New Zealand Journal of Psychology, 1988, 17, 15-18

The Evaluation of Single Centrally Mounted Auxiliary Stop-Lights: A New Zealand Field Test*

Iain A McCormick
Touche Ross & Co, Wellington

Kay Allen
Wellington Psychological Associates, Wellington

Recent research has suggested that the fitting of single, central, high mounted auxiliary stop lights can significantly reduce motor vehicle rear end accident rates. The present study involved a New Zealand field study of this lighting configuration with 1786 local body, hospital board, and central government vehicles. The experimental group of 578 were fitted with the auxiliary lights while the 1208 control vehicles were left unmodified. After one year there were 61 relevant rear end accidents in the control group and only 11 in the experimental group. This represents a statistically significant reduction of 62.3%. The vehicles that were fitted with the auxiliary lights but still had rear end accidents produced a statistically significant reduction in repair costs with the mean difference between the two groups being $612.00. Cost benefit ratios indicated the utility of fitting the auxiliary light at full retail price, even when only the cost of repairs and prevention is considered for the vehicle with the light. However, when both the vehicles in the rear end accident, which by definition must involve two vehicles, are considered and the cost of injury is included the cost benefit ratio grows to over 1:18.

There is now a body of research which suggests that high mounted auxiliary stoplights could significantly reduce the incidence of rear end accidents. This research has included the work of Kohl and Baker (1978), who demonstrated the utility of the high mounted lights in 2,100 taxis in the Washington D.C. area of the U.S.A. Reilly, Kurke, and Buckenmaier (1980) validated this study using 5,400 telephone company cars, half of which were fitted with the single centrally mounted auxiliary stop light and half were not modified and acted as controls. Rausch (1981; cited in Helmers & Tornos, 1983) undertook a study of 900 New York taxis and demonstrated the effectiveness of single centrally mounted light as compared to other lighting configurations. Helmer and Tornos (1983) in commenting on the research questioned whether the U.S.A. results would generalise to European conditions. This issue was raised because of the differences between vehicles in the U.S.A. and Europe. For example, vehicles in Europe are reported to have different positions and colouring of stop and turning indicator lights. In a recent review of research on the prevention of motor vehicle accidents, McCormick (1984) recommended that a field study of high mounted auxiliary stop lights should be undertaken in New Zealand in order to assess the generality of results to this country.

Method

A total of 1787 vehicles used by New Zealand hospital boards, local bodies and Government Departments were included in the study. The vehicles were all passenger cars that were on the road throughout the one year period of the study. They were all regularly serviced and any accidents were recorded by the fleet owners.

The vehicles were randomly divided into two groups, the experimental group which was fitted with centrally mounted auxiliary stop lights and the control group which was unmodified. A computer simulation with relevant facts was undertaken before the field study and this suggested that the most appropriate ratio of control to experimental vehicles was 2:1 with about

* Reprint requests should be sent to Dr Iain McCormick, National Director Human Resources, Touche Ross, PO Box 2093, Wellington. The present paper is based on a report prepared by the authors for the Accident Compensation Corporation. Permission has been granted for reproduction of the material in the present paper.

2,000 vehicles in the total sample. This ratio and number of vehicles allowed a fair test of the lights with the smallest and therefore most economical sample size.

To generate the control and experimental groups a random selection of seven numbers less than 10 was obtained and those vehicles that had number plates ending with these numbers (1,2,4,5,7,8, or 0) were used in the control group. Those vehicles with number plates ending in 3,6, or 9 formed the experimental group. During the project a periodic check was conducted to establish that all fitted lights were maintained in good working order.

Twelve months after the auxiliary stop lights were fitted the accident records of the various organisations were examined and the number, descriptions and cost of the accidents were obtained. In addition the number of kilometres driven was also obtained where available.

The Auxiliary High Mounted Stop Light

The additional brake light was mounted on the boot lid, hatch back or station wagon rear door, on the longitudinal rear centre line of the vehicle directly below the rear screen. The lamp functioned as a stop light only in conjunction and simultaneously with the vehicle's existing stop lamps.

The third brake light was identical to that used in the studies by Kohl and Baker (1978) and Reilly et al. (1980). The housing of the lamp was black moulded polycarbonate, 18.5 cm wide by 3.8 cm high by 7.6 cm deep. The depth of the unit did however vary depending on the fittings for sedan, hatch back and station wagon. The lens colour was plain red, averaging 14.2 cm wide and 2.1 cm high, giving a lens area of 29.8 sq cm. One electrical lead of the lamp connected to a convenient earth inside the boot area, the other connected directly into the positive brake light wiring in the boot. The lamp illuminated only when the brake pedal was depressed. The installation time required was between 15 and 30 minutes. The brake light unit met the photometric standards laid down by the Society of Automotive Engineers in Recommended Practice SAE J186, as well as conforming to US Federal Motor Vehicle Safety Standard 108.

