How the Benefits of Disfluency in Education Vary with Ability and Dyslexia


^ email: mail@matthewfrench.net
* Physics Department, Clifton College, Guthrie Road, Clifton, Bristol. BS8 3EZ
# Biology Department, Clifton College, Guthrie Road, Clifton, Bristol. BS8 3EZ

Abstract

Previous research has shown that presenting educational materials in slightly harder to read (disfluent) fonts than is typical engenders deeper processing. This leads to better retention and subsequent recall of information. Before this extremely simple to implement and cost-effective adaptation can be made routinely to educational materials, it needs to shown to benefit all pupils, or at the very least not to hinder any particular group. This study found that pupils across the ability spectrum demonstrate a significant improvement in retention and recall when presented with information in a disfluent font. Significantly, those pupils with dyslexia are also found to greatly benefit.

1 Introduction

Some teachers and educational researchers have suggested that it is always beneficial to simplify material and its presentation to reduce the cognitive load on the learner (Sweller & Chandler, 1994). In a school setting pupils and teachers sometimes judge the success of a lesson based on the ease of understanding, processing and remembering the presented information. This can lead to a lesson being deemed effective by the teacher, pupils and any observer. It perhaps also leads to the conclusion that pupils have made progress in a lesson even if they remember very little of the information they have studied at a later date.

In some cases it has been shown that making information harder to learn can improve future recall (Bjork, 1994 and Bjork 1999). This has been linked by Craik & Tulving (1975) to the deeper
cognitive engagement required to process the information, which consequently leads to better retention. So-called “desirable difficulties” are manipulations of the information to be learnt which can make it harder for the learner and slow the learning process, but lead to increased retention of the information over time. For example, Richland et al. (2005) find real-world educational benefits in two distinct imposed difficulties: firstly, requiring learners to partially generate word pairs e.g. “fish:ch__s” instead of “fish:chips” and secondly, to interleave lists of words eg A1B1A2B2 rather than A1A2 B1B2. These methods, however, increase both the subjective and objective difficulty of learning the material. Additionally, a link has been made between the handwriting and keyboard typing speed of children: if they are slower and less fluent at writing by either method they use more metal resources as they find in more cognitively demanding (Connelly, 2007). Where the goal is to remember the text, additional cognitive processing is beneficial.

Disfluency is the subjective experience of difficulty associated with completing a mental task. It has been shown that disfluency can be easily introduced by degrading or changing the font in which the information is written (Alter et al. 2007; Alter & Oppenheimer, 2009). In a previous study Alter et al. (2007) showed that when participants took a cognitive test in a degraded (and therefore disfluent) font they performed significantly better. However this test looked for processing of information in a question and answer format and did not look for recall of information at a later time. Disfluency may indicate to a reader that they do not fully understand the information and are less confident with it so that they try harder to learn it (Alter et al. 2007). In addition the increased difficulty in reading the font may lead to enhanced cognitive processing (Craik & Tulving, 1975).

Most recently, Diemand-Yauman et al. (2011) have shown a direct educational benefit (i.e. improved future recall) when information is presented in a disfluent font. However they raise the concern that because disfluent reading can be perceived as more difficult, less motivated or less able students may become frustrated and give up on the material.
2 The Clifton Study

2.1 Participants

Two hundred and seventy five pupils in years 9-11 (ages 13-16) participated in this study which was conducted across the Upper School at Clifton College, an independent public school of over 1000 pupils in Bristol, UK (Clifton College Website). Classes are mixed gender and set by ability ranging in size from around 10 to 24.

2.2 MiDYIS Data

MiDYIS tests comprise vocabulary, maths, non-verbal reasoning and skills sections. They are administered by the Centre for Evaluation and Monitoring at Durham University (CEM Website) and are primarily designed to be taken when pupils enter secondary school either in year 7, 8 or 9 in the UK (age 12, 13 or 14 years). The tests are designed to measure, as far as possible, ability and aptitude for learning rather than achievement. All tests are designed to fit into a lesson period (about 1 hour) and are strictly administered to ensure that all pupils are exposed to the same instructions, explanations and examples, ensuring fair, high quality, reliable data. Based on the results of the tests pupils are placed into one of 4 groups: group A which contains the most able 25% of pupils through groups B (25%) and C (25%) to group D which contains the least able 25% of pupils. They are used extensively across many UK schools to provide a measure of ‘typical’ expected GCSE performance.

