4 Rehabilitation of Lexical Orthography in Writers with Dysorthographia

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This chapter presents the guiding principles of a program centered on the morphological structure of the words. This intervention was carried out with pupils, from 10 to 12 years of age, presenting a writing disability. The interventions implemented took several aspects into account: 1) teaching approaches of the read-write effectiveness to support the development of the specific processes of identification and production of the written words; 2) certain cognitive characteristics of the apprentice, in particular its capacities of morphological awareness; 3) morphological characteristics of the French orthography. In order to systematically follow the evolution of their orthographical representations, a single case design with multiple subjects comprising the taking of continuous measurements is used. The results of one participant are analyzed via a "control chart." The intervention had beneficial effects on the written production of plurimorphemic words, particularly for the representation of studied suffixes.

Cet article présente les principes directeurs d'un programme de rééducation centré sur la structure morphologique des mots. Cette intervention a été réalisée auprès d'élèves, âgés de 10 à 12 ans, présentant une dysorthographie. Dans cette étude, un protocole individuel avec sujets multiples comportant la prise de mesures continues a été mis en œuvre. Afin de suivre systématiquement l'évolution des représentations orthographiques et de démontrer l'effet des interventions, l'analyse des résultats d'un des participants a été effectuée par l'entremise de la carte de contrôle. De façon générale, l'intervention a eu des effets bénéfiques sur la production écrite de mots plurimorphémiques, particulièrement pour pour ceux présentant des suffixes auxquels les élèves ont été entrainés.

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Lexical spelling or orthography is a significant challenge for writing beginners. Indeed, in alphabetic writing systems, phonemes correspond to graphemes, but the associations are not always transparent. French spelling has many complexities (Catach, 2008; Ferrand, 2007; Ziegler & Montant, 2005), and the relationship between phonemes and graphemes is often opaque. For example, the French phoneme /*E*/ can be spelled differently (è, ê, *ai*, *est*, *et*, etc.). Consequently, in French, in orthographic production, writers must develop not only specific knowledge related to rules for translating phonology into orthography (Mousty & Allégria, 1999), but also knowledge related to lexical orthography (Martinet, Valdois & Fayol, 2004) and the regularities of morphology (Pacton, Fayol, & Perruchet, 2005).

1. Developing Orthographic Skills

Learning lexical orthography involves processes specific to writing (Fayol & Jaffré, 2008; Torrance & Galbraith, 2006). To account for reading-writing acquisition and the development of phonological, orthographic, and morphological representations, Seymour (2008) developed a theoretical framework presenting the cognitive processes used to identify and produce written words. The author uses a cognitive and interactive information-processing model.

One of the bases of the model, logographic recognition, involves the process of identifying and directly producing familiar words. The second basis of the model, the alphabetic process, establishes a link between phonemes and graphemes during written word production. This sequential processing is used to represent less familiar words and pseudo-words.

Orthographic structure is multileveled since orthographic representations follow a progression from simple to complex (e.g., *pr*, *oigt*, etc.). According to Seymour (2008), this ability to construct complex orthographic representations is based on logographic recognition and the alphabetic process. Orthographic structure provides direct access to orthography and phonology and, consequently, the efficient processing of regular words with spelling rules or regularities, as well as irregular words.

Multisyllabic words composed of a base word and affix are treated by morphographic structure. This process allows direct access to orthographic representations and small pre-stored units of meaning (e.g., in French, *ette* means "a diminutive," so *chambrette* means "small room"). This learning is dependent, among other things, on the completion of orthographic structure (Seymour, 2008).

Such processing depends on and generates lexigraphic memory (Seymour, 2008). Stored representations in this memory allow for the abstraction of or-

thographic principles and the use of analogies for spelling. Lexigraphic memory is essential for identifying and producing written words.

As emphasized by Torrance and Galbraith (2006), writers must automate these processes to focus their cognitive resources on discursive capacities such as choosing and organizing ideas. Students with difficulties using these processes have a specific difficulty in producing written words.

2. Students with Dyslexia-Dysorthographia

The specific difficulty related to reading-writing acquisition is a severe deficit in the processes for identifying and producing written words (Sprenger-Charolles & Colé, 2013; Tunmer & Greaney, 2010). Considering chronological age, cognitive abilities, and education, students with dyslexia-dysorthographia have a delay in transforming phonological information into orthographic codes (Connely et al., 2012). This causes difficulties in identifying and producing written words accurately and automatically. Thus, in writing, dysorthographic students produce lower quality texts than their oral discourse abilities reveal (Berninger et al., 2008).

