Evaluation of the MAG Safety and Elderly Mobility Sign Project

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MARICOPA ASSOCIATION of GOVERNMENTS

Table of Contents

List of Figures

List of Tables

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Executive Summary

In 2007, the Transportation Safety Committee and the Elder Mobility Stakeholders Group of the Maricopa Association of Governments jointly launched a road safety project for installing new Clearview font street name signs, designed for better legibility, based on the *FHWA Guidelines and Recommendations to Accommodate Older Drivers and Pedestrians, <YEAR>*. The types of signs addressed by the project included: street name signs, advance street name signs, and internally illuminated signs, with all of them using Clearview font sizes. The project paid the full cost of producing the new signs with the local agencies being responsible for all installation costs. The project also provided local agencies that have sign fabrication shops, the necessary software for producing signs with Clearview font.

This study was performed, by a research team from the Arizona State University, to evaluate the effect of installing the new Clearview street name and advance street name signs on the safety and the mobility of older drivers. The objective of the study was to develop a sound analytical approach to quantify the mobility and safety impacts of the new signs, with Clearview font, installed at various intersections in the MAG region. Although Clearview font has been shown to improve simple detection and legibility, no studies had been conducted to directly measure the effect of Clearview font on driving performance. Improved legibility is not always predictive of performance in more complex driving tasks and of driving safety in general (Wood & Owens, 2005). The primary goal of this study was to investigate the effect of Clearview font signs on safety and mobility in a simulated driving and navigation environment.

In this study, 36 drivers ranging in age from 56-70 years were asked to navigate through a virtual city in a driving simulator. Their driving performance was compared for Clearview and Standard font overhead and advance intersection signs in simulated day and nighttime driving conditions. Consistent with previous research (Hawkins et al. 1999, Carlson et al., 2001), the study found that the distance at which drivers could accurately recognize street names was consistently and significantly greater for Clearview font signs. The increase in sign recognition distance associated with Clearview font ranged between 8 - 34ft across the drivers in this study with an average increase of 14ft. Expanding on previous research in this area, the study team also found that the usage of the Clearview font was associated with consistent and statistically significant improvements in several measures of driving safety. With Clearview signs, drivers in our study made 52% fewer turn errors, changed lanes for an upcoming left turn at a significantly greater distance (by 5.2 ft on average) from the intersection (indicative of better anticipation and planning) and drove at a speed closer to the designated speed limit (change in speed of 3.2 mph on average). The study also observed fewer collisions with other vehicles when Clearview signs were used. All of these variables are indicators of improved safety and mobility for elderly drivers.

Interestingly, drivers' subjective evaluations of the effectiveness of Clearview signs did not match perfectly with the results for driving performance. Clearview signs were rated as significantly easier to read (ratings were 5% higher on average) but the magnitude of the effect was much smaller than the effect sizes for the driving performance variables and for sign recognition distance. Furthermore, 33% of the drivers in our study indicated that the Standard font sign was easier to read than the Clearview sign when asked to make a forced choice between the two signs. This occurred even though 100% of the participants in the study drove more safely in the Clearview conditions. Therefore, the measured improvements in driving safety are much greater than one might predict from making a passive judgment about the signs. This will be an important point to emphasize when seeking further funding and support for Clearview sign adoption.

Given the significant improvements in driving safety and mobility found in this study it is recommended that the Maricopa Association of Governments continue to encourage the adoption of Clearview font for street name signs.

1. Background

The Clearview alphabet was developed by Meeker & Associates in 1995 to improve the legibility of roadway signage. The visual structure of Clearview font differs from standard fonts used on street signs in two ways; the lower case lettering is taller and the lettering allows for more open space in the interior shape of the letters. The Clearview font's wider open spaces allow for irradiation without decreasing the distance at which the alphabet is legible (Garvey 1997). Two of the main goals of developing the new alphabet were to (i) improve sign legibility for older drivers and (ii) to counter the blooming possibilities when signs fabricated from bright microprismatic sheeting are illuminated by headlights. Visual acuity and motor response time are known to diminish with increasing age. When reading roadway signs, especially at night, the vision of older vehicle operators often suffers from a phenomenon known as irradiation, halation, or overglow. Irradiation becomes a problem if a stroke on the lettering is so bright that it visually bleeds into the character's open spaces. This creates a blobbing effect that reduces legibility. Improvements to reflective material on roadway signs have increased the occurrence of irradiation. Clearview font was designed to reduce the magnitude of irradiation or blooming as illustrated in Figure 1.

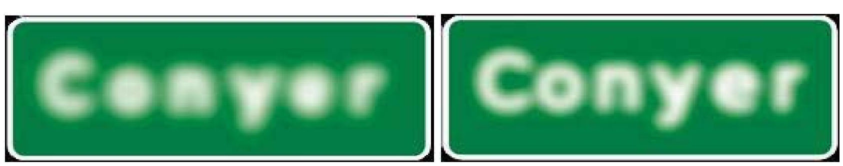

Figure 1: Blooming from Standard (left) and Clearview Font (right)

Research has shown that Clearview font can improve the legibility of roadway signs both in daytime and nighttime conditions. Hawkins et al (1999) compared Clearview and Series E (Modified) font signs under day and night conditions for drivers over 65 years of age. Drivers were required to read sign names aloud and the recognition distance for each sign was recorded. Clearview signs outperformed Series E signs in all cases; however, the difference in recognition distance was only statistically significant for overhead signs in daytime conditions. Overall, Clearview signs showed a modest but consistent improvement in recognition distance, ranging from 3-8% in magnitude. Carlson et al (2001) compared Clearview and Series E (Modified) font signs fabricated using microprismatic sheeting and nighttime driving conditions. In this study, young (18-34), middle aged (35-54) and elderly (>55) were compared and recognition distance was again used as the performance measure. For advance street name signs, mean legibility distance was 32ft (5%) greater for Clearview signs with the magnitude of the improvement ranging between 18-58ft. The effect of Clearview signs was greater for older drivers (the changes in recognition distance were 5.8, 4.6 and 9.3 % for the 3 age groups respectively). For overhead mounted signs, the mean legibility distance was 40ft (6.7%) greater for Clearview signs with the magnitude of the effect ranging from 26-54ft. Again larger benefits were observed for older drivers (changes in recognition distance were 2.3, 3.5 and 6.8% for the 3 age groups).

