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How to cite

HOEFFLIN, George, FRANCK, Julie. Development of Spelling Skills in Children with and without Learning Disabilities. In: L1 educational studies in languages and literature, 2005, vol. 5, n° 2, p. 175–192. doi: 10.1007/s10674-005-0917-6

This publication URL: https://archive-ouverte.unige.ch//unige:41163
Publication DOI: 10.1007/s10674-005-0917-6

GEORGE HOEFFLIN and JULIE FRANCK

DEVELOPMENT OF SPELLING SKILLS IN CHILDREN WITH AND WITHOUT LEARNING DISABILITIES

ABSTRACT. A number of French-speaking children show difficulties in learning to write, partly as a result of the high complexity of the orthographic system. In order to shed light on the nature of these difficulties, we designed a study which examines the written performances of seven children (mean age 10.0) with learning disabilities (LDS) in comparison to a control group of 22 age-matched normally developing children in a dictation task. Orthographic errors produced by the two groups were analysed according to the linguistic classification of Catach, N., Duprez, D. & Legris, M. (1980, *L'Enseignement de l'orthographe, l'alphabet phonétique international, la typologie des fautes, la typologie des exercises*. Paris: Fernand Nathan). Analysis revealed: (1) important difficulties with grammatical morphology, both in the control group and in the LDS group, and (2) a predominance of phonetic errors in the productions of the group of LDS children, while these are nearly non-existent in the control group. A follow-up study shows that a second control group of 20 younger normally developing children do not show such a predominance of phonetic errors. Across these three groups, studies revealed that the proportion of phonetic errors increases exponentially with the global number of errors. This finding, together with the LDS children's weakness in phonological awareness, suggests that a restraint at the phonetic level of language, independently of the production modality, may constitute a relevant predictor of upcoming difficulties in the acquisition of written speech.

KEY WORDS: LDS children, linguistic typology, phonetic errors, spelling difficulties

1. Introduction

Dysorthographia, often considered a direct consequence of dyslexia (Greenberg, 1995; Guthrie, 1973), affects an important proportion of children, especially in languages with so-called "deep" orthographic systems (i.e., languages characterized by an irregular grapheme-to-phoneme mapping: see Frost, Katz & Bentin, 1987; Paulesu et al., 2001; Perfetti, 1997). Dysorthographia is particularly interesting to study in French given its highly irregular orthographic system. The widespread difficulties shown by learners of French represent a double challenge for researchers. First, at a theoretical level, the way the system dysfunctions imposes important constraints for models of written speech production. Second, at an educational level, researchers are required to go through the difficulties encountered by children with a fine-tooth comb in order to develop adequate therapeutic

L1 – Educational Studies in Language and Literature (2005) 5: 175–192
DOI 10.1007/s10674-005-0917-6

tools. This work bridges theoretical concepts put forward by linguistic theory, models developed by psycholinguistics and clinical observations of children with developmental spelling difficulties.

This paper provides a quantitative and qualitative analysis of the written errors produced by French-speaking children with specific spelling difficulties. In the first study, the error profiles of seven 10 year old children with spelling difficulties are compared to the profiles of an age-matched group (4th grade of primary school) without learning disabilities. A follow-up study on younger children (3rd grade) aims to determine whether the profiles of children in difficulty reflect mere delay in written speech acquisition or rather show specific properties that differ from normal development.

2. Theoretical Framework and Hypotheses

In psycholinguistics, errors are considered highly relevant windows into the underlying mechanisms involved in normal language processing. In the present study, errors were used to learn more of the process of acquisition and mastery of written speech. Three groups of children were presented with a dictation task (children with spelling difficulties, age-matched children from 4th grade, and children from 3rd grade). Their orthographic errors were noted and analysed according to the typology proposed by Catach et al. (1980). This typology is based on the notion of grapheme, defined as "the smallest unit (letter or group of letters) of the written sequence that has a phonological and/or semantical correspondent" (Catach, 1986: 27). It takes into account the phonographic units at the word form level (i.e., syllables and phonemes) and semiographic units at the lexico-syntactic level (i.e., grammatical morphemes and words/lexemes). These two linguistic components are reduced to smaller units in the typology which allows for a fine-grained, qualitative approach to the errors produced in writing. In particular, it provides a tool to determine which components of the writing system are affected in LDS children and whether the difficulties are similar or differ in nature from those of other younger children and whether the LDS and typical children's writing productions differ qualitatively.

