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Real World On-Premise Sign Visibility

The Impact of the Driving Task On Sign Detection and Legibility

USSCF ON-PREMISE SIGNS / RESEARCH CONCLUSIONS

REAL WORLD ON-PREMISE SIGN VISIBILITY

THE IMPACT OF THE DRIVING TASK ON SIGN DETECTION AND LEGIBILITY

A Research Project Of The

UNITED STATES SIGN COUNCIL FOUNDATION

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SIGN ORIENTATION AND NEGATIVE SPACE

Signs are crucial to driver safety, affecting perception of appropriate direction, distance, speed, and the ability to maneuver on the roadway. Drivers depend on signs whether they are traveling on a highway, in a work zone, on an interchange, or simply driving down a street looking for a store. This last scenario however, is often taken for granted. This is unfortunate because storefront signs are often the end point of the information system travelers use to navigate to their final destination. Simply stated, storefront (or on-premise) signs have not been traditionally thought of as part of the formal route guidance system. If their role as a fundamental part of this system were better understood, on-premise sign design and implementation would seriously consider visibility and traveler safety. However, as the situation now stands, local planning officials regulate on-premise signs based mainly on aesthetics often neglecting the minimal requirements necessary to make a sign visible to a vehicle operator traveling toward it at a high rate of speed. This approach frequently results in on-premise signs with deficiencies that cause loss of time and increased fuel consumption and emissions, as drivers may have to circle a block several times to find their destination. It also leads to greater potential for motor vehicle crashes due to erratic last-minute maneuvers, loss of concentration caused by driver frustration, and simply increased exposure, all of which may have a deleterious effect on traffic safety. To correct this problem will require reeducating both the planning and the highway engineering communities, but first a better understanding of basic issues related to on-premise sign visibility must be attained.

Many factors influence sign detection and readability. Such factors include the visual ability of the driver, sign design (e.g., size and color), sign placement, and the visual and driving environment. Previous research conducted for the United States Sign Council Foundation (USSC-F) by the Pennsylvania Transportation Institute (PTI) evaluated the effect that a number of these variables have on on-premise sign visibility (Kuhn, et al., 1998). That evaluation was performed on a test track applying carefully controlled sign and environmental variables. Specifically, that study looked at sign legibility during the day and at night for various colors, fonts, and lighting designs. That research was important because it was the first scientific effort to establish reading distances for a variety of on-premise sign conditions. This report documents the logical next step: a research project to determine on-premise sign visibility wherein the effects of sign placement and content were systematically evaluated in a real world environment.

RESEARCH OBJECTIVES

The goal of this study was to determine the detectability and legibility of a variety of on-premise signs under real life environmental conditions. This was done by conducting an open-field research study on public roadways in a small downtown area and along a commercial strip development zone. Data were collected during the day and at night using older and younger subjects as vehicle operators. The study evaluated two specific sign variables: 1) sign orientation (parallel to the direction of travel versus perpendicular to the direction of travel) and 2) negative space (the open area around the words or graphic elements of a sign). For the purposes of this study, negative space was defined as the number of words used to convey a message in a given sign space. The information obtained from this research was intended to promote an understanding of the effects of sign content and positioning on sign visibility.

RESEARCH APPROACH

METHOD

Signs

The research team designed the test signs with the guidance of USSC representatives to ensure that the test signs were representative of in-use on-premise signs. The sign designs were generated using a computer-aided graphic design package. All signs had plastic faces with vinyl surfacing and lettering, were internally illuminated at night with a bank of white light fluorescent lamps sufficient to produce uniform illumination across the sign face, used an Helvetica font, and were rectangular in shape. At each location, a single color combination and contrast orientation ("negative contrast"– dark text on a lighter background, or "positive contrast"– light on dark) was used; however, to avoid subjects identifying the signs by color, four color combinations were applied across locations. (See Appendix A for photographs of the individual signs). Once the final sign designs were established, the USSC was responsible for fabricating and installing the signs (Figure 1), which were obtained from USSC member designers and manufacturers. Three signs were evaluated at each of eight locations for a total of 24 signs (Table 1).

Figure 1. Sign Installation

Sign Locations

All experimental signs were mounted near commercial premises on public roads in the State College, Pennsylvania area. Eight locations were selected; four on downtown roadways with 25-mile-per-hour (mph) posted speed limits and four on strip development area roadways with 35-mph speed limits (Table 2). The downtown roadways were minor arterials that are a portion of Pennsylvania State Route 26. The roads consisted of a two-lane, one-way cross section with an adjacent parking lane in some locations and were part of a one-way couplet (i.e., two parallel one-way streets running in opposite directions) that forms the major downtown vehicle circulation route. The strip development area roadway was a major arterial that is a portion of U.S. Route 322. This road is comprised of a four-lane, two-way cross section with curbing (Figure 2).

Final locations were chosen based on a number of variables including sight distance and the proximity of other retail outlets. All locations had a 500-foot, straight, flat line-of-sight from the roadway to the sign position with no permanent obstacles blocking the sign. This allowed the experimental signs to be tested at their maximum legibility distances. The locations also had to have other on-premise signs nearby. This increased the visual complexity and avoided artificially long visibility distances not representative of real world conditions.