A major limitation of this previous research is that it does not measure the effect of Clearview signs on active driving performance. Continuously and passively monitoring a road sign while sitting in a moving vehicle is a highly unrealistic task. In real navigation situations drivers must perform sign recognition in conjunction with several other important driving tasks including collision avoidance, lane keeping, watching for pedestrians entering the road, monitoring speed etc. As recognized by Carlson et al (2001) drivers must sample the information presented on a road sign intermittently (i.e., between sampling other information form the road, vehicle dashboard, etc). Therefore, measures of sign recognition performance in the unnatural situation where the driver's only task is to read the sign may not predict performance under more natural, multi-tasking conditions. Furthermore, even if Clearview font makes signs more legible and easier to read there is some previous research which suggests that this may not actually impact driving safety. The ability of a driver to see clearly (i.e., measures of acuity such as Snellen acuity or contrast acuity) can only explain a small amount of the variance (<10%) in driving accidents (Higgins and Wood, 2005; Wood and Owens, 2005). Therefore, an evaluation of the direct effects of Clearview font on driving performance is crucial to inform future efforts to install additional Clearview street name signs with in the MAG region.

2. Methods

2.1 Participants

Thirty-six participants (20 female and 16 male) completed the study. Participants ranged in age from 56-70 years (M=62.2, SE=0.56). An additional 5 participants could not complete the study due to motion sickness and therefore their data were discarded. All participants were compensated $20 for their participation.

2.2 Apparatus

Driving simulator. The driving simulator was composed of two main components: (a) a steering wheel mounted on a table top and pedals (Wingman Formula Force GP, Logitech™) and (b) three 19” Dell™ LCD monitors. The monitors were viewed from a distance of 57cm. The three monitors were positioned side-by-side as shown in Figure 2 to create a driving scene that subtended a total of 130° H x 30° V of visual angle. The visual scene was rendered and updated by DriveSafety™ driving simulator software running on four PC’s (Dell Optiplex GX270) at a rate of 60 Hz.

Figure 2: Driving simulator

Road signs. Road sign images were generated using FlexiSign™ software and imported into the driving simulation. Both overhead intersection and advance street signs were used. Advance signs were placed at a distance of 150ft from the intersection and were always placed on the right side of the road. The two road sign fonts were Clearview (as shown for the overhead sign in Figure 3) and Series 200 Standard Highway Font (as shown for the overhead sign in Figure 4). Both overhead and advance signs were presented in the same font.

Figure 3: Example of Clearview Font overhead sign image.

Figure 4: Example of Standard Highway Font (Series 200) overhead sign image.

2.3 Procedure

Participants were asked to navigate through a virtual city in the driving simulator. The city, shown in a top-down view in Figure 5, consisted of 4-lane roads with signaled intersections. The surrounding environment (e.g., buildings, etc) were highly similar for each intersection so as to provide no ‘landmark’ cues to the location in the virtual city. Each intersection was marked with an overhead road sign. Drivers were instructed that the speed limit was 35 mph. A speedometer was presented via a heads-up display on the center monitor. Other random traffic was present along the roadway. The route that the driver followed on each run was indicated by an auditory in-car navigation system. Each route consisted of 6 turns. An example route is shown in Figure 5.

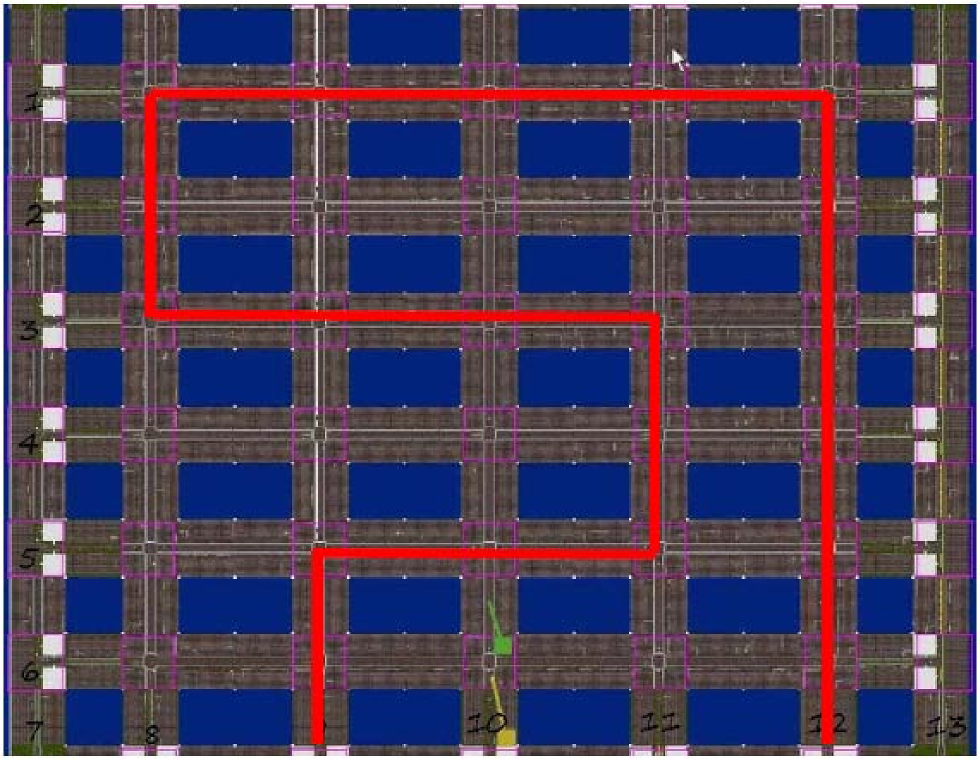

Figure 5 – Overhead view of the driving environment

Pre-recorded auditory messages were given to drivers such as, "Next turn: Left on Washington Street". Messages were presented roughly 10 sec after the completion of the previous turn. Participants were also given the option of hearing the navigation instruction again at any time by asking the experimenter.