2.3 Procedure

In a double blind study, conducted by members of the Biology department during normal lessons, pupils were shown a PowerPoint slide projected at the front of the class with text describing eight facts about a fictional star. This ensured the pupils had no prior knowledge of the
material. Pupils were given a maximum of 90 seconds to read the text in silence. The lesson then continued in the usual way. Approximately 35 minutes later the pupils individually completed a short test of seven multiple choice questions testing their recall of facts from the PowerPoint slide. They were not warned about the test when they read the text. Pupils wrote their names on the surveys: this allowed their score out of seven to be linked with their MiDYIS band and whether they had a diagnosis of dyslexia.

A control group of one hundred and twenty one pupils was shown the star facts in Arial font (the control font). The study group of one hundred and fifty four pupils was shown identical star facts in Monotype Corsiva font (the disfluent font). See figure 1. Classes were assigned to either the control or disfluent font to provide approximately the same number of pupils in each band and reading each font. Monotype Corsiva was one of three disfluent fonts tested by Diemand-Yauman et al. (2011). In their research no difference was found between the effects of Italicised Comic, Monotype Corsiva or Haettenschweiler. However, all showed a significant improvement compared with an Arial control font.

3 Results and Discussion

The tests were scored out of seven and the results linked to the individual pupils by name. The pupils’ MiDYIS band, the font in which they saw the star facts and whether or not they were dyslexic were recorded. For each pupil the raw score out of seven was converted to a percentage. The mean percentage score was found for each group of pupils (Arial and Monotype Corsiva): this allowed the overall mean percentage difference to be calculated. The pupils’ results were converted into Z scores and an independent samples t-test (for samples with unequal sample sizes and unequal variances) revealed if the results were significant ($p < 0.05$). The full results are detailed in Table 1.

Overall the mean score was 12.8% higher for those who had read the star facts in the disfluent font (Monotype Corsiva) compared with those who read the star facts in the control font
(Arial). A t-test revealed this was statistically significant with $p < 10^{-7}$. It is also in good agreement with the 14% difference found by Diemand-Yauman et al. (2011) in their first study.

Confident that a similar effect to that seen by Diemand-Yauman et al. (2011) had been reproduced, the results were split by MiDYIS band (see Table 1). Notably, this revealed there was a higher mean score for pupils in each band when reading the disfluent font. This indicates that using a disfluent font did not hinder pupils in any particular band. Additionally, there was no observable band related trend in the mean percentage difference in the scores. The mean score was 11.5% higher for the most able pupils (those in band A) if they had read the star facts in Monotype Corsiva compared to Arial ($p=0.035$). The minimum increase in the mean score seen was amongst the pupils in band C (7.9%), however, this was still deemed significant with a p-value of 0.041.

The final variable under investigation was the effect of the disfluent font on dyslexic pupils. The definition of dyslexia is not uniformly agreed upon; however the British Dyslexia Association defines it as “a specific learning difficulty which mainly affects the development of literacy and language related skills”. The pupils identified as dyslexic in this study have been diagnosed by an educational psychologist, usually following a school referral after a sufficiently low score on the Edinburgh Reading Test 4 published by the Educational Assessment Unit, University of Edinburgh. Current educational trends suggest that simple fonts should be used to aid reading by dyslexic pupils (British Dyslexia Association Style Guide).

