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## Introduction

One of the greatest challenges of dyslexia remediation is to ease the process of reading. Current practices involve remediation that targets subskills of reading, such as phonological awareness. Another way to improve the accessibility of reading is through the manipulation of print material. Previous studies have found that large letter spacing and larger font sizes can independently improve reading performance in students with dyslexia (Perea et al., 2012; Zorzi et al., 2012). However, little is known about the combined effect of such text features on reading fluency and comprehension, as well as the effects of text manipulation in non-alphabetic, logographic writing systems, such as Chinese.

## Aims

- Explore the effects of the manipulation of English text features on reading performance in students with dyslexia, and if this carries over to Chinese.
- Inform educators and add to literature on the effects of text manipulation on reading performance in students with dyslexia.

### Study 1: English

#### Methods

- 36 Singaporean students with dyslexia (33 male, 9 to 12 years old) read four different English passages under four conditions (see *Figure 1*) in a randomised order.
- They answered four comprehension questions after reading each passage.

#### Results

##### Speed (Reading time in seconds)

- Font size and inter-letter spacing had no effect on reading speed.

##### Accuracy (Number of errors)

- Main effect of font size,  $F(1, 35) = 5.71, p = .02$  on reading accuracy. **Students with dyslexia made significantly more errors in the small font conditions ( $M = 30.68, SD = 3.04$ ) than in the large font conditions ( $M = 28.06, SD = 2.85$ ).**
- Main effect (marginal) of inter-letter spacing on the number of reading errors,  $F(1, 35) = 3.22, p = .08$ . **Students with dyslexia made more errors reading text with smaller spacing ( $M = 30.5, SD = 3.06$ ) than in the large spaced conditions ( $M = 28.24, SD = 2.86, Figure 2$ ).**

##### Comprehension (Number of correct responses)

- Main effect of inter-letter spacing on the reading comprehension,  $F(1, 35) = 4.44, p = .04$ . **Students with dyslexia displayed better comprehension in the small spaced conditions ( $M = 3.21, SD = 0.13$ ) than in the large spaced conditions ( $M = 2.96, SD = 0.18, Figure 3$ ).**