Participants were instructed to press the blue 'x' button on the steering wheel (see Figure 2) as soon as they could read the road sign at each intersection. They were then asked to say the name aloud and the experimenter recorded whether or not the name was accurately reported. The distance from the intersection at which the button was pressed was recorded by the simulation software.

Each participant completed 4 drives (Day/Clearview, Day/Standard, Night/Clearview, and Night/Standard). The street names for each drive are shown in Table 1. These names were chosen to have a moderate level of confusability. The order of these drives was counterbalanced across participants.

Participants also completed two types of questionnaires. Following each drive they were asked to rate the difficulty of reading the road signs in the condition they just completed on a scale of 1-5. The following categories were assigned to each number: 1 (“effortless to read”), 2 (“easy to read”), 3(“about average level of reading difficulty), 4(“somewhat difficult to read), and 5(“very difficult to read”). Following the completion of all drives they were shown examples of the two fonts (e.g., Figures 3 and 4) and were asked t make a forced choice as to which was easier to read.

Table 1: Street sign names

Track 1	**Track 2**	**Track 3**	**Track 4**
Sterling Dr	Hampton Dr	Drummer Rd	Pleasant Rd
Shumway Ave	Madison Dr	Clearwater Dr	Hardwood Dr
Princeton Dr	Montana Dr	Clearview Dr	Hampton Dr
Hampton Dr	Newcastle Rd	Aurora Ave	Alderwood Ave
Montana Rd	Washington St	Amandor Rd	Raymond Ave
Newport St	Whispering St	Madero Rd	Aurora Rd
Rochester Rd	Crescent Rd	Freestone Rd	Fountain Dr
Peterson Rd	Clearwater Rd	Emerald Rd	Lavender Dr
Redwood St	Claiborne Dr	Crismon Dr	Inverness Dt
Pheasant Rd	Grandview Dr	Crescent St	Larkspur Dr
Pineridge Dr	Creekwood Dr		

2.4 Data Analysis

Several different dependent measures were taken to quantify the effect of road signage on driver perception and performance. To allow for comparison with previous research, the *recognition distance* for all road signs was analyzed. To extend previous research we also analyzed several performance variables including *turn errors* (instances in which the driver either made a turn on an incorrect street or missed a turn), *lane change distance* (the distance from the intersection for which the driver changed lanes when a left turn was required), *lane position variance*, *intersection approach speed* and *collision with other vehicles.* Finally, the *subjective reading difficulty ratings* were also analyzed. All of these variables were analyzed statistically using separate 2x2 repeated measures ANOVAs with Sign Font and Time of Day as factors. Detailed results from these analyses are provided in Appendix A.

3. Results

3.1 Sign Recognition Distance

Figure 6 plots the mean simulated distance from the advance sign at which participants pressed the steering wheel button. Only responses for which participants correctly named the street are included (across all participants 12% of responses were discarded due to naming errors). Consistent with previous research (Hawkins et al. 1999), recognition distances in both day and night conditions were larger for Clearview font than for standard font and the magnitude of this difference was greater for simulated nighttime conditions. On average, recognition distance was 12.1 ft (8.0%) larger for daytime and 15.4 ft (10.9%) for nighttime. The statistical analysis revealed significant main effects of Font [$F(1, 35)=182.2$, $p<0.001$] and Time of Day [$F(1, 35)=217.1$, $p<0.01$] and a significant Font x Time of Day Interaction [$F(1, 35)=7.7$, $p<0.01$].