Location	Sign	Condition	Color (copy/background)	Size (ft)	Cap Height (in)	Loop Height (in)	Copy
1	1	Perp-A	Black/White	2x3	4	3.13	Grayson's Sporting Goods
	2	Parallel-2A		3x4.5	6	4.5	
	3	Parallel 3A		3.5x5.5	7	5.13	
2	4	Perp-A	Yellow/Green	2x3	4	3.13	Quick Copy Center
	5	Parallel-2A		3x4.5	6	4.5	
	6	Parallel 3A		3.5x5.5	7	5.13	
3	7	25%	White/Black	3x5	7.13	5.5	Clear Fresh Water Company
	8	50%					Clear Fresh Water
	9	75%					Fresh Water
4	10	Perp-A	Green/Yellow	3x5	7	5.5	Happy Food Market
	11	Parallel-2A		4x7	9.5	7.25	
	12	Parallel 3A		5x9	12	9	
5	13	Perp-A	White/Black	3x5	7	5.5	Hannah's Sandwich Shop
	14	Parallel-2A		4x7	9.5	7.25	
	15	Parallel 3A		5x9	12	9	
6	16	25%	Green/Yellow	3x5	7.13	5.5	Ed's Party Supply Store
	17	50%					Ed's Party Supply
	18	75%					Party Supply
7	19	25%	Yellow/Green	2x3	4	3.13	Alisa's Truck Rental Center
	20	50%					Truck Rental Center
	21	75%					Truck Rental
8	22	25%	Black/White	2x3	4	3.13	Tony's Car Insurance Plaza
	23	50%					Car Insurance Plaza
	24	75%					Car Insurance

Table 1. Sign Description

	Location Number	Roadway Classification	Speed Limit (mph)	Cross Section (ft)	Lane Width (ft)	Average Daily Traffic
Downtown	1	Arterial	25	36	12	14,000
	2			39	13	14,000
	7			30	12	14,000
	8			26	13	14,000
Strip Commercial	3	Arterial	35	57	10	35,000
	4					20,000
	5					35,000
	6					20,000

Table 2. Description of Roadways Used in the Study

Sign Installation

Each downtown sign was mounted on the left side of the roadway beyond the sidewalk in an area adjacent to a commercial establishment. Each sign in the strip commercial area was mounted on the right side of the roadway in the front yard of a commercial property. Because of real-world constraints found in the built environment, the lateral offset and mounting height for each sign was different at each location (Table 3). Lateral offset was the distance measured from the curb to the sign face for parallel signs and the sign edge closest to the road for perpendicular signs. Sign height was the height from the top of the curb to the bottom of the sign. Both the lateral offset and the sign height were selected to match, as closely as possible, the other storefront signs in the immediate area.

Location	Lateral Offset (ft)	Sign Height (ft)
1	9.5	5.0
2	11	5.0
3	23	5.0
4	20	3.5
5	10	3.5
6	18	8.0
7	17	3.0
8	8	4.5

Table 3. Sign Mounting Positions

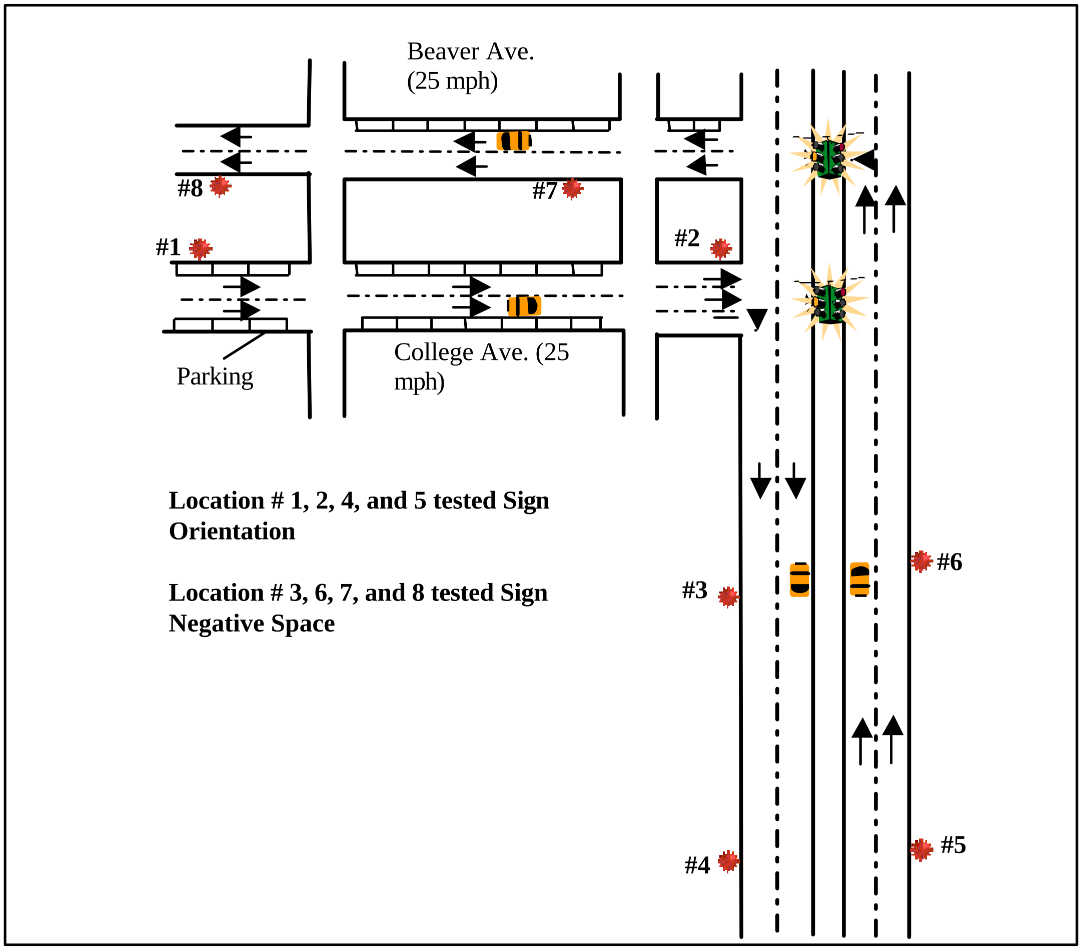


Figure 2. Schematic Diagram of Study Route

Subjects

A total of 120 subjects participated in this research. Sixty older (65 years of age and above) and 60 younger drivers (17-35 years of age) comprised the subject sample. All subjects had valid Pennsylvania driver's licenses, drove regularly, and suffered no self-reported visual deficits.

Apparatus

The observation vehicle was a full-sized 1997 Chevrolet sedan obtained from Penn State's Fleet Operations and equipped with a Nu-Metrics distance measuring instrument (DMI) to record sign reading distances. The DMI interfaced with a laptop computer on which the data were stored for analysis. The stimuli consisted of the set of 24 experimental on-premise signs previously described.

