

Book review

Spelling and Writing Words: Theoretical and Methodological Advances

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Introduction. The book *Spelling and Writing Words: Theoretical and Methodological Advances*, edited by Cyril Perret and Thierry Olive (2019), is an insightful and thorough state-of-the-art of the research on written word production and spelling. The works included in this volume are based on the premise that investigating cognitive processes extends our understanding of lexical writing skill. For this purpose, the editors have brought together various researchers that explore many aspects of written word production, so as to provide the reader with updated and in-depth insights on this topic.

The book contains 12 chapters. It opens with an introduction by the editors, Perret and Olive, in which they provide a summary of the research on written production of isolated words. Then, the book is divided into three parts: Part I (Chapters 2-6) is the *Theoretical and Empirical Section*, which addresses essential topics in the field such as the role of phonology in writing, bilingual spelling in alphabetic systems, writing difficulties in language disorders, graphotactic knowledge, and orthographic acquisition, as well as the influence of handwriting on reading. Part II (Chapters 7-10) is the *Methodological Section*, and focuses on individual differences in spelling, how to measure handwriting performance in different handwriting styles, and neurophysiological approaches to explore written word production such as electroencephalography (EEG). Part III (Chapters 11-12) includes two concluding chapters, which discuss the future of research on written word production.



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Contents

In **Chapter 1**, Perret and Olive introduce the psychological processes, structures, and levels of representation incorporated in the production of written words. The editors describe the two main processing levels that are involved – namely, central and peripheral. Central processes refer to cognitive mechanisms that retrieve orthographic information about words from long-term memory. Peripheral processes translate abstract language codes into motor commands. Importantly, the editors also mention brain-imaging works that support a neuro-anatomical distinction between those two processing levels (Planton et al., 2013; Purcell et al., 2011).

Perret and Olive also discuss the two ways in which the orthographic representation can be reached, and cite the findings of Bonin et al. (2012), who revealed the different implications of the lexical pathway depending on task demands. The lexical pathway is a direct route by which sub-lexical orthographic information connects with whole-word orthographic representations, which then provide access to whole-word phonology, and higher-level semantic information. Bonin et al. (2012) found that dictating a word led participants to prioritize the sub-lexical pathway, whereas a conceptually driven writing task mainly engaged the lexical pathway.

Perret and Olive highlight real-time analyses of the production of written words as one of the main methods used nowadays to investigate the writing of single words. They also describe picture-naming tasks, spelling-to-dictation tasks and copying tasks as some of the tasks that are currently employed. In picture-naming tasks, participants are instructed to write down the name of a pictured item as soon as it is presented – the lexical pathway seems to be emphasized in this task (Bonin et al., 2015); in spelling-to-dictation, participants are instructed to write down single words as soon as they are dictated; in copying tasks, participants are instructed to read words that they subsequently must copy. In these last two tasks, both the lexical and the sub-lexical pathways appear to be activated (Bonin et al., 2015). The editors end the introductory chapter by challenging the reader and the researchers to question the universality of written production models and the flexibility of the writing systems.

In **Chapter 2**, Damian states that phonological processes, involved in speech sounds, are surely involved in writing. Despite a few inconsistent findings that the author briefly demystifies, and despite the absence of sublexical correspondences between spelling and sound, the two areas appear strongly interrelated, as shown in a few studies conducted with Chinese writers (Qu et al., 2016), which suggested an effect of phonology on handwritten production. The author argues that the role of phonology in writing could be notably expressed in multi-word writing (multiple word writing as opposed to single word writing), since the repetition of information in short-term memory presumably engages phonological codes. Damian supports this with evidence from patients with

typical writing ability but with deficits in accessing phonology. These patients tend to write short written statements, often with omissions or substitutions of function words. The author comments that individual differences probably exist in orthographic processing, and makes a reference to Perfetti's "lexical quality" hypothesis, according to which readers vary strongly on how well-integrated their orthographic and phonological codes are.

In **Chapter 3**, Pacton, Fayol, Nys and Peereman focus on the statistical learning of graphotactic regularities, which they describe as the patterns for arranging letters in written words, i.e., the fact that certain letter sequences occur in specific positions in the words of a certain language. They do so by reviewing studies showing that both children and adults have a sensitivity to graphotactic regularities. Specifically, in a study made with young French children, they demonstrated that learning to spell is not a matter of word-by-word memorization, which was consistent with other findings. The children in Pacton et al.'s (2013) study exhibited important graphotactic patterns and seemed to use those patterns to learn the spellings of new words. The position of a letter within a word played an important role – the children who came across a new word with a doublet in a medial position (difficult to remember) sometimes remembered that a word had a doublet but not where. In cases like this, they appeared to use their knowledge of graphotactic patterns – the notion that in French double consonants can occur before but not after single consonants, for instance – and this led them to make errors such as misspelling "gupprane" as "gupprane". In contrast, when a doublet was in the initial position (easier to remember), they frequently remembered that the word contained a doublet and which letter was doubled. In short, the authors illustrate how strongly children appear to be influenced by graphotactic knowledge.

