album" /albom/ read /albym/). On the other hand, high frequency words were not more accurately read than low frequency ones. In the same way, comparisons between words and pseudowords showed no word superiority. Altogether these results suggest that French-speaking children mainly use phonological mediation at the beginning of reading acquisition. Nevertheless, very rapidly the orthographic lexicon is constructed, as shown by the fact that words were better read than pseudowords at the end of first grade and that, at the same time, frequency had an impact on the reading results.

Children in the later stage of reading acquisition are, thus, able to match a written word directly with its form in their orthographic lexicon. However, this procedure does not entirely replace phonological mediation. This can be seen by the regularity effect observed at the end of first grade which was even stronger that the regularity effect in the previous session, since the difference in the results between regular and irregular words increased with time to the detriment of irregular ones. In the same way, the mean number of regularization errors increased between sessions. Moreover, in a silent reading task we observed a strong effect of homophony, not only at the end of first grade but also at the end of second grade. As for reading aloud, this effect increased with time. For example, 'pijon', homophone of the word 'pigeon' (and not the visual foil 'pigean') was accepted as a correct exemplar for 'birds' more often at the end of first grade that four months before.

These results suggest that French children pass through a first phonological stage but rapidly set up their orthographic lexicon which allows them to use the orthographic route. Nevertheless, this route does not entirely replace the phonological route whose weight increased between sessions, in reading aloud (Sprenger-Charolles and Casalis, 1995; Sprenger-Charolles and Siegel, 1998; Sprenger-Charolles, et al. forthcoming) as well as in silent reading (Sprenger-Charolles, et al., 1998).

2.4 English- vs German-, Spanish- and French-speaking children

When reading results obtained from English- and German-speaking children were compared, fewer pseudoword errors were found in younger German children than in older English ones. High correlations between word and pseudoword reading times were also observed in the youngest German group but not in the youngest English group (Wimmer and Goswami, 1994).

In another comparative study with English-, French- and Spanish-speaking children, the pseudoword accuracy was observed to be less in the English group than in the Spanish group while the French results were in between (Goswami, Gombert and Barrera, forthcoming). Moreover, the length effect was to the detriment of long pseudowords for Spanish children

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but not for English children. These results clearly suggest that English children rely on phonological processing to a lesser extent than Spanish, German and French children.

2.5 Units of phonological processing

The results we have presented show that there are differences between English-, French-, German- and Spanish-speaking children in the degree to which they rely on grapheme-phoneme correspondences. More subtle differences were also observed between vowel and consonant processing. For example, more errors on vowels than on consonants were found in English (Bryson and Werker, 1989; Fischer, Liberman and Shankweiler, 1977; Fowler, Liberman and Shankweiler, 1977; Fowler, Shankweiler and Liberman, 1979; Siegel and Faux, 1989). On the other hand, no more errors on vowels than on consonants were observed in Serbo-Croat (Ognjenovic, Lukatela, Feldman and Turvey, 1983), German (Wimmer, 1993), Italian (Cossu, Shankweiler, Liberman and Gugliotta, 1995) or French (Sprenger-Charolles and Siegel, 1994 and 1998). Moreover, phonological features mainly account for both consonant and vowel errors in Serbo-Croat (Ognjenovic, et al. 1983) and in French (Sprenger-Charolles and Siegel, 1998), but only for consonant errors in English (Fowler, et al. 1979). The English results may be due to the instability of vowels, whose pronunciation is constrained by stress and the following graphemic environment.

The results observed for vowel processing led us to look at what happens at the rime level in English as compared to languages in which the rime unit is not so important. This is the case for Spanish which has predominantly open syllables and vowels, the pronunciation of which is not bounded by the graphemic environment.

The performances of English-, Spanish-, and French-speaking children, were compared in a reading task of monosyllabic and bisyllabic pseudowords (Goswami, et al., forthcoming). These items shared either the same orthographic (O) and phonological (P) rime with real words (O+P+) or only the same phonological rime (O-P+). For example, *dake* and *cake* have a similar visual and phonological ending while *daik* is only phonologically similar to *cake*. Other items shared neither orthographic nor phonological rime with real words (O-P-, for example, *faish*).

Higher scores were observed for O+P+ pseudowords than for O-P-. Nevertheless, the effect of orthographic and phonological rime was less strong for Spanish children than for French and English children. O+P+ pseudowords were also better processed than O-P+, although the effect of orthographic rime was less strong for French than for English children. Moreover, overall scores showed a superiority of Spanish children as compared to French children and a superiority of French children as compared to English ones. Finally, the length effect (monosyllabic pseudoword vs bisyllabic) was to the detriment of long items for Spanish children, but not for English children.

These data suggest that Spanish, French and English children might use rime unit in reading, but not to the same extent. Spanish children rely strongly on grapheme-phoneme correspondences as shown by their high accuracy scores for pseudoword reading, the incidence of the stimuli length on their results and the fact that the effect of orthographic and phonological rime was less strong for these children than for English and French ones. On the other hand, English children benefit more from orthographic and phonological rime than Spanish and French children (but see Bruck and Treiman, 1992).

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These results might be related to the transparency of these writing systems. Spanish is more transparent as regards grapheme-phoneme correspondences than French which, in turn, is more transparent than English. These results might also be related to the fact that rimes might be of little use in Spanish and in French that predominantly have open syllables and vowels whose pronunciation is not highly constrained by the following graphemic environment.

2.6 Developmental dynamics

In the reviewed studies, all the children were first observed to rely on grapheme-phoneme correspondences; the differences were only a function of the degree to which the different writing systems directly represent the phoneme string of the language they encode. The question is to determine the role of phonological processing in developmental dynamics. According to some results, the orthographic lexicon seems to be set up gradually through the phonological route (see Share, 1995).