Relevant Accident Definition

The present study was concerned with rear end accidents in which the auxiliary stop light could have played some role. These accidents were defined in a similar manner to previous research, using the following four criteria:

1. The front of the striking vehicle hit the rear of the research vehicle.

2. The impact resulted from forward movement of the vehicle behind.

Table 1: *Number of vehicles, Number of Accidents, Percentage Reduction in Rear End Accidents and Chi Square Test for Significance.*

	Control	Experimental	Total
Total Number of Vehicles	1208	578	1786
Relevant Rear End Accidents	61	11	72

3. There was evidence of prior braking by the vehicle in the study, that is, the vehicle was decelerating, however slowly.

4. The vehicle must also have been in the process of being driven so that only vehicles where there was a clear indication of the brake pedal being depressed and the auxiliary stop light (where fitted) being on, were considered. Thus, reversing accidents, parked vehicles that were hit in the rear and those that were stopped at stoplights were also eliminated.

All accident descriptions in both the experimental and control groups were read to a "blind" researcher (i.e., a researcher who had no knowledge of whether the vehicle belonged to the experimental or control groups). The researcher then applied the above criteria and decided if the accident should be considered in the present study. Accidents that did not fulfil the criteria were eliminated from the study.

Results

Number of Relevant Accidents

Table 1 indicates the number of vehicles in each group, the number of relevant rear end accidents for the experimental and control groups and the results of the Chi Square test for significance.

There were 1208 control and 578 experimental vehicles providing a total sample size of 1786. There were 61 relevant rear end accidents in the control group, 11 relevant rear end accidents in the experimental group with a total of 72 relevant accidents through the 12 month period of the study. The difference between groups was significant, Chi Square $(1, 1786) = 9.22$, $p < .01$. The resulting decrease in rear end accidents for those vehicles that were fitted with the auxiliary high mounted stop lights was 62.31%.

Relevant Vehicle Repair Costs

There were 45 relevant rear end accidents in the control group where repair costs were known and nine in the experimental group. The total cost of repairs for all 45 control vehicles was $54,360.00, compared with $5,281.00 for the nine experimental group vehicles. Thus the mean cost of repairing the vehicles in the control group was $1,208.00 per vehicle, compared to $586.78 for the vehicles in the experimental group. This means that there is an average of $621.10 per vehicle difference in the cost of repairs. A *t* test for unequal variances indicated that this difference was statistically significant, $t\ (30.2) = 2.23$, $p < .05$.

Distances Travelled by Vehicles

Of the total of 1,786 vehicles used in the present study, odometer readings were obtained from a sample of 711. The total distance travelled by the fleet was 9,055,247kms. The experimental group ($N = 183$) travelled 2,572,042kms and the control group ($N = 528$) travelled 6,483,205kms with an average distance for the study of 12,279kms per vehicle.

A Cost Benefit Analysis

In order to get an understanding of the possible benefits of installing a central single high mounted stop light the experimental group was used to undertake the following analysis (see Table 2).

Table 2: *Cost Benefit Analysis*

Number of Vehicles	578.00
No of accidents	11.00
Expected no of accidents	29.19
Cost per no-light accident	$1,208.00
Expected accident cost	$35,258.00
Actual accident cost	$6,454.58
Saving due to auxiliary lights	$28,803.42
Saving for two vehicle accidents	$57,606.84
Installation cost at $39.95	$23,091.10
Cost/Benefit ratio (property)	1:2.49
Injury cost per person	$4,380.79
Proportion of injury accidents	0.67
Expected injury cost	$85,676.42
Actual injury cost	$32,286.42
Saving in injury costs	$53,390.00
Saving (property + injury)	$82,193.42
Saving for two vehicle accidents	$164,386.84
Cost/Benefit ratio (property + injury)	1:7.12
Installation cost at $15.00	$8,670.00
Cost/Benefit ratio (property)	1:6.64
Cost/Benefit ratio (property + injury)	1:18.96

A total of 578 vehicles made up the experimental group and of these 11 had relevant rear end accidents. It is known that this figure is low as a result of the effect of the high mounted stop lights. In order to get an estimate of the expected number of accidents that would have occurred if the vehicles had not had auxiliary stop lights, it is necessary to work out the usual accident rate. The control group accident rate was examined in order to do this (1208 vehicles and 61 accidents is a rate of 0.0505 accidents per vehicle). If this rate had occurred in the experimental group the expected number of accidents would have been 29.19 accidents (that is 578 vehicles multiplied by the rate of 0.0505 is 29.19).

