Relation Between Roadside Signs and Traffic Accidents: Field Investigation

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The purpose of this study was to investigate systematically the relation between roadside signs located nearest to urban traffic intersections and traffic accidents. Specific sign elements studied were total number, type (public versus private), size, and color. The dependent variable was the number of accidents during 1975 at 60 intersection approaches where the driver who entered the intersection from the direction selected was determined to be at fault in the police accident investigation report. The intersections were selected randomly from cross intersections in the city of Austin where at least one accident occurred during 1975. Results indicate that a number of sign elements had a significant relation to accidents at intersections controlled by stop signs, but no relation was found between signs and accidents at intersections controlled by traffic signals. Possible interpretations of the findings are considered, and some practical suggestions for reducing the effects of distracting signs at stop-sign intersections are advanced.

The roadside environment in many urban and suburban areas is typified by a burgeoning visual complexity of advertising signs, neon lights, and gaudy billboards. Although some recent studies (1, 2) have evaluated the impact of such development from an essentially aesthetic perspective, surprisingly little research has examined the relation between this array of potential visual distractors in the roadside environment and traffic safety. This concern is underscored by three recent on-site accident investigation studies (3, 4, 5), which have estimated that a principal causal factor in 10 to 25 percent of automobile accidents was distraction.

A large body of research has examined perception of the target traffic stimulus (6, 7) (e.g., the color, size, and lettering of road signs), but almost no inquiry has investigated perception of the target traffic signal as a function of distractors in its environmental background. Thus, traffic engineers possess considerable knowledge relevant to the construction of adequate traffic signs isolated from their environmental context, but very little is known about how to evaluate features of the background environment that may contribute to or reduce road sign effectiveness. Ordinances in most local communities regulate the placement, size, and light intensity of commercial signs; however, such regulations are often very vague. One local regulation (8), for example, prohibits "any change in light intensity, motion, or color which subconsciously fixates or attracts the eyes of the motorist when they should be driving."

Very little inquiry has been directed toward visual distractors and traffic accidents in field settings, and those data that do exist are both contradictory and open to methodological criticism. Two studies (9, 10) reported positive correlations between the presence of advertising devices and automobile accidents on multilane highways. Two other studies (11, 12) indicated a positive relation between traffic accidents and the number of elements in the roadside environment, such as commercial establishments, intersections, driveways, and traffic signals. Other evidence, however, has reported no relation between highway accidents and advertising signs (13, 14). Two recent laboratory investigations offer some support for the view that distracting stimuli decrease driving performance significantly under controlled conditions (15, 16), although both studies note that the performance decrements were small and might not relate to a safety problem under actual driving conditions.

The present study is based on the results of the small number of available field studies. Signs were categorized in terms of a number of dimensions including (a) total number of signs, (b) type of sign (public versus private), (c) size of sign, and (d) color of sign. We hypothesized that increasing numbers of signs, larger size of signs, and greater similarity of color between signs and target traffic device would all relate positively to the number of traffic accidents.

METHOD

Sixty intersections were selected at random from a list of intersections within the city of Austin that had at least one accident during 1975. Both intersections controlled by traffic signs and those controlled by stop signs were studied. The stop-sign intersections were predominantly two-way stops, although some four-way stops were included in the sample. To control for extraneous variables, several criteria were used to restrict the sample. Only cross intersections, where two through streets intersected at a 90° angle, were examined. None of the intersections studied was characterized by unusual landscape features, such as an approach from a steep hill or visual obstructions due to natural or designed features. The sample was also restricted to intersections that had a recent 24-h traffic count of between 5000 and 30 000 vehicles; thus intersections of very high or very low traffic flows were eliminated.

A data sheet was developed to classify every sign observable at an intersection in terms of its type, size, and dominant color. Public signs were defined as signs erected by a governmental entity, such as street signs, restricted-parking signs, bus-stop signs, or bicycle-lane signs. Private signs were defined as signs erected by a nongovernment entity and included those on storefronts or in store windows. A small sign was defined as a sign whose size was equal to or smaller than a standard stop sign; a large sign was one that was larger than a stop sign. Signs were also categorized as either red or nonred, according to their dominant colors. Red signs had a red or partially red background, regardless of the letter color or any red letters or figures on a neutral background of white, black, brown, or clear (glass). All other signs were defined as nonred.

