revues.org

Current Psychology Letters
Behaviour, Brain, & Cognition

Search

Last issues
18, Vol. 1, 2006
17, Vol. 3, 2005
16, Vol. 2, 2005
15, Vol. 1, 2005
14, Vol. 3, 2004
13, Vol. 2, 2004
12, Vol. 1, 2004
11, Vol. 2, 2003
10, Vol. 1, 2003

Prior issues
2002/3, 9
2002/2, 8
2002/1, 7
2001/3, 6
2001/2, 5
2001/1, 4
2000/3, 3
2000/2, 2
2000/1, 1

Information
Editorial board
About CPL/BBC
Notice to contributors
Contacts
Prior Issues

Index
Authors
Keywords

Contact us

CPL Current Psychology
Behaviour, Brain & Co

17, Vol. 3, 2005 .

Article

Sonia KANDEL and Sylviane VALDOIS

The effect of orthographic regularity on children's handwriting p

Résumé

Ce travail étudie comment l'irrégularité orthographique des mots influenc graphomotrice de l'écriture. Des enfants de CP et CE1 ont écrit des m irréguliers sur une tablette digitalisante. L'irrégularité pouvait se trouver en dé de mots acquis tôt et tard. Les résultats montrent que les durées de produc importantes pour les mots irréguliers que pour les mots réguliers. Toutefois n'étaient significatives que pour les mots acquis tard. Les mots réguliers et ir tôt, seraient donc activés directement du lexique orthographique. Les m seraient traités par application de règles de recodage phonologique. L'é réguliers serait satisfaisante. L'écriture de mots irréguliers nécessiterait la r l'orthographe du mot entier ainsi que le rappel de l'identité et de la localisatior orthographique. Cette opération constituerait une surcharge cognitive ré augmentation de la durée de production.

Abstract

This study investigated how orthographic irregularity affects handwriting pr spelling acquisition. First and second graders wrote regular and irregular word The orthographic irregularity was located at the beginning, middle or end of early and late. The results revealed that movement duration was always high irregular than regular words. However, the differences only reached signific acquired late. Therefore, regular and irregular words acquired early are access the orthographic lexicon. A different mechanism operates when writing word The child applies a phonological recoding operation that works successfu regular words. When the child has to write an unfamiliar irregular word, memorize the spelling of the whole word and remember the identity and orthographic irregularity. This operation constitutes a supplementary cognitive in an increase in processing time.

Full Text

Received October 10, 2004

Revised June 2, 2005
Accepted June 8, 2005
On line July 13, 2005

Introduction

Handwriting is a linguistic motor task involving differe stages. From the intention of writing to the actual movement execut different processing levels such as semantic activation, syntax spelling recovery, allograph selection, size control and muscular adj Galen, 1991). This study focuses on the spelling level. It examines linguistic characteristics of orthographic representations such as irregularity- affect the organisation of handwriting movements d acquisition.

Motor programming in handwriting does not merely activation of letter strings at the spelling module (Teulings, Thoma Galen, 1983; Van Galen, Smyth, Meulenbroek, & Hylkema, 1989). It i multi-dimensional orthographic representations that store informatio consonant and vowel status of letters and the syllabic structure (Caramazza & Miceli, 1990; Caramazza, Miceli, Villa, & Romani, 198 Badecker, Goodman-Schulman, & Aliminosa, 1994; Wing & Bad Experimental studies also revealed that specific linguistic cha orthographic representations require additional processing a s cognitive load- that affect the temporal and spatial features o production (Kandel, Alvarez, & Vallée, submitted; Orliaguet & Boë, 19 Zesiger, Boë, & Mounoud, 1993; Wing, 1980). Zesiger, Mounoud (1993), for example, showed that adults' movement time and trajector writing pseudo-words was systematically higher than when writing values increased even more when the pseudo-words had embedd trigrams. The authors suggested that these increases translate a arising from the presence/absence of an orthographic representation and/or a more complicated search process in the case of non freq The present experiment attempts to shed some light on wh orthographic irregularities in words affect handwriting production d acquisition.