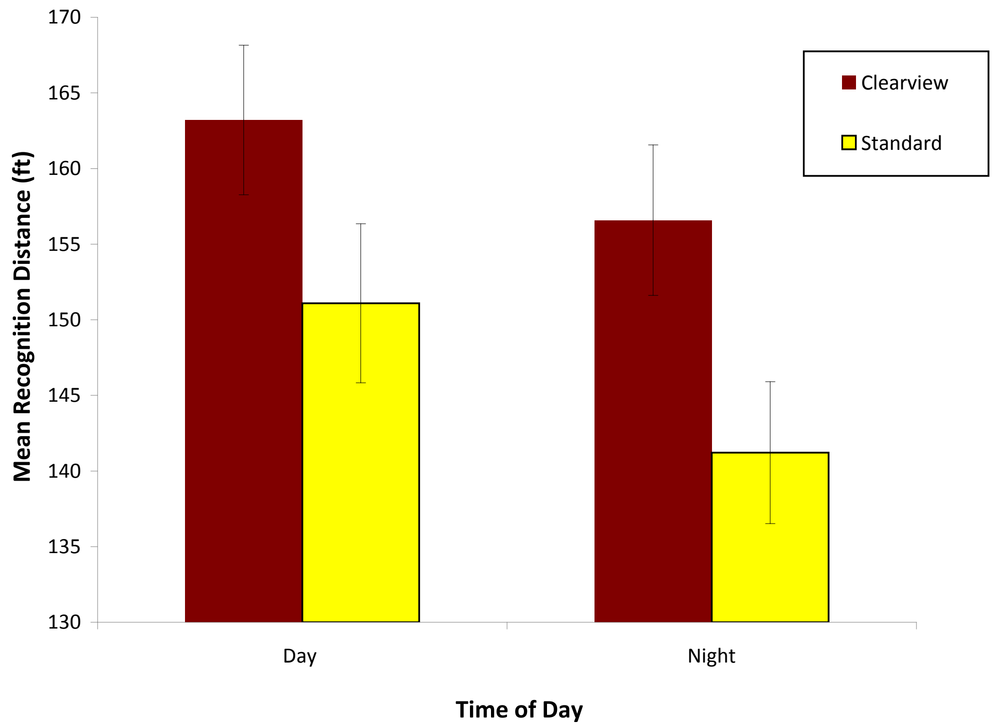

Figure 6 – Mean sign recognition and legibility distances

3.2 Number of Turn Errors

Figure 7 plots the mean number of turn errors per condition. These errors include both instances when the driver failed to execute a turn indicated by the navigation system and when they made a turn that was not instructed. Although the number of turn errors was relatively small (<1 per condition), drivers did make fewer errors with the Clearview font than with the Standard font. The magnitude of reduction was not substantially different for day and night conditions (0.45 vs 0.35 reduction in turn errors respectively). The statistical analysis revealed a significant main effects of Font [$F(1, 35)=32.4$, $p<0.001$]. Neither the main effect of Time of Day nor the Font x Time of Day interaction were statistically significant.

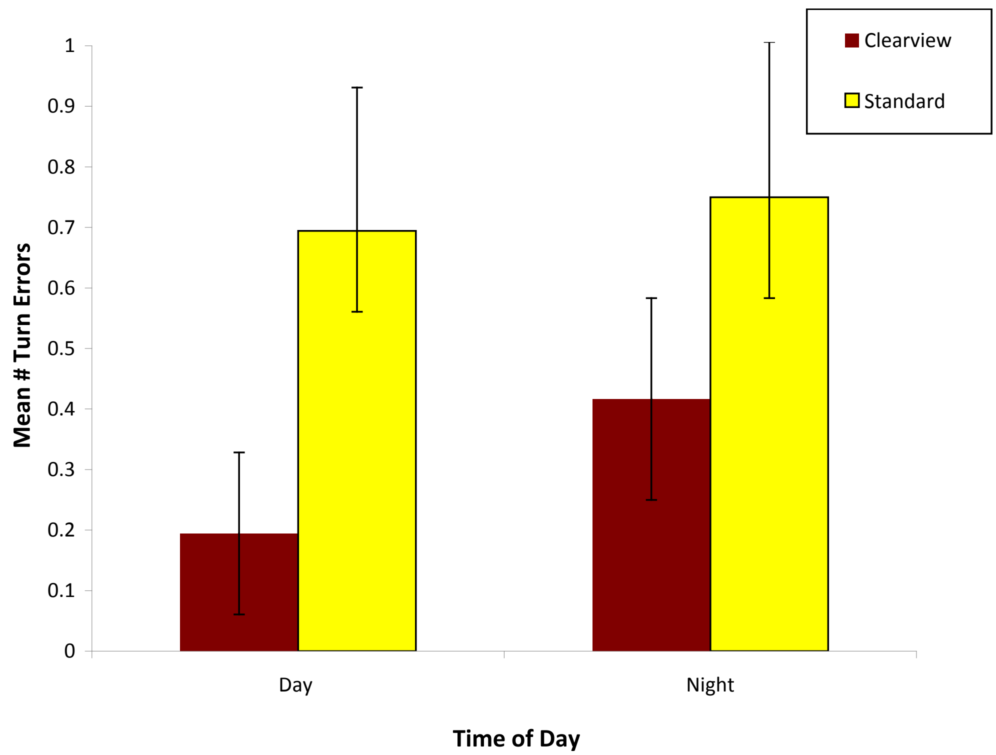

Figure 7– Mean Number of Turn Errors

3.3 Lane Change Distance

Figure 8 shows the mean distance from the intersection at which drivers changed from the right lane to left lane when executing a left turn. Lane changes were executed further from the intersection for Clearview font than for Standard font. The magnitude of difference between the two fonts was slightly larger under simulated night conditions: Clearview font resulted in an increase in lane changed distance of 1.4ft (3.1%) for day and 2.1ft (5.6%) for night. The statistical analysis revealed significant main effects of Font [$F(1, 35)=59.7$, $p<0.001$] and Time of Day [$F(1, 35)=31.0$, $p<0.001$]. The Font x Time of Day Interaction was not significant indicating that there was no statistical difference in the effect of font between day and night.