Only recently has research on dysorthographia begun to seriously develop in French-speaking laboratories, although dyslexia has received considerable attention (Sprenger-Charolles, 1992; Sprenger-Charolles & Casalis, 1996). From these two areas of research, it appears that reading and writing are intimately connected and develop in interaction with each other (Ehri, 1997). Dyslexia and dysorthographia are both found to be highly correlated to impairments of phonological awareness as measured by tasks that require phonological processing (like phoneme and syllable

segmentation, detection or suppression). These relationships are reported in a number of languages like French, Portuguese and English (Frith, 1985; Morais, Bertelson, Cary, & Alegria, 1986; Morais, Cluytens, & Alegria, 1984; Sprenger-Charolles & Casalis, 1996).

Bétrix Koehler (1991) indicated in her research that the normal process of written speech acquisition is characterized by a progressive reduction in phonographic errors. Whether children with spelling difficulties show a similar development on this dimension remained to be systematically investigated. Indeed, these children may show a persistence of phonographic errors if the problem originates from a phonetic impairment: if the phonological deficit observed orally suggests phonetic difficulties, the problem is expected to also emerge in writing. If this is the case, children with dysorthographia may show specific difficulties with components of the writing system constrained by phonetic rules. Consequently, whereas writing errors of normally developing children should focus mostly on the implicit aspects of the French language (given that no correspondence can be established between their knowledge of the spoken language and written speech), LDS children may show a parallel distribution of difficulties with implicit grammatical morphology and phonetic constraints.

3. Experiment 1: LDS Children and Age-matched 4th Grade Children

3.1. *Method*

3.1.1. *Participants*

The LDS group consisted of seven children aged between 9 years, 4 months, and 10 years, 9 months (mean age 10; 0). Coming from different classrooms, some had great difficulty following the school curriculum, others were behind in their curricular knowledge and some came from small special education classes with not more than 12 children. All were involved in speech therapy provided by the Service de Psychopédagogie Scolaire (School educational psychology service). They had been diagnosed by the therapist with reading and writing disorders, as well as weak phonological awareness. This was assessed through word and pseudo-word segmentation and phoneme deletion tasks.

The control group consisted of 22 children aged between 9 years, 7 months and 10 years, 8 months (mean age 10;1). All children came from the same area of Lausanne (French-speaking part of Switzerland).

3.1.2. *Materials*

Materials consisted of an 82-word long text from a school reading manual (see Appendix A). Two main criteria were adopted. First, the text should

pose no comprehension problems for the students. Second, the text had to demonstrate the theoretical distribution of the typology of graphemes elaborated by Catach (1986) for common French texts.

3.1.3. *Procedure*

Children with spelling difficulties were tested in the framework of a speech therapy diagnosis, while their classroom teacher tested non-LDS children. All received the test at the same period of the year. The teacher dictated the text and asked students to write the words as correctly as possible. Students could take the time needed to finish the dictation. At the end of the session, the text would be read again for verification. Students were informed that no assessment would be done of their work, but the teacher's and the speech therapist's corrections would later be used to help improve their spelling. *Scoring*: The orthographic errors produced by the students were noted and analysed using a typology developed by Catach et al. (1980). This classification distinguishes between eight different categories of errors:

Phonetic[1] *errors* include phoneme omissions (e.g., *"gaçon"* [gasõ] for *"garçon"* [gaʀsõ]: "boy") or phoneme substitutions (e.g., [s] for [z]; [ʃ] for [ʒ] or [f] for [v]).

Illegitimate phonographic errors involve words that are transcribed in an "illegitimate" way in that the orthographic code transforms the phonetic value of the word (e.g., *"gardin"* [gaʀdɛ̃] for *"jardin"* [ʒaʀdɛ̃]: "garden" or *"cocie"* [kɔsij] for *"coquille"* [kɔkij]: "shell").

Legitimate phonographic errors involve words that are transcribed in a "legitimate" way from a phonetic point of view but still do not respect the orthographic constraints of the language (e.g., *"bato"* [bato] for *"bateau"* [bato]: "boat" or *"bocou"* [boku] for *"beaucoup"* [boku]: "much", with "o" and "eau" where no difference will be heard, as well as "ou" and "oup").

Grammatical morphographic errors involve mute letters marking grammatical morphemes that are either missing or incorrectly coded (e.g., omission of mute endings like the plural "s" on the noun or the plural "-nt" on the verb).

Lexical morphographic errors in which mute letters belonging to lexical families are missing or incorrectly coded (e.g., the final "t" in *"petit"* [pəti] that is pronounced only in the feminine occurrence *"petite"* [pətit]: "small").