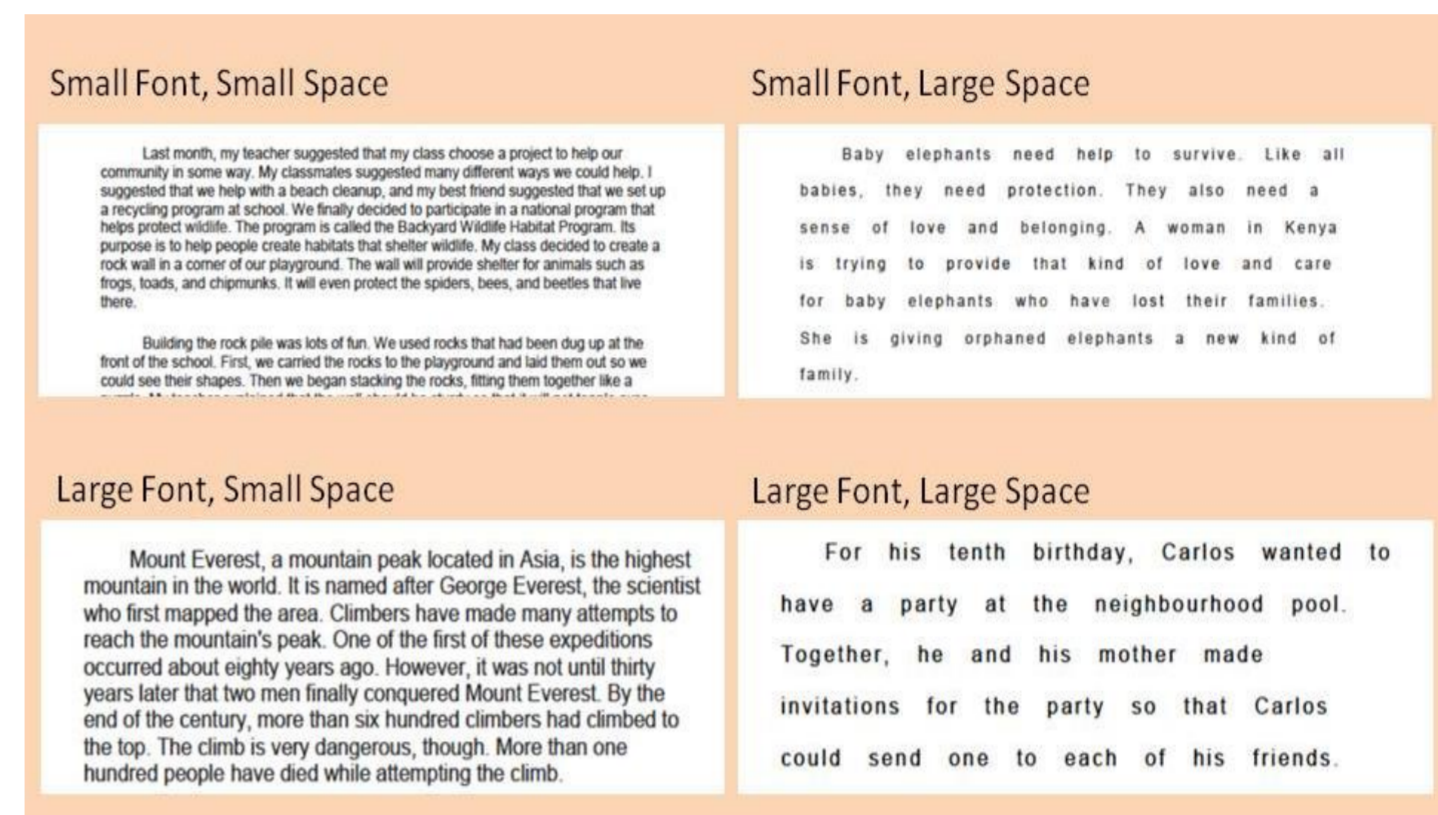


Figure 1. Participants of Study 1 read passages in four different conditions.

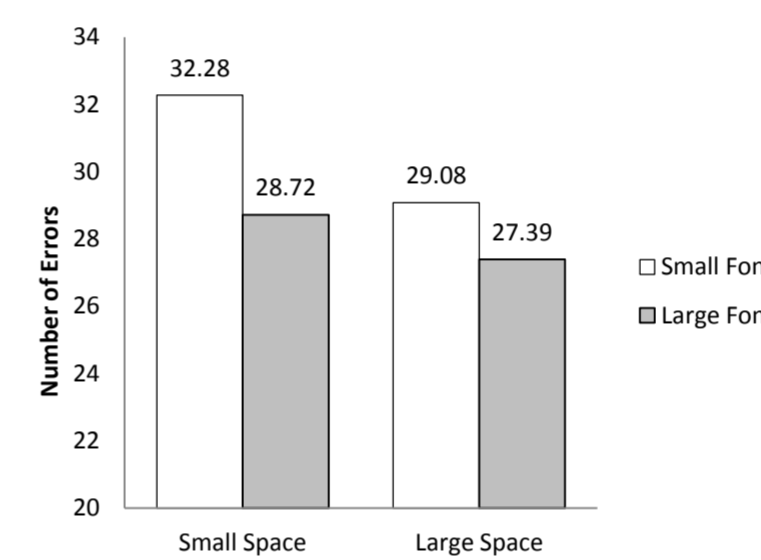


Figure 2. Increasing font size and inter-letter spacing can improve reading accuracy.

