

# EFFECT OF DISTANCE AND MOTORCYCLE HEADLIGHT CONDITION ON MOTORCYCLE NOTICEABILITY

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This paper describes the design and results of a set of motorcycle noticeability experiments to determine the distances and differences in distances during daylight at which motorcycles with headlights on can be perceived by drivers as opposed to motorcycles with headlights off. The experimental design included two motorcycle headlight conditions—no light and high beam—and 6 distances ranging from 50 to 300 ft from the opposing vehicle. The experiment was conducted in downtown Philadelphia. The results of this experiment indicate that, when a motorcycle operates during the daylight with a headlight, drivers of other vehicles will notice the motorcycle sooner and at greater distances and should thus be in a better position to take evasive actions when necessary to avoid accidents.

•AS PART of a recent study for the National Highway Safety Bureau, the Franklin Institute Research Laboratories conducted a series of motorcycle noticeability experiments (1). One of these experiments was concerned with determining the distances and differences in distances during daylight at which motorcycles with headlights on can be perceived or detected by drivers as opposed to headlights off.

The design of this experiment was guided by the results of previous work indicating that the perceptibility of vehicles could be increased, accidents could be reduced, and lane position could be improved through daytime use of headlights or running lights (2 through 6). None of these studies, however, was specifically concerned with motorcycles. A survey in Wisconsin (7), which has a daytime motorcycle headlight law, found that most automobile drivers felt that the daytime use of motorcycle headlights helped them to see motorcyclists better in both rural and urban traffic.

An experiment was designed to evaluate the effects of motorcycle headlight condition and distance as independent variables on motorcycle noticeability.

## DISTANCE VERSUS NOTICEABILITY EXPERIMENT

The experiment was conducted to determine the effect of a motorcycle headlight operating during the daylight on motorcycle noticeability as perceived by oncoming vehicles at various distances from the motorcycle. Noticeability was determined at distances ranging from 50 to 300 ft. Two motorcycle headlight conditions were considered: (a) no light and (b) high-beam headlight at 50, 100, 150, 200, 250, and 300 ft. The experiment consisted of 12 cells as follows:

| Motorcycle<br>Light<br>Condition | Distance (ft) |      |     |     |     |     |
|----------------------------------|---------------|------|-----|-----|-----|-----|
|                                  | 50            | 100  | 150 | 200 | 250 | 300 |
| No light                         | I             | II   | III | IV  | V   | VI  |
| Headlight                        | VII           | VIII | IX  | X   | XI  | XII |

Each cell consisted of approximately 100 vehicles. Because the weather remained clear approximately 90 percent of the time, no stratification by weather condition was made. The experiment was conducted during the second through fourth weeks of May 1970. On each day, 4 to 6 cells were considered.

### Procedure

Figure 1 shows the experimental test site (20th and Race Streets, Philadelphia), and Figure 2 shows the test site with the motorcycle in position as seen from an oncoming car. The motorcycle was placed at  $P_1, P_2, \dots, P_6$  corresponding to 50 ft, 100 ft,  $\dots$ , 300 ft from  $P_0$ , the center of the intersection. Vehicles traveling on Race Street that did not turn at 20th Street were stopped at  $P_7$  by a researcher and a Philadelphia police officer and questioned concerning the noticeability of the motorcycle. No vehicles were parked along the south side of Race Street either in front of or behind the motorcycle.