Dependent Variable

The dependent variable was the number of accidents during 1975 at 60 intersection approaches where the driver who entered the intersection from the direction selected was determined to be at fault in the police accident investigation report. The sample of intersection approaches investigated showed a range of from 1 to 12 at-fault accidents during the year. The distribution of accidents was positively skewed; 67 percent of intersection approaches had fewer than three accidents. The accident data were available from the urban transportation office and were derived from the reports of investigating police officers. For every accident, the data listed the direction of the vehicles involved, time of day, probable cause, and responsible party. Accidents that occurred at night when signs were not clearly visible were excluded from the count, as were accidents that were apparently not related to distraction (e.g., driving while intoxicated or speeding). The remaining at-fault accidents were due primarily to drivers failing to yield the right of way or ignoring stop signs.

Table 1. Mean number of signs under each distractor element for traffic-signal and stop-sign intersection approaches.

	Traffic Signal		Stop Sign	
Distractor Elements	Low Rate (N = 79)	High Rate (N = 66)	Low Rate (N = 26)	High Rate (N = 33)
Total signs	17.78	25.85	3.46	10.39
Public	7.38	9.74	1.85	6.61
Private	11.53	18.18	2.19	3.88
Large	11.21	15.71	1.04	3.33
Small	10.43	13.59	3.23	7.18
Red	7.86	11.62	1.46	3.82
Nonred	13.85	17.74	2.85	6.70

Table 2. Zero-order correlations between distractor elements and at-fault accidents at traffic-signal and stop-sign intersection approaches.

	Traffic Signal			Stop Sign		
Distractor Elements	Correlation	Degrees of Freedom	Probability	Correlation	Degrees of Freedom	Probability
Total signs	0.10	115	0.131	0.23	57	0.040
Public	0.09	115	0.171	0.17	57	0.100
Private	0.09	115	0.175	0.14	57	0.140
Large	0.10	115	0.137	0.22	57	0.047
Small	0.07	115	0.214	0.15	57	0.131
Red	0.12	115	0.107	0.13	57	0.170
Nonred	0.07	115	0.219	0.23	57	0.043

Table 3. Partial correlations between distractor elements and at-fault accidents when the influence of traffic flow is controlled at traffic-signal and stop-sign intersection approaches.

	Traffic Signal			Stop Sign		
Distractor Elements	Correlation	Degrees of Freedom	Probability	Correlation	Degrees of Freedom	Probability
Total signs	0.00	114	0.495	0.21	56	0.050
Public	-0.07	114	0.214	0.16	56	0.122
Private	0.02	114	0.424	0.14	56	0.156
Large	-0.01	114	0.478	0.21	56	0.058
Small	0.00	114	0.481	0.14	56	0.155
Red	0.05	114	0.308	0.11	56	0.212
Nonred	-0.04	114	0.335	0.22	56	0.050

Table 4. Partial correlations between distractor elements and at-fault accidents at stop-sign intersection approaches that have two or more accidents when the influence of traffic flow is controlled.

Distractor Elements	Correlation	Degrees of Freedom	Probability
Total signs	0.45	15	0.033
Public	0.11	15	0.337
Private	0.50	15	0.020
Large	0.59	15	0.006
Small	0.24	15	0.175
Red	0.07	15	0.400
Nonred	0.58	15	0.008

Procedure

Three undergraduate psychology students collected the data for the study. An observer stood at the right-hand curb, facing the intersection recording first at a point 61.0 m (200 ft) from the cross street. Every sign visible from that observation point within a 180° visual angle was classified along the three dimensions. The observer then advanced to a point 15.2 m (50 ft) from the cross street and recorded any additional signs within a 180° visual angle, but which had not been visible from the first observation point. The procedure was repeated for each of the other approaches to the intersection. (For a one-way street, observations were recorded only facing the same direction as vehicles traveling on the street.) All observations were conducted in the summer of 1975, during the day under good light conditions. The undergraduate observers received training from a skilled observer who served as a criterion observer. The sample intersections were observed only after each observer had achieved 90 percent agreement with the criterion observer. Periodic interrater reliability checks were conducted between each observer and the criterion observer throughout the study. Average agreement was 92 percent.

