

Spacing, Not size, Limits Word Recognition on Highway Signs

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Drivers need to read highway signs. Under time pressure, drivers sometimes read signs peripherally. The required size and spacing of words for readability was tested in both central and peripheral vision. Human observers read words, each four-letters long. Letter spacing (0.02-20 degrees) and sizes (.01-10 degrees) were tested. Readability was assessed as the proportion of times the word was identified correctly. The results show that spacing contributes more to word recognition than size in both central and peripheral vision. This challenges the prevailing view that spacing dominates only in peripheral vision. These results lead to recommendations for size and spacing of words on highway signs.

I. COMPARING SIZE AND SPACING TRENDS

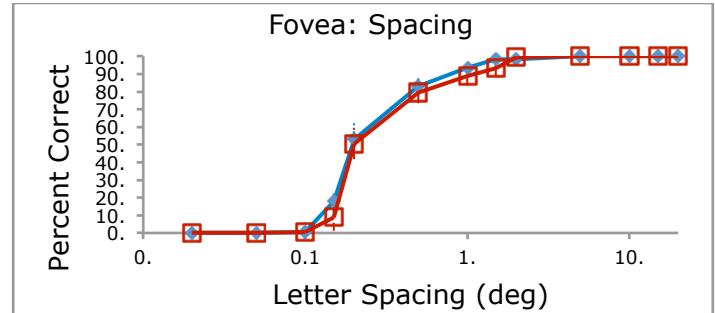
Increasing spacing between letters of words is emerging as an idea to improve word recognition. Spacing relieves *crowding*, which is the impairment of recognition due to clutter around a target object (Bouma, 1970). Size and spacing aid recognition in different parts of the visual field. The *fovea* is the center where recognition occurs within 2 degrees of the visual field. Surrounding the fovea, the *periphery* is where recognition is impaired due to crowding (Pelli, 2008). Spacing relieves crowding in the periphery. There is a double dissociation between spacing and size, in which each factor independently contributes to word recognition (Song, 2014). Therefore, each factor, size and spacing, can be directly compared to determine which has a greater impact on word recognition.

To assess word recognition, human subjects read words of various size and spacing manipulations. One condition involved identifying words of various spacing but constant size. The other condition involved identifying words of various sizes and spacing. The proportion of words identified correctly was calculated for each condition.

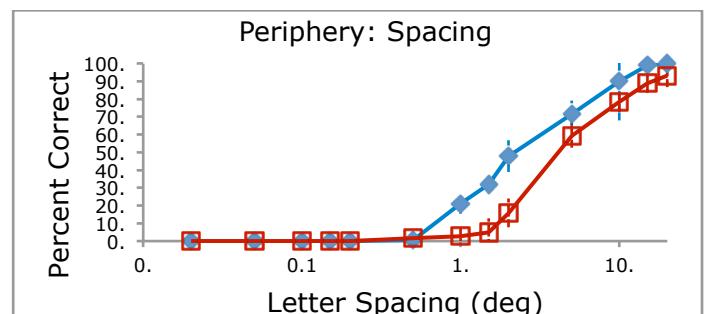
The significance of enhanced word identification can be applied to reading highway signs. Due to the restrictive time pressure that drivers face on the highway, it is important that the words on highway signs be readable for safe driving.

II. SPACING CONTRIBUTES MORE TO WORD RECOGNITION THAN SIZE

Subjects were asked to identify words in the periphery for 10 trials. The proportion of words identified correctly among subjects for each visual stimulus was calculated. Spacing increased at the same rate for both conditions, but the red curve represents condition 2, which kept size constant. Each point represents the mean percent correct of 19 subjects. Error bars represent ± 10 standard deviation. There is an insignificant difference between the curves due to the overlap in standard deviation. Therefore, the changing variable of size is insignificant in the fovea and periphery.



- Percent of words identified correctly in the fovea graphed as a function of letter spacing. The blue curve represents variable size and spacing. The red curve represents constant size and variable spacing.



- Percent of words identified correctly in the periphery graphed as a function of letter spacing. The blue curve represents variable size and spacing. The red curve represents constant size and variable spacing.

The investigation confirms the prevailing view that spacing aids recognition in the periphery, but surprisingly supports the idea that spacing also mainly aids recognition in the fovea. The results indicate a limited restriction of size on word recognition and that spacing is mainly responsible for our ability to identify words. For both fovea and periphery, the results show little or no effect of letter size; spacing is the main limit of our ability to identify words. Words on highway signs should have optimal letter-to-letter spacing so that the words are easier to identify.

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