Variables

Dependent Variables

The dependent or measured variables were sign detection and a real-world combination of sign detection/legibility distance. The detection variable had two levels: subjects were given a "one" if they found and read the sign correctly regardless of distance, and a "zero" if they drove past the sign without seeing it at all. The operational definition of the detection/legibility distance variable was the greatest distance at which a subject could correctly find and read a particular sign after he or she was prompted to look for it. In conditions where there were few missed signs, only the detection/legibility distance variable was analyzed.

Independent Variables

Roadway type (downtown versus strip), posted speed limit (25 versus 35 mph), location complexity, sign color, and contrast orientation were varied in this study, however it was not possible to assess the individual effects of these variables as these variables were confounded with one another. For example, a reduction in performance at 25 mph might be due to speed or the fact that this was the downtown area where location complexity was higher. Because all these variables were confounded, each location was used as a unique testing ground for the non-confounded independent variables. The independent variables that were manipulated in such a way as to avoid confounding were, time of day (defined as daytime and nighttime [with signs illuminated]), observer age group, and the two sign variables (orientation and negative space).

Sign Orientation

Sign orientation was evaluated to address the commonly held belief that signs perpendicular to the roadway (projecting signs) are more visible then those mounted parallel (wall signs) (Claus and Claus, 1978). In addition, to evaluate the hypothesis that increasing the size of parallel signs could improve their visibility, two parallel sign sizes were tested. For ease of discussion, these conditions will be referred to as Perp-A, Parallel-2A, and Parallel-3A, respectively. Signs in the Parallel-2A condition had twice the area as Perp-A, and those in the

Perp-A

Parallel-2A

Parallel-3A

Parallel 3A condition had three times Perp-A's sign area. (See Table 1 for exact dimensions and Figure 3 for photographs.)

Figure 3. Sign Orientation Condition

<u>Negative Space</u>

There is a long-standing debate as to how much negative (or white) space to include on a sign. Some of the arguments are strictly aesthetic and relate to sign balance and figure/background considerations; however, there has been some disagreement regarding the optimum negative space for sign detectability and copy legibility. To evaluate the effect of this variable, three levels of negative space were used: 25, 50, and 75 percent. In this study, the definition of negative space was the area subtended by the open space surrounding lines of type.

To manipulate negative space without changing letter characteristics such as height or weight, additional neutral words were added to the sign. For example, at Location 3, the 25 percent

25-Percent

50-Percent

75-Percent

condition read “Clear Fresh Water Company,” the 50 percent condition read “Clear Fresh Water,” and the 75 percent condition read “Fresh Water” (Table 1; Figure 4).

Figure 4. Negative Space Condition

Experimental Design

The nature of the dependent variables required an experimental design in which each subject was only exposed to each location once. The reason for this type of approach was that sign location is quickly learned. The same subject could not be asked to find two or three signs at the same location under different conditions (e.g., during the day and at night or mounted parallel and perpendicular). To do this, the pool of 120 subjects was divided into three groups of 40. Each group consisted of four sub-groups with 10 subjects each (Table 4). The four subgroups were: young daytime, young nighttime, older daytime, and older nighttime.

Speed	Variable	Location	Subject Group 1	Subject Group 2	Subject Group 3
25 mph	Orientation	1	Perp-A	Parallel-2A	Parallel-3A
		2	Perp-A	Parallel-2A	Parallel-3A
	Negative Space	7	25%	50%	75%
		8	50%	25%	75%
35 mph	Negative Space	3	50%	25%	75%
		6	25%	50%	75%
	Orientation	4	Perp-A	Parallel-2A	Parallel-3A
		5	Perp-A	Parallel-2A	Parallel-3A

Table 4. Experimental Design

PROCEDURE

The subjects were positioned in the driver's seat of the instrumented vehicle. The experimenter was located in the front passenger seat. To become acquainted with the vehicle's handling, the subjects drove for approximately five minutes on a prescribed route prior to beginning the session. The subjects then drove through an established test route of approximately 6 miles lasting about 40 minutes (Figure 2). Throughout the test route, the subjects were asked to maintain the vehicle speed at the posted limits.

At predetermined locations along the test route, the experimenter directed the subjects to find a particular business type by locating the appropriate sign. The experimenter prompted the subjects without providing the exact sign wording. For example, subjects were asked to find a place at which they could buy athletic equipment, and the target sign read "Grayson's Sporting Goods." The subjects were asked to wait until they felt confident that the sign was the target sign before responding. (See Appendix B for subject instructions.)

When the subject read the sign aloud, the experimenter pressed a button connected to the DMI. When the vehicle reached the sign, the experimenter pressed the button again and the distance between the two button presses was logged on the computer as the detection/legibility distance for that subject, for that location, under the specific sign conditions. This procedure was repeated for all eight signs shown to that subject in that session. This experimental technique resulted in fewer than 5 percent false alarms (that is, the subject detecting the wrong sign).

STATISTICAL ANALYSES

The objective of the statistical analyses was to determine if sign orientation, negative space, time of day, and age had statistically significant effects on sign detection or detection/legibility distance and if there were any interactions between the independent variables. Statistical significance means that any differences found between the variables were real; that is, they could be replicated and were not the result of mere chance. An interaction occurs when, by changing the level of a single variable, the effect of a second variable is changed. An example of a time of day by age interaction would be if younger subjects were able to read signs better at night, while older subjects performance improved in daylight. The two dependant measures used in this research require different statistical analyses.

Binary regression and chi-squared analyses were used for the detection variable to compare conditions that resulted in numerous missed signs. These analyses made it possible to determine whether a condition was significantly different from the others based solely on the drivers' ability to detect the sign (e.g., were parallel signs missed more often than perpendicular signs).

Analysis of variance (ANOVA) and the general linear model (GLM) with Tukey pairwise comparisons were conducted to evaluate the detection/legibility distances of signs that were detected. These analyses treated undetected signs as missing data, because missed signs were undetected signs (not signs that were detected or read at zero feet), and converting undetected signs to zero detection/legibility distances would have distorted the results. (See Appendix C for detailed tables containing descriptive data that include the undetected signs.)