Casalis et al. (2003) found that students with dyslexia have a higher level of morphological awareness compared to phonological awareness. Furthermore, non-specific processes of language comprehension of these students are efficient (Connelly et al., 2012). Therefore, readers-writers with a specific reading-writing difficulty should be able to use graphomorphological codes to identify and produce written words. Indeed, the use of morphemes could be an effective compensatory strategy, because they are the smallest units of meaning in alphabetic languages (Baumann et al., 2002; Bryant & Bindman, 2006; Kemp, 2006; Pacton, 2005).

3. The Contribution of Morphology

Morphology is the study of word structure and formation (Béguelin, 2000; Catach, 2008). Most words in French are composed of several morphemes. Indeed, according to Rey-Debove (1984), about 75% of French words are constructed or multi-morphemic. Derivational morphemes result in the creation of new lexical units (Béguelin, 2000). The significance of derivational morphemes is that they alter the semantics of a word and thus increase the lexicon of students.

According to Pacton (2005), morphological knowledge is necessary to spell correctly. Fayol (2008) states that morphological rules must be learned systematically since few learners discover these intuitively. Therefore, separate interventions must be proposed to promote the development of this read-

ing-writing process. In this study, the interventions involve derivational morphemes since they promote the formation of new words by using orthographic representations of multi-morphemic words.

4. The Objective of the Study

According to Troia (2006), students with learning difficulties in writing require, among other things, intensive, individualized, and specific instruction in writing strategies. It is in this perspective, i.e., the use of interventions promoting the development of lexical spelling skills, that this study was conducted. Consequently, the study aims to demonstrate the effect of remedial interventions[1] using the morphological structure of words, on morphographical processing during the orthographic production of isolated words, in students with dysorthographia.

5. Methodology

In this study, a single-case ABA-type design was used to determine the effect of intervention on learning in students with a distinct learning profile. According to Horner et al. (2005) and Neuman (2011), this type of design helps to better understand the response to intervention and define educational practices at the individual level.

The timeline of the study, lasting 20 weeks, began with a preparatory session that helped familiarize the students with the remedial intervention program (vocabulary and material). It continued with the establishment of the baseline. For four weeks, the baseline conditions of the subjects with regard to the production of polymorphemic words were identified through ongoing measurements. While no interventions regarding morphological knowledge or strategies were conducted, students were given two dictations containing polymorphemic words each week during this phase. The intervention phase followed the baseline phase. Lasting 12 weeks, it included 36 rehabilitative sessions spread over 6 intervention periods. Each period was held over two weeks and focused on a different suffix. The periods consisted of six rehabilitative sessions. Thus, each week during the intervention, students participated in three rehabilitative sessions and one evaluation session to conduct ongoing measurements. Finally, to verify learning stability, the study concluded with an observation phase. This phase lasted four weeks, during which ongoing measurements continued.

6. Participants

The study was conducted with nine participants with dyslexia-dysorthograph-

ia, aged 10 to 12 years. The extent of their difficulties with lexical orthography was demonstrated by their results well below those expected for their chronological age, obtained through assessments measuring their use of processes specific to reading-writing. In addition, to reflect the persistent nature of these difficulties, students had to have participated in special education workshops at school. Regarding exclusion criteria, general cognitive capacities had to have been above 85 (Wechsler, 2006). Furthermore, no severe sensory impairments and no behavioral problems were to have been reported by parents or school staff. Finally, the mother tongue of the participants had to be French. The students participating in the study attended schools in the greater Montreal area, in the province of Quebec.

7. Instructors

Five fourth-year Bachelor of Education students in School and Social Adaptation implemented the rehabilitation program during their final teacher training internship. Before beginning the interventions, the student instructors received six hours of training from the researcher on implementing the intervention program and conducting ongoing measurements. In addition, two observational meetings were held to check the quality of implementation of the program by each student instructor. Three group supervision meetings were also held during the experiment.

8. Intervention Program

The remedial actions proposed by the intervention program emphasized explicit instruction and direct intervention for the teaching of strategies, since a significant effect has been shown in research for students with learning difficulties (Chard et al., 2002; Swanson et al., 1999, 2000; Wanzek et al., 2006). In addition, a cumulative review of the concepts, as well as exercises providing immediate feedback by the instructors, were proposed. Furthermore, the intervention was conducted individually or in small homogenous groups of two students matched by their type of difficulty.

Each rehabilitative session consisted of three phases: preparation, implementation, and incorporation. These phases facilitated the development of knowledge and new strategies (Laplante et al., forthcoming). The preparation phase included activities to help make connections between previous sessions and classroom activities. In addition, the review of concepts led to automatic recognition of the suffixes taught. During the implementation phase, several activities allowed the students to manipulate concepts related to morphology,

using mono- or polymorphemic words or pseudo-words. The final phase enabled students to incorporate their knowledge and demonstrate their ability to produce polymorphemic words in writing, particularly those words practiced in the rehabilitative sessions.

