Aspects of Fluency in Writing

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Abstract The notion of 'fluency' is most often associated with spoken-language phenomena such as stuttering. The present article investigates the relevance of considering fluency in writing. The basic argument for raising this question is empirical — it follows from a focus on difficulties in written and spoken language as manifestations of different problems which should be investigated separately on the basis of their symptoms. Key-logging instruments provide new possibilities for the study of writing. The obvious use of this new technology is to study writing as it unfolds in real time, instead of focusing only on aspects of the end product. A more sophisticated application is to exploit the key-logging instrument in order to test basic assumptions of contemporary theories of spelling. The present study is a dictation task involving words and 'non-words', intended to investigate spelling in nine-year-old pupils with regard to their mastery of the doubling of consonants in Norwegian. In this study, we report on differences with regard to temporal measures between a group of strong writers and a group of poor ones. On the basis of these pupils' writing behavior, the relevance of the concept of 'fluency' in writing is highlighted. The interpretation of the results questions basic assumptions of the cognitive hypothesis about spelling; the article concludes by hypothesizing a different conception of spelling.

Keywords Spelling · Strategy · Automaticity · Awareness · Key-logging

Introduction

In the study of reading disorders over the past decades, the phonological basis for written-language acquisition has been focused upon, and assumptions about phonological causes have been included in definitions of 'dyslexia' (Tønnessen, 1997). By means of new key-logging technology, it is now possible to investigate writing behavior without a priori assumptions about the relationship between written-language and spoken-language skills. The motivation for carrying out such investigations is empirical, and the objective is to enhance our knowledge about the relationship between written-language and spoken-language skills: 'By implication, we believe that the coupling of on-line studies of linguistic behavior and the flow of discourse in both speech and writing with analyses of linguistic information encoding will pave the way for a richer and more fruitful scientific investigation of the production, percep- tion/understanding, and acquisition of language' (Strömqvist, Nordqvist, & Wengelin, 2004). In the present study, we investigate the potential of key-logging technology for testing established

hypotheses about spelling. In doing so, we stress the notion of 'process' by focusing on spelling as it unfolds in real time.

In this respect, our work is different from traditional approaches, which tend to focus on 'process' as a series of end products, for example by studying the time elapsed in writing whole words. First, our position is based on a neo-Whorfian view of the differences between spoken and written language, formulated as *thinking-for-speaking* (Slobin, 1996) and *thinking-for-writing* (Strömqvist et al., 2004). According to this position, the differences in terms of on-line constraints on spoken and written communication determine the cognitive effort required and the temporal patterns manifested in each mode. The time elapsed is seen as related to the degree of cognitive effort: a short time is interpreted as indicative of a small effort, while a long time is considered to indicate a large effort. It should be noted, however, that to some extent, pausing behavior during writing seems to be sensitive to linguistic structures of different spoken languages (Weingarten, Nottbusch, & Will, 2004; Wengelin & Strömqvist, 2005).

Second, we base our approach on a nuanced understanding of 'skill', defined as a flexible combination of automaticity and awareness (Tønnessen, 1999). According to this view, every skill involves some degree of awareness, and even a very skilled writer exhibits some degree of awareness, on a continuum from monitoring (low-awareness and high-automaticity) to steering (high-awareness and low-automaticity). Tønnessen's position is central to our understanding of 'process' and opens up for seeing writing from the viewpoint of fluency. These two theoretical positions are combined (Uppstad & Wagner, 2006) in order to interpret the measurements of transition times between keystrokes provided by the key-logging instrument ScriptLog (www.ScriptLog.net).

Research on the cognitive processes involved in children's spelling has given rise to the claim that two main strategies are used. The first involves mapping of phonemes onto graphemes representing them, and is often called the *rule-based* or *phonological strategy*. The second strategy emphasizes orthographic knowledge and word-specific memory, and is often referred to as the *lexical* or *orthographic strategy.* As regards development, the phonological strategy is claimed to precede the orthographic strategy in learner writers. Several models have been proposed to portray how the spelling process changes as a pupil acquires word-spelling skills (Henderson and Beers, 1980; Gentry, 1983; Frith, 1985; Bråten, 1991; Ehri, 1997; Høien, 1997). These models are based on analyses of spelling errors in children's invented spellings. Ellis (1997) has claimed that most of the models of development in spelling can be seen as stage theories. An implicit premise of stage theories is that development is viewed as discontinuous; each stage is qualitatively different from the previous one, and development proceeds in a specific order. For spelling, this implies a characteristic progression from stage to stage where qualitatively different cognitive processes are involved in children's spelling at different points in their development. To illustrate these different cognitive processes, some researchers have identified different strategies (Bråten, 1991; Høien, 1997) or processes (Ehri, 1997; Ehri & McCormick, 1998). A stage theory in the strict sense of the term does not allow any overlap between stages. Varnhagen (1995) claims that a more direct examination — in terms of 'letter-production latencies' — may lead to a richer description of children's strategic spelling behavior. She suggests that by using this kind of approach, we would be able to make closer observations of developmental and individual differences in spelling strategies. Ehri and McCormick (1998, p. 140) have chosen to describe a development through phases,

