

## RESEARCH NOTE

# The Slow Handwriting of Undergraduate Students Constrains Overall Performance in Exam Essays

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Undergraduates producing handwritten essays in university exams need to transcribe information onto the page in a rapid and efficient manner under considerable time pressure. In fact, capacity models of the writing process predict that the more automated students can make the transcription process then the more resources will be available for higher order writing processes. This study examined the impact of low level handwriting processes on undergraduate writing in pressurised and unpressurised tasks. Students completed a measure of handwriting fluency and provided samples of writing from exam conditions and a formative class essay. The results indicated that, compared to a class essay, exam writing was constrained by the low level writing skill of handwriting fluency. Surprisingly, it was found that the undergraduates were very slow writers whose writing speed was equivalent to published fluency data on 11-year-old schoolchildren. The relationships between handwriting fluency and writing quality were also very similar to those of published data on 11-year-old children, with handwriting fluency accounting for large amounts of the variance in writing quality and tutor marks for exam answers. The results of the current study indicate that lower level processes constrain the higher level performance of undergraduate students to a significant extent. This limitation needs to be considered when undergraduate exams are designed and inferences drawn from exam performance.

The majority of current university exam procedures require undergraduates to produce written text under pressurised exam conditions. Little consideration has been paid to the ways in which low level transcription skills might impact on exam performance at this level. The current study aimed to examine these issues by considering the relationship between handwriting fluency and exam performance in a cohort of UK second year undergraduate students.

Writing is a complex and difficult form of language production. Most language

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production models contain three main processing components (Bourdin, Fayol, & Darciaux, 1996): a conceptual planning component that generates and selects ideas; a linguistic planning component that maps ideas to an appropriate linguistic structure; and an articulation component that executes the plan either phonetically (oral production) or graphemically (written production). These components all draw on the same limited amount of cognitive resources. An increase in the amount demanded by one component will mean fewer cognitive resources are available for the other components. An important prerequisite to articulating complex and coherent written texts is producing legible and fluent handwriting.

Evidence shows that the fluency of handwriting can predict composition quality well into the teenage years. The amount of variance in composition quality accounted for by handwriting fluency declines from 66% at early primary level to 16% at middle secondary level (Berninger, 1999). This decrease in the variance accounted for by handwriting suggests that as mechanical low level skills become fluent they may have less impact on cognitive load. This is supported by data indicating that children from age 11 onwards, and adults, are better able to produce written texts when writing them than when dictating them (Bereiter & Scardamalia, 1987). Handwriting fluency, it is argued, is no longer constraining writing performance. This argument has not gone unchallenged. Graham (1990) and Berninger (1999) have both argued that handwriting will always have some impact on cognitive load. When adults are forced to write in an unfamiliar way, thus increasing the memory load of the transcription process, performance on higher level components drops (Bourdin & Fayol, 1994). Placing extra demands on the apparently fluent output skill affects performance. Equally there is evidence that placing demands on the higher order cognitive processes can affect performance in writing tasks in both adults and children (Olive & Kellog, 2002). Thus the nature of the task (high/low cognitive demand) and handwriting fluency will interact.

The extent to which current undergraduate students should be conceived of as experienced and fluent handwriters needs to be established. Data collected from school children may not provide valid normative comparisons. Schoolchildren handwrite every day, often for considerable periods of time, in their varied school lessons. In an age when undergraduate use of word processors for coursework is increasing and exam assessment slowly but surely decreasing (Glasner, 1999), handwriting practice at university level may be much less than in school and possibly less than in previous university cohorts. Yet there is a direct link between the amount of handwriting practice carried out by individuals and handwriting fluency (Graham, 1992; Jones & Christensen, 1999). This may pose a problem for current undergraduate cohorts when it comes to handwriting exam essays.