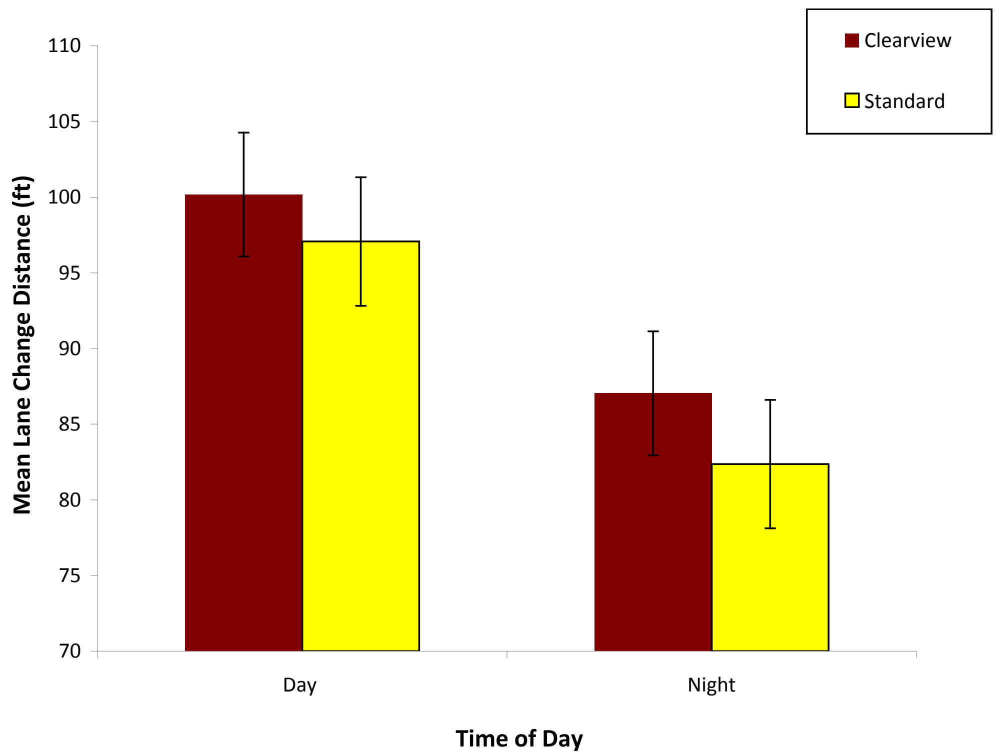

Figure 8– Mean Lane Change Distance

3.4 Intersection Approach Speed

Figure 9 plots the mean driving speed measured at a distance of 200ft from the intersection. Note that the speed limit in the simulation was 35 mph as indicated by the horizontal line. In the conditions with the Standard font driving speed was slower (and well below the speed) limit as compared to conditions with Clearview font indicating that drivers were having a more difficult time reading signs in the former case. The magnitude of speed difference was larger in day (-3.7mph, 11.5%) than in night (-2.1%, 6.8%) conditions. The statistical analysis revealed significant main effects of Font [$F(1, 35)=19.9$, $p<0.001$] and Time of Day [$F(1, 35)=30.0$, $p<0.001$]. The Font x Time of Day Interaction was not significant indicating that there was no statistical difference in the effect of font between day and night.

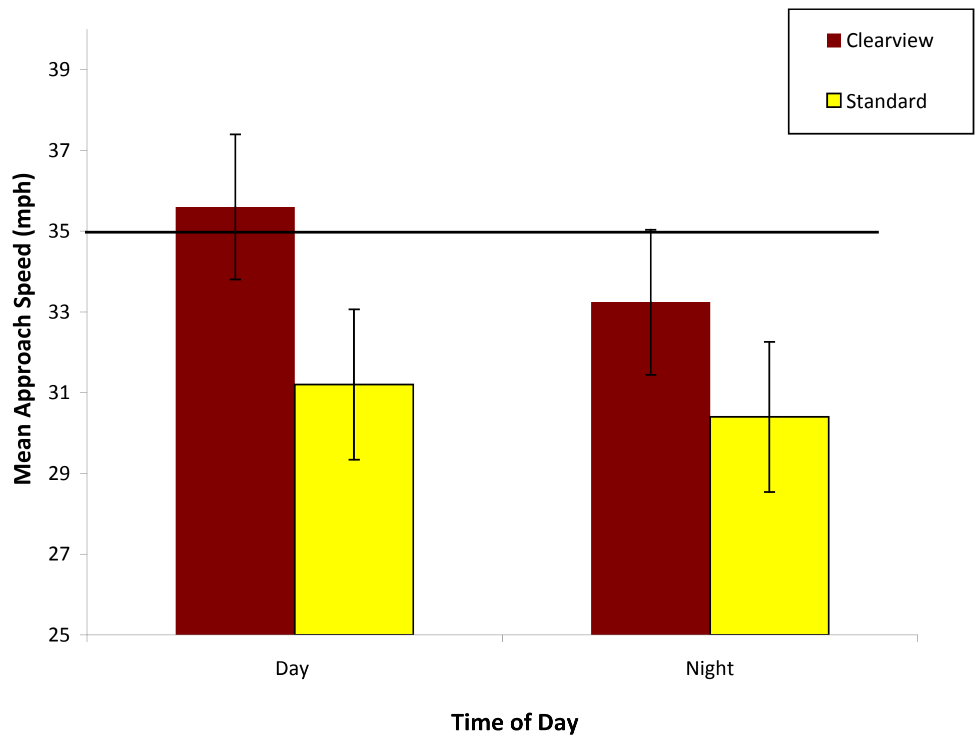

Figure 9– Mean Intersection Approach Speed

3.5 Lane Variability & Collisions

We also analyzed lane position variability (i.e., the extent to which the driver was weaving within their lane) and the number of collisions. There were no significant differences found for these variables between any of the conditions. Mean lane position variability data were as follows: Day/Clearview: 0.9, Day/Standard: 0.92, Night/Clearview: 1.2, Night/Standard: 1.1. Mean number of collisions data were as follows: Day/Clearview: 0.1, Day/Standard: 0.22, Night/Clearview: 0.31, Night/Standard: 0.36.

3.6 Questionnaire Data

Figure 10 shows the mean reading difficulty rating (out of 5) for each of the conditions. On average drivers rated Clearview font as slightly easier to read than Standard font. The magnitude of the differences in ratings were 0.22 (5.5%) for daytime and 0.17 (4.4%) for nighttime. The statistical analysis revealed marginally significant effects of Font [$F(1, 35)=3.9$, $p \approx 0.05$] and Time of Day [$F(1, 35)=5.2$, $p \approx 0.04$]. The Font x Time of Day Interaction was not significant indicating that there was no statistical difference in the effect of font between day and night.

