RELATIONSHIP BETWEEN ROADSIDE SIGNS AND TRAFFIC ACCIDENTS: A FIELD INVESTIGATION

CHARLES J. HOLAHAN

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16. Abstract

The purpose of this study was to systematically investigate the relationship between signs located proximally to sixty randomly selected urban traffic intersections and traffic accidents at those intersections. Specific sign dimensions studied were: total number, type (public versus commercial), size, and color. The dependent variable was at-fault accidents during the 1975 calendar year. Results indicated that larger sized commercial signs were significantly related to accidents at stop sign controlled intersections. No relationship was found between signs and accidents at traffic signal controlled intersections. Possible interpretations for the findings are considered, and some practical suggestions for reducing the effects of distracting signs at stop sign intersections are advanced.

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EXECUTIVE SUMMARY

The contemporary roadside environment in many urban and suburban areas is typified by a burgeoning visual complexity, with advertising signs, neon lights, and gaudy billboards dominating the visual landscape. Surprisingly, little research has examined the relationship between this array of potential visual distractors in the roadside environment and traffic safety. This concern is underscored by recent on-site accident investigation studies which have estimated that between ten and twenty-five percent of automobile accidents involve distraction as a principal causative factor.

While a large body of research has examined perception of the target traffic stimulus (e.g., the color, size, and lettering of road signs), almost no inquiry has systematically investigated perception of the target traffic signal as a function of distractors in its environmental background. Thus, while traffic engineers possess considerable knowledge relevant to the construction of adequate traffic signs isolated from their environmental context, very little is known about how to evaluate features of the background environment which may contribute to or reduce road sign effectiveness.

The present study systematically investigates the relationship between signs located proximally to urban traffic intersections and the number of traffic accidents at those intersections. Sixty intersections were randomly selected from a list of intersections within the city of Austin having at least one accident during the 1975 calendar year. The sample is restricted to intersections having two through streets intersecting at a 90-degree angle, a recent 24-hour traffic count of between 5,000 and 30,000 vehicles, and a range of from 1 to 29 accidents during the 1975 calendar year -- with the distribution skewed toward the upper end. The number of at-fault accidents attributed to drivers approaching from each direction was computed for every intersection for the 1975 calendar year. Accidents occurring at night when signs were not clearly visible were excluded from the count, as were accidents apparently not related to distraction -- e.g., driving while intoxicated or speeding.

Every sign observable at an intersection was classified along three dimensions -- type of sign, size, and dominant color. These data were collected by an observer standing at the right-hand curb and facing the intersection recording first at a point two hundred feet from the cross-street. Every sign visible from that observation point was classified along the three dimensions. The observer then advanced to a point fifty feet from the cross-street and recorded any additional signs which could then be seen, but which were not visible from the first observation point. This procedure was repeated for each of the other approaches to the intersection. All observations were conducted in the summer of 1976, during the day under good light conditions.

Examination of the zero-order correlation between distractor dimensions and at-fault accidents for both traffic signal controlled and stop sign controlled intersection approaches indicates: (1) no distractor dimensions demonstrated a significant relationship with at-fault accidents for traffic signal approaches, and (2) three distractor dimensions (total signs, large signs, and non-red signs) demonstrate a significant positive relationship with at-fault accidents for stop sign intersections. To control for the possible confounding influence of traffic flow, partial correlation analysis was performed on all the data. For all distractor dimensions, especially for traffic signal approaches, the partial correlations were somewhat weaker than the zero-order correlations, indicating that part of the relationship between signs and accidents is explained by traffic flow. Nevertheless, under the stop sign approaches, total signs and non-red signs remain statistically significant and large signs show a very strong statistical trend. A particularly strong picture of the relationship between signs and traffic accidents emerges when data are examined separately for stop sign approaches showing two or more annual accidents, controlling again for the effect of traffic flow. Under these conditions, four distractor dimensions (total signs, private signs, large signs, and non-red signs) demonstrated a strongly significant positive relationship with at-fault accidents.