In this paper we shall compare the relationship between handwriting fluency and undergraduate writing quality in two writing tasks. The first task was a formative essay done under timed conditions. According to the literature there should be little relationship between this standard writing task and handwriting fluency as the undergraduates should be able to compose and handwrite concurrently. The second task was an essay taken as part of a course examination under the same timed

conditions. Exams have been noted to impose additional cognitive load due to the burden of stress on the participants (Everson, Smodlaka, & Tobias, 1994). Therefore it is more likely, given the more limited cognitive resources available to students in stressful exam situations, that handwriting fluency may show a stronger relationship with performance.

This paper will investigate whether there is a significant relationship between handwriting fluency and writing quality in undergraduate exam performance compared to non-exam performance. It is predicted that the cognitive demands of a formal exam will be high and students' performance in these contexts will be influenced by their handwriting fluency. In contrast, where such pressure is not evident and sufficient time is available for both planning and transcription, then fluency in handwriting should not impact on performance.

## **Method**

### *Participants*

The participants were 22 psychology undergraduate students at South Bank University in London. They were aged between 19 and 35 and were in the second year of a psychology degree. The participants were all social science students in a psychology single honours program primarily with a science background.

### *Handwriting Fluency Measure*

Berninger, Mizokawa, and Bragg (1991) developed a simple measure of handwriting fluency that involves the participant writing out the letters of the alphabet, in lower case, in order, as quickly as they can, in one minute. Letters are only counted towards a total amount of letters per minute if the letters are in the correct order and legible. A letter is classed as legible if, in the marker's opinion, it would have been recognisable alone on the page, without cues from other letters to help identify it. This task has been shown to have a very high inter-rater reliability ( $r = 0.97$ ; Berninger et al., 1997). The task has also been used and cited in many large scale handwriting studies on handwriting fluency (see Berninger, 1999 for a review) and has psychometric information available on test development and links to other writing skills.

### *Writing Measures*

*Unpressurised writing task.* This measure was a formative class test given to the second year undergraduate developmental psychology class. A short pre-seen essay task was completed in a one hour timed session using pen and paper.

*Pressurised writing task: actual timed exam.* This measure was a pre-seen essay question answered in an exam with a recommended one-hour answer time using pen and paper. The exam was the second year developmental psychology exam and contributed a substantial proportion of the students' overall module marks that ultimately contributed to their final degree marks. The students had a choice of six questions.

### *Procedure*

Second year developmental psychology students were asked to participate in a study designed to improve written language performance. Permission to access the essays was given when the students signed up for the study. As part of the regular tutorial time students completed the handwriting fluency measure (Berninger et al., 1991). The participants were told that if they reached the end of the alphabet before the time was up then they were to continue by writing out another alphabet until they were told to stop.

The unpressurised essay was completed in a seminar as a practice formative piece of work where tutors would provide feedback. All the participants completed the task in the required time span. The pressurised essay was their final end of module exam answer. The essays produced in both writing tasks were marked as part of the normal course workload and marks were assigned to the essays by the course tutors who were blind to the students' involvement in the research project.

*Coding.* Word counts were made for each essay and for the introduction, main body, and conclusion sections. These sections were identified following criteria specified by Westby and Clauser (1999). In addition to this, we analysed the essays for structure using a rubric (Connelly, Dockrell, & Barnett, 2004). A rubric is a common method used to assess children's writing and can be adapted to assess all levels of writing. It uses a set of rules or benchmarks to judge different levels of performance. The student's writing is assessed by its conformity to the benchmarks, in terms of a score or percentage measure of conformity. It is a measure of the structure and quality of the text produced by the students.

The rubric used in the current study consisted of 24 questions in four sections—introduction, overall body, within topics, and conclusion. The rubric assessed each student's skill at sectioning the essay clearly, ordering ideas, linking ideas, showing sufficient support and expansion of ideas, and showing a sufficient sense of audience. The rubric displayed good internal reliability ( $\alpha = .91$ ). The item discrimination was high and it also showed good concurrent validity ( $r = .79$  with the TOWL-3 standardised measure of writing; Hammill & Larsen, 1996). The TOWL-3 was used as it is a well researched and reliable standardised measure of writing that has good psychometric properties.