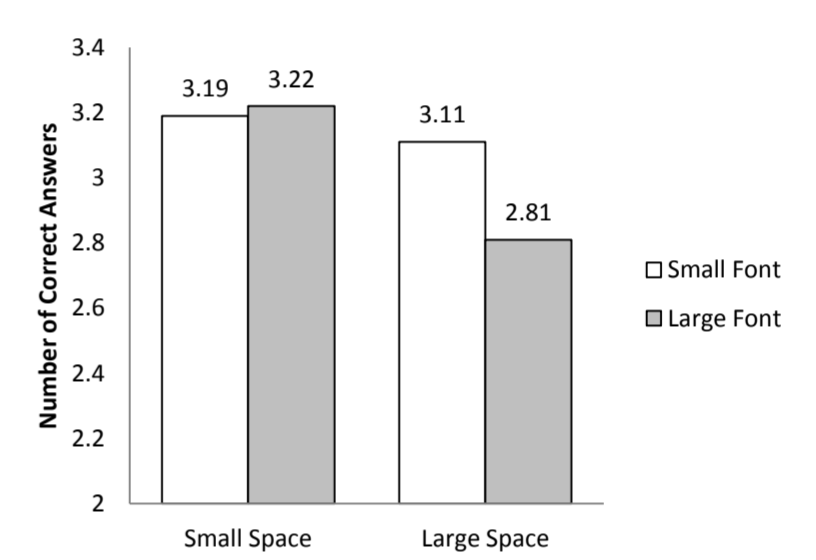


Figure 3. Increasing inter-letter spacing negatively impacts reading comprehension.

Font used: Arial  
Small font=12 pt  
Large font=16 pt  
Small spacing: Default  
Large Spacing: Increased by 2.5 pt

### Study 2: Chinese

#### Methods

- 32 Singaporean students with dyslexia (29 male, 8 to 10 years old) read four different sets of unrelated Chinese sentences across four conditions (*Figure 4*).

#### Results

##### Speed (Reading time in seconds)

- No effect of font size was found on reading speed.
- A main effect of inter-character spacing on reading speed,  $F(1, 31) = 7.54, p < .05$ . **Students with dyslexia took a longer time to read sentences with a smaller spacing ( $M = 99.82, SD = 47.71$ ) than those with a larger spacing ( $M = 92.00, SD = 35.15$ ),  $p < .05$  (*Figure 5*).**

##### Accuracy (Number of errors)

- No significant effects were found for font size and inter-character spacing on reading accuracy.
- A significant Font x Spacing interaction effect,  $F(1, 31) = 7.17, p < .05$ . **Students with dyslexia made the least errors in the small font-large spacing condition (*Figure 6*).**



Figure 4. Participants of Study 2 read Chinese sentences in four different conditions.

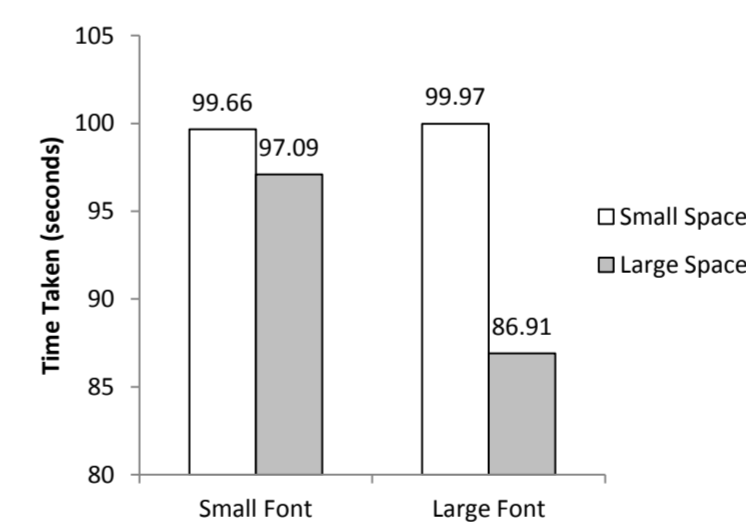


Figure 5. Larger font size improved reading speed.