The intervention program consisted of 20 "typical" activities, some of which were performed during each rehabilitative session, while others were performed during two sessions of a same period. This variety of activities called upon different abilities related to morphological awareness and the identification and production of morphemes, words, and pseudo-words (see Table 4.1). Furthermore, the nature of the words and the meaning of the morphemes were taught explicitly. The morphemes used were derivational suffixes forming nouns or adjectives.

The lexicon consisted of 30 polymorphemic words. Each period focused on a minimum of five words containing a target morphograph. These words then corresponded to items used in the activities of subsequent periods. In this way, the students became familiar with the suffixes *-ette, -age, -tion, -ance, -aire, and -esse.* These morphemes presented a certain level of complexity because of their orthographic neighbours (*-ette* > -ète). Therefore, using the meaning of a morpheme was helpful in choosing the morphograph that produced the polymorphemic word accurately.

Table 4.1. Activities of the remedial intervention program

Activities	Morphological awareness				Identification				Production			
	Categorization	Isolation	Segmentation	Fusion	Morpheme	Base word	Polymorphemic word	Pseudo word	Morpheme	Base word	Polymorphemic word	Pseudo word
Preparation and review phase												
3 "typical" activities			①	①	①	①	①	①				
Implementation phase												
16 "typical" activities	③	①	②	①		②	③		②	①	④	①
Incorporation phase												
1 "typical" activity											①	

9. Measurements

Assessment tools are crucial in single-case-study designs. According to Kazdin (2011), they are key to this type of research and methodology for evaluating the effects of an intervention. As part of this study, in order to observe student learning regarding lexical orthography, two tests were devised. These measurements allowed determining the effect of the intervention on processing used in the production of written words.

To measure the production of written words, an exhaustive lexicon containing the target morphemes was created using the MTannulex database (Lété et al., 2004). Lexical frequencies were identified according to first to grade five word categories. Since words qualified as "frequent" in this study had low frequency, morphographic processing had to be used to produce the suffixes contained in these words. Indeed, using the meaning of the morphographs facilitated memory recall of the written representation of the polymorphemic words (Pacton et al. 2012). To create the two tests (word dictations), base words with low lexical frequency corresponding to polymorphemic words with low frequency were drawn from the lexicon created for the intervention program (e.g., *tolérer*: 0.00; *tolérance*: 0.47). Subsequently, two lists of words were created and matched, as best as possible, based on their lexical frequency and their syllabic and graphemic structures (e.g. *tolérance* was matched with *dominance*). The first list included polymorphemic words practiced during the intervention, while the second list consisted of control words not practiced but which contained the target suffixes. Since remedial interventions increase the occurrence of the lexicon used in a rehabilitation program, students could use logographic processing when producing the practiced words (Seymour, 2008). As such, the dictation of non-practiced polymorphemic words would demonstrate the use of morphographic processing in the production of written words.

A correction sheet accompanied each test. Students received two points for each correctly spelled item for a maximum of 60 points. If the root of the word was spelled correctly, one point was given, and if the target morpheme was spelled correctly another point was given (e.g., *tolér-* = 1 point, *-ance*" = 1 point). A total of 60 points could thus be obtained.

10. Data Analysis Method

In single-case-study designs, experimental control depends on the measures taken throughout the study on the dependent variables. Since this study was part of an approach focused on the participant and the influence of the intervention context, the data analysis plan related to methods reflecting intra-in-

dividual variability in the production of written words. As part of this study, in order to present changes in the behavior assessed by ongoing measurements of a single participant, a control chart was created. The control chart reported the raw data of the ongoing measurements. It was thus similar to the visual analyses used in this type of research design, but it consisted of a confidence interval in which the upper and lower limits were within two standard deviations of the mean of observations. For this study, the center line of confidence interval was established from the mean of the baseline results, and the upper and lower limits were established from data of the baseline and intervention phases. In this method, a parameter is considered to have changed when two observations are outside the confidence interval or when one observation is three standard deviations away from the mean (Juhel, 2008; Satake et al., 2008). In this study, a positive effect of the intervention was statistically significant when the result was outside the upper limit of the confidence interval, i.e. more than two standard deviations from the mean of baseline observations.