The handwriting measure was double marked by a second investigator. There was 100% agreement in the scoring between the first and second investigators.

## **Results**

The students showed a mean rate of 76.5 letters per minute ( $SD = 10.7$ ) for the handwriting fluency measure. The range of letters per minute produced varied from 50 to 95 letters. According to handwriting fluency norms produced by Graham, Berninger, Weintraub, and Schafer (1998) the mean number of letters per minute produced by our undergraduates was equivalent to 11-year-old children (fifth graders' mean score of 72.74 letters per minute). Therefore, it would appear that the undergraduates in the sample are demonstrating very slow handwriting and are performing at about the 11–12-year-old level.

### *Measures of Writing*

There were three sources of information about the participant's handwritten essay skills: tutor mark, word count, and rubric assessment scores. The results of these assessments are presented in Table 1. The students were scoring at the midrange of the upper second-class degree category for the exam essay question, indicating that this is a typical midrange sample of UK university students. The amount of words produced in the unpressurised essay was equivalent to about 13 words per minute. Assuming an average of five letters per word this equates to about 69 letters per minute and fits in with the data from the handwriting fluency measure. However, the pressurised exam essay has an average of 19 words per minute, equating to about 95 letters per minute. This calculation is correct if the students are only spending the recommended one hour on this task. Many of the students after the exam commented to the investigators that they took longer on the exam essay than the recommended one hour period.

The participants' handwriting fluency results were correlated with essay mark, word count, and rubric assessment scores. The correlations are reproduced in Table 1.

It can be seen that the handwriting fluency measure was not associated with performance in the unpressurised class test essay. This is the typical finding associated with the adult writing literature measured in experimental tasks (Bereiter & Scardamalia, 1987). However, there were large and significant correlations with the exam essay measures—30% of the variance was accounted for by a regression of handwriting fluency on tutor mark [ $F(1,20) = 8.1, p < .05$ ].

There were also significant correlations of handwriting fluency with the number of words produced in the exam essay (although this correlation became non-significant after a Bonferroni correction had been applied to the significance level). This may be expected given the time pressure the students are under. It is instructive to see that it is not the length of the introduction that correlates with handwriting fluency; the correlations are more with the body of the essay and particularly the conclusion section. The faster writers are those who have been able to produce a conclusion.

There were also significant correlations with the rubric score. The overall score correlates significantly with handwriting fluency. Handwriting fluency accounted for

Table 1. Correlations of writing measures with handwriting fluency and mean scores of writing measures

Measure	Correlation with	Mean score	SD
handwriting fluency			
Handwriting fluency		77.5 letters	10.0
Unpressurised class test			
Tutor mark	-0.116	59.3%	9.1
Overall essay word length	0.136	830.8	252.4
Rubric overall score	-0.005	59.2%	16.7
Introduction word length	0.161	108.7	182.4
Body word length	0.175	712.6	267.6
Conclusion word length	-0.225	46.2	37.2
Rubric intro score	0.025	39.1%	25.5
Rubric body score	0.077	64.8%	20.8
Rubric within topics score	0.065	61.8%	17.1
Rubric conclusions score	-0.322	46.9%	32.1
Pressurised exam essay			
Tutor mark	0.545*	66.6%	5.8
Overall essay word length	0.432* <sup>(1)</sup>	1154.6	372.7
Rubric overall score	0.671**	70.6%	14.1
Introduction word length	-0.068	107.0	182.4
Body word length	0.347	1011.1	343.1
Conclusion word length	0.609**	73.6	40.9
Rubric intro score	0.382	44.4%	31.0
Rubric body score	0.639**	78.5%	16.6
Rubric within topics score	0.646**	71.7%	14.6
Rubric conclusions score	0.370	69.4%	26.7

Note. \*  $p < .05$ ; \*\*  $p < .01$ ; (1) This particular correlation became non-significant after a Bonferroni correction was applied to the results; all other correlations remained significant after the correction was applied.