RESULTS

Table 1 shows the number of signs under each distractor element observed at accident-intersection approaches for both intersections controlled by traffic signals and intersections controlled by stop signs. At the traffic-signal approaches, low accidents was defined as one or less annual accidents and high accidents as two or more annual accidents. For the stop-sign approaches, low accidents was defined as zero annual accidents and high accidents as one or more annual accidents. For all distractor elements the number of signs at high at-fault accident intersection approaches exceeded the number of signs at low-accident approaches.

Table 2 shows the zero-order correlation between each distractor element and at-fault accidents for both intersection approaches controlled by traffic signals and those controlled by stop signs. At traffic-signal approaches, no distractor dimensions demonstrated a significant relation with at-fault accidents. At stop-sign intersections, in contrast, three distractor elements—total signs, large signs, and nonred signs—demonstrated a significant positive relation to at-fault accidents.

A problem in interpreting the data in Table 2 is the possibility that the positive relation between number of signs and traffic accidents may reflect a positive correlation between both of these variables and rate of traffic flow. In order to discount the possible influence of traffic flow, the data were reanalyzed and controlled statistically for the influence of traffic flow. Table 3 shows the partial correlations, when the rate of traffic flow is controlled, between each distractor element and at-fault accidents for both traffic-signal-controlled and stop-sign-controlled-intersection approaches. For all distractor elements, especially for traffic-signal approaches, the partial correlations are somewhat weaker than the zero-order correlations, which indicates that part of the relation between signs and accidents is explained by traffic flow. Nevertheless, at the stop-sign approaches, total signs and nonred signs remain statistically significant and large signs show a very strong statistical trend ($p = 0.058$).

A particularly strong picture of the relation between signs and traffic accidents emerges when we examine separately the sample of stop-sign approaches showing two or more annual accidents, controlling again for the effect of traffic flow. Table 4 shows the partial correlations when the rate of traffic flow was controlled, between each distractor element and at-fault accidents for stop-sign controlled approaches that had two or more annual accidents. Four distractor dimensions—total signs, private signs, large signs, and nonred signs—demonstrated a strongly significant positive relation with at-fault accidents.

Based on these findings, a summary picture of the relation between distracting signs in the roadside environment and traffic accidents can be presented. There is no evidence that signs presented a traffic safety problem at the intersections controlled by traffic signals. There was, however, evidence that signs were related to accidents at the intersections controlled by stop signs. The relation between the total number of signs and accidents was especially strong at stop-sign intersections characterized by a relatively high number of accidents. In addition, the present data indicated that the signs that predominated at these intersections were larger, private signs. The relation between nonred signs and accidents probably reflected both the influences of a diversity of colors in the distractor and the higher number of nonred signs in the environment.

The differential effects of signs on traffic signals and stop signs may be due to a number of factors. The present data do not directly address this issue, but we may speculate about some possible factors. Most important in the case of stop signs may be that distractors and target are of the same medium. Also, for most of the sites investigated, the placement of signals and stop signs relative to distractors differed. All stop signs were placed at the right-hand curb; however, almost all traffic signals were placed at mid-road on an extension arm. Thus, stop signs and distractors tended to be located together proximally in the visual field, but traffic signals tended to be located more distantly from distractors in the visual field.

The present results support a number of practical suggestions for traffic engineers concerned about reducing the effects of distracting stimuli in the roadside environment. In general, such feedback falls under two areas of application: (a) the establishment of appropriate ordinances to limit legislatively the effect of distractors, and (b) engineering decisions about design changes in the target signal oriented toward counteracting the potential negative effects of background distractors. These findings suggest the need for a wider range of engineering alternatives at some stop-sign intersections to counteract the effects of potential distractors, such as the design of a larger or brighter target traffic device or the employment of neutral background shields to contrast more effectively the target and its surrounding context. Where such design alternatives are not feasible at sites where a significant number of distractors are present, traffic signals should be employed rather than stop signs.

In summary, these results underscore the need for the traffic engineer to accept broader responsibility for the total traffic environment, including both the public roadway and the contingent environmental context in order to cope effectively with the dramatically increased visual complexity of today's roadside environment.

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