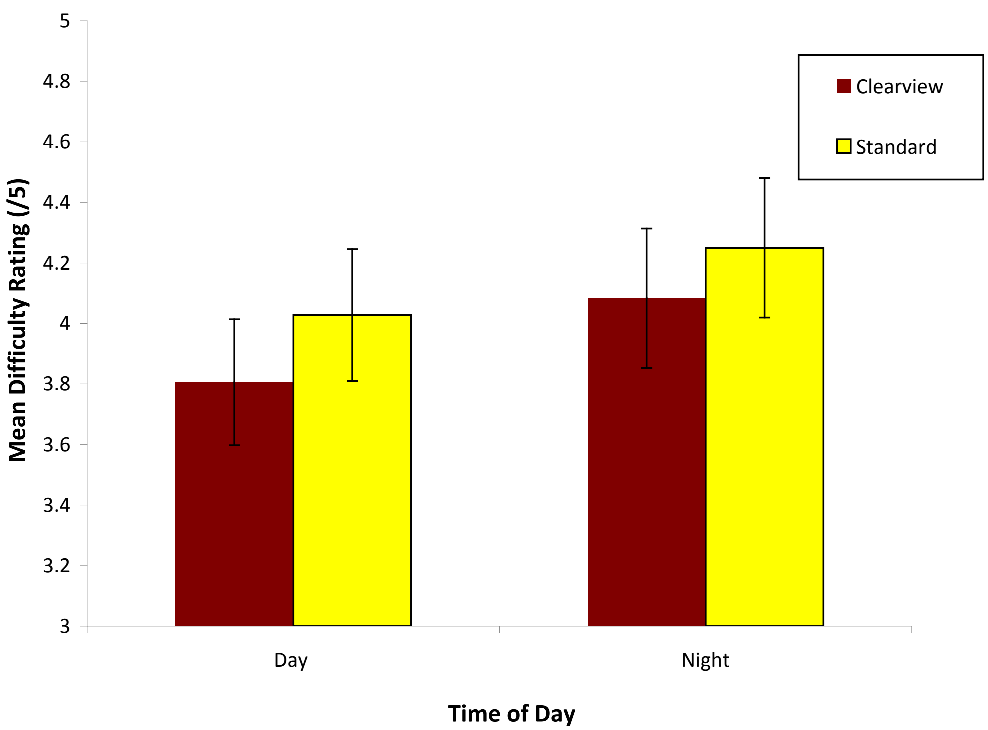

Figure 10– Mean Difficulty Rating

For the forced choice question asked at the end of the study 21/32 (66%) participants indicated that the Clearview font sign was easier to read.

4. Conclusions

Consistent with previous research on Clearview font signage (Hawkins et al. 1999; Carlson et al 2001) we found consistent but modest improvements in sign recognition performance for Clearview font as compared to Standard font. The 8-10% increase in sign recognition distance for Clearview signs found in our driving simulator study was similar to that reported in the previous studies using instrumented vehicles and real signs. This indicates that that the driving simulation used in our study has good external validity. For a driver traveling at 35 mph (the speed limit in our simulated urban environment), the legibility improvement of 14ft found in our study would equate to an extra 0.35 seconds to read the sign.

Expanding on previous research we also found consistent effects of Clearview font on measures of driving performance and safety. When Clearview signs were used, drivers in our study made significantly fewer turn errors, changed lanes for an upcoming left turn at a significantly greater distance from the intersection and drove at a speed closer to the designated speed limit. All of these factors would be expected to improve safety and mobility under real driving conditions. When drivers miss a turn they often panic and execute a dangerous driving maneuver such as a rapid U-turn. Furthermore, for elderly drivers a high frequency of missed turns can reduce driving confidence resulting in less driving and decreased mobility (Ball et al, 1993). Switching lanes earlier for an upcoming turn is indicative of better anticipation and planning by the driver and would make it less likely that they would have to make a sudden lane change when they are close to the intersection (Groeger, 2000). Such sudden lane changes increase the probability of missing a vehicle in the driver's blind spot and having a side swipe accident. Finally, driving closer to the speed limit improves driving safety by decreasing the chance that an impatient driver will attempt to make a dangerous maneuver to get around the slower moving driver. Driving too far below the posted speed limit has been linked with accidents in elderly drivers (Ball et al, 1993). Note that there were also fewer collisions in the Clearview conditions although this difference was not statistically significant.

As discussed above, the impact of Clearview font on sign legibility is expected to be greatest under night driving conditions due to the reduction of potential blooming effects (see Figure 1). Differences between the effectiveness of Clearview font under day and night conditions were somewhat inconsistent in our driving simulator study. Only for *sign recognition distance* did we find that the effect of Clearview font was significantly greater under nighttime conditions than daytime conditions. For all driving performance variables, the improvement in safety associated with the use of Clearview signs was similar in magnitude (and not statistically different) for simulated day and night conditions. This is perhaps not surprising given that we could not accurately simulate microprismatic sheeting and blooming effects in our driving simulation. A more advanced simulation that allowed for more complex illumination algorithms and sign imagery would be needed to properly evaluate the effect of Clearview font under nighttime conditions. However, the findings of our study also suggest that the improvements in sign legibility associated with the usage of Clearview font are not solely due to the reduction of blooming effects at night.

Drivers' subjective impressions of sign readability (assessed through post-driving questionnaires) were consistent with the quantitative effects found for driving performance. However, the effect magnitude for ratings was much smaller. While large, highly-significant improvements on driving performance and recognition distance were found for Clearview font, drivers' ratings of sign readability were only marginally better for Clearview font as compared to Standard font. For example, the number of turn errors decreased by 40-62% in the Clearview conditions while the ratings of sign readability were only 4-6% greater. In addition, about two thirds of drivers indicated that the Clearview sign was easier to read when forced to make a choice. This occurred even though all participants in our study showed driving safety improvements in the Clearview conditions. This mismatch between performance data and subjective judgments is consistent with several previous studies on human performance (e.g., Gray et al., 2006) and can be explained by the theory that perception for conscious judgment involves different areas of the brain than perception for the control of action (Goodale & Milner, 1992). According to this theory, when participants are reading the signs while driving they are using the dorsal areas of their brain while when they are asked to make a passive judgment they are using the ventral areas. Therefore, it is not surprising that the effects of the two are different. In practical terms this is a very important point to emphasis: the measured improvements in driving safety are much greater than one might predict from making a passive judgment about the signs. Even if someone indicates something to the effect "I don't see any difference between the signs" we would still expect a significant improvement in driving safety and mobility.

