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## Short Report

# Raeding Wrods With Jubmled Lettres

## There Is a Cost

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Two years ago, a widely circulated statement on the Internet claimed that resarche at *Cmabrigde Uinervtisy* fuond that sen-  
tences in whcih lettres weer transpoed (or jubmled up), as in  
the setnence you are now raeding, were easy to read and that  
letter position in words was not important to the ability to read  
successfully. In actuality, the statement was a hoax in that no  
such research had been conducted at the University of Cam-  
bridge (see <http://www.mrc-cbu.cam.ac.uk/personal/matt.davis/Cmabrigde/>). We report here results from a study showing that  
although some variations of sentences with transposed letters  
are relatively easy to read, other variations are not, and that  
there is generally always a cost associated with reading words  
with transposed letters.

We asked 30 college students at the University of Durham,  
United Kingdom, to read 80 sentences in which letters were  
transposed. In each sentence, transpositions were consistently  
located at the beginnings, middles, or ends of words (see Table  
1). About 40% of the words in the sentences (all content words  
longer than four letters) had letter transpositions. In addition,  
the students read sentences without any transpositions. Eye  
movements were recorded via a Fourward Technology Dual  
Purkinje eyetracker; the spatial resolution of this eyetracker is  
less than 10 min of arc. Comprehension questions were asked  
after 30% of the sentences. Readers were able to answer the  
questions with high accuracy, but 50% of them indicated that  
there were a few words that they did not understand.

Whereas the base reading rate for normal sentences was 255  
words per minute (wpm), all of the variations involving letter  
transpositions resulted in some cost to reading. When internal  
letters were transposed, the reading rate was 227 wpm (an 11%  
decrement in reading speed). However, when the transpositions  
involved the ending letters of words, reading rate was 189 wpm  
(a 26% decrement), and when the transpositions were at the

beginnings of the words, reading rate was 163 wpm (a 36%  
decrement).<sup>1</sup> Readers made more and longer eye fixations (see  
Table 1) with the more difficult transpositions.

The Internet statement was correct in that some letter trans-  
positions do yield words that are relatively easy to read. How-  
ever, our results clearly demonstrate that transpositions always  
carry a cost. Furthermore, our research also shows that trans-  
positions vary in their costliness depending on their location in  
the word: Transpositions of internal letters are much less costly  
than transpositions of ending letters, which in turn are less  
costly than transpositions of beginning letters. These results  
demonstrate the importance of beginning letters for word rec-  
ognition (see Rayner & Pollatsek, 1989, for a summary). In other  
work (Christianson, Johnson, & Rayner, 2005), we have also  
demonstrated that letter transpositions that cross morpheme  
boundaries (even with internal letters) are associated with an  
additional cost. Thus, *susnhine* is more difficult to read than  
*sunhsine*.

Finally, a previous study showed that when letters are sub-  
stituted rather than transposed, readers take much longer to read  
sentences (Rayner & Kaiser, 1975). In the case of substitutions  
involving visually similar letters, substitutions for internal let-  
ters (e.g., *problem* printed as *pncblem*) doubled reading time, as  
did substitutions for ending letters (e.g., *problnc*); substitutions  
for beginning letters (e.g., *qproblem*) were associated with reading  
times 2.5 times longer than normal. In the case of substitutions  
involving visually dissimilar letters, substitutions for internal  
letters (e.g., *prkylem*) or final letters (e.g., *problky*) tripled  
reading time; substitutions for beginning letters (e.g., *fyoblem*)  
quadrupled reading time. In all cases (except when visually  
similar letters were substituted for internal letters), substitutions  
also reduced comprehension.

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<sup>1</sup>The decrements reported are undoubtedly an underestimation of the true cost  
of reading text with transposed letters because we transposed letters only in  
content words. One might expect the cost to be even greater if transpositions  
occur in all the words of a sentence.

**TABLE 1**  
*Example Sentences and Results for Measures of Fixation*

Condition	Example	Number of fixations	Percentage regressions	Average fixation duration (ms)
N	The boy could not solve the problem so he asked for help.	10.4 <sub>a</sub>	15.0 <sub>a</sub>	236 <sub>a</sub>
INT <sup>a</sup>	The boy cuold not slove the probelm so he aksed for help.	11.4 <sub>b</sub>	17.6 <sub>b</sub>	244 <sub>b</sub>
END	The boy could not solev the problme so he askde for help.	12.6 <sub>c</sub>	17.5 <sub>b</sub>	246 <sub>b</sub>
BEG	The boy oucld not oslve the rproblem so he saked for help.	13.0 <sub>d</sub>	21.5 <sub>c</sub>	259 <sub>c</sub>

**Note.** N = normal text; INT = transpositions of internal letters; END = transpositions of letters at word endings; BEG = transpositions of letters at word beginnings. Within each column of results, entries that do not share a subscript differ at  $p < .01$ . <sup>a</sup>There were two types of internal letter transpositions: Either the beginning internal letters (as in *slove*) or the ending letters (as in *probelm*) could be transposed. Because the results showed no difference between beginning-internal and ending-internal transpositions, we have collapsed the results across these two types. Note that the example shown was constructed to illustrate both of these types and was not used in the experiment itself.

The fact that text with letter transpositions is so much easier to read than text with letter substitutions demonstrates that the specific letters of a word are critical for identifying what the word is (Grainger & Whitney, 2004) and that readers cannot rely exclusively on context for word recognition. In comparison to letter substitution, letter transposition makes it much easier for readers to recover what the actual form of the word should be. But the main point of our findings is that although it may seem that it is easy to read text with transposed letters, and although some transpositions do not entail as much added difficulty as others, there is always a cost involved in reading such text in comparison to normal text.

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## REFERENCES

- Christianson, K., Johnson, R.L., & Rayner, K. (2005). Letter transpositions within and across morphemes. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 31, 1327–1339.
- Grainger, J., & Whitney, C. (2004). Does the human mind read words as a whole? *Trends in Cognitive Sciences*, 8, 58–59.
- Rayner, K., & Kaiser, J.S. (1975). Reading mutilated text. *Journal of Educational Psychology*, 67, 301–306.
- Rayner, K., & Pollatsek, A. (1989). *The psychology of reading*. Englewood Cliffs, NJ: Prentice Hall.

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