Homophonic errors involve two words with similar phonology where no differences will be heard between these words but they have different

[1] The terms phonetic and phonological are equivalently used here to refer to the sounds of the language. The term phonetic is used essentially when referring to Catach et al. (1980) error typology as it prevails in their original work.

semantic values (e.g., *''vers''* [vɛʀ] ''towards'' for *''vert''* [vɛʀ] ''green'' or *''ses''* [se] ''his'' for *''ces''* [se] ''these'').

Ideographic errors consist of omissions or adjunctions of punctuation or capital letters.

Non-functional errors are related to etymologic or historical letters (e.g., *''boite''* [bwat] ''box'' for *''boîte''* [bwat] or *''farmacie''* [faʀmasi] ''pharmacy'' for *''pharmacie''* [faʀmasi]).

Three judges ensured reliability in error classification. Coherence between judges was above 90%.

3.1.4. *Data Analysis*

Paired comparisons using the Welch Modified *t*-test were conducted to compare the two groups of children on the raw number of errors and error proportions. The Welch modified *t*-test was used since it allows for comparisons between two groups of different sizes and with different variance[2]. Nevertheless, children in the LDS group and, to a lesser extent, in the control group, showed different levels of writing difficulty and, therefore, did not constitute a homogeneous group. In order to exploit this heterogeneity, regression analyses were also conducted, which deal with proficiency as a continuous variable, though it has to be kept in mind that the LDS group is globally well below the performance level of the control group.

3.2. *Results and discussion*

A total of 995 writing errors were reported: 421 in the control group and 574 in the group of children with spelling difficulties. Given that orthographic errors can bear on infra-lexical units, (i.e., units below the word level), the total amount of errors produced can exceed the number of words in the dictation. The distribution of errors across the different categories of the typology is illustrated in Table 1.

Children with spelling difficulties produced about four times more errors than the control group, a difference that is statistically highly significant (t (6.5) = 5.8; $P < .001$). Importantly, the LDS group showed an error rate clearly below 2 standard deviations (SD) from the typical group, the best performance being at 2.2 SD, the less performing at 10.1 SD from the controls' mean. This finding supports the diagnostic of the speech therapist that all these children suffer from severe spelling difficulties (e.g., reading

[2] Degrees of freedom are calculated as a function of the samples' variance, which explains their variation from one test to the other, as well as the fact that they are not integers.

TABLE 1

Distribution of the mean number of errors (and standard deviation) for each group in the different scoring categories.

Scoring categories of errors	LDS group	4th grade
Phonetic	18.3 (13.7)	0.5 (0.9)
Illegitimate phonographic	14.6 (7.5)	3.0 (2.2)
Legitimate phonographic	11 (3.5)	3.8 (4.0)
Grammatical morphographic	20.3 (5.3)	6.8 (3.5)
Lexical morphographic	1.7 (1.2)	0.5 (1.0)
Homophonic	3.7 (1.3)	1.4 (1.4)
Ideographic	7.9(2.7)	1.5 (0.8)
Non-functional	4.6 (2.2)	1.7 (1.2)
Total	82	19.1

disorders: DSM-IV manual, 1995 considers reading abilities as pathological at two standard deviations below the expected level of reading achievement).

The main axis of errors in the control group concerns morphology and, more specifically, grammatical morphemes (on average, nearly 7 errors per dictation). Phonographic errors, both illegitimate and legitimate, appear in second position (between 3 and nearly 4 errors on average). Other error types are very rare (below 2 errors on average). Similar to their control counterparts, LDS children produced a significant number of errors in grammatical morphology (more than 20 errors per dictation). However, in contrast to the control groups, they showed a particularly high number of phonetic errors (more than 18 errors). Finally, phonographic errors appear in third position with an average between 11 and 14.6 errors.

To illustrate more clearly the different error profiles that emerge from the results, we compare the proportion of errors within each group of children; that is, the number of errors produced for each category divided by the total number of errors produced by the group (see Table 2).

The main tendency revealed in Table 2 indicates that whereas LDS children show rather similar performances to the control group for most scoring categories, profiles clearly differ for phonetic errors and grammatical morphographic errors. Errors on grammatical morphemes account for nearly 40% of the overall errors in normally developing children, whereas they reach more than 25% of the error rate in LDS children, a difference that is highly significant (t (20.5) = 2.9; $P < .001$). In contrast, phonetic errors only account for about 2% of the error rate in typical children, opposed to 19% of the errors produced by children with difficulty (t (6.4) = 3.6; $P < .01$). It is important to recall that the predominance of difficulties with grammatical morphology in the control group is actually subverted in the

TABLE 2

Percentage of errors (and standard deviation) in the different scoring categories within each group.