'(...) which is a less stringent way to characterize periods of development than the concept of stage'. Ehri (1997) proposes that knowledge about the alphabetic system and word-specific knowledge serves as a knowledge base for writers' spelling. This knowledge base enables writers to arrive at the spelling of a word along different routes: by memory, by invention or by analogy. Which kind of knowledge is activated depends on whether a particular written word form is familiar or unfamiliar. According to Ehri, familiar words are spelled by activation of knowledge from memory, while unfamiliar words are spelled by invention (i.e. by slowing down the pronunciation, detecting sound units, and activating knowledge about the alphabetical system to generate plausible letter sequences for the words) or by analogy with familiar words already present in memory. In our view, though, it is very unclear how to distinguish between memory, invention, and analogy. Ehri suggests a development where alphabetic knowledge is the key capability underlying developmental stages/phases. Instead of there being strict dividing lines between processes, she argues that each phase highlights a characteristic of word learning which rises to prominence in that phase.

The relationship between strategies used in spelling and the developmental sequence seems to differ somewhat across orthographies. English-speaking children start out as mainly logographic spellers, and while most of them develop into phonological readers and spellers as time goes by, poor readers continue to rely heavily on visual-memory skills (Lennox & Siegel, 1996, 1998). German-speaking children, on the other hand, appear to break the alphabetical code relatively easily and depend less on an inadequate logographic strategy than English-speaking children (Valtin, 1997; Wimmer & Landerl, 1997). These differences are explained with reference to the transparency and complexity of the two orthographies (German orthography being more transparent than English) and differences in reading instruction (German reading instruction focusing more on phonics than English). As regards Norwegian orthography, Hagtvet and Lyster (2002) found a pattern more similar to that of German-speaking than of English-speaking children. It should be noted, however, that all these studies focus on beginning spellers.

In addition to the developmental domain, where a phonological strategy seems to precede a lexical (orthographic) strategy, the use of strategies is also explained in relation to different word types, that is high- versus. low-frequency words and words with versus. without orthographic complexities.

The present study focuses on the doubling of consonants in Norwegian. This context is of particular interest for two reasons. First, it represents the most frequent spelling error among Norwegian pupils? Second, it highlights aspects of prosody in the process of writing. By focusing on the representation of quantity, we study a word type with hypothesized orthographic complexity. In Norwegian orthography, the consonant is doubled if the preceding vowel is short. This general 'quantity rule' is quite abstract because the doubling of the consonant depends on quantity conditions lying outside the segment in focus — specifically, the quantity of the preceding vowel. This Norwegian rule can be said to be a somewhat more intellectualized rule than the Finnish one, where quantity is represented in a more direct way by doubling of the vowel or consonant, or both, according to the quantity of the sound(s). Such a major difference in the representation of quantity compared with Finnish might have a strong impact on transition times between keystrokes in our target conditions, because different notational systems (orthographies) may require more or less awareness at different levels. In the Norwegian curriculum, the representation of quantity is not dealt with until the fifth grade; as the pupils

included in the study have not yet reached the fifth grade, what we are investigating is more an issue of correct spelling than mastery of a part of the basic notational system.

Earlier studies of Finnish have found that sensitivity to quantity is a central factor differentiating children at risk of developing dyslexia from controls (for instance, Leppänen et al., 2002; Lyytinen et al., 2005). Our approach is similar to that used to investigate temporal measures in a Finnish study (Nordqvist, Leiwo, & Lyytinen, 2003). This study found the transition time *before* the first of the doubled consonants to be significantly longer than the transition time *between* the doubled consonants, but with no differences between groups of pupils. The differences found between these two contexts were interpreted as showing that the judgement of quantity was undertaken before writing the doubled consonants, not between the two consonants. In our study, we hypothesized a difference between groups of pupils in that the marked position would be before the doubled consonants in a group of strong writers, but not in a group of poor writers. This hypothesis was based on the different ways of representing quantity in the two orthographies. It should be noted that this hypothesis questions traditional views of strategies in spelling.