In **Chapter 4**, Tainturier proposes a set of general hypotheses concerning the cognitive processes that are responsible for bilingual spelling abilities, supported by experimental evidence from the literature and from ongoing studies in the author's own lab. The main focus was not to propose a learning theory, but to make some predictions about learning patterns in second language learners. The theory of bilingual spelling in alphabetic systems, or BAST, aims to account for spelling in a combination of languages using the same alphabet, although it obviously predicts an influence of the degree of similarity between languages at the lexical and orthographic levels. The organization and processing characteristics of bilingual spelling rely on definitions from the monolingual spelling literature, as well as on research on bilingual spoken word production. In line with models of bilingual spoken word production, it is assumed that access to the bilingual spelling system is non-selective, which means that the representations corresponding to each language are always co-activated, and that this co-activation should be modulated by the degree of proficiency of the person in each language. Furthermore, written production is more complex than spoken production because it clearly involves

more processes: orthography in addition to phonology, lexical and sub-lexical orthographic retrieval procedures, and various output modes (i.e., typing). The author offers supporting evidence and suggests several ways in which BAST could contribute to future research in the domain of bilingual spelling. In practice, it could contribute to the development of more regimented teaching methods and also prove helpful in the rehabilitation of spelling disorders.

In **Chapter 5**, Wamain aims to understand whether the way literate people write letters impacts how they read it. In order to do so, the author presents a number of behavioral and neurophysiological studies that indicate robust interactions between motor and perceptual processes during the perception of movement, and also several studies that show that the observation of handwritten copies can reactivate information about the movements involved in its production, suggesting that action and perception are highly interconnected. For instance, the author mentions a few studies that compared learning in typing and handwriting tasks. Results showed a better recognition of new characters in the handwriting condition than in the typing one, both in children (Longcamp et al., 2005) and adults (Longcamp et al., 2006). So, even nowadays in the era of digital tools that are impacting immensely the writing experience – and consequently, learning and reading – these findings suggest that handwriting still stands out, and has a strong influence on literacy development. It allows children to build fine sensorimotor skills about letters that could facilitate reading processes. The author makes an interesting comment that, even if handwritten letters are harder to recognize than printed ones – since each handwriting style is different – at the same time, they have a familiar and friendly side to them. And we agree, given its uniqueness, that handwriting serves as individuals' very own written fingerprint (Alves & Silva, 2022) Something that carries such a meaning should only be expected to last.

In **Chapter 6**, Afonso, Connelly and Barnett review the evidence on writing difficulties often observed in three different developmental disorders: Developmental Language Disorder (DLD) (previously known as Specific Language Impairment [SLI]), Developmental Dyslexia (DD), and Developmental Coordination Disorder (DCD). They notice that, although written word production is slower or not as accurate in DLD, DD and DCD compared with typically developing children, the processes affected seem to differ in each disorder. Children with DLD have problems with inflectional morphology – categories of morphology that are responsive to the grammatical environment in which they are expressed – which mostly affects verb production. Individuals with DD seem to use morphological information properly, but produce errors and a pattern of within-word pauses that indicates poor phonological awareness and diminished orthographic information. Regarding spelling in individuals with DCD, not much is known yet about the variables involved, but it seems that motor aspects of writing constitute the primary reason of impairment. However, given that spelling and handwriting seem to be closely related during writing development, (Afonso et al., 2018), both

skills end up competing for limited resources (viz., in working memory). So, if children with DCD have difficulties in automatizing handwriting, they may not possess enough resources available to focus on spelling. The authors conclude that spelling impairment in children with DCD might have to do with both peripheral and central aspects of writing.

In Part II, **Chapter 7**, Bonin and Méot address a theoretical and methodological issue: how to investigate individual differences in word production? They try to persuade readers that the strategy of empirically researching the production of single words has been fruitful. The reason for this is that focusing on isolated words makes it possible to single out different parameters and measures (e.g., frequency, length) and better study their influence. They argue that it is also possible to investigate specific parameters in text production, but they defend that it is somewhat more difficult.