Scoring categories	LDS group	4th grade
Phonetic	19.0 (11.4)	2.6 (5.7)
Illegitimate phonographic	17.4 (7.3)	15.7 (7.1)
Legitimate phonographic	14.1 (3.5)	15.9 (12.4)
Grammatical morphographic	26.5 (6.9)	38.4 (14.1)
Lexical morphographic	2.2 (1.3)	2.0 (3.6)
Homophonic	5.5 (4.0)	7.0 (7.2)
Ideographic	9.7 (2.2)	9.6 (8.6)
Non-functional	5.7 (2.4)	8.7 (6.2)
Total	100	100

LDS group by the persistence of phonetic errors: children of this latter group evidently produce on an average more errors than the controls in grammatical morphology.

Comparing the two groups suggests that the general pattern that appears is reflected at a discrete level when one considers the overall error rates produced by children with spelling difficulties. Since the general pattern shows a predominance of errors in grammatical morphology in the control group *versus* equal difficulty with grammatical morphology and phonetic rules in the LDS group, the same result is true again for children with spelling difficulties when looking more specifically at the overall errors (such an analysis would be meaningless with typical children given the close to zero rate of phonetic errors). As illustrated in Figure 1, the ratio between phonetic and grammatical morphographic errors is a function of the overall error rate: the better the child performs orthographically, the less phonetic errors she produces, and the more her productions are characterized by errors in grammatical morphography.

Finally, phonographic errors results are much less contrasted. The presence of phonographic errors that modify the sounds of the words, even in the control group (about 15% of the errors, see Table 2), suggests that the rules that guide letter positions are still not fully mastered by age 10. It is interesting to note that errors that preserve the phonological value of the letters are equally common. Although these errors are legitimate at the phonological level, this is not so at the orthographic level. In both cases, what appears to pose a problem is clearly the well-formedness of orthographically irregular words, not their underlying phonological or phonetic composition.

Globally, the finding that children with spelling difficulties performed more poorly than their age-matched control group is unsurprising.

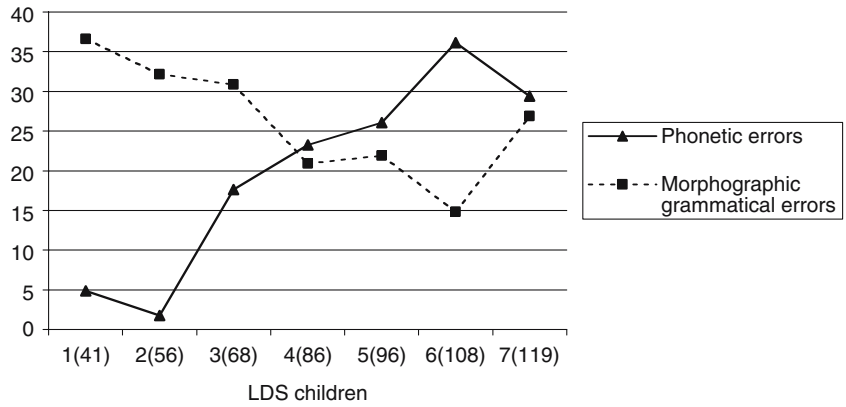

Figure 1. Distribution of phonetic and grammatical morphographic error proportions as a function of the overall error rate (between parentheses) in LDS children.

The interesting aspect emerging from this first study is that not only do these children in difficulty generate more errors globally; they also show significantly different patterns of errors. The main difference lies in the mastery of the phonetic aspects of the French language. Would younger children, in an earlier phase of written language acquisition, show similar phonetic disruption as the LDS group? Such a finding would support the hypothesis that children with spelling difficulties simply show a delay in the learning process (i.e., that they do not set up deviant procedures for spelling). In order to shed light on the delay versus deviance (for a review of this question on dyslexia see Morais, 1994), Experiment 2 investigates the written productions of younger children from 3rd grade of primary school using the same dictation task.

4. Experiment 2: Follow-up Study on Younger 3rd Grade Children

4.1. *Method*

4.1.1. *Participants*

Twenty children from 3rd grade of primary school (aged 8 years, 9 months to 9 years,11 months, mean age 9 years, 4 months) participated in the dictation task. As in the 4th grade control group, none were diagnosed as LDS children. They originated from the same area as the two groups of children in Experiment 1.

Materials, Procedure, Scoring and Data analysis: Same as Experiment 1.