RESULTS

Sign Orientation (Perpendicular vs. Parallel)

Sign Detection

Sign orientation was tested at Locations 1, 2, 4, and 5. At Locations 1, 4, and 5 the perpendicular signs were detected significantly more often (i.e., missed less) than either of the parallel signs (Figure 5, Table 5), even though the parallel signs were two to three times larger. The two parallel conditions were equally detectable, demonstrating that increasing the size of the parallel signs had no statistically significant effect on detectability at three of the four locations. At Location 2 the perpendicular sign and the largest parallel sign were equally detectable; both were missed less often than the smaller parallel sign.

At all but Location 5, the younger age group outperformed the older group, and signs at locations 1 and 2 were detected at night more often than in daylight. There were no interaction effects (i.e., orientation by age; orientation by time of day; age by time of day; and the triple interaction of age by time of day by orientation) at any of the sign locations.

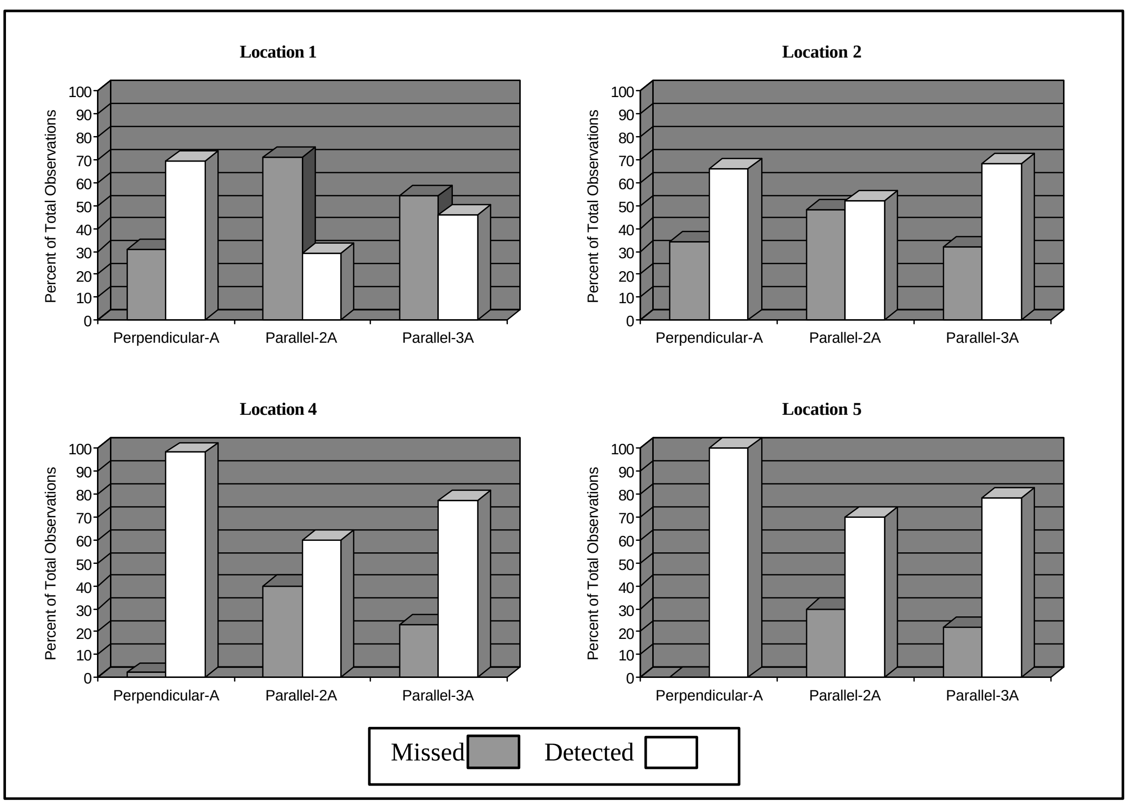


Figure 5. Sign Orientation: Percent of Signs Missed/Detected (Both Age Groups, Day and Night)

Location	Condition	Daylight Condition		Nighttime Condition	
		% Missed	% Detected	% Missed	% Detected
1	Perp-A	40	60	17	83
	Parallel-2A	62	38	81	19
	Parallel-3A	65	35	42	58
2	Perp-A	47	53	19	81
	Parallel-2A	67	33	26	74
	Parallel-3A	44	56	21	79
4	Perp-A	0	100	0	100
	Parallel-2A	45	55	35	65
	Parallel-3A	24	76	22	78
5	Perp-A	0	100	0	100
	Parallel-2A	10	90	38	62
	Parallel-3A	5	95	16	84

Table 5. Sign Orientation: Absolute Detection (Both Age Groups)

Detection/Legibility Distance

Location 1 showed no sign orientation effect. At the other three locations, the perpendicular signs were found and read significantly further away than either of the parallel conditions. At Location 2 (downtown) the perpendicular signs were found and read at twice the distance of the parallel signs, and at Locations 4 and 5 (strip development) the perpendicular signs were visible about four times further than the parallel signs (Figure 6; Table 6). There were no significant differences between the two parallel conditions at any of the locations. As in the detection analysis, this indicates improvements in sign performance for perpendicular versus parallel signs, but no improvement as a function of increasing the size of the parallel signs. Age group was significant at Locations 2, 4, and 5 with younger subjects again outperforming their older counterparts, but time of day did not affect detection/legibility performance at any location.

Two significant interaction effects were found, both at Location 5. There was an orientation by age group interaction where the older age group slightly outperformed the younger group in the Parallel-2A condition. A time-of-day by age group interaction effect showed that at this location younger subjects were able to read signs further away in daylight while older subjects performance improved at night.