Bonin and Méot review written naming and spelling to dictation tasks. These tasks made it possible to investigate several important issues in writing, such as the role of phonological codes in skilled written naming, the role of syllables in written naming, the locus of word frequency in spelling to dictation, as well as the dynamics of the information flow in written naming. The authors sustain the importance of being careful when choosing which task to investigate spelling since findings show that linguistic effects are robustly found in certain spelling tasks but not in others. Several studies are discussed, which show how handwriting contributes to the visual recognition of letters (Longcamp et al., 2010), that learning how to write letters is beneficial for children's recognition of them (Longcamp et al., 2005), and that adult students who take notes by hand understand better and remember more information than the ones who take notes on a laptop (Mueller & Oppenheimer, 2014).

At the end of the chapter, the authors present a study by Mangen et al. (2015) that compared memory of words that had been written by hand, on a typical keyboard, or on a virtual iPad keyboard. In free recall (but not in recognition), the participants remembered the words better when they had handwritten them, compared to when they had produced them via the two keyboards. These results suggest that learning handwriting is still valuable and that it seems a more effective note-taking technique for students, for instance.

In **Chapter 8**, Afonso and Álvarez summarize evidence showing that central processes do not have the same impact on writing durations in adulthood as they do during writing acquisition (Afonso et al., 2018). The authors discuss online measures of handwritten responses that support the idea that central processes have an impact on the dynamics of motor performance. Although a growing number of studies have reported writing durations as a measure of central processing during handwriting, not much is known about the mechanisms which explain the effect of cognitive-linguistic variables in motor processes. In this sense, the au-

thors note that the mechanisms thought to cause the effects of syllabic and morphemic structure, probability of the phoneme-to-grapheme (P-G) correspondences, word frequency, and graphemes complexity determine the interpretation on the mentioned effect. At this point of the development of writing production research, the authors comment on how researchers face the challenge of gathering both method and theory in order to better grasp this subject.

In **Chapter 9**, Séraphin-Thibon, Gerber and Kandel present a study on letter production. They aimed to provide a methodological contribution to handwriting studies in which movement data is normalized on the basis of stroke number. In their study, adults had to write the letters of the alphabet in upper-case format on a scanner. They were either guided to follow the model of the letter presented on a screen or to write it as they wanted. The results revealed that there were 19 letters that were produced, in at least 50% observations, with the same number of strokes, regardless of the instructions. The results also indicated that the instructions to follow a specific model could have had an impact on the number of strokes for some letters. Briefly, this study shows that the participants produced many letters with the same number of strokes, and that, when following a model of a letter, the numbers of strokes produced was not the same. The authors concluded that it is therefore likely that the “grammar of action” we learn during writing acquisition prevails on production strategies throughout life.

In **Chapter 10**, Perret and Qu demonstrate how EEG recordings can, in part, compensate for some of the limitations of mental timing measurements. First, they describe the characteristics of the EEG measurements, focusing on two possible analytical approaches: the Event-Related Potentials, or ERP analysis, and the spatio-temporal segmentation. The aim of the authors was to briefly present how EEG recordings can be used to address concerns involved in the handwritten production of single words, and to convince readers on the value of EEG measurement, despite its inherent challenges. The reported main advantage of EEG is that it makes it possible to precisely analyze not only reaction times or errors, but also the time-course of the cognitive processes. The authors report that ERP studies done recently using EEG and speaking tasks have demonstrated that frequency effects arise at the stage of both lexical-semantic (lemma) access (i.e., the process of retrieving information about a word from a semantic base) and phonological processing during the production of speech. It is proposed that EEG can be used to explore questions regarding linguistic units larger than isolated words. Nonetheless, the authors pose that EEG recordings should not be seen as the only source of information given its limitations. For instance, EEG does not allow researchers to explore the question of the transmission of the activation flow between processing levels (e.g., Kandel & Perret, 2015).

In **Chapter 11** (the first chapter of Part III), Fayol gives emphasis to the role of word production research within the broader field of writing research. The author points out that words have sub-lexical units, and therefore, to understand word

production, it is necessary to analyze how these units are combined to form words. Throughout the chapter, the author lays down the main concerns and scientific challenges in research on written word production (particularly single words), and discusses how, despite most multidimensional structures have been investigated in single word production, further studies are still needed to determine whether and how they contribute to variations in the production of isolated words. For instance, Fayol reveals data showing that, when composing text, the mind usually processes several words in parallel, with the impact being observed at the level of between-word pauses, intra-word pauses, and writing rate. In addition, processes are described by a cognitive delay between the cognitive and linguistic operations related to the word, contrary to the assumptions of the immediacy-of-processing models. Overall, the data mentioned shows the intricacy of written production, so the author ends the chapter by observing how words should be explored, namely in two different directions: by analyzing its components, and as processing units.