Studies on children handwriting production support the linguistic characteristics of orthographic representations at the modulate movement execution. Søvik, Arntzen, Samuelstuen, & (1994) showed that 9 year old children produce lower movement d writing frequent words than less frequent words. In another researc Valdois (in press), showed that French first to fifth graders handwriting movements according to their syllable structure. The very familiar words and pseudo-words on a digitiser. Movement revealed that the children programmed the gesture to produce th before starting to write. There was a systematic duration increase at of the second syllable irrespective of lexical status, item length and

These duration increases were higher for pseudo-words than fo pattern of results indicates that the children programmed the moveme second syllable during the production of its first letter. Durir production, there were concurrent processes -information representational levels- that were active simultaneously (Van Gale Galen, Meulenbroek, & Hylkema, 1986), resulting in duration increa be noted however, that the younger children, mostly first graders, wro (in general pseudo-words) letter by letter.

The present study examined how another linguistic cl orthographic regularity- affects handwriting production during the writing skills. The effect of orthographic regularity has been w (Sprenger-Charolles, Siegel, Béchennec, & Serniclaes, 2003; Wat Seidenberg, 1985). Orthographic regularity refers to the way in whic associates letters to sounds. To learn how to read and write, the child detailed orthographic representations of regular and irregular word them globally (Frith, 1985, 1986). Regular words have straightforwarc between graphemes and phonemes, like *camera* = /kameRa/. They and/or written correctly by applying analytic grapho-phonologica mechanisms. Irregular words require global processing and read/written by accessing orthographic representations. To acquire irr the child has to be aware of certain spelling peculiarities, e.g. the pronounced /a/ (/fam/) instead of /e/. In the present study, we investig the processing of these orthographic peculiarities constitutes a cog handwriting production during written language acquisition. Bloemsa and Meulenbroek (2003) have shown that orthographic irregularity performance when typewriting Dutch words. There was an increase time and typing time. In line with this study, we hypothesized that w irregular words, orthographic irregularities constitute a supplementa load that results in an increase in movement time at the location of th In our study, the orthographic irregularity was located at the beginn end of words acquired early or late. If the child is familiar with the wor write it down by recovering information from the corresponding representations. In this case, the processing of irregular and regular be the same and yield no duration differences for words acquired ea mechanism operates when writing unfamiliar. The child applies a recoding mechanism that works successfully when writing regular wor the child has to write an unfamiliar irregular word, he/she has to spelling of the whole word and remember the identity and loc orthographic irregularity. This operation constitutes a supplementary that results in an increase in production time. We expected orthograp to affect first graders more than second graders. Second graders ha exposed to written language than first graders, so they should have information stored in memory and therefore recover the spelling c irregular words globally rather than analytically (Share, 1995, 1999).

Method

Participants

Fourty-four right-handed children participated in the expe were 22 first graders (mean age 6;8 ranging from 6;1 to 7;3, standa months) and 22 second graders (mean age 7;7 ranging from 7;0 to deviation 3 months). They were all pupils of two schools of the Gı area and were tested throughout the month of March 2002. We m their mother tongue was French. The teachers reported the readinç global and phonological, since it also focused on graphe correspondences. None of the subjects were repeating nor skipping were attending their grade at the regular age. They all had normal oı normal vision and reported no hearing impairments. No learning disa behavioural problems were reported. School attendance was regular.

Material and procedure

The stimuli consisted of 24 six and seven letter Frenc Appendix). 12 words were orthographically regular and the other 1 orthographically irregular. The irregularity of the words was sit beginning of the word (e.g. ***qu****atre*), in the middle (e.g. *ca****h****ier*), and a *soldat****t***). We used the Dubois-Buyse scale as a reference for age (Ters, Mayer, & Reichenbach, 1988). This scale distributes the French words for children in 43 sets of increasing familiarity. The wo sets are learnt before the words in the last sets. In this experiment words could either be acquired early (sets 11 to 17) or acquired late (s The orthographically regular words were matched to the irregular wo acquisition and number of letters.