4.2. *Results and Discussion*

The children produced a total of 643 errors. Their distribution across the different scoring categories is reported in Table 3, in parallel with the results of the LDS children and of the 4th grade controls tested in Experiment 1.

Children from 3rd grade produced considerably fewer errors than children in the LDS group, a difference that is statistically significant (t (6.7) = 4.5; $P < .01$). Nevertheless, their error rate is significantly higher than found in the 4th graders (t (37.8) = 3.8; $P < .001$), an important finding since the aim of this follow-up study was to determine whether error distribution in less proficient writers would resemble the profile observed in the LDS group.

Third grade children had difficulties with grammatical morphology, as revealed by the high rate of grammatical morphographic errors (on average 10 per dictation). This finding is similar to the 4th grade children, although 3rd graders produce significantly more errors (t (38.2) = 3.3; $P < .005$). However, the most important aspect that emerges of the results is that children from 3rd grade, in spite of their high error rate, produced significantly less phonetic errors than LDS children (t (6.1) = 2.9; $P < .05$), although the numbers were higher than for children from 4th grade (t (22.8) = 2.7; $P < .01$).

TABLE 3

Distribution of the mean number of errors (and standard deviation) for each group in the different scoring categories.

Scoring categories of errors	LDS group	3rd grade	4th grade
Phonetic	18.3 (13.7)	2.1 (2.5)	0.5 (0.9)
Illegitimate phonographic	14.6 (7.5)	3.2 (2.5)	3.0 (2.2)
Legitimate phonographic	11 (3.5)	8.8 (4.4)	3.8 (4.0)
Grammatical morphographic	20.3 (5.3)	10.0 (2.6)	6.8 (3.5)
Lexical morphographic	1.7 (1.2)	0.6 (0.9)	0.5 (1.0)
Homophonic	3.7 (1.3)	3.4 (2.5)	1.4 (1.4)
Ideographic	7.9 (2.7)	1.9 (1.8)	1.5 (0.8)
Non-functional	4.6 (2.2)	2.4 (1.8)	1.7 (1.2)
Total	82	32.2	19.1

The fact that French letters can take different phonetic values depending on their position in numerous words, appears to pose little problem to both 3rd and 4th grade children, as indexed by the low number of illogical

TABLE 4

Percentage of errors (and SD) in the different scoring categories within each group.

Scoring categories	LDS group	3rd grade	4th grade
Phonetic	19.0 (11.4)	5.9(5.4)	2.6 (5.7)
Illegitimate phonographic	17.4 (7.3)	8.9 (4.9)	15.7 (7.1)
Legitimate phonographic	14.1 (3.5)	26.6 (10.7)	15.9 (12.4)
Grammatical morphographic	26.5 (6.9)	33.5 (11.1)	38.4 (14.1)
Lexical morphographic	2.2 (1.3)	1.6 (2.6)	2.0 (3.6)
Homophonic	5.5 (4.0)	10.5 (7.7)	7.0 (7.2)
Ideographic	9.7 (2.2)	5.9 (4.6)	9.6 (8.6)
Non-functional	5.7 (2.4)	7.1 (5.4)	8.7 (6.2)
Total	100	100	100

phonographic errors (only 3.2 and 3 on an average, respectively). In contrast, LDS children demonstrate difficulties dealing with letter positioning. The significant difference found between LDS children and 3rd grade children on this axis attests of their difficulty dealing with these rules (t (6.4) = 3.6; $P < .005$). Noticeably, 3rd grade children produced an important number of legitimate phonographic errors (nearly 9), and do not differ from the LDS group on this component (t (12.4) = 1.3, $P = .2$), although they do differ from 4th grade children (t (38.3) = 3.7; $P < .001$). The finding that 3rd grade children made more legitimate than illogical errors suggests that they take into account phonetic constraints in writing, while the high number of both legitimate and illegitimate errors in LDS children clearly suggests that the lack of some of the phonetic rules did not constrain their writing procedures.

The comparison between error profiles shown by the three groups is best demonstrated in the analysis of error proportions, as illustrated in Table 4.

In 3rd grade children, errors in the grammatical morphography category were the most common, similar to 4th grade findings. The global proportion of these errors in the 3rd grade is similar to the 4th grade (t (39.2) = 1.2; $P = .2$), and significantly higher for LDS children (t (16.4) = 1.9; $P < .05$).

Proportionately to all other errors, children in 3rd grade produced more phonetic errors than children in 4th (t (32.9) = 2.6; $P < .01$), but less than LDS children (t (6.9) = 2.7; $P < .05$). In order to clarify the relationship between the global error rate and phonetic difficulties, a regression analysis was conducted including the three groups of children (see Figure 2).