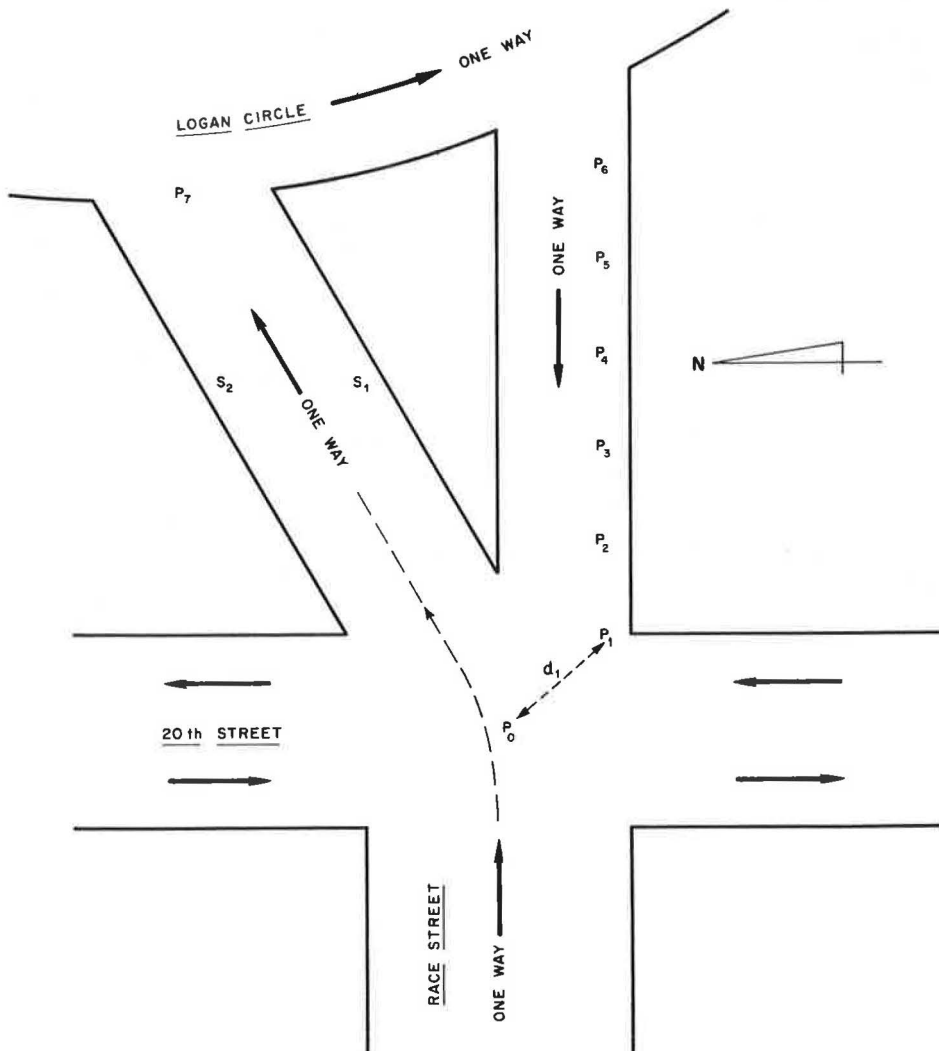


Figure 1. Site for experiment, 20th and Race Streets.

Buses were normally parked at  $S_1$  and  $S_2$ , which helped the experiment by screening the motorcycle from the drivers while they were stopped for questioning. There was a stop sign at the intersection with Logan Circle.

Motorists were asked the following question: "Did you notice a motorcycle as you passed through the last intersection?" Motorists who answered "yes" were also asked: "Did you pass this intersection and were you questioned on a previous day?" (if so, the driver was omitted since there was an obvious learning curve; drivers almost always noticed the motorcycle once they had been questioned previously) and "Where was the motorcycle located?" (this was done to verify that our motorcycle, and not another, was seen).

Normally, 100 to 150 drivers were questioned in the daily 3-hour period. This time period was varied each day (9:30 to 12:30, 11:00 to 2:00, 12:30 to 3:30, 9:30 to 12:30, etc., in that order) to reduce the likelihood of stopping the same vehicles for questioning.

## Results

Table 1 summarizes the results of this experiment; Figure 3 shows the results graphically. An analysis of variance (8) was run on the data. It showed that the effects of both light condition and distance were significant at the 1 percent level. The analysis of variance is given in Table 2.

The upper curve in Figure 3 shows noticeability as a function of distance for the light-on condition; the lower curve shows the same data for the light-off condition. Both curves have the same slope and appear to level off with increasing distance; that is, someone will always see the motorcycle, even at great distances. (In this experiment, if vehicles are allowed to park directly behind the motorcycle, noticeability drops to near 0 between 150 and 200 ft. This is probably caused by the masking effect of the automobile behind the motorcycle.)

