

Handwriting and Writing

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Published as: Medwell, J. & Wray, D. (2010) 'Handwriting and Writing', in Wyse, D., Andrews, R. & Hoffmann, J. (Eds.) *The Routledge International Handbook of English, Language and Literacy Teaching* London: Routledge. Pp 193-202e

Abstract

Handwriting has been a rather neglected aspect of writing in mainstream education, although there has been a great deal of important research carried out from a special needs perspective. One major purpose of this chapter is to relate the findings of this research to mainstream writing education. We will do this by firstly suggesting that composition-led approaches to writing have underestimated the role of automatic handwriting within that composition. We go on to explore this role and the importance of what has come to be known as orthographic-motor integration. We conclude by suggesting some pedagogic ways forward in this area, particularly in terms of designing suitable intervention programmes, and producing a rational basis for selecting those learners who might benefit from such interventions.

Introduction

Handwriting is a well researched area of literacy activity but remains an unfashionable topic in mainstream literacy teaching. This chapter explores this paradox and reviews research from the domains of neuroscience, graphonomics and psychology. This research raises important issues for mainstream literacy teachers and suggests that handwriting is a crucial part of the writing process which may be neglected for many children. This neglect may in turn adversely affect the composition of these children.

The handwriting paradox

The last thirty years have seen some major shifts in definitions of literacy. Early literacy studies across the world (e.g. Ferreiro & Teberosky, 1979; Pontecorvo & Zuccermaglio, 1990) identified the forms of writing of pre-school children and placed them on a developmental continuum. Researchers demonstrated that, with the right support, children could write meaningful texts before they had mastered the writing system (Teale & Sulzby, 1986). They analysed children's early writing for evidence of understandings about the language system (Clay, 1975), spelling (Gentry, 1981) and audience (Hall, 1987). This produced a pedagogy that came to be known as *emergent writing* (Hall, 1987; Teale & Sulzby, 1986) which placed the focus of attention in children's writing firmly on the meanings children were able to create. In such a pedagogy, children were encouraged to write freely and to use their emerging understandings of language and writing skills to express themselves. This inevitably created tension between ensuring that children developed correct letter formation and the desire to allow them to write unimpeded. (This dominance of early composition was not universal. French speaking countries, for example, continued to emphasise "graphisme" and pursue the teaching of handwriting before beginning composition.)

The pedagogy of writing for older children was, likewise, shaped by research that stressed the division between the processes of composing and transcribing text (Graves, 1983) producing what was known as a 'process approach'. Graves describes the writing process as a series of stages, with the teacher as facilitator, rather than instructor. Process writing researchers had little to say about handwriting, except to emphasise that it was not a significant success criterion in writing.

A composition-led view of writing is very much part of mainstream literacy teaching in many countries. In England, the National Curriculum (DfEE, 2000) requires that children be taught to plan, draft, revise, proof-read and present their work, a direct reflection of the process approach. In the US, the achievement standards set in most states follow a similar line. In Pennsylvania, for example, the academic standards expected of all children list 5 standards for writing which emphasise aspects of composition, one which focuses on spelling, and one which mentions presentation, where children are expected to "Present and/or defend written work for publication when appropriate" (Pennsylvania Department of Education, 2008) This particular standard is the same for children from Grade 1 (6-7 year olds) to Grade 11 (17-18 year olds). This recurrent emphasis upon composing may have drawn attention away from handwriting at a time when a good deal of interesting research about the relationship between handwriting and writing was being undertaken.

Handwriting and writing

Over the years, a number of models of the writing process have been developed which ascribe different roles to handwriting. Hayes and Flower's (1980) model placed great emphasis on the recursive nature of the writing process, especially the planning and self-monitoring required by the writer. However, the translation element of this model, the component in which ideas are generated and written on paper, was given little importance in planning and reviewing. Berninger and Swanson (1994) modified the translation component to include two aspects: text generation and transcription. Text generation is how the writer transforms the ideas generated in planning into language representations in working memory. Transcription is how the writer transforms those representations into orthographic symbols through writing (or keyboarding). They theorised that deficits in transcription could interfere with text generation.

