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## The Distribution of Visual Information in the Vertical Dimension of Roman and Hebrew Letters

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*English and Hebrew native speakers read texts mutilated by removing a narrow or a wide strip at the top or at the bottom of the lines. Whereas reading the English texts was impaired more by mutilating the top, the reverse was found for the Hebrew texts. This result is ascribed to the different ways in which information is distributed along the vertical axis of Roman and Hebrew letters. Interactions between region and width of mutilation are argued to indicate that the effect is not due just to features at the very top and very bottom.*

DIFFERENT PARTS of writing symbols may vary in their informativeness, i.e., in their contribution to letter differentiation. A simple heuristic device for distinguishing between highly and poorly informative letter segments is to test how their removal would impair reading. As early as 1879 Javal (see Huey, 1908) noted that when an English text was presented in such a way that the lower half of each line was removed, readers could read it faster and more accurately than when the upper half was removed. Huey suggested that the part the removal of which the reader could withstand better contained probably less information. He concluded, thus, that the upper part of an English text is more informative than its lower part. Kolers (1969) used the same rationale to show that the right halves of Roman letters are on the average more informative than the left halves.

However, one could contend, as Javal did, that the upper part may have an inherent advantage. For example, perhaps people tend to attend more to the upper part of visual stimuli (see, e.g., Kimura, 1959), or at least to the upper part of Roman letters. In that case they may develop a habit to rely more on features at the upper part; they may be then less practiced with inferring the identity of letters from their lower features. One purpose of the experiment we report on was to establish that vertical position of a letter-segment is just a *correlate* of informativeness and has no effect of its own, whatever

that may be, on reading. For this matter we hoped to find two alphabets with reversed relationship of informativeness and vertical position. Our intuitions and some informal studies led us to choose the Roman and Hebrew alphabets, because Hebrew letters seemed to be distinguished mainly by features at their bottom.

Another objective was to gain a better idea of where along the vertical dimension of the letter the source of the differential effect of mutilation resides. For this purpose we manipulated the width of the horizontal strip removed from the lines of text; if the same pattern recurs with the finer mutilation, part of the effect must be attributed to features located at the upper and lower margins of the letters. An interaction between the amount of mutilation and the region mutilated would indicate that marginal features are not the sole locus of the effect, and that features or feature-segments at the center do contribute to it.

### Method

Eight native English speakers were asked to read aloud four different English passages printed in Berling type and mutilated in one of four different regions: (a) very bottom, (b) lower half,<sup>1</sup> (c) upper half, (d) very top (see Figures 1a, 1b, 1c, and 1d, respectively). Eight native Hebrew speakers were asked to read aloud the translations of those four passages to Hebrew printed in Frank-Rihl type and mutilated in a similar manner (see Figures 1e, 1f, 1g, and 1h, respectively). Pairing of passages and regions of mutilation as well as order of presentation were counterbalanced by means of a Graeco-Latin square design, so that each subject read four passages each mutilated in a different manner. Passages were mounted on 5 x 8-inch cards. To provide some context, the paragraph immediately preceding the passage in the book out of which the passages were taken was mounted in intact form on the back of the card. The subject started by reading the intact passage aloud, then turned the card over and started reading the mutilated passage aloud. Regressions and retroactive self-correction were discouraged. When a subject failed to decipher a word in 3-4 seconds, the experimenter signaled to skip it, and the word was counted as an omission. Reading was tape-recorded.

Time to read the mutilated passages and the number of omissions and substitution errors were recorded. For the analysis, both observations of reading-time and number of errors (omissions plus substitutions) were divided by the number of words in the passage.

### Results

Three-way analyses of variance were performed on the two dependent variables: time per word and percentage of words incorrectly read (namely, omitted or substituted for).

As expected, the effect of the region of mutilation does interact with the language of the text; for reading time:  $F_{(1,14)} = 95.81$ ;  $p < .001$ ; for error probability:  $F_{(1,14)} = 44.68$ ;  $p < .001$ . As can be seen in Figure 2, removal of segments from the upper half of an English line impairs reading more than removal of segments from the lower half ( $F_{(1,14)} = 26.82$ ;  $p < .001$ , and  $F_{(1,14)} = 37.78$ ;  $p < .001$ , for time and errors respectively). But the reverse is true for the Hebrew texts ( $F_{(1,14)} = 72.44$ ;  $p < .001$  and  $F_{(1,14)} = 10.93$ ;  $p < .01$ , for time and errors respectively).