The children saw each word on the centre of the scree (Sony Vaio PCG-FX203K) written in lowercase Times New Roman presentation was preceded by an auditory signal and a fixation p duration). The participants' task was to copy the item on the digi Intuos 1218, sampling frequency 200 Hz, accuracy 0.02 mm). The c write the word that was presented on the screen so that the correct word was available since the beginning until the end of the writing digitiser was connected to a computer that monitored the movem produced to write the word. The children copied the words as th writing at school" (i.e. in cursive handwriting). There were no time li constraints. They had to write (with an Intuos Inking Pen) on a lined p stuck to the digitiser (the vertical limit was 0.8 cm and the horizonta cm). Once the child finished writing the word, the experimenter following one. Two practice items preceded the experiment.

Data processing and analysis

As many studies on handwriting production, we use duration as an indicator of a supplementary processing load

programming. We followed the standard procedure of movement a the data were smoothed with a Finite Impulse Response filter (Ra 1975) with a 12 Hz cut-off frequency. To segment each word constituents, we used geometric (cuspids and curvature maxima) a (velocity minima) criteria. With this segmentation procedure we duration of each letter in the word. The duration measure cond movement execution (the time the child took to look at the word, or a of pause, were excluded). In order to compare the duration of lett different spatial configurations, the duration of each letter was d number of strokes it contained. To define the number of strokes, we segmentation procedure presented by Meulenbroek and Van Galen for instance, has two strokes: an up-stroke and a down-stroke. If the d *l* was 180 ms, then the mean stroke duration was 180/2 = 90 ms. The duration was divided by the sum of all the mean stroke durations of then, converted to percentages. This normalization procedure provide on the global organization of the handwriting movement. It reveals th of the duration throughout the word. Mean stroke duration increas locations result from parallel processing of orthographic and moto When one of these variables, like orthographic irregularity, requi processing, then duration percentages increase (Van Galen, 1991; al., 1986). In addition, mean stroke duration percentages allow compa all participants, from very slow to very fast ones. For instance, the duration of a given letter can be 100 ms for one child and 200 ms for the duration percentages for this letter for both children are around 1 children program their movement in the same manner. This is very im study because the children's age varied from six to eight, which is a of motor development. Indeed, many authors have shown that absolu duration decreases as the child grows up (Meulenbroek & Van Galen 1989; Mojet, 1991; Zesiger et al., 1993). For the analysis of words d irregularity at the onset, we focused on the duration percentages of le For the words having the irregularity at the middle, we examined percentages of letters 3 and 4. For the words with the irregularity a analysed duration percentages of letters 5 and 6 for six-letter words a seven-letter words.

Results

For each irregularity position, we conducted an Analysi (ANOVA) with School level (1st, 2nd grade) as between-participan orthographic characteristics of the word (irregular, regular) and age (early, late) were analysed as within-participants factors.

Onset

Figure 1 presents the mean stroke duration percentag acquired early and late at the Onset position. Analysis revealed

differences in duration percentage between grades 1 and 2. Grad
interact with any of the other factors. Mean duration percentages w
irregular words than for regular words ($F(1, 42) = 16.65$, $p < .001$).
age of acquisition was also significant ($F(1, 42) = 16.08$, $p < .001$). T
between orthographic regularity and age of acquisition did not reach s