Based on these findings, a summary picture of the relationship between distracting signs in the roadside environment and traffic accidents can be presented. First, there is no evidence that signs present a traffic safety problem at intersections controlled by traffic signals. There is, however, evidence that signs are related to accidents at stop sign controlled intersections. The type of signs most strongly related to accidents at stop sign intersections are larger-sized commercial signs. The differential effects of signs on traffic signals and stop signs are probably due to a number of factors. Most important is probably the fact that, in the case of stop signs, distractors and targets are the same medium, while with traffic signals, the mediums differ. Also, for most of the sites investigated, the placement of signals and stop signs relative to distractors differed.

The present results support a number of practical suggestions that may be offered to traffic engineers concerned with reducing the effects of distracting stimuli in the roadside environment. First, there is a need for appropriately restrictive legislation concerning the number and size of commercial signs located proximally to stop signs. Where proximate distractors cannot be legislatively restricted, a wider range of engineering alternatives may be needed to counteract their effects, such as designing a larger or brighter target traffic device or employing neutral background shields to more effectively contrast the target with its surrounding context. Alternatively, when legislative or design alternatives are not feasible, traffic signals should be employed rather than stop signs at sites where a significant number of commercial distractors are present.

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I. INTRODUCTION

The contemporary roadside environment in many urban and suburban areas is typified by a burgeoning visual complexity, with advertising signs, neon lights, and gaudy billboards dominating the visual landscape. Although some recent studies have attempted to evaluate the impact of such development from an essentially aesthetic perspective,[1] surprisingly little research has examined the relationship 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[2] which have estimated that between ten and twenty-five percent of automobile accidents involve distraction as a principal causative factor.

While a large body of research has examined perception of the target traffic stimulus,[3] e.g., the color, size and lettering of road signs, almost no inquiry has systematically investigated perception of the target traffic signal as a function of distractors in its environmental background. Thus, while traffic engineers possess considerable knowledge relevant to the construction of adequate traffic signs isolated from their environmental context, very little is known about how to evaluate features of the background environment which may contribute to or reduce road sign effectiveness.

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[1]Boston Redevelopment Authority, City Signs and Lights, (Boston: Boston Redevelopment Authority,1971); G. Winkel, R. Malek and P. Thiel, "Community Response to the Design Features of Roads: A Technique for Measurement," Highway Research Record, 305 (1970), pp. 133-145.

[2]A.B. Clayton, "Road-user Errors and Accident Causation," paper presented at 17th International Congress of Applied Psychology, Liege, Belgium, July 1971; C.R. Ruck, D.E. Stackhouse, and D.J. Albright, "Automobile Accidents Occurring in a Male College Population," American College Health Association Journal, 18 (1970), pp. 308-312; U.N. Wanderer and H.M. Weber, "First Results of Exact Accident Data Acquisition on Scene," Proceedings of International Conference on Occupant Protection (New York: n.p., 1974), pp. 80-94.

[3]T.W. Forbes, "Factors in Highway Sign Visibility," Traffic Engineering, 39 (1969), pp. 20-27; T.W. Forbes, T.E. Snyder and R.F. Pain, "Traffic Sign Requirements I: Review of Factors Involved, Previous Studies and Needed Research," Highway Research Record, 70 (1965), pp. 48-56.

Although ordinances exist in most local communities which regulate the placement, size, and light intensity of commercial signs, such regulations are often very vague. One local regulation, 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."[4]

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 have reported positive correlations between the presence of advertising devices and automobile accidents on multilane highways.[5] In addition, two studies have indicated a positive relationship between traffic accidents and the number of elements in the roadside environment, such as commercial establishments, intersections, driveways, and traffic signals.[6] Other evidence, however, has reported no relationship between highway accidents and advertising signs.[7] Two recent laboratory-based investigations offer some support for the view that distracting stimuli significantly decrease driving performance

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[4]R.T. Shoaf, "Are Advertising Signs Near Freeways Traffic Hazards?," Traffic Engineer, 26, No. 2 (1955), pp. 71-76.