From this analysis, it appears that the best fit ($R = .83$) accounting for the relationship between these two variables is an exponential function whose second degree equation is represented on Figure 2. That is, phonetic difficulties increase exponentially with the total number of errors. We do not report a linear regression to account for the error profiles of our three groups

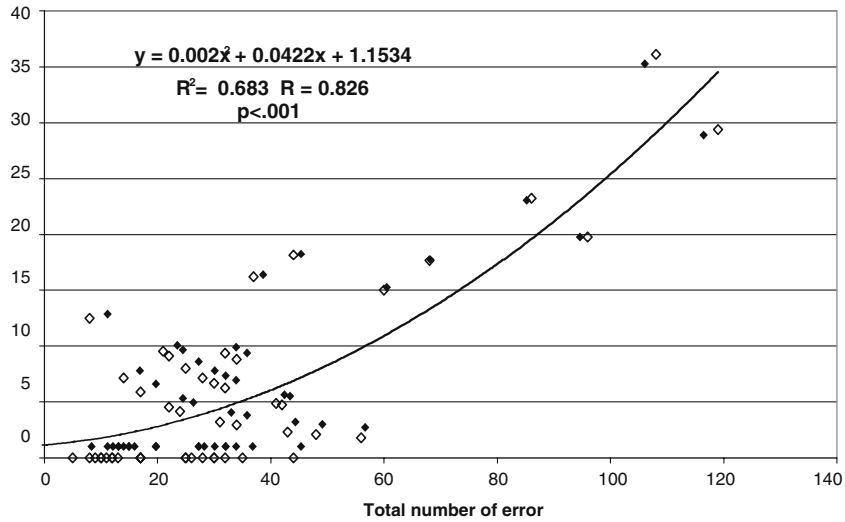

Figure 2. Relationship between the proportion of phonetic errors and error rate.

of children; the equation is of second degree and reflects an exponential relationship between the phonetic errors ratio and the general error rate each child shows. Consequently, this relationship is not the same throughout the three groups. What is interesting is that it was possible to model the overall errors produced by the three groups by an exponential function, which means that they are not distributed randomly but follow a precise pattern. Moreover, we made the possibility more explicit that two LDS children actually performed like children without difficulty, since their error ratio shows proportionally less phonetic errors than morphological errors, suggesting a delayed pattern more than a deviant one. In contrast, the five other children from the LDS group, at the point where the phonetic errors rise steeply, progressively show an inverted ratio (proportionally more phonetic errors than morphological errors), which may suggest a truly qualitative different profile where deviance could be considered (see Figure 1 p. 10).

5. General Discussion and Conclusions

The observations reported in this paper provide new insights into the development of writing in French. Although each control group (3rd and 4th grade) investigated consisted of children in the same classroom, it is not likely that this results from their educational background, given that Bétrix Koehler (1991) reported similar results in a study conducted on represen-

tative samples of a 157 3rd grade children and 160 4th grade children from the same area of Switzerland (county of Vaud)[3].

First, it appears that normally developing children still produce an important number of orthographic errors by age 10: 19 on average in a 82-word text. The text, taken from a school manual of the corresponding educational level, was relatively simple. Some words showed a complex orthography (like *''têtards''* [tɛtaʀ]: ''polliwogs'' requiring a circumflex accent and a final mute ''d'' or like *''aquarium''* [akwaʀiɔm]: ''aquarium'' requiring ''qu'' rather than the ''c'' that is more frequent, after that, a ''u'' rather than ''o'' like the end of the word is pronounced in French) and, as a result, generated errors. Nevertheless, these errors, situated at the level of lexical morphography, were rare.

Most errors produced by the 4th grade children were limited to the grammatical morphology component of written speech. Younger children of 3rd grade, as well as LDS children, also showed important difficulties at this level. Part of the difficulty comes from the fact that a great deal of grammatical morphemes is actually phonologically silent in French (i.e., they do not have any phonological correspondence). For instance, considering the morphology of number, less than 1% of nouns are marked for number in spoken French. By contrast, most nouns show an orthographic variation of number – plurality expressed by adding an –s to the singular form (e.g., *''table''* –S/*''tables''* –P), or occasionally an –x (e.g., ''*neveu*/*neveux*'', ''nephew–S/nephews–P''). Similarly, plurality in the verbal system is far from being phonologically transparent: most verbs take the final morpheme –nt in the plural (''*ils mangent''*, they eat-Plural), which is inaudible. Similarly, gender morphology is often silent on adjectives and past participles. It seems relevant to assume that silent letters constitute one of the hardest aspects to master when acquiring written French.