The effect of mutilation is larger the wider the strip removed (For reading time:  $F_{(1,14)} = 46.44$ ;  $p < .001$ ; for errors:  $F_{(1,14)} = 54.52$ ;  $p < .001$ ). More specifically, the width of the removed strip affects error percentage in both languages: Error percentages across both languages are 7.6% and 27.3% for narrow and wide removed strip respectively; and there is no interaction between the effects of width and language ( $F < 1$ ). However, the width factor affects reading speed of Hebrew texts more than it affects reading speed of English texts. The F ratio for the interaction between the effects of width and language is  $F_{(1,14)} = 18.67$ ; the simple effect of width for just Hebrew texts is highly significant ( $F_{(1,14)} = 62.02$ ;  $p < .001$ ), whereas the corresponding simple effect for English texts is nonsignificant ( $F_{(1,14)} = 3.11$ ;  $p \approx .10$ ). A conceivable explanation is that in the Hebrew, widening the region deleted from the line creates a deficiency that may sometimes be compensated for by more thorough processing using probably some redundancies; in English, however, the similar factor tends to lead to erroneous reading of the words rather than to a rise in processing time.

The data suggest that the effects of the width factor are greater when the parts removed contain more information (namely, the more its removal impairs the two criteria of reading performance). Since information appears to be distributed differently in the two languages, an interaction of width and informativeness must be reflected in triple interactions.

These triple interactions were significant: For reading time:  $F_{(1,14)} = 4.80$ ;  $p < .05$ ; for errors:  $F_{(1,14)} = 14.13$ ;  $p < .005$ . To make the picture even clearer, the data were collapsed across languages by the informativeness of the removed region and replotted in Figure 3.

It is undoubtedly much easier for a young child to learn to play by himself or with other children than for a parent to learn to play with that young child. The parent needs to get off his adult high horse and get down to the child's level in play. This is not easy for many parents. We need to learn to play games with a young child to make up spontaneous games, to tell stories and read books to him. There is an art to all of these activities. They are learned skills.

If you are quite honest with yourself, you will find that there are times when you will lose your temper, fly off the handle at your child, and yell at him or spank him, only to realize afterwards that what he did actually should not have elicited such a violent outburst from you. You were really mad at your husband or your neighbor. Or just cranky for some unknown reason. And you took it out on your child.

Your preschooler will need to play with other children and learn these socializing skills during the ages of three, four, and five. Nursery school is an ideal place to learn them, because in nursery school the learning can be supervised by a trained teacher. In neighborhood play, the learning is hit or miss, trial and error. In neighborhood play, for example, there's no trained person to help a shy child integrate himself into a group and learn to build up his self-confidence and grow out of his shyness.

When a child is three, he craves companionship in his play. He wants to separate from his mother and become more independent. The easiest way to help him to do this is to send him to a good nursery school. Even though a three-year-old wants to be separate from mother and get out into the world of his peers, he still has ambivalent feelings about leaving the security and protection of mother. It is only natural that he should feel this separation anxiety. For mother has been home base for him for three long years. Some children feel these separation anxieties more strongly than others.

1a

1b

1c

1d

מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים  
 ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש  
 מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים  
 ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש  
 מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים

1e

עם שנת החורף זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים  
 ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים  
 ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים

1f

ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים  
 ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים  
 ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים

1g

ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים  
 ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים  
 ללמוד לשחק עם ילדים אחרים זהו תהליך מורכב ודורש מאמץ רב על מנת ללמוד לשחק עם ילדים אחרים

1h

Figure 1. Examples of English and Hebrew texts mutilated in four different ways.