In the final **Chapter 12**, Rapp makes the reader think about the complexity of writing and models of the writing process, and how that should encourage investigators to explore further the way in which the varied cognitive systems interact in the brain. The author does so by discussing topics that other authors touched upon in previous chapters of the book. In discussing foundational questions, such as interactivity (processes in the mind are viewed in a holistic way) and modularity (specialized function in processes of the mind), the author draws a parallel with previous chapters. For instance, in Chapter 8, Afonso & Alvarez had their focus on the interaction between central spelling and peripheral writing processes. On a modular view, peripheral processes start only when central processes are finished, operating independently. On an interactive view, peripheral and central processes interact with feedback. Additionally, Chapter 4 by Tainturier seems to reveal both interactivity and modularity of processes in bilingualism. Bilingual individuals were able to write without words from another language intruding, showing functional specialization (modularity). However, there are also findings showing that spelling knowledge is shared and interacts across scripts, revealing interactivity. Rapp comments that, in order to understand the interactivity/modularity of the writing system in general, and the bilingual spelling system in particular, it is necessary to consider the different findings that are available.

The book ends with Rapp suggesting that one way of judging our understanding is by building computational models which, in line with the work described in this volume, exemplify the diversity of experimental methods and empirical approaches that have been successfully implemented so far. This will allow researchers to make progress in their understanding of the writing process.

Concluding remarks

This book is an extensive and remarkable contribution to the body of knowledge on written word production. Since words are units of written language, needless to say, the more we know about their written production, the more we should know about how writing processes work, and how words are processed in the mind. Every work in a given field relies upon the basics. They are the foundation from which more complex discoveries can be derived. In neuroscience, one could never understand the overall function of a neural system without first understanding the low-level processes that relate to the functioning of neural cells. Knowing the fundamentals is what ultimately allows researchers to dissect a problem and devise a way to solve it.

The book starts with a great synopsis of the research on the written production of isolated words (Chapter 1) by the editors, thus providing the reader with all the necessary context for the following chapters. Damian (Chapter 2) gives a very detailed and thorough analysis of literature on the role of phonology in word production, reviewing studies and models ranging from foundational to modern neuropsychology (Poeppel & Hickok, 2004), which gives the reader an encompassing picture on the matter.

The proportion of bilinguals has been growing considerably since the last century, perhaps equating to more than half the population (Grosjean, 2021). Therefore, Tainturier (Chapter 4) offers a scientific new system to look at bilingual spelling that can and should contribute to further research in this area, which now seems more necessary than ever. This line of thought also applies to language disorders. Afonso, Connelly, and Barnett (Chapter 6) examine the writing difficulties of children who have language disorders, particularly DLD, DD, and DCD. By doing so, they make a significant contribution to the research done so far, since studies of word production involving young writers with language disorders are not frequent enough, and typically come from research on text production. After studying models of word production on neurotypical individuals – thus, having a baseline for analysis – it should only be expected that lexical processes in individuals with language disorders are also made intelligible. Given that writing demands a complex set of motor and information processing skills, simply knowing that a student has a disorder is not sufficient. Only by examining the difficulties implicated in each specific disorder, it becomes possible to break new ground and develop specific accommodations in the learning environment that will allow each student to practice and learn the skills required to be an accomplished writer.

We are also reminded by Bonin and Méot (Chapter 7) that, in order to gain a better understanding of spelling (or of another concept, for that matter), it is important that researchers take individual differences into account. Along these lines, Séraphin-Thibon, Gerber and Kandel (Chapter 9) showed that individuality

should be considered in writing research, since different styles of handwriting affect the number of strokes used to compose certain letters.

Mental chronometry refers to the measurement of the duration of psychological processes that rely mainly on oral input (in spelling-to-dictation), visual input (with picture naming), and reading input (in copy tasks). From a methodological point of view, Perret and Qu (Chapter 10) show how EEG recordings can be a great tool when looking for the locus of an effect in scientific studies, since they answer questions that mental chronometry does not easily answer.

Finally, Rapp (Chapter 12) summarizes the important place that written language holds in human experience in the twenty-first century, and explains why research on writing is essential. The author draws a parallel with previous chapters when discussing the still relevant use of written language even in this age of pervasive digital communication. Difficulties in the learning process are particularly difficult to detect, and as technology is having an impact on education at every level, teachers can face significant challenges when it comes to providing personalized feedback and support in order to help students overcome their difficulties. Technology definitely carries substantial advantages for students, granting them access to all the information available at any time. On the other hand, and at the very least, much of what is shown in the book is a warning against abandoning or significantly reducing the practice of handwriting. For instance, both Wamain (Chapter 5), and Bonin and Méot (Chapter 7) showed benefits that are linked with handwriting tasks.

