

Introduction

The existence of interactions between spelling and handwriting is obvious, but the literature is unclear regarding their nature. Among those studies, some authors gave evidence that the graphomotor abilities influence the spelling performances. By the use of tasks that vary in terms of motor demand, authors showed that when the gesture required more cognitive resources, children made more spelling mistakes (i.e. for grammatical agreements, [Van Reybroeck & Hupet, 2009](#)). Other studies, conducted among children with dyslexia, reached the conclusion that their poor spelling abilities explain their slowness in handwriting, caused by a higher number of pauses ([Sumner, Connelly & Barnett, 2013](#)).

While the orthographic complexity is a well established concept, we do not know much about the graphic complexity of words. Only few studies focused on the graphic complexity inside the word itself. A better understanding of what constitutes graphic complexity appears relevant in order to further investigate the interactions between spelling and handwriting.

Aim of the study

This study aims to identify the graphic variables that have an impact on handwriting performances.

Hypothesis: Words are not equally demanding in terms of graphomotor abilities. We make the prediction that complex words will lead to more handwriting difficulties (reduction in speed and poorer quality of handwriting).

Method

Materials

Words' characteristics (n=48)

Orthographic

Regular or very frequent words for 2nd graders, success rate above 80% in EOLE ([Pothier & Pothier, 2003](#))

Graphic
Independent variables

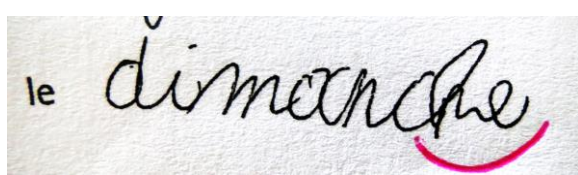


- The word's **length** (in cm),
- The number of times of **pen ups**
- The number of **curves**
- The number of **angles**
- The number of **modified links**
- The number of **turn backs**

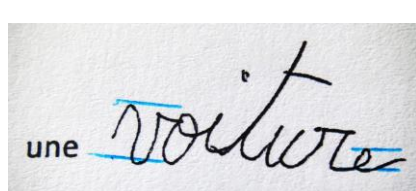
Measures (dependent variables)

Extracted from the tablet **Speed**

Distortion of a letter

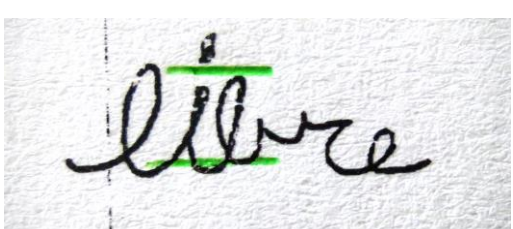


Abnormal variation of the size of the **small letters**

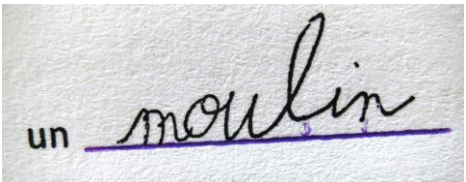


Aesthetic criterion from the BHK scale ([Charles, Soppelsa & Albaret, 2004](#))

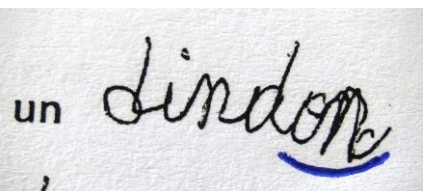
Abnormal **relative height** between small letters (i.e. "a", "i", "s") and tall/tail letters (i.e. "y", "t", "h")



Non-straight **line**



Presence of graphic **correction**.



Participants

Twenty children in 2nd grade from 2 different classes in a French speaking school in Belgium were tested (average age: 7;9 years).

Procedure

• Control tasks:

Measures of nonverbal reasoning ability, vocabulary, alphabet writing, word reading and spelling were individually administered to all participants.

• Experimental task: *single-word dictation*

Children were tested by groups of four, in a quiet available room in their school.

They performed on a dictation task of 48 previously recorded words. Each child was given an interactive inking pen and performed the task on an ordinary sheet of paper attached to the digital tablet (*Wacom intuos pro*)

Results

The data were analysed using a general linear mixed model (GLMM). This allowed taking into account for the variability induced by both participants and items in the same analysis.

Only words with correct spelling were taken into consideration (n=749)

Graphic characteristics	Speed	Distortion	Small letters	Relative height	Line	Correction
Turn backs						
Angles	-0,405***		+2,154**	+4,035**		
Curves			+2,240***		+2,515***	
Modified links		+4,084*	+7,637***	+9,019**	+4,76*	
Pen ups			+1,1*	+2,383*	+1,27*	
Word length		+0,174***	+0,192***	+0,308***	+0,223***	+0,283***

* p-value < 0,05; ** p-value < 0,01; ***p-value < 0,001

Note. The coefficients are reported in the table above. The lines represent the independent variables (the graphic characteristics of the words) and the columns represent the dependent variables (our measures reflecting the quality of the handwriting). The importance of the relationship between two variables is indicated by the darkness of the colour.

The results showed that several of the graphic characteristics comprised in words influences the handwriting of children.

- **The presence of angles was negatively related to speed.**
- **The modification of the link between two letters lead to a poorer quality of the handwriting.** Words with modified links were produced with distortions, abnormal variations of the size and height of letters, and non- straight lines.
- **The word's length also had a slight effect on all aesthetic variables.** Longer words were more likely to lead to difficulties in handwriting.

Discussion

This research enabled a fine-grained analysis of handwriting, allowing us to identify precisely the variables that influence the handwriting of children.

In agreement with our hypothesis, our results showed that words have different level of graphic complexity. Several graphic characteristics significantly influenced the quality of the handwriting, and some appeared to have a bigger impact than others.

This study suggests that it is now worth considering manipulating the graphic complexity of words. This can be helpful for future researches tackling the question of the development of the writing skills throughout development and how they interact.

References

- Charles, M., Soppelsa, R., & Albaret, J.-M. (2004). BHK, Echelle d'évaluation rapide de l'écriture chez l'enfant, Paris: ECPA.
- Pothier, B., & Pothier, P. (2003). Echelle d'acquisition en orthographe lexicale. Paris: Retz.
- Sumner, E., Connelly, V., & Barnett, A. L. (2013). Children with dyslexia are slow writers because they pause more often and not because they are slow at handwriting execution. *Reading and Writing*, 26(6), 991-1008.
- Van Reybroeck M., & Hupet, M. (2009). Acquisition of number agreement: effects of processing demands. *Journal of Writing Research*, 1(2), 153-172.