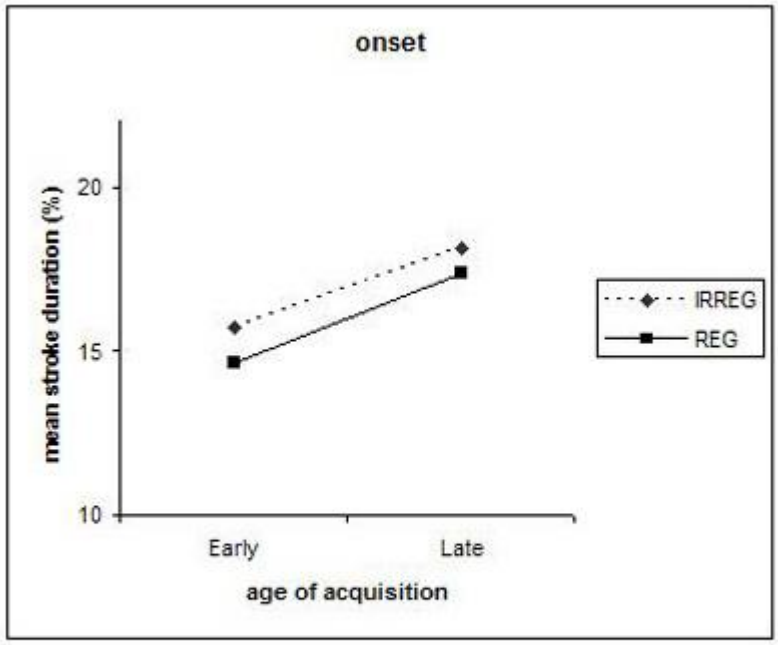

Figure 1. Mean stroke duration percentages for words a
and late in the Onset condition as a function of the orthographic cha
the word (irregular, regular).

Middle

Figure 2 presents mean stroke duration percentages for w
early and late at the Middle position. Again, there was no grade e
factor did not interact with any of the other variables. Means st
percentages were higher for irregular words than regular ones ($F(1, 4$
< .001) but the differences were significant only for the words acqu
42) = 78.33, $p < .001$). Age of acquisition was also significant ($F(1, 4$
< .001). The interaction between orthographic regularity and age of a
significant ($F(1, 42) = 23.92$, $p < .001$).

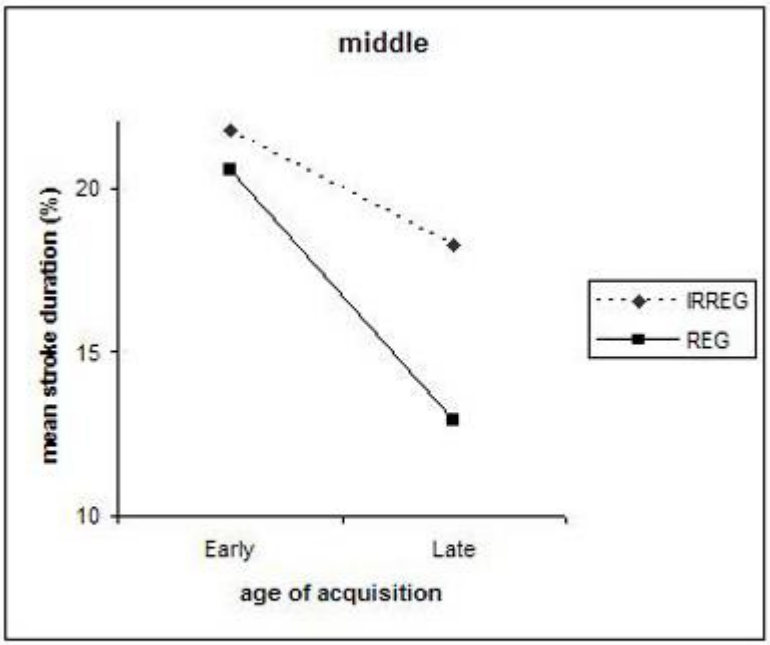

Figure 2. Mean stroke duration percentages for words a
and late in the Middle condition as a function of the orthographic cha
the word (irregular, regular).

End

Figure 3 presents mean stroke duration percentages for w
early and late at the End position. The ANOVA revealed no significar
of grade level. It did not interact with any of the other factors.
regularity did not yield significant effects. Age of acquisition was si
42) = 10.12, p = .002). The interaction between the two factors was si
42) = 17.74, p < .001). For words acquired early, duration percentage
for regular than irregular words (F(1, 42) = 4.04, p = .05). For words
duration percentages were higher for irregular than for regular word
18.21, p < .001).