Figures 4 and 5 show the improvement obtainable by using motorcycle headlights during the day. Figure 4 shows the improvement in the distance in number of feet between the two curves in Figure 3 for a given percentage of detection. For example, 20 percent detection with no light on occurs at approximately 135 ft, whereas with the light on, 20 percent detection occurs at approximately 235 ft; hence, there is a 100-ft improvement. At 40 percent detection, the improvement in distance with the light on is about 60 ft.



Figure 2. View of test motorcycle as seen from an oncoming car.

TABLE 1

SUMMARY OF RESULTS: DISTANCE VERSUS NOTICEABILITY

| Distance<br>(ft) | Light Off                      |  |  | Light On                       |  |  |
|------------------|--------------------------------|--|--|--------------------------------|--|--|
|                  | Total<br>Number of<br>Vehicles | Number of<br>Motorists<br>Noticing<br>Motorcycle | Percentage<br>of Motorists<br>Noticing<br>Motorcycle | Total<br>Number of<br>Vehicles | Number of<br>Motorists<br>Noticing<br>Motorcycle | Percentage<br>of Motorists<br>Noticing<br>Motorcycle |
| 50               | 103                            | 35   | 34   | 102                            | 56   | 55   |
| 100              | 105                            | 29   | 28   | 102                            | 53   | 52   |
| 150              | 101                            | 18   | 18   | 108                            | 35   | 32   |
| 200              | 101                            | 15   | 15   | 102                            | 24   | 24   |
| 250              | 97                             | 7  | 7  | 102                            | 18   | 18   |
| 300              | 109                            | 5  | 5  | 114                            | 18   | 16   |

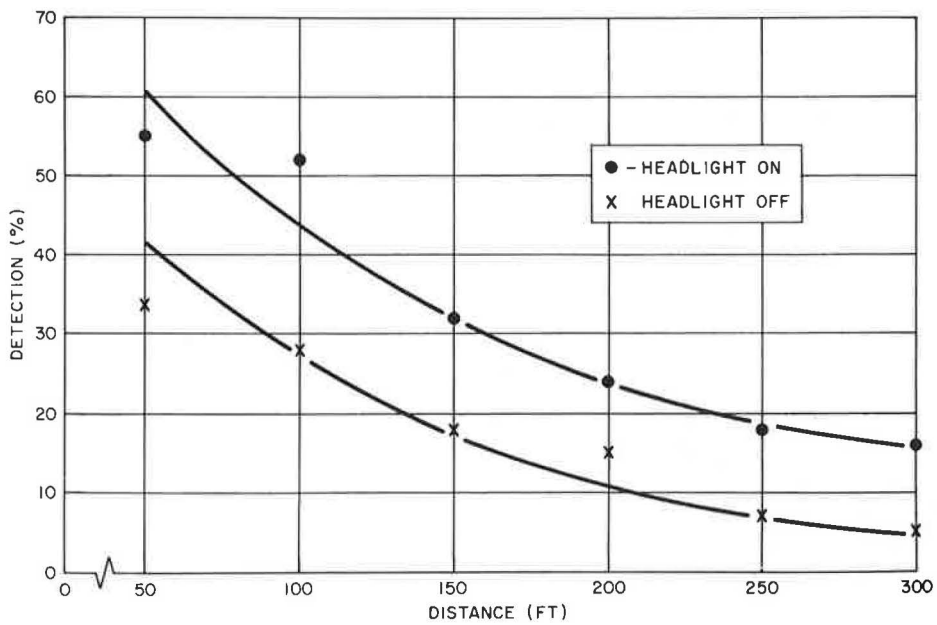


Figure 3. Experimental results, distance versus noticeability.