The second aspect that emerged from the two studies highlights the considerable difficulties regarding the basic phonological component of language of the LDS group. Although younger children from 3rd grade produced more phonetic errors than the 4th grade group, they still produced considerably fewer errors than LDS children. Moreover, in French, letters can take different phonetic values depending on the following letter (e.g., ''c'' in front of ''i'' is pronounced [s] and not [k] as is the case when in front of ''u''). Errors that do not reflect these rules (i.e., illogical phonographic errors) were rare in the 3rd grade group, in spite of the fact that these children produced a significant number of legitimate phonographic errors

[3] The reason why we tested additional control children in the present study was that the dictation text used by the speech therapist in children with spelling difficulties was different from the one used in Bétrix Koehler's study.

(concerning pure orthographic rules with no phonological impact). In contrast, children from the LDS group showed an equally high number of legitimate and illogical errors. Phonological problems, therefore, provides a clear index of spelling deficiencies shown by the LDS group.

The seven children were part of a larger study (Hoefflin, 1998) investigating other aspects of their written productions. All showed important difficulties in phonological tasks involving meta-linguistic discrimination (like word and pseudo-word segmentation, and phoneme deletion). Crucially, phonological awareness and the performance of the dictation task were found to be highly correlated, which adds further support to the hypothesis to the conception of a deficit in dealing with abstract, phonological representations.

Interestingly, a general relationship was established between the proportion of phonetic errors and the general error rate, indicating that children producing the most errors are also more prone to producing phonetic, rather than other kinds of error. A closer look at the error rates within the LDS group showed that the phonetic/grammatical morphographic errors ratio was a function of the overall error rate the child produced. Together with the reports for normal children, these findings suggest that, whereas competent writers' profiles can reveal a high proportion of errors in grammatical morphology and a low proportion of phonetic errors, the opposite is true of poor writers.

It is still not clear at this point whether phonological difficulties reflect a delayed process of written speech acquisition, or whether they attest a non-standard use of writing procedures. The study on 3rd grade children showed that at this age, phonological aspects of written speech are already rather well mastered. Nevertheless, one cannot exclude the possibility that younger children, in their first or second year of learning to write, would not behave like the LDS group. Indeed, we found a significant difference between 3rd and 4th grade children with regard to the occurrence of phonetic errors.

However, the difficulties of LDS children with the phonetic component of language in the dictation task mirrors the poor performance they showed in phonological awareness tasks like word and pseudo-word segmentation or phoneme deletion in words and pseudo-words. The parallel between their performance in oral (phonology) and written (phonography) speech suggests that their problems originate at the phonological level, independent of the modality of production. Moreover, further investigations within the LDS group indicated that two children, although significantly different from their age-matched controls in terms of error rate (below 2SD), show a profile qualitatively similar to the 3rd group of normally developing children: predominance of morphographic errors on phonetic errors (see Figure 1) and good performance to phonological tasks (phoneme segmentation and

deletion, Hoefflin, 1998). In other words, these two children are quantitatively similar to the LDS group, since their error rate is below 2SD, but qualitatively close to the children of the 3rd grade control group given their error profile. Hence, the group of children identified as LDS on the basis of their high error rate in spelling appears heterogeneous. Strikingly, heterogeneity has also been reported by Sprenger-Charolles and Colé (2003) regarding dyslexia: the summing up of six international studies suggest that "mixed" dyslexia prevails over pure phonologic dyslexia or pure surface dyslexia (morphology). This prevalence (between 50% and 75% of the subtypes of dyslexia) corresponds with our finding of mixed profiles (phonetic and morphographic grammatical errors) in LDS children. The heterogeneity we observed in dysorthographic writing process can be accounted for by the relationship between the error rate and the ratio of phonetic to morphographic errors: the error rate correlates positively with the phonetic/morphographic ratio. Importantly, an inversion of this ratio, emerging after 68 errors, was noted from 96 errors on, suggesting a switch in the performance of these children situated above this mark. Whether this switch speaks to a split between delayed *versus* non-standard profiles of spelling difficulties remains to be investigated further. However, what appears clearly throughout our observations is that phonological processing is at the core of the spelling ability.

The mastery of basic phonological knowledge constitutes a necessary step towards the acquisition of spelling. Phonological difficulties can be detected early in language acquisition (i.e. before the child learns to write through games with rhymes or syllable and phoneme detection, for instance.). They provide parents and teachers with a good predictor of potential difficulties in spelling. Detecting early signs of developmental problems is extremely important given that it allows acting on the knowledge and providing support and a context to prevent, or at least reduce, potential problems. In the present case, education could be focussed on the phonological component of language by having children exercise their phonological awareness (i.e., phonological instructions as promoted by the US National Reading Panel[4]).