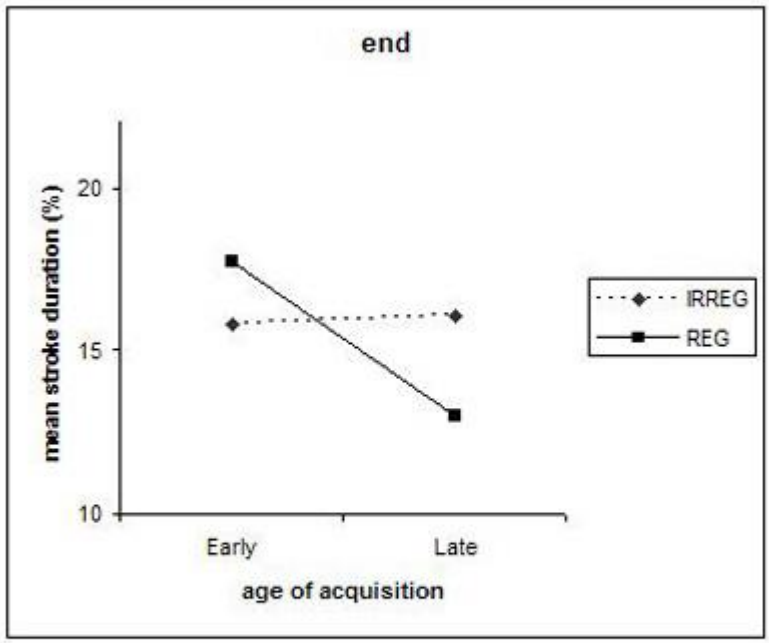

Figure 3. Mean stroke duration percentages for words a
and late in the End condition as a function of the orthographic charac
word (irregular, regular).

Discussion

This study investigated whether orthographic irregularity
supplementary processing load in handwriting production du
acquisition. We used movement duration as an indicator of cognit
orthographic irregularity was located at the beginning, middle or
acquired early or late. The results revealed that mean stroke duratio
for irregular words were higher than for regular ones, both for firs
grade children. This pattern of results only reached significance for w
late.

The fact that the relative duration of critical letter strokes
irregular than regular words indicates that orthographic irregularity
supplementary processing load with respect to the processing of r
However, the differences did not reach significance for words acquir
suggests that irregular words acquired early are already stored in the
lexicon together with their orthographic characteristics and are acce
There was no supplementary processing time because the children
the spelling from the lexicon, in the same fashion as for regular wo
words are unfamiliar, their corresponding orthographic representatio
be unavailable (Share, 1995) or underspecified (Perfetti, 1992). The
tends to apply phonological recoding rules. These rules work succ
writing regular words (Share, 1995, 1999). The child reads the regula
screen, keeps its spelling in the graphemic buffer and programs the

write it down. When the child has to write an unfamiliar irregular v of operation fails. He/she has to memorize the spelling of the wh remember that there is a part of the word -the irregularity- that re attention. In other words, the spelling of the word is harder to keep because there is no coherence between graphemes and phonemes a of the irregularity. Therefore, the strategy the child has to adopt to v without error is a) to process the identity and location of the letters t irregularity separately; or b) to write the word by applying graphc conversion rules and realise that the rules do not apply at certain lc kinds of operations constitute supplementary cognitive loads t consuming and result in an increase in processing time, as shown by al. (2003) in typing.

It should be noted that Kandel and Valdois (in press) children program their handwriting movements according to the syllab the word. In other words, they anticipate the letter sequences furth program them before hand. The results presented in this paper for ir acquired late indicate that there is a more letter by letter programmi several reasons for these differences. The most important one is tha Valdois (in press) used very familiar regular bi-syllabic words. The c therefore access their orthographic representation i.e. their spelli "unwrap" the word into the syllabic components that serve as input system. This is supported by the fact that in the present study there differences between regular and irregular words when they are a Another relevant reason for these differences is that orthographic syl irregular words is not as straightforward as for regular words. For ex is the syllable boundary for the word *monsieur*? Phonologically, the sy m/sj, but orthographically it is unclear to which syllable the *o* and because normally they represent the phoneme /õ/. So when the irre unfamiliar, it is likely that the children apply a letter by letter processir that does not even consider syllable boundaries. Finally, note that i Valdois (in press) first graders wrote some pseudo-words letter by let that an analytic strategy can be applied when letter sequences are un

Furthermore, age of acquisition was significant at the thr positions. For the onset position, the duration of critical letter strokes words acquired early than acquired late. This could be due to the fa onset position the retrieval is done just before starting to write. Alsc and writing from an overlearned spelling dictionary is more efficient. F end positions, the duration of the critical letter strokes was globally hig acquired early than acquired late. It seems that the retrieval by l through the application of phoneme-grapheme transcription rules efficient way.

