Understanding Text Polarity Effects ECVP 2005

Lauren V. Scharff, Stephen F. Austin State University, *lscharff@sfasu.edu*
Albert J. Ahumada, NASA-Ames Research Center, *al.ahumada@nasa.gov*

Question

Scharff and Ahumada (2002, 2003) measured paragraph readability and letter identification for light text and dark text. Responses to light text were slower and less accurate for a given contrast. Is this polarity effect
(1) the result of different sensitivities in the ON and OFF retinal pathways, or
(2) the result of more experience with dark text on light backgrounds?

Strategy

To distinguish between these alternatives we separated the polarity of the contrast signal from the polarity of the letter by using a pedestal only slightly larger than the letters. The positive letters were placed on a negative pedestal so that the letter was at zero contrast with respect to the large background, but had positive contrast with respect to the local surround. Similarly, negative contrast letters were placed on a positive pedestal.
If the physiological explanation holds, the polarity of the pedestal should control the performance rather than the polarity of the letters.

Left: the letter "g" at 40% negative contrast. **Right**: the pedestal at 40% negative contrast, the letter "g" at 0% contrast with respect to the background.

Methods

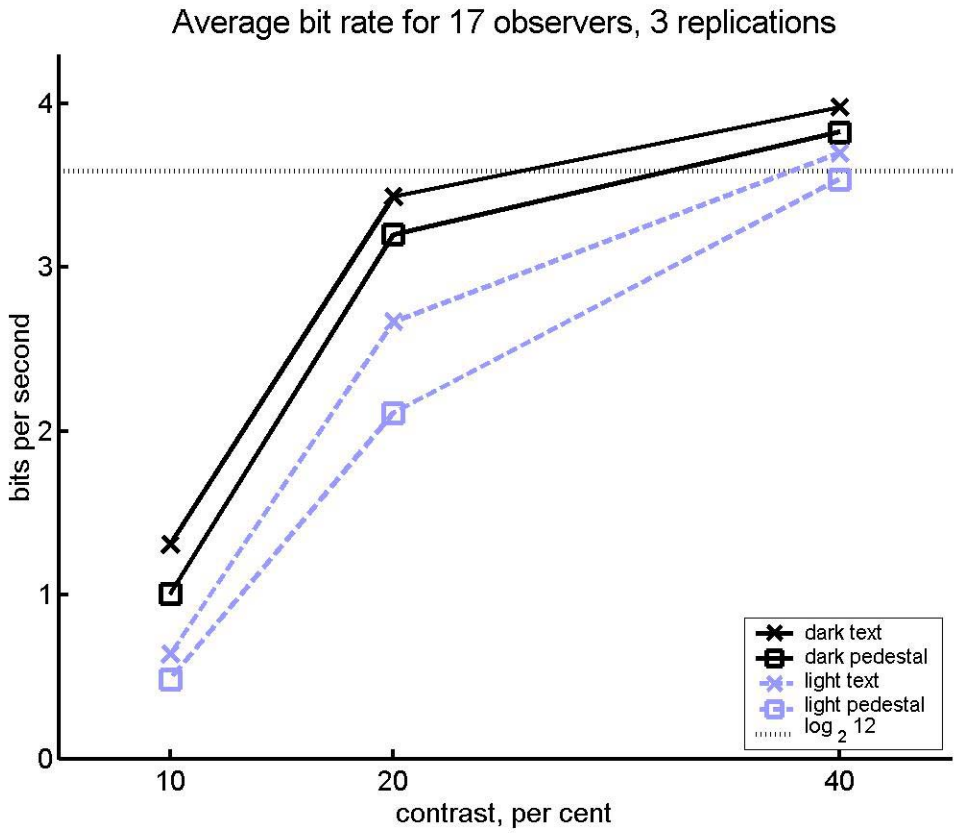
- We presented 3 randomized blocks of all combinations of three contrast levels (10, 20, 40%) and the two polarities, both with and without a pedestal.
- The 12 letters (acegilnqrstu) were those used in earlier experiments.
- The observers (N = 17) identified the presented letter by typing it as quickly as possible. Feedback was given.

Results

Reaction times T and accuracy Pc were combined with alphabet size n into a bit rate score:
$BR = (Pc \log_2(n\ Pc)+(1-Pc)\log_2(n\ (1-Pc)/(n-1)))/T$

Without the pedestal, dark letters were identified with a higher bit rate. With the pedestal, dark pedestals (light letters) were better ($F(1,16) = 90.7$, $p < .001$).

Pedestal stimuli had lower bit rates than letter stimuli without pedestals ($F(1,16) = 24.0$, $p<.001$). Bit rate increased with contrast ($F(1,16) = 92.4$, $p<.001$).



Does Negative Contrast Dominate in our Negative Stimuli? (Yes, but more so for letters alone)

We simulated ON and OFF channels with Difference of Gaussian filters with a center spread of 2 arc min and a balanced surround spread of 6 arc min (method from Ratliff et al., 2005).

Letters alone had 87+-2% of their contrast energy in the channel with the letter polarity.

Pedestal letters had 75+-2% of their energy in the pedestal polarity channel.

Conclusions

Polarity of the signal energy, not the text polarity, determines performance. Pedestal letters were worse.

Acknowledgements

Support provided by NASA Aerospace Systems and the San Jose State University Foundation.

References

Scharff, L. F. V., and Ahumada, A. J. Jr. (2002). Predicting the readability of transparent text, Journal of Vision **2**(9), 653-666. http://www.journalofvision.org/2/9/7/.

Scharff, L. F. V., and Ahumada, A. J. (2003). Contrast measures for predicting text readability, B. E. Rogowitz and T. N. Pappas, eds., Human Vision and Electronic Imaging VII, SPIE Proc. **5007**, Paper 46.

Ratliff, C., Sterling, P., and Balasubramanian, V. (2005). Negative contrasts predominate in natural images, Investigative Ophthalmology and Visual Science 46, ARV0 e-Abstract 4685.