40% of the variance in the overall rubric score [ $F(1,20) = 15.6, p < .01$ ], indicating the impact of handwriting on the structure and quality of the text produced by the students. The rubric questions rating the body section of the essay and how the essay is structured within topics also correlated significantly with handwriting fluency, indicating that the quality and linkage shown within topics and in the body of the text were of a higher quality when the student had more resources available to think of and produce them. The slower the writer, the less concurrent planning and editing can take place to ensure the body section of the essay is of a high standard.

The introduction section and the conclusion section marks on the rubric do not correlate significantly with handwriting fluency. This mirrors the results for word length in terms of the introduction section but does not for the conclusion section. However, the conclusion section's lower correlation may be due to one prominent outlier in the conclusion rubric scores. One individual scored zero for the conclusion section but is a reasonably fast writer in terms of the group (80 letters per minute).

Once this individual is removed from the calculation then the correlation reaches 0.49 and is highly significant ( $p < .01$ ). There are no similar outliers for the introduction scores.

## **Discussion**

This study aimed to consider the ways in which handwriting fluency impacted on the written performance of undergraduate students. Surprisingly it was found that the current participants' handwriting fluency was equivalent to those of young people entering secondary education. Performance on this task cannot be interpreted as a ceiling effect, as in published studies with schoolchildren fluency rates rose to over 100 letters a minute for eighth graders (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997).

The current study indicated that this slow speed of handwriting had no effect on performance in an unpressurised situation. However, students' fluency in writing accounted for a significant proportion of the variance in their final mark for the pressurised exam task. Fluency was not correlated with the exam essay introduction, suggesting that students had sufficient time to produce these, but a significant relationship was evident with the conclusion. The conclusion is one of the fundamental parts of the essay and provides the students with the opportunity to synthesise their response in the exam essay. Students who do not have time to write a conclusion are at an obvious disadvantage. Similar relationships were evident with the planning and organisation measures. For these students, writing fluency is impacting on a range of the critical dimensions of persuasive essay performance.

The students' handwriting in the current study was not so slow as to prevent the simultaneous activation of handwriting and composition. The lack of any significant correlations between the non-assessed class test essay and handwriting fluency would tend to support this. However, when students were faced with a real life test situation where success was important, then handwriting fluency became an important factor. Exam stress, which has been hypothesised to impair cognitive capacity (Kanfer & Ackerman, 1996), makes fewer cognitive resources available to the higher order processes needed for composition. A capacity theory of writing implies that any activity that can be automatised frees up more working memory resources for other activities. More working memory resource will positively influence the quality of the writing. However, if the student is a slow writer then they will have fewer working memory resources to give to higher order processes such as planning and editing. We have seen that these students were not fully automatised writers as they were writing at the fluency rate of 11-year-old children. Therefore, the writing produced by the undergraduates in this sample may be of an inferior quality, despite their knowledge of the topic being examined, due to the added burden of being slow writers.

Berninger (1999) has demonstrated that handwriting fluency accounted for 41% in the variance of compositional quality in fourth to sixth graders in the United States. Given that our sample were performing at the speed of sixth graders and that

handwriting fluency accounted for 42% of the variance in compositional quality, as measured by the rubric, then we can see that the current results mirror those of Berninger (1999). Since the undergraduates were producing handwriting at the speed of 11-year-old children then the same constraints that handwriting fluency imposes on 11-year-olds writing quality were also imposed on the undergraduates.

The results we found are correlational in nature and do not provide any indication of causation, but they do give scope for further research that is of educational interest. There are a number of other limitations to this small study. First of all, it would be useful to repeat the study with another measure of handwriting fluency, given the surprisingly slow speed of the students. It would also be useful to include measures that tapped into the motivational and anxiety issues surrounding the exam essay. This was not possible in this study but gives scope for future research. Our results, however, do fit in with published work on children with equivalent writing fluency rates that show that it is only when cognitive load is high that handwriting fluency becomes an important predictor of writing quality. This does not bode well for handwritten exams, where it is presumed that the quality of knowledge produced reflects the learning of the student, not simply how fluently they can write.

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