11. Results

The participant whose results are presented in this study was a boy from a middle-low socioeconomic background from the South Shore of Montreal. At the beginning of the intervention, he was 12 years and four months old and in the second year of the third cycle (Grade 6). The boy was an only child living with his mother. According to the latter, the participant had reading-writing difficulties since the second year of the first cycle (Grade 2). He repeated that year and began special education workshops. In the second cycle (Grade 4), following assessment of his reading and writing skills, he was diagnosed with dyslexia by a speech-language pathologist.

To verify what he had learned regarding production of the practiced words, the experimental test was administered to the participant each week during the study. In the first evaluation, he correctly spelled fourteen base words (14/30) and three suffixes (3/30). To represent the morphographs studied in the rehabilitation program, the student used various orthographic neighbors or groups of letters (*-ette* → *-ait*, *-age* → *-aje*, *-tion* → *-llon, -ance* → *-ans, -aire* → *-er, -esse* → *-ais*).

From the first session of the intervention phase, the participant incorporated the orthographic representation of the morphemes studied. Subsequently, after two weeks of intervention, the student obtained a result of 34 (34/60). Remarkable progress was made in the third week of the intervention (41/60), which was also attributed to an improvement in writing affixes. However, the three next results were significantly lower (35/60, 36/60, 35/60). Analysis of the

student's answers revealed that this decrease was associated with the spelling of the morphographs *-aire* and *-esse*, which were not taught at that time. The student completed the intervention phase with a result of 50 points (base words: 20/30, suffixes: 30/30). The threshold of 30 correct answers for the suffixes was reached for the first time in the last evaluation of the sixth intervention period.

The observation period revealed that the student maintained what he learned (49/60, 50/60, 50/60, 51/60). At the conclusion of the experiment, observation of the results showed greater progress for the production of suffixes compared to base words.

Visual analysis showed substantial progress for this student regarding the words presented in the rehabilitation program. Indeed, the six results above the upper limit of the confidence interval, i.e., more than two standard deviations (19, 32) and thus significant, attest to this progress.

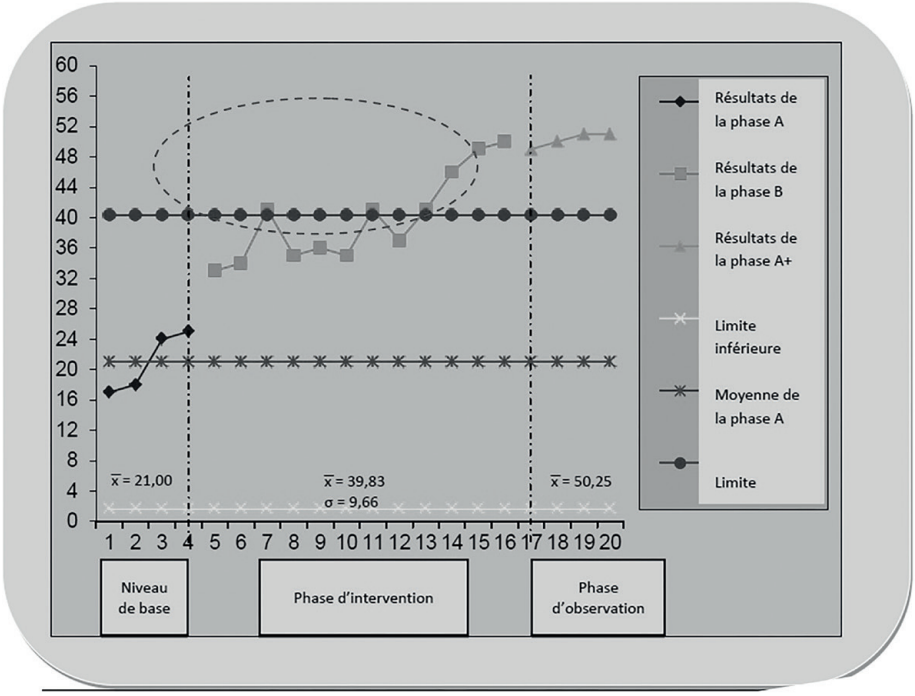

Figure 4.1. Experimental test results for the production of practiced words

Experimental dictations of non-practiced words were given to the participant to verify the effect of the intervention on the use of morphographic processing. The results observed at baseline were unstable (13/60, 20/60, 18/60, 26/60). As with the practiced words, the morphemes studied in the rehabilitation program were represented using various groups of letters and

not correctly spelled by the student until after the intervention. Moreover, at the end of the fifth intervention period, the student's results showed significant progress since correct representation of the affixes increased by 12 points (Week 13: 18/30; Week 14: 30/30). Few improvements were observed in the production of base words. Thus, the improvement in results was due to the performance of the participant in the production of suffixes. At the end of the experiment, despite some variation in the results, the student maintained what he had learned (44/60, 44/60, 48/60, 47/60).