How can we import these experimental findings into teaching practices? The teachers' manual on language in this area of Switzerland (Besson, Geneoud, Lipp, & Nussbaum, 1997) requires providing children with phonographic and grammatical instructions. Crucially, this manual focuses the teaching on the complex correspondences between the phonological and orthographical codes in French. Such an approach may underestimate the

[4] See publications as "Put reading First": http://www.nationalreadingpanel.org/Publications/publications.htm.

role of phonology in the first steps of learning to write. Indeed, two opposed teaching methods can be observed in practice: some teachers refer to a so-called 'analytical' method of literacy (holistic approach), while others refer to a so-called 'synthetic' method (phonological approach). Whereas most young children seem to spontaneously adopt a more holistic view of written language, some require explicit instructions to discover writing principles (i.e. a synthetic teaching pointing to the phoneme-to-grapheme correspondences).

Unfortunately, few teachers combine the two approaches although such a combination would ensure a teaching that could benefit all children. Moreover, from 3rd grade on, teaching is homogenized in that all teachers focus on grammatical instruction, dropping any kind of phonological education. Hence, at this stage, children with phonological difficulties no longer receive classroom support and are referred to the school educational psychology service by their teacher. Some of these children, who indeed show a dyslexic/dysorthographic profile, will benefit from the follow-up of a speech therapist. However, an important proportion of these children should not be directed to this service, but exposed to prolonged phonological teaching.

Our findings point to the importance of a teaching program that takes into account the specific difficulties underlined in children demonstrating problems in writing. It appears crucial for these children to maintain explicit phonological instructions in 3rd and possibly 4th grade classes, rather than switching exclusively to grammatical teaching. However, since most children at that age master both phonology and phonographic correspondences, a differentiated teaching is necessary (i.e. dividing the group in subgroups of children working on different exercises, either centred on the grammar, or centred on phonology/phonography) for children with difficulties.

This will not exclude the children from all interactions and knowledge development with their peers. For instance, children from the 'grammar group' could occasionally work in cooperation with children from the 'phonology group'. Such cooperation would benefit children with difficulties learning from children with no difficulty. Those able children, in the process of instructing phonological principles, will reinforce their personal metalinguistic knowledge.

Collaborative tasks could involve communicative writing situations (e.g., descriptions of game rules, stories for younger children, correspondence with children from other schools, etc.) with particular attention to correcting the texts produced, on phonological, phonographic and grammatical levels. Teachers would obviously need to follow each group separately, encouraging them to apply correct strategies for normative writing and using scaffolding to put children on the right track. Importantly, phonological teaching for children with spelling difficulties should not be understood as the only aspect of teaching writing. Parallel, explicit teaching of written morphology is also

necessary (Hoefflin, 2000). This may be particularly important, as the study suggests, for LDS children who require and benefit from specific, sequential and ongoing support beyond the first early years.

Acknowledgements

The work reported here was supported by Grant number 3/03 from the Research Council of the High School for Pedagogy to George Hoefflin, and by grant number 1114–068250 from the Fonds National de la Recherche Suisse to Julie Franck. We are grateful to Gianreto Pinni and Olivier Renaud for their statistical support. We thank Giorgia Cavadini, Valentina Pagani, Elisa Pellegrini and Carola Silvanti for their participation as judges in the classification of spelling errors. This research would not have been possible without the active involvement of Gioia Zin, principal teacher of the primary school where the research took place, her colleagues and the students – many thanks to all of them.

6. Appendix A

6.1. *Le zoo de Marc*

Alors Marc met ses têtards dans un aquarium plein d'eau, dans le jardin, à l'abri du soleil. Il leur donne des petits morceaux de viande à manger. ''A présent j'ai dans mon zoo quatre sortes de bêtes à observer'' dit Marc.

Marc se promène dans le jardin. Il voit des escargots. Ils rentrent dans leur coquille mais Marc voit encore les cornes. Il en met quelques-uns dans une boîte et retourne à la maison.

6.2. *Mark's Zoo*

So Mark put his polliwogs in an aquarium full of water in the garden in the shade, out of the sun. He gives them small pieces of meat to eat. ''Now I have four types of animals in my zoo to observe'' said Mark.

Mark walks in the garden. He sees some snails. They withdraw into their shell but Mark sees their feelers. He put some of them into a box and returns home.

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