The rather precise hypothesis tested in the present study is also supported by our general reflections on the notion of 'strategy'. A cross-linguistic perspective shows 'strategies' to be highly heterogeneous, and therefore the relevance of such a concept is questioned. Another unfortunate aspect of the term 'strategy' is its strong implication of awareness. Our position is based on Tønnessen's (1999) model of 'skill' as the flexible combination of automaticity and awareness. The theoretical foundation of this model is connectionism (Elman et al., 1996). Tønnessen himself has applied the model to reading; here it is expanded to spelling and writing. According to this model, a skill is always partly automatic and partly conscious, and we know that something is a skill when it can be performed better with awareness than without it. From this point of view, there are no static modes of spelling behavior to be characterized — instead, the exact combination of automaticity and awareness alters as the writing of even a simple word unfolds.

Method

The sample included 47 subjects with an average age of 9 years and 3 months (standard deviation: 6 months), drawn from a population of 135 pupils. There were 28 girls and 19 boys. The pupils were chosen based on their teachers' evaluation of them as either poor writers (22 pupils) or strong writers (25 pupils). The teachers were asked to choose the five weakest and five strongest writers in each class. While it should be noted that the number of pupils in each class varied, this would mean that the cut-off points of the two groups of good and poor writers represent approximately the 18th and 81st percentile of the population. All pupils except two have Norwegian as their first language. These two pupils are included in the sample, one in each of the two groups, and may stand as an example of the position chosen in this paper concerning writing behavior: when studying writing, one should be careful about the use of exclusion criteria that are based on the subjects' spoken-language skills.

Further, the pupils differ with regard to what written norm of Norwegian they are taught: 19 of them follow a curriculum based on the written norm 'Nynorsk' and 28 of them one based on the written norm 'Bokmål'. In fact, the Norwegian language situation is unique in that it has two norms which are very close to one another

(Kristoffersen, 2000). Norwegian is also a language without an officially recognized spoken norm. This means that few inhabitants can be said to speak a language extensively reflecting the norm which they follow in writing; Kristoffersen (2000) claims that more writers of Bokmål than of Nynorsk can be said to 'speak as they write'. In our experiment, the target words were recorded in the regional dialect, and the pupils wrote them according to the norm of their choice. As a consequence, the target words in the experiments are all present according to both norms.

The recordings and analyses of the pilot were carried out using the tool ScriptLog (Strömqvist & Karlsson, 2001), developed by Professor Sven Strömqvist and his team (University of Lund, Sweden, and University of Stavanger, Norway). ScriptLog makes it possible to study writing behavior on-line — that is, as it unfolds in real time. Computer logging of writing activity provides a record of a writer's speed, his or her fluent and hesitant phases, and revisions made during the spelling of a word or the composition of a text. ScriptLog keeps a record of all events on the keyboard and provides highly precise measures of transition times between keystrokes as data for statistical analyses. Further, ScriptLog provides facilities for designing different writing experiments, for example different types of elicitation instruments.

The words were chosen to reflect the phonotactic properties of Norwegian and were recorded in a natural voice. The recordings of the words were set up as elicitation material in a writing experiment designed within the ScriptLog format. The pilot test was divided into two parts: a list of 'non-words' and a list of real words. The 'non-word' experiment consisted of 13 items, where eight contained consonant doubling. These eight items consisted of four 'non-words', each appearing twice. The analysis made is based on these eight items. The experiment with real words consisted of 25 items, of which 15 contained consonant doubling. These 15 items consisted of eight different words representing a diversity of frequency, ranging from infrequent to very frequent words (see Appendix A). When instructed before the test, the sub- jects were told whether they would be hearing 'non-words' or real words. Within each experiment, the words appeared in random order and each word was pronounced twice (with a one-second interval). The subjects were asked to spell the word they had just heard, using the keyboard. When they finished typing a word, they pressed a button, and the next item was presented. Only words which were spelled correctly with respect to consonant doubling were analysed.