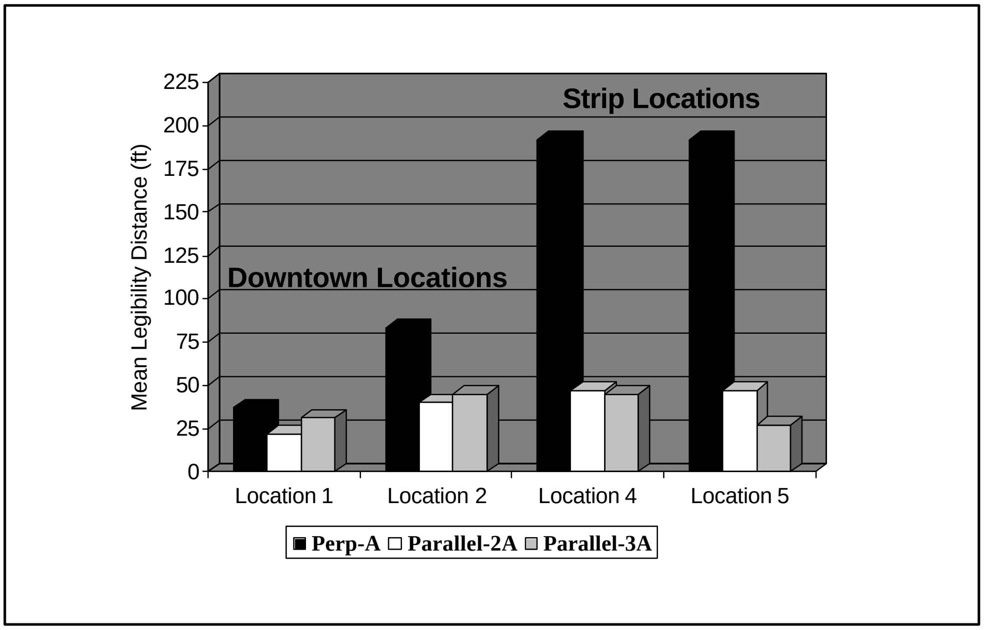


Figure 6. Sign Orientation: Detection/Legibility Distance (Both Age Groups, Day and Night)

Location	Condition	Mean Detection/Legibility Distance (ft)*
1	Perp-A	37
	Parallel-2A	22
	Parallel-3A	31
2	Perp-A	83
	Parallel-2A	40
	Parallel-3A	45
4	Perp-A	192
	Parallel-2A	47
	Parallel-3A	45
5	Perp-A	192
	Parallel-2A	47
	Parallel-3A	27

*Mean legibility distances for signs that were detected

Table 6. Sign Orientation Detection/Legibility Distance (Both Age Groups, Day and Night)

Negative Space (25, 50, 75 percent)

Detectability

Negative space was evaluated at Locations 3, 6, 7, and 8. Very few signs were missed at these locations, therefore the focus of the analyses was sign detection/legibility distance.

Detection/Legibility Distance

Overall, raising or lowering the percent of negative space had no consistent effect on sign detection/legibility distance (Figure 7; Table 7). Negative space only significantly affected Location 3, where the 25-percent condition was found at a greater distance than the 75-percent condition, and Location 7, where the 75-percent condition was found further away than the 25- and 50-percent conditions. Subject age was a significant factor for all locations, with young again outperforming old, while time of day effect was significant only at Location 8, with signs being read at greater distances in daylight than at night.

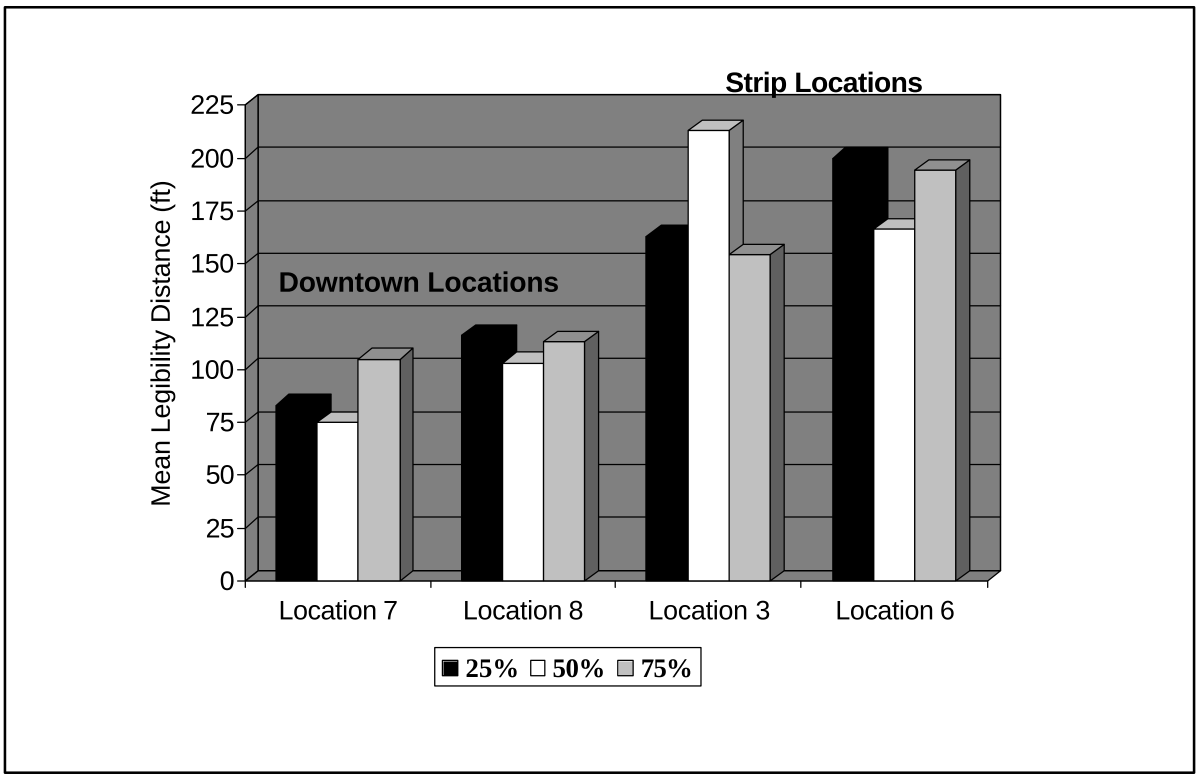


Figure 7. Negative Space Detection/Legibility Distance (Both Age Groups, Day and Night)