[5]Madigan-Hyland, Inc., Signs and Accidents on New York State Thruway, Report prepared for the New York State Thruway Authority, February 1963; Minnesota Department of Highways, Minnesota Rural Trunk Highway Accident, Access Point, and Advertising Sign Study (Minneapolis: Minnesota Department of Highways, 1952).

[6]J.A. Head, "Predicting Traffic Accidents from Elements on Urban Extensions of State Highways," Highway Research Board Bulletin, 208 (1959), pp. 45-63; J. Versace, "Factor Analysis of Roadway and Accident Data," Highway Research Board Bulletin, 240 (1960), pp. 24-30.

[7]J.C. McMonagle, "Traffic Accidents and Roadside Features," Highway Research Board Bulletin, 55 (1952), pp. 38-48; J.C. McMonagle, "The Effects of Roadside Features on Traffic Accidents," Traffic Quarterly, 6, No. 2 (1952), pp. 228-243.

in controlled conditions[8], although both studies note that the performance decrements were small and might not relate to a safety problem under actual driving conditions.

The purpose of the present study was to systematically investigate the relationship between signs located proximally to urban traffic intersections and the number of traffic accidents at those intersections. Based on the results of the small number of available field studies and a desire to afford applicable information to traffic engineers, signs were categorized along a number of specific dimensions. These dimensions included: total number of signs, type of sign (public versus commercial), size of sign, and color of sign. It was predicted 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 number of traffic accidents.

II. METHOD

Selection of Intersections

Sixty intersections were randomly selected from a list of intersections within the City of Austin having at least one accident during the 1975 calendar year. To control for extraneous variables several criteria were used to restrict the sample. Only cross-type intersections, where two through streets intersected at a 90° angle, were examined. The sample was also restricted to intersections having a recent 24-hour traffic count of between 5,000 and 30,000 vehicles, thus eliminating intersections with very high or very low traffic flows. The final sample was composed of intersections that showed a range of from 1 to 29 accidents during the 1975 calendar year, with the distribution skewed toward the upper end.

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[8] C.J. Holahan, Effects of Visual Distraction on Reaction Time in a Simulated Traffic Environment, Council for Advanced Transportation Studies Research Report 47 (Austin, Texas: The University of Texas at Austin, Council for Advanced Transportation Studies, 1977); A.W. Johnston and B.L. Cole, "Investigations of Distraction by Irrelevant Information," Australian Road Research, 6, No. 3 (1976), pp. 3-23.

Instrument

A data sheet was developed to classify every sign observable at an intersection along three dimensions--type of sign, size, and dominant color. Type was categorized as public or private. Public signs were defined as signs erected by a governmental entity, such as street signs, restricted parking signs, bus stop signs, and bike lane signs. Private signs were defined as signs erected by a nongovernmental entity including those on storefronts or in store windows. Signs were also categorized into two sizes. Small signs were defined as signs whose size was equal to or smaller than a standard stop sign; large signs were those larger than a stop sign. In addition, signs were categorized as red or non-red according to their dominant color. Red signs were defined as those having a red or partially red background regardless of the letter color, or having any red letters or figures on a neutral background of white, black, brown, or clear (glass). All other signs were defined as non-red.

Dependent variable

The number of at-fault accidents attributed to drivers approaching from each direction was computed for every intersection for the 1975 calendar year. 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 occurring at night when signs were not clearly visible were excluded from the count, as were accidents apparently not related to distraction -- e.g., driving while intoxicated or speeding. Remaining at-fault accidents were due primarily to drivers failing to yield the right of way or ignoring stop signs.

Procedure

Three undergraduate psychology students collected the data for the study. The data collection procedure involved an observer standing at the righthand curb and facing the intersection recording first at a point 200 feet (61.0 meters) from the cross-street. Every sign visible from that observation point was classified along the three dimensions. The observer then advanced to a point 50 feet (15.2 meters) from the cross-street and recorded any additional signs which could then be seen, but which were not 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 1976, 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 inter-rater reliability checks were conducted between each observer and the criterion observer throughout the study. Average agreement was 92 percent.