This study investigated the effect of orthographic regu developmental perspective. We hypothesized that orthographic irre affect first graders more than second graders. The results do not sup There was no grade effect in any of the conditions. This could be d that the words acquired late were equally unfamiliar to first graders th

graders. Another possibility is that second graders did have s orthographic representation of the irregular words acquired late, bu information was underspecified or insufficient (Perfetti, 1992). It shou out that Bloemsaat et al. (2003) found an irregularity effect in irregularity effect when writing unfamiliar words could therefore b adulthood and not evolve during spelling acquisition. Further researcl assess this issue.

Finally, this experiment provides further evidence t variables such as orthographic regularity (Bloemsaat et al., 200 familiarity (Søvik et al., 1994) affect written language performance movement time during word production. Movement time increase supplementary cognitive loads that arise from the parallel proce linguistic characteristics of the word and the lower levels of handwriti such as allograph selection, size control and muscular adjustments 1991; Van Galen et al., 1986).

Appendix.

Irregular and regular words for early and late acquire orthographic irregularity appeared at the onset, middle and end of the are indicated the orthographic irregularities of the irregular words.

	Irregular words		**Regular**
	Acquired early	Acquired late	Acquired
Onset	quatre horloge	hurler mystère	diable bordure
Middle	cahier bonheur	façade méthode	camion bonjour
End	soldat cadenas	désert paletot	sortir capital

References

Bloemsaat, J. G., Van Galen, G. P., & Meulenbroek, R. G. J. (20 effects of orthographical irregularity and auditory memory load on the transciption typewriting. *Psychological Research, 67*(2), 123-133.

Caramazza, A., & Miceli, G. (1990). The structure of graphemic *Cognition, 37*, 243-297.

Caramazza, A., Miceli, G., Villa, G., & Romani, C. (1987). The role c buffer in spelling: Evidence from a case of acquired dysgraphia. *Cognition, 26*,

Frith, U. (1985). Beneath the surface of developemental dyslexia. In K J. C. Marshall & M. Coltheart (Eds.), *Surface dyslexia: cognitive and neu studies of phonological reading* (pp. 301-330). London: Erlbaum.

Frith, U. (1986). A developmental framework for developmental dys
Dyslexia(36), 69-81.

Kandel, S., Alvarez, C. J., & Vallée, N. (submitted). Syllables as pro
handwriting production.

Kandel, S., & Valdois, S. (in press). Syllables as functional units in a
visuo-othographic and graphomotor approach. *Language and Cognitive Proce*

McCloskey, M., Badecker, W., Goodman-Schulman, R. A., & Alimi
The structure of graphemic representations in spelling: Evidence from a c
dysgraphia. *Cognitive Neuropsychology, 11*(341-392).

Meulenbroek, R. G. J., & Van Galen, G. P. (1986). Movement analy
behavior of first, second and third grade primary school children. In H. S. R.
Galen & R. Hoosein (Eds.), *Graphonomics: Contemporary research in hanc*
92). Amsterdam: North Holland.

Meulenbroek, R. G. J., & Van Galen, G. P. (1988). The acqui
handwriting: Discontinuous trends in kinematic variables. In A. M. Cooley
(Eds.), *Cognition and action in skilled behavior* (pp. 273-281). Amsterdam: Nor

Meulenbroek, R. G. J., & Van Galen, G. P. (1989). The productio
strokes in cursive writing: Developing co-articulation in 8 to 12 year-old
Plamondon & C. Y. Suen & M. L. Simner (Eds.), *Computer recognition and hu*
of handwriting. Singapore: World Scientific.

Meulenbroek, R. G. J., & Van Galen, G. P. (1990). Perceptual-mot
printed and cursive letters. *Journal of Experimental Education, 58*, 95-110.

Mojet, W. (1991). Characteristics of developping handwriting skill
education. In W. J. & W. A. M. & N. Sovik (Eds.), *Development of graphic s*
London: Academic Press.

Orliaguet, J. P., & Boë, L. J. (1993). The role of linguistics in the spee
movements. *Acta Psychologica, 82*, 103-113.