Location	Condition	% Detected	Mean Daylight Detection/Legibility Distance (ft)	Mean Nighttime Detection/Legibility Distance (ft)
7	25%	97	84	75
	50%	98	71	79
	75%	96	120	86
8	25%	96	107	97
	50%	100	123	102
	75%	100	120	104
3	25%	98	150	174
	50%	98	192	207
	75%	95	146	164
6	25%	98	197	180
	50%	93	165	164
	75%	95	200	177

Table 7. Negative Space: Absolute Detection and Detection/Legibility Distance (Both Age Groups)

SUMMARY AND DISCUSSION

DRIVER AGE GROUP

Under almost every condition, the younger drivers who participated in this research missed fewer signs than the older group and were able to read the signs that were detected at a greater distance. Across all conditions the younger group missed 25 percent fewer signs and were able to read the signs 60 percent further away than their older counterparts. However, while in general the younger subjects were better able to detect and read the signs, in some cases (e.g., the two parallel conditions of Location 1 during the day), older drivers reversed this trend and performed better than their younger counterparts. The reason might be that, although told to maintain the vehicle at the posted speed limits, the older subjects were observed to drive at a slower rate than the younger subjects. This compensatory behavior might have been more pronounced in Location 1 because this location had the highest visual complexity and driving difficulty. Driving at this slower speed would have given the older group more time to detect the signs and once they detected them would have resulted in the longer legibility distances that the older group demonstrated at this location.

TIME OF DAY

Absolute sign detection was better at night. Overall the subjects missed 40 percent fewer signs at night than they did in the daytime. The increased sign detectability at night was likely due to decreased driving difficulty and increased sign conspicuity. At night there was less vehicle and pedestrian traffic, allowing the subjects to attend more to the task of finding the signs. There was also a reduced level of visual distraction in the nighttime scene. At the same time, the signs may have had greater target value at night because of the enhanced external contrast resulting from the fact that the signs were brightly illuminated against dark backgrounds.

Overall, sign detection/legibility was unaffected by time of day. Across all sign locations, the younger subjects read the signs in the daytime at a mean distance of 125 ft and at night a mean distance of 111 ft. The older subjects had a mean detection/legibility distance of 77 ft in daylight and 86 ft at night.

SIGN ORIENTATION AND NEGATIVE SPACE

The sign orientation findings indicate that perpendicular signs are both more detectible and legible than are parallel signs, and that increasing the size of parallel signs does not improve their visibility. The number of signs missed, as a function of sign orientation however, was location-dependant. At Location 1, 30 percent of the perpendicular signs versus 60 percent of the parallel signs were missed. Location 2 showed the same trend, but the results were not as extreme. In the strip development locations (4 and 5) the perpendicular signs were almost never missed while the subjects drove past 30 percent of the parallel signs, even though the parallel signs were two to three times larger.

When the subjects did find the signs, the distance at which they could be read was substantially greater for the ones that were mounted perpendicular to oncoming traffic. The downtown perpendicular signs were read 100 percent further away than the parallel signs and on the strip development roadways perpendicular mounting increased detection/legibility distance by about 400 percent over parallel.

The negative space condition was less clear-cut. All the negative space signs were mounted perpendicular to the drivers' line of sight and there were, therefore, very few missed signs. The detection/legibility analyses revealed few significant differences between the negative space conditions. At the two locations where there were significant effects, they were site specific and inconsistent, with one location showing a benefit of reduced negative space and the other showing the opposite effect.

DOWNTOWN VERSUS STRIP, AND VISUAL COMPLEXITY

Signs in the strip development areas had a much higher rate of detection and much longer detection/legibility distances than did the downtown signs. Fifty-five percent more signs were missed in the downtown locations than on the strip development roadway. This finding was expected, as the signs were larger in the strip development condition, and in town there was more congestion, pedestrian traffic, and visual complexity; however, even between the downtown sites, large location effects were found. This was most likely due to the fact that while the environmental conditions for the strip locations were relatively uniform, this was not the case in town. Additional research should be conducted to further evaluate the influence that location and other environmental factors, such as sign size, offset, vertical height, parking, visual complexity, and congestion level have on on-premise sign detectability and legibility.

REAL WORLD VERSUS TEST TRACK SIGN VISIBILITY

Since the 1930's there have been numerous research studies aimed at evaluating the visibility of roadway signs (for a review see Garvey, et al., 1995). Some of these studies were designed to evaluate the ability of motorists to read sign copy (e.g., Forbes and Holmes, 1939; Forbes, et al. 1950; Mace, et al. 1994; Garvey, et al., 1998; Garvey et al., 2001). Other studies have attempted to determine sign detectability (e.g., Cole and Jenkins, 1982; Mace et al., 1994). While a few of the detection studies have evaluated signs in real world environments, most of the legibility studies have taken place on test tracks and in laboratories and have used methodologies that are unrepresentative of actual driving conditions.

The goal of many of these studies was to establish the "pure legibility" of signs. That is, the maximum legibility distance at which a sign can be read without the interference of a driving task or any other variables such as environmental complexity. While this is arguably an effective tool for establishing the legibility of sign copy under optimal conditions and is a useful technique to compare the relative legibility of competing fonts, symbols, colors, and brightness, it provides only relative legibility and does not reflect the distances at which real signs are readable in an actual driving situation.

Despite this shortcoming, the legibility distances that resulted from these studies have historically been used to set letter height recommendations for use in the real world. A concept known as the Legibility Index (LI) was developed to account for differences in legibility for different letter height copy. LI is the ratio of letter height to legibility distance and is defined as feet of legibility distance per inch of letter height, or ft/in. Early studies resulted in LIs of 50 ft/in (Forbes, et al. 1939) for standard highway alphabets and this benchmark was used as the gold standard for sign letter heights over the next 60 years.

In the 1990's it became apparent that sign copy based on an LI of 50 was insufficient to accommodate a large portion of drivers. Part of the reason was that these studies used only younger observers. New research using the same methodologies (e.g., Mace, et al., 1994) was conducted using older drivers, and LIs dropped to about 35 ft/in. Letter height recommendations for the same minimum required legibility distances increased proportionally. Recently however, the fundamental methodologies used to obtain these LIs have been brought into question

(Chrysler, et al., 2001). New data has begun to show that pure legibility derived from test track studies, where the observer was either stationary or was moved very slowly toward the signs with no other task than to read the signs, had resulted in unrealistically long reading distances.