Given the consistent improvements in driving safety and mobility it is recommend that the Maricopa Association of Governments continue to encourage member agencies to expand their adoption of Clearview road signs.

Sources Referenced:

Ball, K., C. Owsley, et al. (1993). Visual-attention problems as a predictor of vehicle crashes in older drivers. *Investigative Ophthalmology & Visual Science, 34,* 3110-3123.

Garvey, P. M., Pietrucha, M. T., & Meeker, D. (1997). Legibility of guide signs. *Transportation Research Record 1605*, TRB, National Research Counil, Washington, D. C., pp 73-79.

Goodale, M. A. & Milner, A. D. (1992). Separate visual pathways for perception and action. *Trends in Neuroscience 15,* 20-5.

Gray, R., Regan, D. Castaneda, B., & Sieffert, R. (2006). Role of feedback in the accuracy of perceived direction of motion in depth and control of interceptive action. *Vision Research*, *46*, 1676-1694.

Groeger, J. A. (2000). *Understanding driving: Applying cognitive psychology to a complex everyday task.* Philadelphia, PA, Psychology Press.

Hawkins, H. G., Wooldridge, M. D., Kelly, A. B., Picha, D. L., & Greene, F. K. (1999). Legibility comparison of three freeway guide sign alphabets. *FHWA/TX-99/1276-1F*, College Station, Texas, May 1999.

Higgins, K. E. and Wood, J. M. (2005) Predicting components of closed road driving performance from vision tests. *Optom. Vis. Sci. 82*, 647–656.

Carlson, P. J. (2001). Evaluation of clearview alphabet with microprismatic retroreflective sheeting. *Report 4049-1*, College Station, Texas, October 2001.

Wood, J. M. and D. A. Owens (2005). Standard measures of visual acuity do not predict drivers' recognition performance under day or night conditions. *Optometry and Vision Science, 82*, 698-705.

Appendix – Data Analyses

Recognition Distance

Within-Subjects Factors

Measure:MEASURE_1

Timeof Day	Font	Dependent Variable
1	1	Day_CV
	2	Day_st
2	1	Night_CV
	2	Night_St

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
TimeofDay	Sphericity Assumed	471.614	1	471.614	182.158	.000
	Greenhouse-Geisser	471.614	1.000	471.614	182.158	.000
	Huynh-Feldt	471.614	1.000	471.614	182.158	.000
	Lower-bound	471.614	1.000	471.614	182.158	.000
Error(TimeofDay)	Sphericity Assumed	90.616	35	2.589		
	Greenhouse-Geisser	90.616	35.000	2.589		
	Huynh-Feldt	90.616	35.000	2.589		
	Lower-bound	90.616	35.000	2.589		
Font	Sphericity Assumed	1309.234	1	1309.234	217.093	.000
	Greenhouse-Geisser	1309.234	1.000	1309.234	217.093	.000
	Huynh-Feldt	1309.234	1.000	1309.234	217.093	.000
	Lower-bound	1309.234	1.000	1309.234	217.093	.000
Error(Font)	Sphericity Assumed	211.076	35	6.031		

	Greenhouse-Geisser	211.076	35.000	6.031		
	Huynh-Feldt	211.076	35.000	6.031		
	Lower-bound	211.076	35.000	6.031		
TimeofDay * Font	Sphericity Assumed	18.347	1	18.347	7.702	.009
	Greenhouse-Geisser	18.347	1.000	18.347	7.702	.009
	Huynh-Feldt	18.347	1.000	18.347	7.702	.009
	Lower-bound	18.347	1.000	18.347	7.702	.009
Error(TimeofDay*Font)	Sphericity Assumed	83.373	35	2.382		
	Greenhouse-Geisser	83.373	35.000	2.382		
	Huynh-Feldt	83.373	35.000	2.382		
	Lower-bound	83.373	35.000	2.382		

Turn Errors

Within-Subjects Factors

Measure:MEASURE_1

Timeof Day	Font	Dependent Variable
1	1	Day_CV
	2	Day_st
2	1	Night_CV
	2	Night_St

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
TimeofDay	Sphericity Assumed	.694	1	.694	1.000	.324
	Greenhouse-Geisser	.694	1.000	.694	1.000	.324
	Huynh-Feldt	.694	1.000	.694	1.000	.324
	Lower-bound	.694	1.000	.694	1.000	.324
Error(TimeofDay)	Sphericity Assumed	24.306	35	.694		
	Greenhouse-Geisser	24.306	35.000	.694		
	Huynh-Feldt	24.306	35.000	.694		
	Lower-bound	24.306	35.000	.694		
Font	Sphericity Assumed	6.250	1	6.250	32.407	.000
	Greenhouse-Geisser	6.250	1.000	6.250	32.407	.000
	Huynh-Feldt	6.250	1.000	6.250	32.407	.000
	Lower-bound	6.250	1.000	6.250	32.407	.000
Error(Font)	Sphericity Assumed	6.750	35	.193		
	Greenhouse-Geisser	6.750	35.000	.193		
	Huynh-Feldt	6.750	35.000	.193		
	Lower-bound	6.750	35.000	.193		
TimeofDay * Font	Sphericity Assumed	.250	1	.250	1.129	.295
	Greenhouse-Geisser	.250	1.000	.250	1.129	.295
	Huynh-Feldt	.250	1.000	.250	1.129	.295
	Lower-bound	.250	1.000	.250	1.129	.295
Error(TimeofDay*Font)	Sphericity Assumed	7.750	35	.221		
	Greenhouse-Geisser	7.750	35.000	.221		
	Huynh-Feldt	7.750	35.000	.221		
	Lower-bound	7.750	35.000	.221		