Coming back now to Figure 2, we can see that the difference between the top and the bottom of the line with regard to the effect of the width of the removed strip is more pronounced in English than in Hebrew. This seems to be due to the extremely asymmetric distribution of information along the vertical dimension of English letters. In English, there appears to be very little, if any, information in the bottom, as indicated by the very low number of errors (2%) committed when segments of the bottom part are removed. Consequently, it does not matter much whether the whole lower half is removed or just the very bottom (3.5 vs. 1.0 percent errors respectively). In Hebrew, however, removing segments of the less informa-

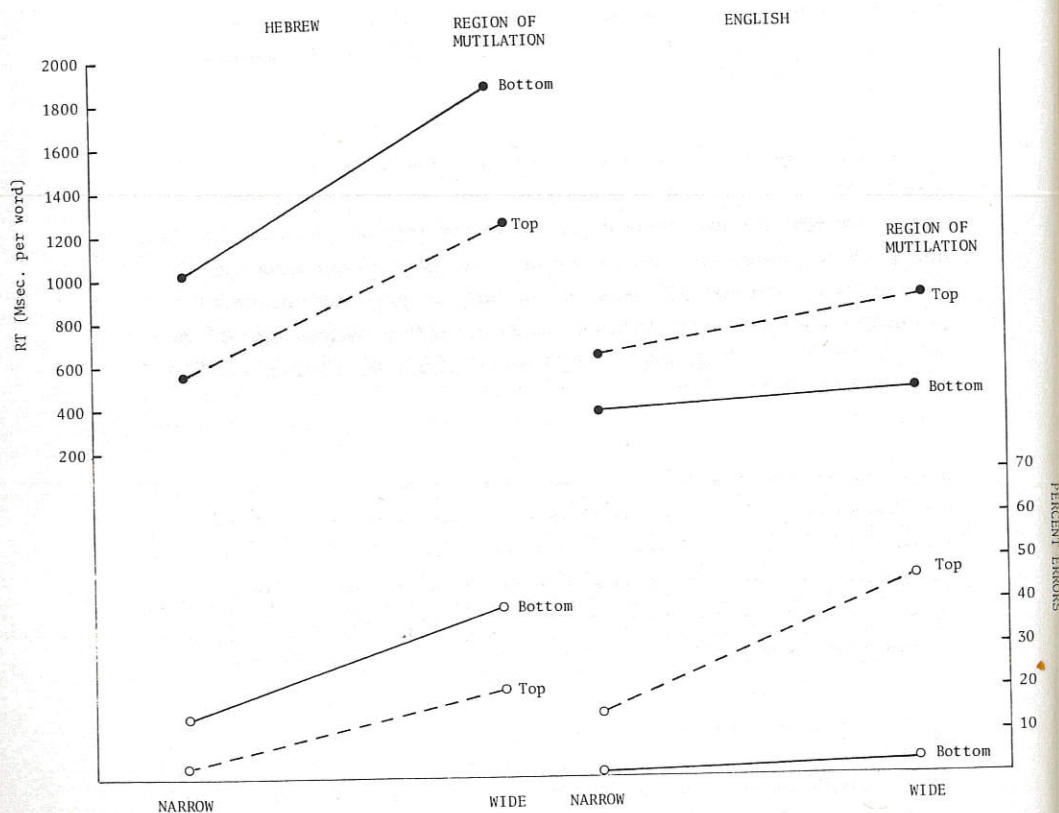


Figure 2. Mean reading times per word in msec (filled circles) and percentages of errors (empty circles) as a function of width of removed strips and region of mutilation (top-dashed lines; bottom-solid lines) plotted separately for English and Hebrew.

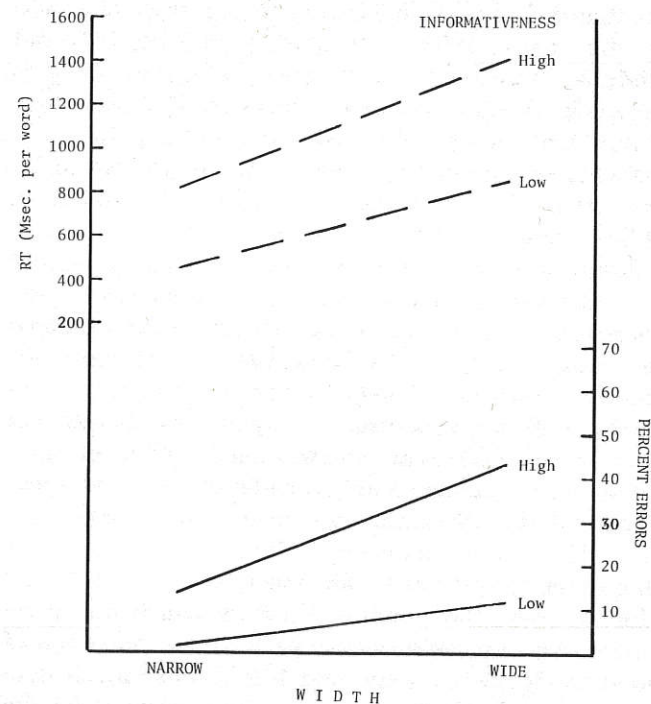


Figure 3. Mean reading times per word in msec (dashed lines) and percentages of errors (solid lines) as a function of width of removed strip and inferred degree of informativeness of the region of mutilation.