At the heart of the process is working memory, in particular short term working memory, the temporary storage of the information necessary for carrying out tasks. This is limited in the amount of material it can hold (a few items) and in the length of time it can hold it (a few seconds). Understanding the ways different writing processes draw upon the same limited working memory resources could explain why some writing processes are more difficult than others and how these processes may interfere with each other. Most models of writing (e.g. Kellogg, 2001; Hayes & Flower, 1980) give a central role to working memory and the findings of Gathercole *et al* (2004) suggest that working memory is particularly associated with the literacy scores of younger children. If young writers have to devote large amounts of working memory to the control of lower-level processes, such as handwriting, they may have little left for higher-level processes. If handwriting consumes a large proportion of working memory capacity it

may limit the child's ability to generate ideas, select vocabulary, monitor progress and revise text.

This is the key issue for models of writing and handwriting in primary schools today. Christensen (2005) points out that individuals can generally conduct only one cognitive task requiring attention at a time (Sweller, 1988). This means that in addition to the processes of writing such as idea generation, planning and revising, the way in which an individual manages his or her cognitive resources is also critical for successful writing (Saada-Robert, 1999). One way to limit the demands on working memory is to sequence tasks so that only one is undertaken at a time. This has been a popular way to manage writing processes at a pedagogical level and planning, drafting, revising and proofreading have been sequenced as steps in the writing process in many classrooms, in an attempt to reduce their competing demands on young writers. However, the research discussed above suggests that this is unlikely to be a successful strategy at a cognitive level, as writing processes are recursive and closely linked. It is also hardly possible to isolate or defer the handwriting element of writing, since without it, no writing would actually exist!

A better solution is to make some processes, such as handwriting, automatic, in order to free up cognitive resources to deal with higher level processes. Automaticity is achieved when a process can be effected swiftly, accurately, without the need for conscious attention (La Berge & Samuels, 1974). The development of skill in writing may require the automatization of lower-level skills so that they use less of the available working-memory resources. An impressive programme of structured research undertaken in the last fifteen years (Berninger *et al*, 2002; Berninger, 1994; Berninger & Graham, 1998) has led to the development of a simple model of writing with a developmental element (Wong and Berninger, 2004). This involves the application of "transcription skills" (letter production and spelling) and emerging "executive functions" (control of planning, monitoring and revising), through working, long and short term memory, in order to generate text. The research underpinning this model has established that handwriting is far from a purely motor act. Berninger and Graham (1998) stress that it is "language by hand" and their research suggests that orthographic and memory processes (the ability to recall letter shapes) contribute more to handwriting than do motor skills (Berninger & Amtmann, 2004).

Orthographic-motor integration of handwriting is the ability to call to mind and write letter shapes, groups of letters and words efficiently without allocation of cognitive attention. This involves mentally coding and rehearsing visual representations of these patterns and integrating them with motor patterns (Berninger, 1994). A number of studies suggest that automatic handwriting is critical to the generation of thoughtful and well-structured written text and has an impact not only on fluency but also on quality in writing (Berninger & Swanson, 1994; Graham *et al*, 1997). Automatic handwriting requires no cognitive attention, thus leaving more for the composition aspects of writing. Lack of automaticity in orthographic-motor integration can seriously affect young children's ability to express ideas in text (Graham, 1990). De La Paz and Graham (1995) found, for example, that when children were able to dictate their texts to an adult, thus freeing them from physical handwriting, the quality of their composition improved. Other studies have also shown that the elimination of the mechanical demands of

writing through dictation results in an increase in the amount of text generated by primary aged children (e.g., Hidi & Hidyad, 1983; McCutchen, 1996).

Studies have also suggested that orthographic-motor integration accounts for a surprisingly high proportion of the variance in written language performance in children. Christensen and Jones (2000) put this as high as 67% for the seven-eight year olds they studied. Berninger and Graham (1998) reported that handwriting automaticity accounted for 25% of the variance in compositional quality in primary grades in the USA. In our own research, with almost 400 seven and eleven year old children, orthographic-motor integration accounted for 34% of the variance in composition in the seven year olds (Medwell et al, 2007) and 21.5% in the eleven year olds (Medwell et al, forthcoming). Other studies have indicated that the influence of orthographic-motor integration declines with age (Berninger & Swanson, 1994) but continues to exert an influence on writing well into secondary school (e.g. Christensen & Jones, 2000).