It says a lot about the cohesion and the integrative quality of the book that the study by Longcamp et al. (2005) is mentioned in both sections (theoretical and methodological) of the book – the study had not only an obvious theoretical implication, but also a methodological one for future investigators, who should be careful when choosing which tasks to perform in their studies, since findings showed robust linguistic effects in certain spelling tasks but not in others. Interestingly enough, in a very recent study, Wiley & Rapp (2021) also found that handwriting training during letter learning of an Arabic script strengthened reading and spelling skills in adults. The benefits of handwriting training not only included a faster learning trajectory but also extended beyond the tasks on which participants were trained (letter recognition and writing) to untrained tasks, such as letter naming and word reading. Handwriting and spelling (transcription skills) are susceptible to becoming automatic, thus releasing cognitive capacity, improving writing fluency, and facilitating strategic modes of functioning (Alves, 2019). A reverse phenomenon also seems to happen: training to read and attaining automaticity in reading seems to favor fluency in writing and, along with burst behavior, appears to be critical to promote strategic behaviors in writing as well (Alves, 2019).

Back to the book, all of these results surely have great implications for best practices in education: handwriting can represent a fruitful application of learning time, one might say. Noticeably, in their meta-analysis of handwriting instruction, Santangelo and Graham (2016) were able to assess positive impacts on literacy development, and even differentiated the aspects of literacy that are likely to be impacted by handwriting (e.g., handwriting legibility, writing fluency, text length, and even text quality).

Considering how critical phonological awareness is for learning to read any alphabetic writing system (Ehri & Nunes, 2002; Troia & Maddox, 2004), one might point that the book neglects its role in early literacy learning. Research shows that difficulty with phoneme awareness and other phonological skills are predictors of spelling development. Additionally, teaching speech sounds explicitly and directly accelerates learning of the alphabetic code, and instruction in speech-sound awareness reduces and alleviates spelling difficulties (Gillon, 2004). Critically, future research needs to delve into the early intertwining of phonological awareness, handwriting, and spelling.

On a different note, recent studies show that negative emotional induction can alter children's spelling performances depending on their skill level and the complexity of the task (Soulier et al., 2021). Running into difficulties while performing a task, such as writing, can often be accompanied by an emotional response. Thus, emotions might play a critical role in the integration of knowledge. This has been shown in brain imaging studies (LeDoux, 1992), laboratory-based studies (Isen et al., 1987), and applied educational studies (Pekrun, 2005). Emotion can impact the learning process when it poses an obstacle to learning: for instance, confusion has been associated with blockages or impasses when trying to learn (Lodge et al., 2018). A future edition of the current book might fruitfully include a chapter dedicated to the emotion-cognition interactions in the integration of spelling knowledge.

Spelling is, of course, part of the school curricula, and a considerable amount of time is devoted to its proficiency. Good spellers can write their thoughts without needless interruptions, whereas poor spellers are restricted when it comes to writing without constraint. Unsatisfactory spelling progress may be attributed, in part, to inadequate or absent spelling programs based on research findings (Graham & Miller, 1979). For personal purposes, inaccurate spelling is not a problem, but documents to be read by others should be written free of misspelled words. Besides, society often associates "good" spelling with educational accomplishment and cultivation, while "poor" spelling is readily linked with illiteracy (Graham & Santangelo, 2014). Surely there are many individuals who have been made to feel unintelligent simply because of their inability to spell. Sadly, these negative views persist in society and may have long-term consequences for an individual's confidence and desire to write. Spelling is

a crucial component of the writing experience, but sometimes it gets forgotten in the midst of other important elements.

What mostly stands out for us, in terms of how valuable this book is, is its ability to gather an extensive body of information about writing elements – handwriting and spelling – that are often overlooked in literature. Their importance is demonstrated through scientific explanations of why, in a supposedly “post-literate society”, where individuals would not write by hand, they would likely not reach their full potential. Although this might be a very technical book for the common reader, this take-away message should be widely spread. Essentially, the book expands on the knowledge of the role of handwriting in learning and spelling in the development of literacy, revealing itself to be of valuable insight for psychologists, psycholinguistics, and neuroscientists alike. Surely enough, it will also prove to be inspiring for future studies to come.

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