Chrysler, et al. (2001) evaluated the legibility of street name signs using a methodology that included a driving task. The subjects drove a vehicle through the streets of Minneapolis, MN and were instructed to find and read street name signs. The study employed older drivers, high and low visual complexity intersections, and various retroreflective materials. The signs were mounted on either the left or right side of the roadway. The subjects' task was a realistic combination of detection and legibility where the subjects were instructed to drive the vehicle safely through the public roadways and find and read various street name signs. The measure of effectiveness was sign legibility distance.

The results of this study were eye opening. The overall mean legibility distance for all conditions was 153 ft for the 6-inch letter words, or a LI of 25 ft/in. For left mounted signs using low reflectance materials, the LI dropped to 16 ft/in. In the most challenging condition (high complexity, low reflectance, left side mounted) the mean legibility distance was 33 feet, resulting in an LI of 5.5 ft/in. The authors concluded by stating, "Clearly the additional, and realistic, task of driving shortens legibility distances considerably compared to the standard rule of thumb of "50 feet of legibility for every inch of letter height"."

Chrysler and her colleagues found significantly shorter highway sign legibility distances using a real-world driving scenario than were found in the earlier closed road, or test track studies. The logical conclusion of their study is that larger signs should be used. However, because they tested street name signs, the sign design and the mounting locations were very different from those used with on-premise commercial signs. Whether the effects Chrysler et al. found could be generalized to on-premise signs had yet to be determined. To answer this question, a direct comparison between the visibility of commercial on-premise signs when viewed in a controlled test-track environment and the visibility of similar signs tested under real world driving conditions was conducted.

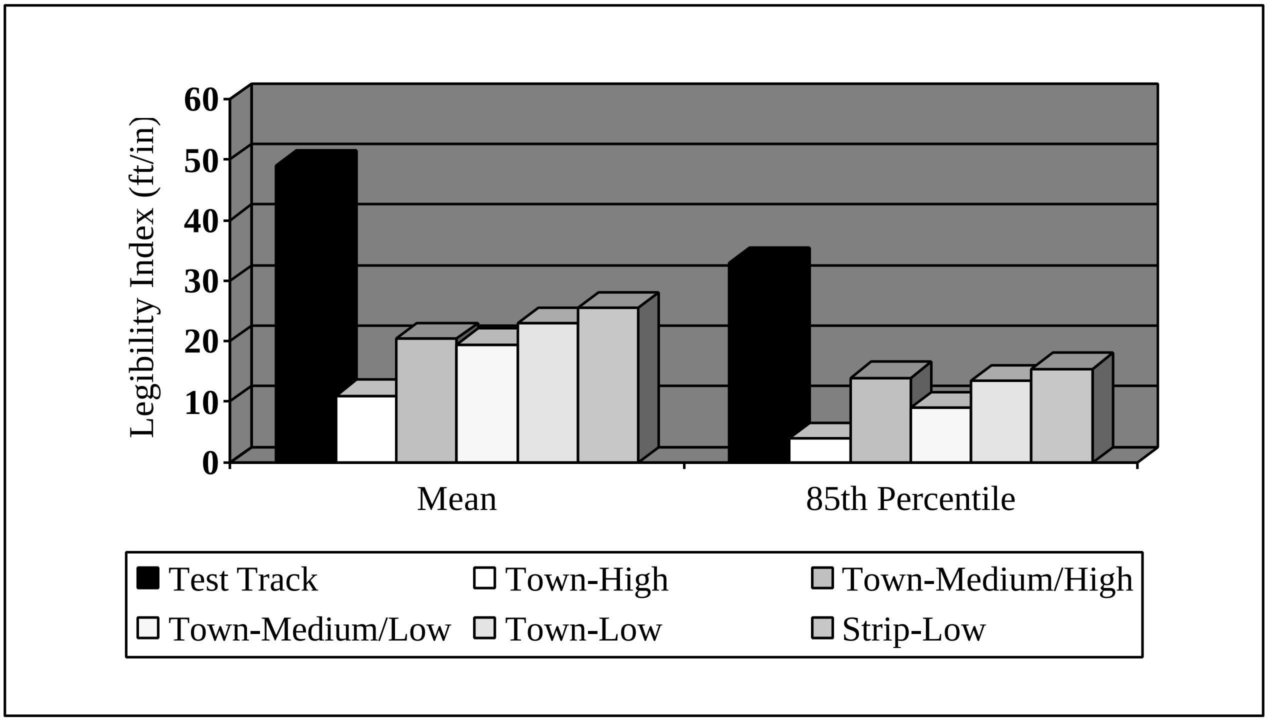
Unlike the wealth of research that has been conducted in the field of highway sign visibility, only one study has been conducted to date to systematically evaluate the legibility of on-premise signs (Kuhn, et al., 1998). A cursory comparison between the Kuhn and her colleagues' test track research and the real world field evaluation of on-premise signs detailed in this report shows substantial differences. In addition to the large number of signs that were totally missed in the real-world study, the detection/legibility distances found in the open field study are substantially shorter than those found in the test track based research. A closer comparison of the research results requires a short description of the procedures and methodologies used in the test track research.

Kuhn, et al., (1998) conducted a study to evaluate the effects of lighting design and font on the legibility of on-premise signs. They studied internally and externally illuminated signs and signs that used neon copy. They also evaluated the difference between serif and sans serif fonts (i.e., Clarendon and Helvetica). The subjects were driven around Pennsylvania State University's one-mile oval test track at about 10 mph and were asked to read the signs, which were mounted at four locations on the track. There were two measures of effectiveness: legibility distance and recognition distance. For the legibility task, the subjects were asked to read one of three words on a sign. For the recognition task the subjects were asked to find the location of a particular word on the sign, Top, Middle, or Bottom. Older and younger subjects were tested in the day and at night. The test track was located in a rural setting and the visual complexity was extremely low with little or no visual stimulation to compete with the test signs.