The research described above generally looks at the products of writing. However, graphonomics can look at handwriting not as a product but as a process by studying its spatial and kinetic parameters. Using digitizing tablets, researchers are able to record and examine the position, time, velocity and acceleration of the writing implement of a writer. This approach has a major benefit in that it allows investigation of the processes of handwriting from an objective point of view, avoiding reliance on the subjective evaluation of handwritten product (Longstaff and Heath, 1997). Graphonomics has given us an impressive body of evidence adding to our knowledge about automaticity in handwriting (Tucha, Tucha & Lange, 2008). Studying the smallest unit of handwriting, the letter stroke, researchers have been able to determine that automated production produces a smooth velocity curve with only one inversion of direction. The velocity profiles of skilled hand writers show that they are producing fully automated movements in their handwriting. By examining the effects of a variety of conditions on the velocity profiles of handwriting, researchers have been able to explore some of the elements which affect automaticity (Tucha, Tucha & Lange, 2008). In adults, writing backwards significantly reduces automaticity (Tankle & Heilman, 1983). Writing dictated non-words also produces significantly more inversions in velocity, indicating less automatic handwriting (Tucha et al, 2004). This suggests that the semantic information activated to write words is as important as the phonological and orthographic information (Siedenburg & McClelland, 1989).

Other graphonomic experiments have involved writers: writing with their eyes closed; visually tracking the pen tip; mentally tracking the highest points in the letter while their eyes are closed. Results show that that conscious visual and mental control of graphomotor output hampers the production of automated handwriting movements (Tucha & Lang, 2005). Experiments with ordinary children, children with attention deficit disorder and adults have demonstrated that the intention to write neatly interferes with automated handwriting processes (Tucha & Lange, 2004, 2005). Tucha et al (forthcoming) also examined the effect of offering a reward for neatness and found that this increased the number of inversions in velocity in children's handwriting. In other words, concentrating on neatness and especially concentrating on neatness for a reward reduces automaticity in handwriting (Tucha et al, 2008). This is a very important finding for handwriting policy and pedagogy!

Handwriting problems

Research has investigated the proportion of children with automaticity problems in handwriting. Graham and Weintraub (1996) estimated that between 12% and 20% of school-aged children experienced handwriting difficulties, and other estimates have ranged from 10% to 34% (Barnett et al, 2006; Rosenblum, 2005). In a longitudinal study of 407 children, 27% were classified as dysfunctional hand writers at age seven, but by age eleven only 13% were so classified (Karlsdottir & Stefansson, 2002). Jones and Christensen (1999) used children's ability to generate less than 13 letters per minute on an alphabet task (Berninger, Mitzokawa and Bragg, 1991) to select children for an intervention programme. In their sample of 114 pupils aged six-seven years this identified 21 (18%) of the sample. In our own study of 189 children of the same age, this cut-off point would identify 69 (37%) of the sample (Medwell et al, 2007). These findings suggest that lack of automaticity is a problem for a significant number of children and may be interfering with their composing processes.

Certain groups of children are more likely to have handwriting difficulties. These include pre-term children (Feder et al, 2005), children with learning difficulties (Waber & Bernstein, 1994) and boys. Boys are more likely to be identified with a handwriting problem than girls (Vlachos & Bonotti, 2004) and research has confirmed that girls are generally better handwriters than boys (Graham & Miller, 1980) both on measures of overall quality and of letter formation (Hamstra-Bletz & Blote, 1990; Ziviani & Elkins, 1984). Girls also tend to write faster than boys (Berninger & Fuller, 1992) and to have better levels of neatness and automaticity (Medwell et al, 2007). If handwriting does have an impact on children's ability to compose, it may be that the lesser likelihood of boys achieving automaticity is significantly implicated in their underachievement as writers. However, pedagogy has not developed to address this and handwriting has not generally been a focus of writing programmes aimed at boys, at least in the UK (e.g. UKLA/PNS, 2004).

Difficulties in handwriting may affect children's written performance in a number of ways. The motivational difficulties experienced by children suffering prolonged failure may cause some to give up on writing. Poor writing can affect emotional well-being through anxiety and children's academic progress is often judged through their handwriting. For children whose handwriting is slower and less automatic, there is a danger that this can create what Stanovich (1986) has called, in reading, the "Matthew effect" whereby those who are more able (usually girls) achieve more successful practice and, because of orthographic-motor integration, have more attention available for composing. In turn this leaves the less able with less opportunity to engage with higher order composing processes. In all these ways, as well as through the more direct mechanism of poor automaticity, handwriting may impact upon children's written composition.

Pedagogic ways forward

In the context of this research the possible effects of teaching on handwriting automaticity are important. Our research (Medwell et al, forthcoming) showed a strong

school effect. In one of the four schools in the study, children had relatively poor composition, speed and orthographic motor-integration but unexpectedly high levels of neatness. Further investigation revealed that the school had introduced regular daily handwriting practice for all children and had succeeded in raising neatness scores on externally marked tests. However, this improvement in neatness had not produced an improvement in orthographic-motor integration or in composition scores. It would seem that traditional handwriting teaching (copying rows of the same letter) had not developed children's automaticity.

