READING VERTICAL TEXT: ROTATED VS. MARQUEE

Michael D. Byrne
Department of Psychology
Rice University
Houston, TX 77005 U.S.A.
byrne@acm.org

Abstract

There are numerous design situations in which it impossible to present English text in its normal horizontal orientation. There are multiple options available when text must be presented vertically: rotating horizontal text 90° to the left or to the right, or in a downward cascade of letters such as on a theater marquee. While it seems intuitive that horizontal text will be recognized faster than vertical text, which presentation format is best for vertical text? An experiment was conducted to investigate, and found that marquee text is indeed read more slowly than rotated text, and that rotated text is read more slowly than standard horizontal text. However, no evidence was found for a difference between left- and right-rotated text. Word frequency effects were larger in all vertical conditions relative to the horizontal control. These results suggest that rotated text is generally to be preferred to marquee-style presentation.

INTRODUCTION

There are numerous design situations in which it is not always possible to present English text in its normal horizontal orientation. For example, in the International Space Station, space for labels is often at a premium and many available spaces are taller than they are wide. Book spines are another familiar example where text is often presented vertically. In these situations, the general solution adopted has been to rotate the text 90°. In the case of book spines, convention dictates that the text be rotated to the right (clockwise). However, there are other alternatives: left rotation and “marquee”-style presentation in which the letters cascade downward (see Figure 1 for examples).

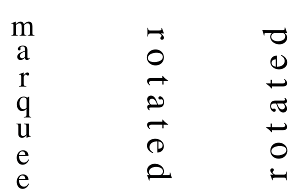

Figure 1. From left to right: Marqee-style text, right-rotated text, and left-rotated text.

The empirical basis for choice among these vertical text presentations is unclear. Human Factors standbys such as Sanders and McCormick (1993) make no mention of vertical text presentation. There is clear evidence that lexical decision times for short (2- to 5-letter) Hebrew words are slowed when the text is rotated off the horizontal (Koriat & Norman, 1984, 1985), but how this applies to longer English words or marquee text is unclear. Navon (1978) looked at text that was mirror-imaged at the word and letter level, and found performance decrements for both, but did not examine rotated text. Numerous studies have been conducted on rotated letters (e.g. Jolicoeur & Landau, 1984) and there does appear to be a decrement in performance associated with presentation at non-horizontal angles, but again, the effect on words is not clear. There is one study which suggests that reading of rotated words is slower than reading of standard horizontal words (e.g., Ferraro, 1992), but it is not clear whether there is a difference between right-rotated text and left-rotated text, or how marquee text compares to either. Given these previous results and four presentation types (horizontal, marquee, and the two rotations), some natural hypotheses and question emerge.

First, based on previous results, it is reasonable to expect horizontally-presented text to be read faster than any of the vertical presentations. However, how marquee text compares to rotated text is not clear. One reasonable hypothesis is that representations of words are representations of visual configurations, and the normal relationships which hold between letters is disrupted in the case of marquee text but not rotated text. Thus, one might expect reading marquee text to be slower than rotated text.

Then, there is the issue of the two directions of rotation. Because right-rotation is probably encountered more often by most people (such as on book spines), it is reasonable to hypothesize that right-rotation would be faster for most readers than left-rotation.However, because the relative spatial configuration of the letters is the same in both right- and left-rotated text, there may not be a difference.

Finally, one prominent factor in reading rate—or at least the rate at which words can be named—is word frequency (for an interesting model of this effect, see Kwantes & Mewhort, 1999). An obvious question is whether any effects of vertical presentation also apply across varying levels of word frequency. There is at least some evidence that the processing of horizontal text is more sensitive than processing of rotated text to factors which facilitate processing, such as visual half-field of presentation (Howell & Bryden, 1987). Thus it is plausible that interactions with word frequency may be present.

The research presented here is an attempt to determine exactly these relationships.

METHOD

Participants

Participants were 72 volunteers, primarily friends and family of undergraduate students enrolled in a psychology research methods course.

Design and Stimuli

There were two factors used in the design, both within-subjects: presentation and word frequency. Presentation had four levels: horizontal (or control), right-rotated, left-rotated, and marquee.

Word frequency had two levels, low and high. All words were three syllables in length. Word frequency measures were taken from Kucera and Francis (1967), a well-accepted word frequency database. High-frequency words had occurrence frequencies between 100 and 482 per million (examples: industry, average, specific), and low-frequency words had appearance frequencies of either 10 or 11 per million (examples: appendix, cohesive, elegance).

All subjects saw all conditions, and order of presentation was counterbalanced such that each of the eight conditions appeared in each serial position the same number of times.

All words used in the experiment were three-syllable words, and each 8.5” x 11” page of stimuli contained 30 words arranged in a 5 x 6 matrix. Words were printed in 14-point Times Roman font. Each page presented words from only one of the eight conditions, e.g. all words on one page were low-frequency controls.

Marquee text presented some additional problems, because most letters are taller than they are wide, so marquee presentation was not quite equivalent in terms of the total visual area occupied by each word. This was mitigated somewhat by using tight (11-point) line spacing, but tighter line-spacing was judged too difficult by pilot subjects because the letters tended to run together.

Procedures

Participants were given eight sheets of paper one at a time and instructed to read the words aloud as quickly as possible while still pronouncing every syllable of each word intelligibly. They were also instructed to read in right-to-left, top-to-bottom order (i.e., normal English reading order). In order to maintain the integrity of the rotated text conditions, participants were instructed to not turn their head or the page from their normal vertical orientations.