The signs used in the open-field or real world study were all internally illuminated and used an Helvetica font. Older and younger observers drove along open public roadways in the daylight and at night. The measures of effectiveness were absolute detection and a real world combination of detection and legibility. The visual and driving task complexity varied between locations from low to high.

A comparison was made between the results of the Kuhn, et al. (1998) test track study and the open field study described in this report. Because of the differences in the two studies, the comparisons were based on a subset of the data collected in each. For the test track study only the data from the internally illuminated, positive contrast, Helvetica font signs were used. For the open field study, only the perpendicularly mounted signs using positive contrast copy were included. The data from the four downtown sites were evaluated separately. The four downtown locations were divided into three categories based on visual and driving task demand: high complexity (Location 1); medium complexity (Locations 2 and 7); and low complexity

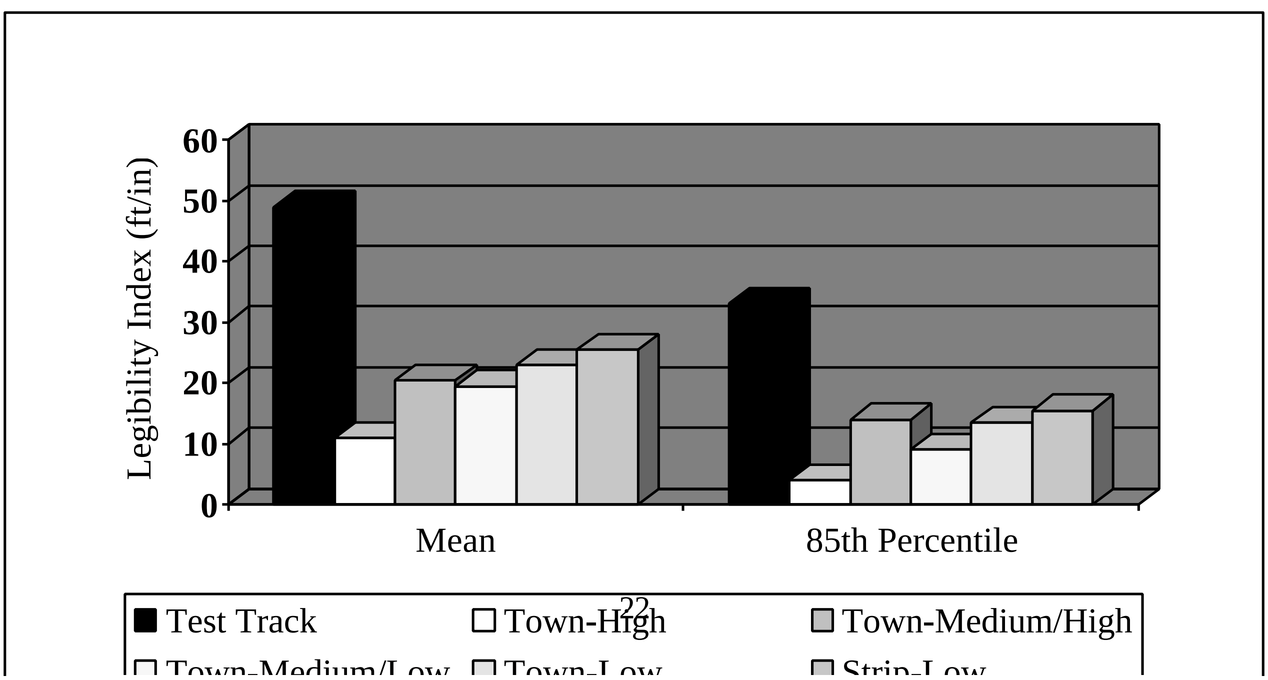
(Location 8). Because the environmental conditions at the four strip development locations were similar, the data from these locations were combined. Day and night comparisons were made for both the average observer (i.e., mean) and the 85th percentile observer. The 85th percentile data



represent the distance at which 85 percent of the observers could read the signs (i.e., only 15 percent of the observers had to be closer to read the signs). The 85th percentile driver is often used in traffic signing to accommodate all but the poorest vision drivers.

Figure 8. Test track/open field comparison: Daytime

Figure 9. Test track/open field comparison: Nighttime



Figures 8 and 9 display performance as a function of legibility index to accomodate the fact that a number of different letter heights were used across the two studies. (To obtain the legibility distance for any given letter height simply multiply the LI by the desired letter height.) The figures clearly demonstrate substantial differences between the open field research and the test track study, with the test track resulting in LI values as much as eight times those found under some real world conditions. The figures also show very large differences in legibility as a function of visual and driving task demand, with the low complexity locations resulting in much greater detection/legibility distances than the high complexity site. (See Table 8 for percentage change in LI from the test track to the open field evaluation.)

Location and Task Complexity	**Percent of Test Track Legibility**			
	Daytime		**Nighttime**	
	Mean	**85^{th} %ile**	**Mean**	**85^{th} %ile**
Town – High	*13%*	*7%*	*23%*	*12%*
Town – Medium	*34%*	*21%*	*41%*	*36%*
Town – Low	*52%*	*37%*	*47%*	*42%*
Strip – Low	*46%*	*35%*	*52%*	*47%*

Table 8. The percent of test track LI found in the open field study.

At the test track, the mean LIs were about 55 ft/in in daylight and about 50 ft/in at night, LIs that are similar to those reported in the earlier traffic sign research which used a similar methodology. By comparison, even under the best conditions (daytime and low complexity) the LIs for the open field study were only approached 30 ft/in (Figure 8). Mean legibility indexes in the open field study ranged mainly from 20 to 30 ft/in, and dropped as low as 7 ft/in in the highest complexity site. These results are consistent with those found by Chrysler, et al. (2001), perhaps indicating an overlap in the processess used by drivers when viewing traffic and commercial signage. Chrysler, et al., stated that their “study demonstrates the importance of conducting sign legibility studies on the road.” The analyses conducted here show that this is not only true for traffic signs, but commercial on-premise signs as well.

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