III. RESULTS AND DISCUSSION

Table 1 shows the number of signs under each distractor dimension observed at high and low at-fault accident intersection approaches for both traffic signal controlled and stop sign controlled intersection approaches. For 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 dimensions the number of signs at high at-fault accident intersection approaches exceeded the number of signs at low accident intersections.

Table 2 shows the zero-order correlation between each distractor dimension and at-fault accidents for both traffic signal controlled and stop sign controlled intersection approaches. For traffic signal approaches, no distractor dimensions demonstrated a significant relationship with at-fault accidents. For stop sign intersections, in contrast, three distractor dimensions (total signs, large signs, and non-red signs) demonstrated a significant positive relationship with at-fault accidents.

A problem in interpreting the data in Table 2 is the possibility that the positive relationship between number of signs and traffic accidents may reflect a positive correlation between both of these variables and rate of

TABLE 1

MEAN NUMBER OF SIGNS UNDER EACH DISTRACTOR DIMENSION AT HIGH AND LOW AT-FAULT ACCIDENT INTERSECTION APPROACHES FOR TRAFFIC SIGNAL AND STOP SIGN INTERSECTION APPROACHES

Distractor Dimensions	Type of Approach			
	Traffic Signal		Stop Sign	
	Low Accidents (n=79)	High Accidents (n=66)	Low Accidents (n=26)	High Accidents (n=33)
Total Signs	17.78	25.85	3.46	10.39
Public Signs	7.38	9.74	1.85	6.61
Private Signs	11.53	18.18	2.19	3.88
Large Signs	11.21	15.71	1.04	3.33
Small Signs	10.43	13.59	3.23	7.18
Red Signs	7.86	11.62	1.46	3.82
Non-Red Signs	13.85	17.74	2.85	6.70

TABLE 2

ZERO-ORDER CORRELATIONS BETWEEN DISTRACTOR DIMENSIONS AND AT-FAULT ACCIDENTS AT TRAFFIC SIGNAL AND STOP SIGN INTERSECTION APPROACHES

Distractor Dimensions	Type of Approach					
	Traffic Signal			Stop Sign		
	r	df	p	r	df	p
Total Signs	.10	115	.131	.23	57	.040
Public Signs	.09	115	.171	.17	57	.100
Private Signs	.09	115	.175	.14	57	.140
Large Signs	.10	115	.137	.22	57	.047
Small Signs	.07	115	.214	.15	57	.131
Red Signs	.12	115	.107	.13	57	.170
Non-Red Signs	.07	115	.219	.23	57	.043

traffic flow. To discount the possible confounding influence of traffic flow, the data were reanalyzed controlling statistically for the influence of traffic flow. Table 3 shows the partial correlations, controlling for rate of traffic flow, between each distractor dimension and at-fault accidents for both traffic signal controlled and stop sign controlled intersection approaches. For all distractor dimensions, especially for traffic signal approaches, the partial correlations are somewhat weaker than the zero-order correlations, indicating that part of the relationship between signs and accidents is explained by traffic flow. Nevertheless, under the stop sign approaches, total signs and non-red signs remain statistically significant and large signs show a very strong statistical trend ($\underline{p}$ = .058).

A particularly strong picture of the relationship 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, controlling for rate of traffic flow, between each distractor dimension and at-fault accidents for stop sign controlled approaches showing two or more annual accidents. Four distractor dimensions (total signs, private signs, large signs, and non-red signs) demonstrated a strongly significant positive relationship with at-fault accidents.

Based on these findings, a summary picture of the relationship between distracting signs in the roadside environment and traffic accidents can be presented. First, there is no evidence that signs present a traffic safety problem at intersections controlled by traffic signals. There is, however, evidence that signs are related to accidents at stop sign controlled intersections. The relationship between signs and accidents is especially strong at stop sign intersections characterized by a relatively high number of accidents. In addition, the type of signs most strongly related to accidents at stop sign intersections are larger sized commercial signs. The relationship between non-red signs and accidents probably reflects both the influences of a diversity of colors in the distractor and the higher number of non-red signs in the environment.