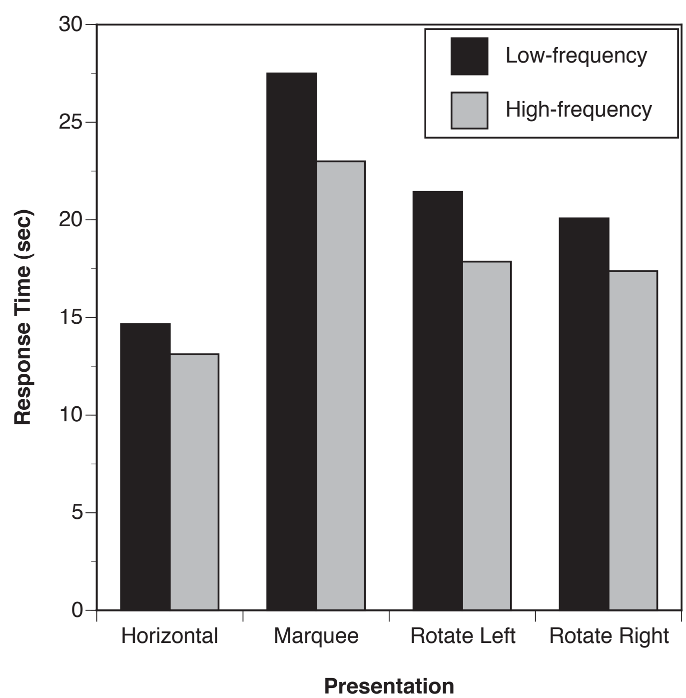

Figure 2. Response time as a function of presentation and word frequency.

Timing was done with a stopwatch accurate to at least tenths of a second. Timing began when the participant began to read the second word on the page such that the experimenter could hear it, timing was stopped as soon as the participant started to read aloud the final word on the page. While these are not the most sensitive reading-time measures possible, the number of participants in the within-subjects design made the additional error variance manageable.

RESULTS

Mean results are presented in Figure 2. Both main effects and the interaction were reliable: for the effect of presentation, $F(3, 213) = 97.08$, $p < .001$, $MSE = 32.18$; for the effect of frequency, $F(1, 71) = 25.76$, $p < .001$, $MSE = 53.06$; for the interaction, $F(3, 213) = 3.09$, $p = .03$, $MSE = 18.51$. However, these omnibus ANOVA results do not tell the whole story, so contrasts were run to test the more specific hypotheses outlined earlier.

First, as expected, the control condition was faster than all three vertical conditions, $F(1, 71) = 264.54$, $p < .001$, $MSE = 524.68$. Second, the marquee condition was slower than the two rotated conditions, $F(1, 71) = 86.59$, $p < .001$, $MSE = 489.01$. However, there was no evidence for a difference between the two rotated conditions, $F(1, 71) = 1.80$, $p = .18$.

The interaction with word frequency is driven entirely by the large effect of word frequency in all three rotated conditions relative to the small word frequency effect in the control condition, $F(1, 71) = 8.89$, $p = .004$, $MSE = 308.0$. There was no statistical evidence that the frequency effect differed between the three vertical conditions.

DISCUSSION

This is obviously a fairly simple study, but the results were quite clear-cut: horizontal text is fastest, followed by both rotated conditions, followed by marquee presentation. The results were quite striking in magnitude, as marquee text took almost twice as long to read as the standard horizontal text. Thus, to support rapid word recognition in situations such a labeling, horizontal text should be preferred where possible. However, when space constraints dictate that text be presented vertically, rotated text should be preferred to marquee text. However, there does not appear to be an inherent advantage for right-rotated vs. left-rotated text.

The ultimate source of the advantage of rotated text over marquee text is not clear. Perhaps with extensive training, experienced readers could learn to recognize words presented marquee-style as rapidly as they recognize rotated text. However, even if this is the case, few people will have this training and thus marquee text should be avoided. This also generally saves on total space, since rotated text is more compact, at least in most typefaces, than marquee text. While there may be specific instances in which marquee text is better, these results suggest that such instances are likely to be few and far between.

ACKNOWLEDGMENTS

I would like to thank Vicky Byrne at the NASA Johnson Space Center for posing the question about marquee vs. rotated text, Ken Laughery for helping me comb the literature to see if anyone else had ever empirically evaluated marquee text, and the students in my research methods class in spring 2000 for their diligence in data collection. I would also like to thank Mary Newsome for providing me with the Kucera and Francis database.

REFERENCES

Ferraro, F. R. (1992). Age-related changes in the effects of target orientation on word recognition. *Journals of Gerontology, 47,* P279-P280.

Howell, J. R., & Bryden, M. P. (1987). The effects of word orientation and imageability on visual half-field presentations with a lexical decision task. *Neuropsychologia, 25,* 527-538.

Jolicoeur, P., & Landau, M. J. (1984). Effects of orientation on the identification of simple visual patterns. *Canadian Journal of Psychology, 38,* 80–93.

Koriat, A., & Norman, J. (1984). What is rotated in mental rotation? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10,* 421–434.

Koriat, A., & Norman, J. (1985). Reading rotated words. *Journal of Experimental Psychology: Human Perception and Performance, 11,* 490–508.

Kucera, H., & Francis, W. N. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University Press.

Kwantes, P. J., & Mewhort, D. J. K. (1999). Modeling lexical decision and word naming as a retrieval process. *Canadian Journal of Experimental Psychology, 53,* 306-315.

Navon, D. (1978). Perception of misoriented words and letter strings. *Canadian Journal of Psychology, 32,* 129–141.

Sanders, M. S., & McCormick, E. J. (1993). *Human factors in engineering and design* (7th ed.). New York: McGraw-Hill.