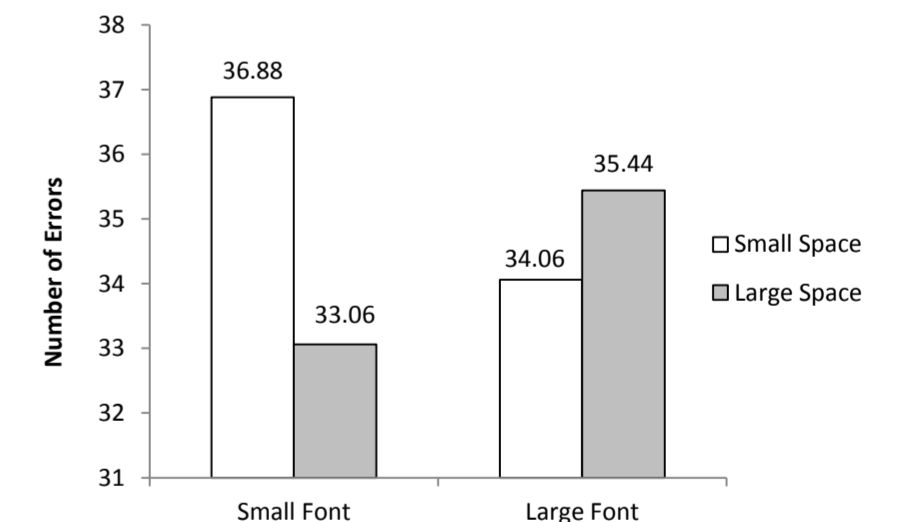


Figure 6. Larger spacing enhanced reading accuracy for smaller text.

Font used: SimSun (Body Asian)  
Small font=14 pt  
Large font=18 pt  
Small spacing: Default  
Large Spacing: Increased by 10 pt

## Discussion

### Study 1 (English)

- Contrary to prior findings, only increased font size improved reading accuracy of English text. Increasing font size may have improved the visibility of words.
- Larger spacing between letters may have interfered with the process of reading comprehension.

### Study 2 (Chinese)

- Like previous studies, larger inter-character spacing led to faster reading speed of Chinese text.
- Small font, large inter-character spacing seems to enhance reading accuracy of Chinese text.

### Overall

- With larger spacing of Chinese text, readers seem to read faster and, under certain circumstances, more accurately.
- However, the effects of larger spacing in English text are less clear with possible increases in accuracy but at the expense of reading comprehension.
- Manipulation of text features may affect the performance of students with dyslexia depending on task requirements (i.e. reading for comprehension vs. mindless reading) as well as text features in alphabetic and non-alphabetic writing systems.

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## DYSLEXIA ASSOCIATION OF SINGAPORE (DAS)

The DAS is a not-for-profit organisation that aims to help people with dyslexia achieve. It serves as a one-stop centre with a multi-disciplinary team of specialist psychologists, speech language therapists, occupational therapist, educational therapists and lecturers to support students with dyslexia.

Since 1991, the DAS has been providing remediation to students with dyslexia aged 6 to 16 years old, and to date, there are a total of 2695 students in the programme.



In recent years, the DAS has also implemented programmes to provide specialist services to students with learning differences. These services include Chinese and Mathematics remediation, among others. For more information, please refer to [www.das.org.sg](http://www.das.org.sg)

### References:

- Perea, M., Panadero, V., Moret-Tatay, C., & Gómez, P. (2012). The effects of inter-letter spacing in visual-word recognition: Evidence with young normal readers and developmental dyslexics. *Learning and Instruction, 22*(6), 420-430.
- Zorzi, M., Barbiero, C., Facioetti, A., Lonciari, I., Carrozzi, M., Montico, M., ... & Ziegler, J.C. (2012). Extra-large letter spacing improves reading in dyslexia. *Proceedings of the National Academy of Sciences, 109*(28), 11455-11459.