The analysis is based on three temporal measures. For each pupil, the median transition times *before* and *between* doubled consonants are used. Additionally, we used the median transition time between all letters (i.e. inside words — not between spaces and letters) in the experiment as a baseline for temporal measures. This measure is represented by 'aˆa', where 'a' represents 'any letter' Fig. 1.

		Before doubled consonants	Between doubled consonants			
	*^e	**e^t**	**t^t**	t^e	e^r	r^*
etter	0.070	**1.542**	**0.230**	0.371	0.430	5.859

Fig. 1 The figure shows an example of transition times (in seconds) of one subject in each micro-context in the word *etter* 'after'. The symbol ^ represents a transition and the symbol (*asterisk*) represents a space. *Bold* characters indicate the target contexts of our study: before and between doubled consonants

Results and interpretation

As regards the 'non-words', the poor writers hardly doubled any consonants at all, and thus no comparison could be made between the two groups. The following results are therefore based only on the real words. The results show differences in relative transition times between the groups:

For the group of strong writers, we found by Wilcoxon signed ranks test that the transition time before the doubled consonants was significantly longer than a^a ($p < 0.005$), while a^a was significantly longer than the transition time between the doubled consonants ($p < 0.001$).

For the group of poor writers, though, we found no significant difference between the transition time before the doubled consonants and a^a. However, a^a was significantly longer than the transition time between the doubled consonants (Wilcoxon signed ranks test: $p < 0.001$). The difference in relative length of transition times for the two groups is shown in Figure 2.

Usually, studies of spelling measure the time elapsed for entire words. In this tradition, a long writing time *indicates* a low degree of automaticity and is usually interpreted as showing the use of a phonological strategy, while a short writing time *indicates* a high degree of automaticity and is usually interpreted as showing the use of an orthographic strategy. However, when we take into account the intra-word differences in fluency which can be seen from the transition times of the two groups investigated in the present article, it becomes evident that the traditional approach fails to capture important information about the writing process. This information concerns the time elapsed in different contexts inside a word.

In the present study, we have found differences in how groups of pupils write doubled consonants. The interesting point is that these findings question the assumptions of the traditional approach. On the assumption that elapsed time can be linked to the degree of cognitive effort and awareness, skilled writers actually show a significantly

Strong writers
Elapsed time before doubled consonants > a^a > elapsed time between doubled consonants
Poor writers
Elapsed time before doubled consonants = a^a > elapsed time between doubled consonants

Fig. 2 Differences in transition times between strong and poor writers. The symbol > means 'significantly longer than' while the symbol = means 'not significantly longer than'

higher awareness before writing doubled consonants than in other contexts. This means that skilled — and not poor — writers perform in a way which has been associated with a phonological strategy when they write doubled consonants. This interpretation is supported by the error analysis and by the fact that the poor writers double consonants only in words of high frequency. Moreover, this difference is not a matter of keyboard skills, because there are significant differences between micro-contexts in each group.

Conclusion and new hypothesis

Those studying only the writing time of an entire word usually adhere to traditional assumptions about strategies, where *either* automaticity *or* awareness characterizes the spelling process. On this position, the spelling of strong writers is characterized by automaticity while that of poor writers is characterized by a great effort spent on awareness. However, our investigation of transition times in different micro-contexts inside words shows a more nuanced picture, and we claim that the flexible relationship between automaticity and awareness which we have found questions traditional views of strategies in spelling.

A new hypothesis of spelling can be formulated on the basis of a nuanced notion of 'skill' as a flexible combination of automaticity and awareness. It is hypothesized that the complex processes of spelling can be described by means of this interplay, and that the relationship between automaticity and awareness varies as writing unfolds in real time in different micro-contexts inside words. This amounts to focusing on a nuanced understanding of 'process' in spelling, a notion that opens for the study of fluency disorders in writing. What is more, this hypothesis is in better accordance with existing data than the cognitive hypothesis, and it is open to falsification.

Appendix A

List of Norwegian target words used in the word experiment, with their English translations and their frequency expressed as the number of occurrences in a written corpus of one million words (Vestbøstad, 1989).

ikkje (ikke)	'not'	10203
dette	'this'	4165
etter	'after'	3047
sette	'put'	382
legge	'lay'	96
slikke	'lick'	4
leggen	'lower leg'	1
tappe	'tap off'	1

The spelling *ikkje* is Nynorsk while *ikke* is Bokmål; the other seven words are spelled identically according to both norms.

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