The differential effects of signs on traffic signals and stop signs are probably due to a number of factors. Most important is probably the fact that

TABLE 3

PARTIAL CORRELATIONS CONTROLLING FOR TRAFFIC FLOW BETWEEN DISTRACTOR DIMENSIONS AND AT-FAULT ACCIDENTS AT TRAFFIC SIGNAL AND STOP SIGN INTERSECTION APPROACHES

Distractor Dimensions	Type of Approach					
	Traffic Signal			Stop Sign		
	r	df	p	r	df	p
Total Signs	.00	114	.495	.21	56	.050
Public Signs	-.07	114	.214	.16	56	.122
Private Signs	.02	114	.424	.14	56	.156
Large Signs	-.01	114	.478	.21	56	.058
Small Signs	.00	114	.481	.14	56	.155
Red Signs	.05	114	.308	.11	56	.212
Non-Red Signs	-.04	114	.335	.22	56	.050

TABLE 4

PARTIAL CORRELATIONS CONTROLLING FOR TRAFFIC FLOW BETWEEN DISTRACTOR DIMENSIONS AND AT-FAULT ACCIDENTS AT STOP SIGN INTERSECTION APPROACHES SHOWING TWO OR MORE ACCIDENTS

Distractor Dimensions	*r*	df	*p*
Total Signs	.45	15	.033
Public Signs	.11	15	.337
Private Signs	.50	15	.020
Large Signs	.59	15	.006
Small Signs	.24	15	.175
Red Signs	.07	15	.400
Non-Red Signs	.58	15	.008

in the case of stop signs, distractors and target are of the same medium, while with traffic signals, the mediums differ. Also, for most of the sites investigated, the placement of signals and stop signs relative to distractors differed. While all stop signs were placed at the right-hand curb, 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, while traffic signals tended to be located more distantly from distractors in the visual field. Based on this interpretation, we might speculate that neon lights in the roadside environment would present a more serious distractor than signs at traffic signal intersections.

The present results support a number of practical suggestions that may be offered to traffic engineers concerned with reducing the effects of distracting stimuli in the roadside environment. In general, such feedback falls under two areas of application: 1) the establishment of appropriate ordinances to legislatively limit the effect of distractors, and 2) engineering decisions involving design changes in the target signal oriented toward counteracting the potential negative effects of background distractors. These findings support the need for appropriately restrictive legislation concerning the number and size of commercial signs located proximally to stop signs. Where proximate distractors cannot be legislatively restricted, a wider range of engineering alternatives may be needed to counteract their effects, such as designing a larger or brighter target traffic device or employing neutral background shields to more effectively contrast the target with its surrounding context. When legislative or design alternatives are not feasible, traffic signals should be employed rather than stop signs at sites where a significant number of commercial distractors are present. In summary, these results underscore the need for the traffic engineer to accept broader legislative and engineering responsibility for the <u>total</u> 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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Holahan received the Publisher's Prize in research competition from the Southwestern Psychological Association in 1974.

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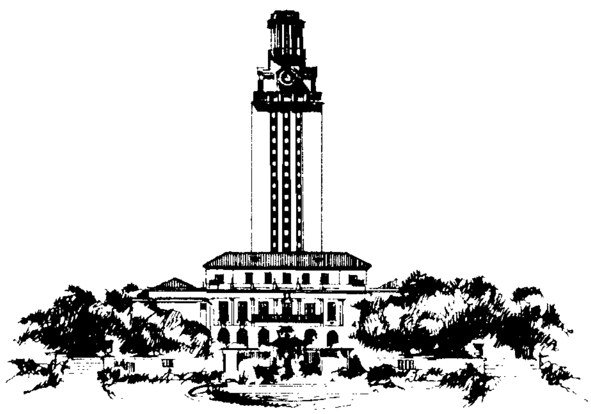

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