For example, it was observed that early good decoders, as compared to poor ones, improved more in reading, including irregular word reading (Jorm, Share, MacLean and Matthews, 1984; see also Byrne, Freebody and Gates, 1992). High correlations were also observed between early pseudoword reading and later irregular word reading (Byrne, et al., 1992; Gough and Walsh, 1991; Sprenger-Charolles, et al., 1998, Sprenger-Charolles, et al., forthcoming). Moreover, in the early stage of reading acquisition, regularization errors were common for good readers and rare for poor readers (Siegel and Kerr, 1996) and these errors were significantly related to correct responses (Sprenger-Charolles and Casalis, 1995; Sprenger-Charolles, et al., forthcoming).

Similar tendencies were observed in a study of two groups of children, a group of "expert" spellers and a group of "poor" spellers (see Sprenger-Charolles and Casalis, 1996; Sprenger-Charolles, et al., 1998). These groups were established according to the children's scores on an orthographic verification task. The experts in spelling were the children who, at the end of second grade, made no errors in this task. They were then supposed as having a better orthographic lexicon than the poor spelling group. The developmental trajectory of these two groups provided arguments supporting the hypothesis that phonological procedure contributes to the establishment of the orthographic lexicon. At the beginning of the last year of kindergarten, the future experts in spelling obtained higher scores than the other children in two metaphonological tasks; at the same time, these subjects differed neither in their non-verbal cognitive level nor in their vocabulary level. More than a year later, at the end of first grade, the future experts in spelling were characterized by a strong reliance on phonological mediation as shown by their results in silent reading as well as in reading aloud and in spelling under dictation. Finally, at the time when the two groups were constituted, at the end of second grade, the experts in spelling obtained better results than the other subjects in a reading comprehension task (Lecocq, 1996). This trend was obtained both in reading aloud and in silent reading but not in oral comprehension. These results clearly show, first, that only reading specific components (at word level) differentiated those two groups of children; second, that the early use of phonological mediation contributed to the establishment of the orthographic lexicon; third, that early metaphonological skills rendered easier the setting up of the phonological processing.

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3. TENTATIVE EXPLANATION

These results might be explained by the fact that the use of phonological mediation, facilitated by phonological awareness, permits the reading of known and unknown regular words as well as of pseudowords. Through the use of this procedure, and the comparison between their decoding outcomes and words that are part of their oral vocabulary, children can infer grapheme-phonome correspondences (GPC), as well as other types of spelling to sound relations. It is important to note 1. that irregular words contain some regular GPC, 2. that some irregularities are purely a question of grapheme frequency and 3. that the comparison with the oral lexicon might allow the learning of low frequency GPC. For instance, the use of GPC in French leads to pronounce the word 'femme' as /fɛm/. Knowing that /fɛm/ does not exist, but that word /fam/ exists, the subject can infer that 'e' must be read as /a/ in this context.

It is reasonable to postulate that children learn most of the relationships between orthography and phonology through this procedure. As a function of spelling to sound and word frequencies, strong associations between orthographic and phonological units enable the child to gradually construct an orthographic lexicon which permits the use of the direct route. Nevertheless, even when the direct route is functional, children may still have recourse to phonological mediation and this procedure becomes more and more efficient as a result of the reinforcement of associations.

In this framework, it is possible to understand, first, the incidence of the relative transparency of the different writing systems. The learning scheme described above works better with shallow writing systems than with deeper ones as suggested by the low level of results obtained by English children as compared to Spanish, German and even French children. This framework can also explain that, as spelling to sound correspondences are more predictable at the rime level in English, English children rely on rime units more than Spanish, German and French children.

Second, in this framework, the fact that the orthographic lexicon develops later in spelling can be better understood as, in this modality, oral lexicon control provides no help. For example, in French, the knowledge of the oral form /tablo/ does not facilitate the spelling of this word (as /o/ has at least three different equally frequent allographs), when this knowledge may facilitate the reading of 'tableau'. This might explain why, at the end of Grade 1, in our longitudinal French study, word spelling scores were inferior to those obtained in word reading and why we did not find such a difference for pseudowords which have no canonical spelling (Sprenger-Charolles and Casalis, 1995; Sprenger-Charolles, et al., forthcoming).

Third, in this framework the difficulties encountered when trying to speak a language that has been learnt only via its written form can be better understood. It now seems well established that reading, even for non-alphabetic writing systems (For example, in Chinese, see Perfetti and Zhang, 1995), depends on phonological processing. So if learners of a new language rely on grapheme-phoneme correspondences of their own language, and if these correspondences differ from those of the language they learn, they will learn to read with incorrect pronunciations, and set up an incorrect oral lexicon.

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Résumé
Les études présentées dans cet article portent sur l'acquisition de la lecture en anglais, en allemand, en espagnol et en français ainsi que sur les relations entre acquisition de la lecture et de l'écriture. Les résultats indiquent que les enfants utilisent massivement le décodage, c'est-à-dire les relations graphème-phonème, au début de l'acquisition de la lecture et que les capacités précoces de décodage ont une influence sur les progrès ultérieurs en lecture. Ils indiquent aussi que l'apprentissage de la lecture est plus facile, et plus rapide, dans les langues qui ont une orthographe transparente (l'espagnol) que dans celles dont l'orthographe est plus opaque (l'anglais). Enfin, ils montrent qu'il y a de fortes relations, mais également des différences importantes, entre l'acquisition de la lecture et de l'écriture. Un cadre de référence permettant d'interpréter ces résultats est proposé.

Mots clés
Lecture (acquisition), Ecriture (acquisition), Médiation phonologique et Procédure orthographique (Acquisition de la lecture et), Graphème-phonème correspondances, Transparence et opacité de l'orthographe, Psycholinguistique, Comparaisons inter-langues

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