Observation of spelled items in the experimental dictations revealed that the student substituted (*boutonnage* → *doutonaje*) or omitted (*militaire* → *millter*) graphemes. Such occurrences are due to difficulties in representing both acontextual graphemes, i.e. using the alphabetic process, and contextual graphemes, which are produced using orthographic processing. The intervention helped to reduce some of the difficulties in representing base words and promoted the use of segmentation to associate graphemes with the phonemes of non-practiced words. However, a few words, even among the practiced words, showed errors at the end of the experiment (*sitation*, *lamontation*, *boutonage*). Thus, even logographic processing cannot compensate for certain difficulties. However, in the last dictation, morphographic processing for producing suffixes was used properly in the 60 target words produced by the student. Therefore, for this participant, instruction targeting morphographic processing improved the production of suffixes.

12. Discussion

Lexical orthography is specific to writing. Given the latter's multidimensional form, the learning writer must use a variety of cognitive processes involved in the accurate production of written words. Thus, in reference to the cognitive and interactive model of reading-writing acquisition (Seymour, 2008), orthographic representations are actualized through a complex management of logographic, alphabetic, orthographic, and morphographic processes. In the context of this study, remedial interventions were focused on teaching the orthographic dimensions associated with morphology. The proposed interventions are thus compensatory in nature. This type of rehabilitation allows the special educator to focus on the development of new knowledge and strategies based on the functional processes of the student. As such, the proposed activities emphasized semantic units, i.e. morphemes.

At the end of the intervention, the results obtained through ongoing measurements of the written production of practiced and non-practiced words revealed that the remedial intervention was beneficial for the participant with

dsyorthographia as well as the eight other students participating in the study. Indeed, the control chart for each participant demonstrated the positive effects of the intervention and revealed that a significant improvement in the orthographic representation of the practiced suffixes was observed. Thus, despite their difficulties in lexical orthography, the writers were able to correctly use morphographic processing, which allows for the retrieval of orthographic representations of morphemes and their meanings. These findings corroborate what Quémart et al. (2011) observed in their study on reading skills, in which students with morphological knowledge accessed orthographic representations more easily. As proposed by Arnbak and Elbro (2000), the segmentation of polymorphemic words into units of meaning allows the writer to focus on the transcription of the words and put less load on working memory. In this way, the orthographic representation of the base words is facilitated. However, according to the results of this study, progress was less marked for the production of base words than for suffixes. This trend was observed in the production of both the practiced and non-practiced words. In addition, the same analysis demonstrated that the writers participating in the study made analogies during orthographic production of the non-practiced words by reusing the knowledge they developed about the practiced words and the composition of polymorphemic words. This observation is consistent with what Pacton (2008) has reported on writer sensitivity regarding infralexical knowledge when learning written words. Indeed, being aware of the morphological structure of the non-practiced words, the participants were able to retrieve from their lexigraphic memory the information they learned for representing the morphemes. Moreover, research suggests that, in reading, morphographic processing facilitates the decoding of polymorphemic words, which have low lexical frequency, by contributing to the recognition of word components (Carlisle & Stone, 2005; Colé et al., 2011). Implementing rehabilitation programs that focus on functional procedures thus promotes the development of orthographic representations; however, specific interventions are needed to reduce the various deficits observed in dysorthographic students.

In addition, the organizational parameters were optimal in this study. Moreover, a fundamental element of the rehabilitation program was explicit instruction. The effectiveness of this educational intervention model among students with learning difficulties is well documented (Gauthier et al., 2004; Swanson et al., 1999; Wanzeck et al., 2006). Indeed, this type of instruction allows special educators to guide students toward gradual acquisition of the targeted knowledge and strategies. According to some studies (Bowers et al., 2010; Kemp & Bryant, 2003; Pacton et al., 2005), writers do not use morphological rules systematically to spell words. Thus, explicit instruction of morphographic structures is neces-

sary to encourage writers with difficulties to use this processing when retrieving the orthographic components of the words to produce, since for dysorthographic students, this strategy allows compensating for marked deficits.

In sum, the possibility of improving morphographic processing, despite significant difficulties in lexical orthography, is clearly established in this study since the intervention led to improvements in the ability to use suffixes accurately, even after the intervention concluded. Future research efforts could be geared toward determining whether certain types of instruction or learning activities are more effective than others in developing orthographic representations of morphemes.

Note

1. Remedial intervention refers to instruction given by a specialist in evaluating and responding to learning difficulties in reading, writing, and mathematics. Usually conducted outside the classroom, remedial intervention is done individually or with a small group of students.

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