Perhaps surprisingly, dyslexic pupils were found to follow the overall trend of a higher mean score on the star facts test if they had read the disfluent font (Monotype Corsiva). This improvement was even more marked than for the general group of pupil at 19% ($p=0.032$). This is a significant finding and one which should certainly be investigated further as it is in contrast to current educational trends. This study suggests dyslexic pupils benefit significantly from reading information in a harder to read front. This could provide support for the hypothesis that it is the greater cognitive processing which is required for reading a disfluent font which gives the retention
improvement. What is not yet clear is the effect of frequently providing a dyslexic pupil with large blocks of text in a disfluent font: do they tire of reading more rapidly or does their motivation for continuing reading decrease? If their quality of processing of written material does decrease over a period of time, is this net effect offset in any way by a more accurate memory of (the first) part of the text? Further research will be necessary to investigate these questions; however for short pieces of text at least up to a length of 56 words (the length used in this study) a significant improvement in retention has been demonstrated.

In conjunction with their study Diemand-Yauman et al. (2011) performed a short follow-up survey to find out the students’ opinions about the use of a disfluent font. No liking or motivational differences based on the disfluent fonts were found.

The present study together with previous work provides strong and robust evidence that harder to read, or disfluent, fonts should be routinely used in educational settings as they promote deeper engagement with and retention of written information. What is not yet clear is whether the effect can wear off over time as readers become accustomed to the disfluent font. Further research should focus on investigating the long term effect of using the same disfluent font and whether there is a point at which a disfluent font becomes so difficult that it becomes a hindrance. However, waiting for the completion of this research before implementing such a beneficial change in educational practice can perhaps no longer be justified. Until the long term benefit of the continued use of the same disfluent font is established the most effective way forward must be to use a wide range of slightly disfluent fonts.
References


CEM Website: www.cemcentre.org

Clifton College Website: www.cliftoncollegeuk.com


Table 1: Table showing the percentage of correct answers when pupils read facts printed in Arial or Monotype Corsiva fonts. The data is stratified by MiDYIS bands A-D, an overall total is given and finally the group of dyslexic pupils is separated out.

<table>
<thead>
<tr>
<th>MiDYIS Band</th>
<th>Arial Percentage</th>
<th>Arial Standard Deviation</th>
<th>Monotype Corsiva Percentage</th>
<th>Monotype Corsiva Standard Deviation</th>
<th>% Difference</th>
<th>Arial Z score</th>
<th>Monotype Corsiva Z score</th>
<th>T test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>83.0%</td>
<td>22.9%</td>
<td>94.6%</td>
<td>9.67%</td>
<td>11.5%</td>
<td>-0.454</td>
<td>0.250</td>
<td>1.93</td>
<td>0.035</td>
</tr>
<tr>
<td>B</td>
<td>84.4%</td>
<td>23.3%</td>
<td>95.4%</td>
<td>10.2%</td>
<td>10.9%</td>
<td>-0.428</td>
<td>0.236</td>
<td>2.10</td>
<td>0.023</td>
</tr>
<tr>
<td>C</td>
<td>80.1%</td>
<td>20.8%</td>
<td>88.0%</td>
<td>12.8%</td>
<td>7.90%</td>
<td>-0.256</td>
<td>0.194</td>
<td>1.78</td>
<td>0.041</td>
</tr>
<tr>
<td>D</td>
<td>70.2%</td>
<td>23.6%</td>
<td>84.3%</td>
<td>16.7%</td>
<td>14.1%</td>
<td>-0.294</td>
<td>0.345</td>
<td>3.24</td>
<td>8.6x10^-4</td>
</tr>
<tr>
<td>Overall</td>
<td>78.0%</td>
<td>23.1%</td>
<td>90.8%</td>
<td>13.0%</td>
<td>12.8%</td>
<td>-0.371</td>
<td>0.291</td>
<td>5.43</td>
<td>9.0x10^-8</td>
</tr>
<tr>
<td>Dyslexic</td>
<td>66.7%</td>
<td>30.7%</td>
<td>85.7%</td>
<td>14.9%</td>
<td>19.0%</td>
<td>-0.543</td>
<td>0.283</td>
<td>2.03</td>
<td>0.032</td>
</tr>
</tbody>
</table>
Figure 1: Example of the text used in the study. Panel a shows the disfluent font (Monotype Corsiva) and panel b shows the control font (Arial).