Studies have explored the effects of more focused handwriting instruction on composition. Jones & Christensen (1999) measured the orthographic-motor integration, reading and written expression of 114 seven year olds before and after an eight week handwriting programme. These children showed significant improvement in their handwriting and, crucially, their composing skills. Christensen (2005) also reports a study of 50 thirteen-fifteen year olds who underwent an intensive handwriting programme. A matched control group did journal writing for a similar period. Although both the journal and handwriting groups were equivalent at pre-test, the scores for the handwriting group after eight weeks of intervention were 70% higher in orthographic-motor integration and 46% higher in quality of written text than the journal group. The handwriting group also wrote approximately twice as much as the journal writers. Christensen's intervention programme gave participants sequenced practice in writing letters, words, and sentences. Beginning with letters based on a circle (e.g., a, d, c), and continuing with other formations until all letters were covered, the programme progressed from participants practising single letters in isolation to two- and three-letter exercises, and finally words, phrases, and short sentences.

These studies offer promising evidence that the right kind of handwriting intervention can make a difference to the handwriting and composition of children in mainstream classes. By improving their ability to produce letters automatically, these young writers freed up their attention for other writing processes.

One of the key goals for researchers and teachers is to identify which children would benefit from additional instruction to improve their handwriting automaticity. It is not always clear how children are selected in intervention studies. Jones & Christensen (1999), for example, chose their participants on the apparently arbitrary basis that they scored 13 or less on a test which involved writing letters of the alphabet in one minute. In our own studies we have tried to develop this, relating automaticity levels to external criteria such as national norms for composing. In Medwell et al (2007) we found that seven year old children who scored 12 or less on the alphabet task had statistically only a 40% chance of achieving the national expectation for composing and could be considered "at risk". In Medwell et al (forthcoming) we found that eleven year olds who scored around 22, or less, on the alphabet task had the same 40% statistical chance of achieving the national standard composing. Our aim is to continue this research to refine further this screening mechanism, possibly including neatness or letter formation.

Conclusions

The research discussed above suggests that role of handwriting in writing has been underestimated in mainstream education. It seems that the necessity for speed and automaticity in handwriting has been neglected in our writing pedagogy, despite good evidence of its importance. Educators have given priority to composing processes in writing but in doing so we may have neglected a skill which makes a significant contribution to the composing we so value.

Handwriting, particularly the automaticity of letter production, appears to play a role in facilitating higher order composing processes by freeing up working memory to deal with the complex tasks of planning, organising, revising and regulating text production. In this way, automatic handwriting facilitates composing. Research undertaken into the predictors of writing competence suggests that automatic letter writing is the single best predictor of length and quality of written composition in the primary years (Graham *et al*, 1997), in secondary school and even in the post-compulsory education years (Connelly *et al*, 2006; Jones, 2004; Peverley, 2006) and research to identify appropriate thresholds for screening is underway.

The assumption that handwriting will become automatic relatively early in writers' development, freeing up cognitive resources to facilitate composition, is endemic in policy and practice. It is difficult to find any recognition, in policy statements worldwide, that handwriting might progress, other than becoming neater, as children gain more maturity in writing. Recent research in England (Medwell *et al*, 2007; forthcoming) challenges this assumption. However, neither national statutory testing nor school policies (Barnett *et al*, 2006) aim to assess handwriting speed or fluency, addressing only writing style and neatness. We appear to be assessing the wrong aspects of handwriting and, given the graphonomic evidence, may be emphasising a criterion which inhibits automaticity (Tucha *et al*, 2008).

On the basis of the findings of intervention studies, we need to reconsider how to develop children's handwriting automaticity and accept that current pedagogy is doing a less than effective job. We know that a significant proportion of children experience handwriting difficulties throughout schooling. More of these children are boys than girls and their handwriting difficulties are likely to impact upon their ability to compose written language. There is evidence that teaching interventions can improve not only handwriting, but also written composition. None of the authors of the studies discussed above make exaggerated claims regarding handwriting instruction. It will not solve all the difficulties of writing but the evidence suggests that it could be helpful to a significant number of young writers. This does not mean more handwriting teaching for all children but, rather, differentiated attention to address the handwriting needs of children who struggle with letter formation and automaticity.

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