New England University Transportation Center
77 Massachusetts Avenue, E40-279
Cambridge, MA 02139
utc.mit.edu

New England
University Transportation Center

Year 25 Final Report

Grant Number: DTRT13-G-UTC31

Project Title:

Assessing the Effect of Typography on In-Vehicle Glance-Like Reading Across the Lifespan

Project Number:	Project End Date:	Submission Date:
MITR25-13	8/31/2017	11/27/2017

Principal Investigator:	Bryan Reimer	**Co-Principal Investigator:**	Jonathan Dobres
Title:	Research Scientist	**Title:**	Research Associate
University:	MIT	**University:**	MIT
Email:	reimer@mit.edu	**Email:**	jdobres@mit.edu
Phone:	617 452 2177	**Phone:**	

Fonts communicate an interface's style and identity, and are also a critical design element of that interface. In safety, critical applications such as driving an automobile, basic readability and the ability to quickly target and identify information of interest is critical to reducing workload and preventing distraction. The importance of providing a driver with a visual user interface in which controls can be rapidly identified and information easily read appears self-evident. Previous research has shown that the typeface used in an interface can meaningfully impact driver behavior, as measured by task completion time, error rates, and cumulative glance time to the device screen.

Our earliest work in this area examined the design of the typefaces themselves, while holding extrinsic factors such as lighting, size, and line weight constant. Subsequent work examined how these factors interact with typeface design. Our most recent work under the auspice of this project further expanded these types of investigations to examine how legibility changes with rendering, illumination and contrast polarity, age, and how fonts are read in common highway signage configurations.

The work is detailed across four publications and has been referenced in numerous popular press articles including Print, Design Week, Design Observer, Best Ride and others.

For further details on this research, please see:

1. Dobres, J., Reimer, B., & Chahine, N. (2016). **The Effect of Font Weight and Rendering System on Glance-Based Text Legibility**. *Proceedings of the 2016 International Conference on Automotive User Interfaces and Interactive Vehicular Applications*. Ann Arbor, MI. https://dl.acm.org/citation.cfm?doid=3003715.3005454

Abstract: In-vehicle user interfaces increasingly rely on digital text to display information to the driver. Led by Apple's iOS, thin, lightweight typography has become increasingly popular in cutting-edge HMI designs. The legibility trade-offs of lightweight typography are sparsely studied, particularly in the glance-like reading scenarios necessitated by driving. Previous research has shown that even relatively subtle differences in the design of the on-screen typeface can influence to-device glance time in a measurable and meaningful way. Here we investigate the relative legibility of four different weights (line thicknesses) of type under two different rendering systems (suboptimal rendering and optimal rendering). Results indicate that under suboptimal rendering, the lightest weight typeface renders poorly and is associated with markedly degraded legibility. Under optimal rendering, lighter weight typefaces show enhanced legibility compared to heavier typefaces. The reasons for this pattern of results, and its implications for design considerations in modern HMIs, are discussed.

2. Dobres, J., Chahine, N., & Reimer, B. (2017). **Effects of ambient illumination, contrast polarity, and letter size on text legibility under glance-like reading**. *Applied Ergonomics*, 60(C), 68–73. http://doi.org/10.1016/j.apergo.2016.11.001

Abstract: Recent research on the legibility of digital displays has demonstrated a "positive polarity advantage", in which black-on-white text configurations are more legible than their negative polarity, white-on-black counterparts. Existing research in this area suggests that the positive polarity advantage stems from the brighter illumination emitted by positive polarity displays, as opposed to the darker backgrounds of negative polarity displays. In the present study, legibility thresholds were measured under glance-like reading conditions using a lexical decision paradigm, testing two type sizes, display polarities, and ambient illuminations (near-dark and daylight-like). Results indicate that legibility thresholds, quantified as the amount of time needed to read a word accurately, were highest for the negative polarity configurations under dark ambient illumination, indicated worse performance. Conversely, the positive polarity conditions under dark ambient illumination and all conditions under bright illumination demonstrated significantly reduced thresholds, indicating greater legibility. These results are consistent with the hypothesis that the "positive polarity advantage" arises because brighter illumination produces pupillary contraction that reduces optical aberrations as light enters the eye. These results have implications for the design of automotive interfaces and other scenarios in which an interface must be optimized for glance-like reading under variations in ambient lighting conditions.

3. Wolfe, B., Dobres, J., Kosovicheva, A., Rosenholtz, R., & Reimer, B. (2016). **Age-related differences in the legibility of degraded text**. *Cognitive Research: Principles and Implications*, 1–13. http://doi.org/10.1186/s41235-016-0023-6

Abstract: Aging-related changes in the visual system diminish the capacity to perceive the world with the ease and fidelity younger adults are accustomed to. Among many consequences of this, older adults find that text that they could once read easily proves difficult to read, even with sufficient acuity correction. Building on previous work examining visual factors in legibility, we examine potential causes for these age-related effects in the absence of other ocular pathology. We asked participants to discriminate words from non-words in a lexical decision task. The stimuli participants viewed were either blurred or presented in a noise field to simulate, respectively, decreased sensitivity to fine detail (loss of acuity) and detuning of visually selective neurons. We then use the differences in performance between older and younger participants to suggest how older participants' performance could be approximated to facilitate maximally usable designs.

4. Dobres, J., Chrysler, S. T., Wolfe, B., Chahine, N., & Reimer, B. (2017). **Empirical Assessment of the Legibility of the Highway Gothic and Clearview Signage Fonts**. Transportation Research Record: Journal of the Transportation Research Board, 2624, 1–8. http://doi.org/10.3141/2624-01

Abstract: Older drivers represent the fastest-growing segment of the driving population. Aging is associated with well-known declines in reaction time and visual processing, and, as such, future roadway infrastructure and related design considerations will need to accommodate this population. One potential area of concern is the legibility of highway signage. FHWA recently revoked an interim approval that allowed optional use of the Clearview typeface in place of the traditional Highway Gothic typeface for signage. The legibility of the two fonts was assessed with color combinations that maximized the contrast (positive or negative) or approximated a color configuration used in highway signage. Psychophysical techniques were used to establish thresholds for the time needed to decide accurately—under glancelike reading conditions—whether a string of letters was a word, as a proxy for legibility. These thresholds were lower for Clearview (indicating superior legibility) than for Highway Gothic across all conditions. Legibility thresholds were lowest for negative-contrast conditions and highest for positive-contrast conditions, with colored highway signs roughly between the two extremes. These thresholds also increased significantly across the age range studied. The method used to investigate the legibility of signage fonts adds methodological diversity to the literature along with evidence supporting the superior legibility of the Clearview font over Highway Gothic. The results do not suggest that the Clearview typeface is the optimal solution for all signage but they do indicate that additional scientific evaluations of signage legibility are warranted in different operating contexts.