If the usual cost of accidents was $1,208.00, it would be expected that the cost of accidents in the experimental group was 29.19 × $1,208.00 = $35,258.00. However due to the effect of the auxiliary stop lights the actual cost was only $6,454.58 (11 accidents at an average cost of $586.78). This means there is a saving of $28,803.42 due to the auxiliary stop lights.

However this saving is for one vehicle only, in a rear end accident that by definition must involve two vehicles. As a result of considering the two vehicles the saving is actually $57,606.84 (that is $28,803.42 × 2). This assumption is the same as that made in similar cost benefit analyses (Kohl & Baker, 1978). At full retail cost of $39.95 but with the vehicle owner installing the light the total cost of fitting these lights is $39.95 × 578 = $23,091.10. The cost benefit ratio is 1: 1.25 (that is costs of $23,091.10 and benefits of $28,803.42). However the cost benefit for the two vehicles involved in the accident is 1:2.49 (that is costs of $23,091.10 and benefits of $57,606.84). Which means that for every dollar spent on auxiliary stop lights a $2.49 saving is achieved.

If estimations of injury costs per accidents are included in the analysis at $4,380.79 (Brown Copeland & Co, 1983; cited in Thomson, 1985) and if the assumption is made that 67% of rear-end accidents involve some injury (Brown, Copeland & Co, 1983) then the expected cost of injury would be $85,676.42. However due to the auxiliary lights the accident rate was reduced and consequently the injury cost was estimated at only $32,286.42 (11 accidents with 67% involving injury at a cost of $4,380.79 per accident). This results in a saving in injury costs of $53,390.00 and a total saving in both property and injury of $82,193.42. The resulting cost benefit ratio is therefore 1:3.56.

This saving and ratio is for one vehicle only, in a two vehicle collision, and when this is taken into account the savings are $164,386.84. The cost benefit when both vehicles are considered is then 1:7.12. This means that for every dollar spent on the auxiliary stop lights $7.12 was saved. However if the total cost of the light could be brought down to $15.00 then the installation costs would be $8,670.00 and the cost benefit ratio when only property costs are considered would be 1:6.64 which means that for every dollar spent on the auxiliary lights $6.64 was saved. However if both property and injury costs were considered then the ratio would be 1:18.96 which means that for every dollar spent $18.96 would be saved.

Discussion

The present study aimed to examine the effectiveness of high mounted auxiliary stop lights in reducing rear end accidents in a New Zealand context. It was found that within the present sample of public service, local body and hospital board vehicles the auxiliary lights produced a statistically significant 62% reduction in relevant rear end accidents. There was also a significant reduction in repair costs for those vehicles which were fitted with auxiliary lights but were involved in relevant rear end accidents. The reduction in cost was calculated to be $621.10. On the basis of this finding it seems reasonable to suggest that there is likely to be a substantial reduction in personal injury for the people involved in such rear end accidents.

The present results are likely to be conservative in that the vehicles were driven mainly during business hours as Reilly et al. (1980) suggest that the auxiliary stop lights are likely to be more effective at dawn, dusk and at night as compared to daylight hours.

A cost benefit analysis was undertaken and it was found that even in a conservative case where the full retail price of the auxiliary light was taken into the calculation and where only property costs but not injury costs were calculated then the cost benefit ratio was 1:2.49. However, where injury costs are estimated, then the ratio rose to 1:7.12. This indicates that on the basis of the present study it is cost beneficial for the average motorist to buy and fit an auxiliary light even if the injury costs are not considered. In a second calculation a lower costing of purchase and installation price ($15.00) of the auxiliary stop light was considered. In this case the cost benefit ratios were substantially improved. When only property costs were considered the ratio was 1:6.64 and where both injury and property costs were considered the ratio was 1:18.96.

The present results are in accord with the results of Kohl and Baker (1978) and there is clear evidence of the generalisation of the accident prevention results in the current sample. The present study now adds to a growing body of research from differing areas of the world that suggest the utility of single centrally mounted auxiliary stop lights.

References

Helmers, G., & Tornos, P. (1983). *High-mounted supplementary brake lights — literature survey and analysis.* The Swedish Road and Traffic Research Institute, S-581 01, Linkoping, Sweden, Report No 261.

Kohl, J. S., & Baker, C. (1978). *Field test evaluation of rear lighting systems.* Essex Corporation, contract number DOT-HS-5-01228.

McCormick, I. A. (1984). *A review of studies on the prevention of motor vehicle accidents with particular reference to high risk groups.* Wellington: Accident Compensation Corporation.

Reilly, R. E., Kurke, D. S., & Buckenmaier, Jr. C. C. (1980). *Validation of the reduction of rear end collisions by a high mounted auxiliary stop light.* National Highway Safety Administration, DOT-HS-7-01756.

Thomson, G. (1985). *High mounted auxiliary brake lights.* Paper presented to the Road Traffic Safety Research Council. Wellington, May 1985