tive top half is still considerably harmful (11 percent errors on the average), so it makes a big difference whether the whole upper half is deleted or just the very top (20.3 vs. 2.6 percent errors respectively). Thus, in Hebrew the information contained in the upper half does not reside solely in the very top, but also in the more central region.

### Discussion

The interaction found here between language and region of mutilation suggests that the differential effect of removal of the upper and lower halves of a line of text is due to the distribution of information or distinctive features along the vertical axis of letters. If it had been the case that attention was allocated unevenly along the

vertical axis or that the natural direction of visual processing was top-to-bottom, then native Hebrew speakers would probably not have been different in this respect. Thus the effect is most likely to be due to the alphabets rather than to their users. The effect may vary with the type font used but this just supports the point.

This conclusion is strengthened in view of the region-width interactions in Figure 2. If "completing" missing parts (or, inferring the identity of the whole from the partial sensory cues) in one direction suffers a disadvantage with respect to the other direction, that disadvantage should add to the disadvantage associated with the larger mutilation rather than interact with it. The most plausible account of this result seems to be that the distribution of informative segments along the vertical axis of letters is skewed, so that most of them are located at both upper quarters in English (and both lower ones in the Hebrew alphabet). Removing the margin of the informative half eliminates a considerable number of identity cues; but there are still a lot of cues in its more central part which are eliminated by a larger mutilation. That is not the case with the less informative half in which each quarter contains just a few cues.

Consider, for example, the number of letters which are made ambiguous when seen in isolation under each of the four ways of mutilation shown in Figure 1. We counted 4, 4, 9, and 8 lower-case Roman letters, and 11, 17, 11, and 8 Hebrew letters (out of 27) for mutilating the very bottom, lower half, upper half, and very top respectively. Of course, recognizability may suffer even when the letter is still unambiguous on thorough inspection. We presume, however, that the degree of recognizability of unambiguous mutilated letters under a given way of mutilation is not uncorrelated with the number of ambiguations it brings about. The empirical results reported here seem to support such a view.

1. Vertical size was defined as the height of lower-case letters. Thus the texts mutilated at the bottom had the extra advantage of showing a large part of the several upper-case letters which appeared in the passages.

### References

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## Figure/ground, Brightness Contrast, and Reading Disabilities

Olive Meares

*Evidence is cited which indicates that the maximum brightness contrast of black-on-white print was a strong contributing factor in the reading disabilities of children attending a New Zealand reading clinic. Children's responses to questions and general comments about their perception of a printed page indicate a need for research into the figure/ground and brightness contrast organization of children's books. The ill-effects of maximum brightness contrast print could range from a minor irritation to a massive barrier to progress in learning to read.*

TEACHERS HAVE long been aware that some children of average or above average intelligence have quite extraordinary difficulty in learning to read. There is no general agreement about the nature and causes of such difficulty. Vellutino (1977) has presented a fine overview of the extensive, inconclusive, and conflicting research which has developed in this complex area. The purpose of this paper is to ask researchers to consider a factor which does not seem to have received adequate attention: the print that children look at. In my own reading, I have found only four related references to print and its possible interference with reading:

1. Critchley (1964) speculates about the reasons why some "dyslexics" have a marked preference for small print.
2. Monroe and Rogers (1964) consider that children's complaints about print blurring and jumping are an indication of vision defect.
3. Bedwell and Grant consider that "bits of the print blur or disappear" because of the child's poor eye control. (From an account of their work in *National Education* [N.Z.], January 1978.)
4. In a checklist of faulty vision symptoms Jordan (1972) lists:
  - Sees double images.
  - Loses place when reading.
  - Skips line above or below.
  - Loses place when making return sweep to begin a new line.
  - Words "spread apart."
  - Letters or symbols appear to move about.