Orliaguet, J. P., Zesiger, P., Boë, L. J., & Mounoud, P. (1993). *Effects*
handwriting production: Analysis of reaction time and movement velocity. Pap
the Sixth International Conference on Handwriting and Drawing, Paris.

Perfetti, C. A. (1992). The representation problem in reading acquisiti
& L. C. Ehri & R. Treiman (Eds.), *Reading acquisition* (pp. 145-174). Hillsdale
Erlbaum Associates.

Rabiner, L. R., & Gold, B. (1975). *Theory and application of digital si*
N.J.: Prentice-Hall.

Seidenberg, M. S., Waters, G. S., Barnes, M. A., & Tanenhaus, M. I
does spelling or pronunciation influence word recognition? *Journal of Verb*
Verbal Behavior, 23, 383-404.

Share, D. L. (1995). Phonological recoding and self-teaching: S
reading acquisition. *Cognition, 55*, 151-218.

Share, D. L. (1999). Phonological recoding and orthographic learning
the self-teaching hypothesis. *Journal of Experimental Child Psychology, 72*, 95

Søvik, N., Arntzen, O., Samuelstuen, M., & Heggberget, M. (1
between linguistic wordgroups and writing. In C. Faure & G. Lorette & *A*
Advances in handwriting and drawing: A multidisciplinary approach (pp. *2*
Europia.

Sprenger-Charolles, L., Siegel, L., Béchennec, D., & Sernicla
Development of phonological and orthographic processing in reading aloud, i
and in spelling: A four-year longitudinal study. *Journal of Experimental Child*
194-217.

Ters, F., Mayer, G., & Reichenbach, D. (1988). *L'échelle Dubo*
Editions OCDL.

Teulings, H. L., Thomassen, A. J. W. M., & Van Galen, G. P. (1983)
partly precued handwriting movements: The size of movement units in ha
Psychologica, 54, 165-177.

Van Galen, G. P. (1991). Handwriting: Issues for a psychomotor *Movement Science, 10*, 165-191.

Van Galen, G. P., Meulenbroek, R. G., & Hylkema, H. (1986). On tl processing of words, letters and strokes in handwriting: Evidence for a m parallel model. In H. S. R. Kao & G. P. V. Galen & R. Hoosain (Eds.), *Contemporary Research in Handwriting* (pp. 5-20). Amsterdam: North Holland.

Van Galen, G. P., Smyth, M. M., Meulenbroek, R. G. J., & Hylkema role of short-term memory and the motor buffer in handwriting under visual guidance. In R. Plamondon & C. Y. Suen & M. L. Simner (Eds.), *Computer human production of handwriting* (pp. 253-271). Singapore: World Scientific.

Waters, G. S., Bruck, M., & Seidenberg, G. (1985). Do children use s to read and spell? *Journal of Experimental Child Psychology, 39*, 293-305.

Wing, A. (1980). The height of handwriting. *Acta Psychologica*(82), 35

Wing, A. M., & Baddeley, A. D. (1980). Spelling errors in handwriting: distributional analysis. In U. Frith (Ed.), *Cognitive processes in spelling*. Lo Press.

Zesiger, P., Mounoud, P., & Hauert, C. A. (1993). Effects of lexica frequency on handwriting production in children and adults. *Acta Psychologica*

About Sonia KANDEL

Laboratoire de Psychologie et NeuroCognition - CNRS UMR 5105 U Mendès France, Grenoble - France B.P. 47 38040 Grenoble Cedex 09 Fr 476 82 58 93 Fax : 33 476 82 78 34 Email : Sonia.Kandel@upmf-greno Estudios Lingüísticos y Literarios - El Colegio de México, Mexico D.F. - M

About Sylviane VALDOIS

Laboratoire de Psychologie et NeuroCognition - CNRS UMR 5105 U Mendès France, Grenoble - France

To quote this article

Sonia Kandel and Sylviane Valdois . «The effect of orthographic regularity handwriting production». *Current Psychology Letters,* 17, Vol. 3, 2005 http://cpl.revues.org/document463.html

<< Previous