Lane Change Distance

Within-Subjects Factors

Measure:MEASURE_1

Timeof Day	Font	Dependent Variable
1	1	Day_CV
	2	Day_st
2	1	Night_CV
	2	Night_St

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
TimeofDay	Sphericity Assumed	1342.001	1	1342.001	59.698	.000
	Greenhouse-Geisser	1342.001	1.000	1342.001	59.698	.000
	Huynh-Feldt	1342.001	1.000	1342.001	59.698	.000
	Lower-bound	1342.001	1.000	1342.001	59.698	.000
Error(TimeofDay)	Sphericity Assumed	786.794	35	22.480		
	Greenhouse-Geisser	786.794	35.000	22.480		
	Huynh-Feldt	786.794	35.000	22.480		
	Lower-bound	786.794	35.000	22.480		
Font	Sphericity Assumed	104.380	1	104.380	30.946	.000
	Greenhouse-Geisser	104.380	1.000	104.380	30.946	.000
	Huynh-Feldt	104.380	1.000	104.380	30.946	.000
	Lower-bound	104.380	1.000	104.380	30.946	.000
Error(Font)	Sphericity Assumed	118.055	35	3.373		
	Greenhouse-Geisser	118.055	35.000	3.373		
	Huynh-Feldt	118.055	35.000	3.373		
	Lower-bound	118.055	35.000	3.373		
TimeofDay * Font	Sphericity Assumed	4.271	1	4.271	1.045	.314

	Greenhouse-Geisser	4.271	1.000	4.271	1.045	.314
	Huynh-Feldt	4.271	1.000	4.271	1.045	.314
	Lower-bound	4.271	1.000	4.271	1.045	.314
Error(TimeofDay*Font)	Sphericity Assumed	143.074	35	4.088		
	Greenhouse-Geisser	143.074	35.000	4.088		
	Huynh-Feldt	143.074	35.000	4.088		
	Lower-bound	143.074	35.000	4.088		

Intersection Approach Speed

Within-Subjects Factors

Measure:MEASURE_1

Timeof Day	Font	Dependent Variable
1	1	Day_CV
	2	Day_st
2	1	Night_CV
	2	Night_St

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
TimeofDay	Sphericity Assumed	162.988	1	162.988	19.903	.000
	Greenhouse-Geisser	162.988	1.000	162.988	19.903	.000
	Huynh-Feldt	162.988	1.000	162.988	19.903	.000
	Lower-bound	162.988	1.000	162.988	19.903	.000
Error(TimeofDay)	Sphericity Assumed	286.612	35	8.189		
	Greenhouse-Geisser	286.612	35.000	8.189		
	Huynh-Feldt	286.612	35.000	8.189		

	Lower-bound	286.612	35.000	8.189		
Font	Sphericity Assumed	316.840	1	316.840	30.038	.000
	Greenhouse-Geisser	316.840	1.000	316.840	30.038	.000
	Huynh-Feldt	316.840	1.000	316.840	30.038	.000
	Lower-bound	316.840	1.000	316.840	30.038	.000
Error(Font)	Sphericity Assumed	369.180	35	10.548		
	Greenhouse-Geisser	369.180	35.000	10.548		
	Huynh-Feldt	369.180	35.000	10.548		
	Lower-bound	369.180	35.000	10.548		
TimeofDay * Font	Sphericity Assumed	24.668	1	24.668	4.271	.046
	Greenhouse-Geisser	24.668	1.000	24.668	4.271	.046
	Huynh-Feldt	24.668	1.000	24.668	4.271	.046
	Lower-bound	24.668	1.000	24.668	4.271	.046
Error(TimeofDay*Font)	Sphericity Assumed	202.142	35	5.775		
	Greenhouse-Geisser	202.142	35.000	5.775		
	Huynh-Feldt	202.142	35.000	5.775		
	Lower-bound	202.142	35.000	5.775		

Reading Difficulty Ratings

Within-Subjects Factors

Measure:MEASURE_1

TimeofDay	Font	Dependent Variable
1	1	Day_CV
	2	Day_st
2	1	Night_CV
	2	Night_St

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
TimeofDay	Sphericity Assumed	2.250	1	2.250	5.164	.029
	Greenhouse-Geisser	2.250	1.000	2.250	5.164	.029
	Huynh-Feldt	2.250	1.000	2.250	5.164	.029
	Lower-bound	2.250	1.000	2.250	5.164	.029
Error(TimeofDay)	Sphericity Assumed	15.250	35	.436		
	Greenhouse-Geisser	15.250	35.000	.436		
	Huynh-Feldt	15.250	35.000	.436		
	Lower-bound	15.250	35.000	.436		
Font	Sphericity Assumed	1.361	1	1.361	3.924	.055
	Greenhouse-Geisser	1.361	1.000	1.361	3.924	.055
	Huynh-Feldt	1.361	1.000	1.361	3.924	.055
	Lower-bound	1.361	1.000	1.361	3.924	.055
Error(Font)	Sphericity Assumed	12.139	35	.347		
	Greenhouse-Geisser	12.139	35.000	.347		
	Huynh-Feldt	12.139	35.000	.347		
	Lower-bound	12.139	35.000	.347		
TimeofDay * Font	Sphericity Assumed	.028	1	.028	.103	.751
	Greenhouse-Geisser	.028	1.000	.028	.103	.751
	Huynh-Feldt	.028	1.000	.028	.103	.751
	Lower-bound	.028	1.000	.028	.103	.751
Error(TimeofDay*Font)	Sphericity Assumed	9.472	35	.271		
	Greenhouse-Geisser	9.472	35.000	.271		
	Huynh-Feldt	9.472	35.000	.271		
	Lower-bound	9.472	35.000	.271		