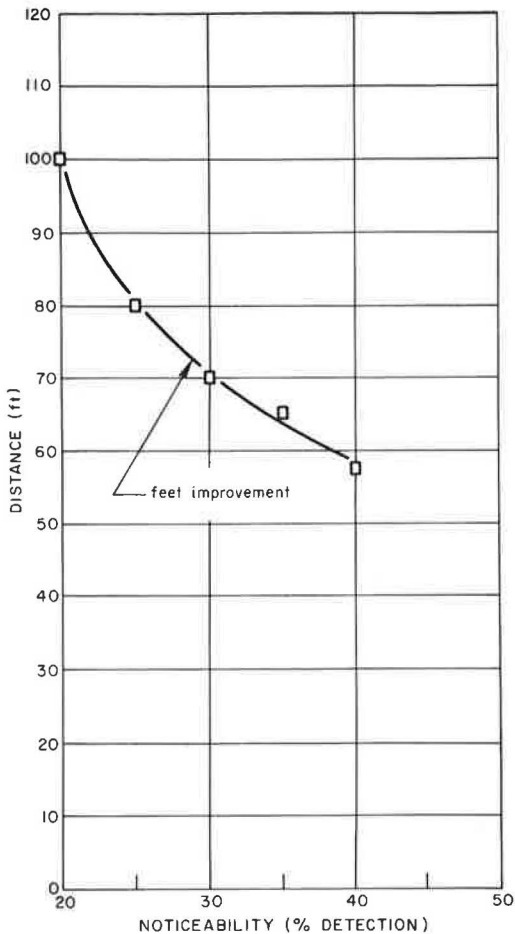


Figure 4. Noticeability improvement in distance caused by motorcycle headlight.

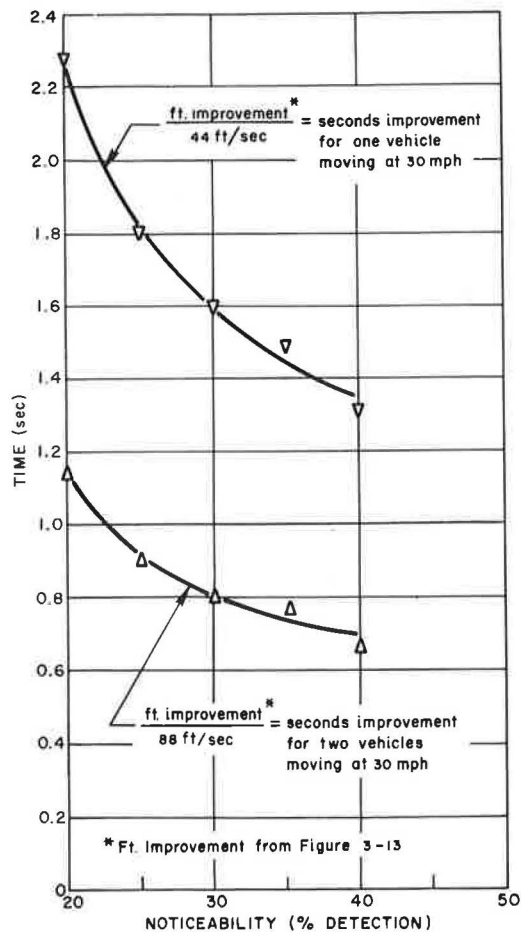


Figure 5. Noticeability improvement in time caused by motorcycle headlight.

The curves of Figure 5 correspond to one vehicle and both vehicles moving at 30 mph respectively. The respective improvement (in time) is 2.3 and 1.1 sec for 20 percent detection.

The latter calculations show that when a motorcycle operates during the daylight hours with a headlight on, drivers of other vehicles will notice the motorcycle sooner and at greater distances. Drivers should thus be in a better position and have more time available to take necessary evasive actions when required. These improvements in noticeability range from (a) increased distance of about 60 ft at 40 percent detection to 100 ft at 20 percent

detection, (b) increased time of 0.7 sec at 40 percent detection (two vehicles moving at 30 mph) to 1.1 sec at 20 percent detection (two vehicles moving at 30 mph), and (c) increased time of 1.3 sec at 40 percent detection (one vehicle moving at 30 mph) to 2.3 sec at 20 percent detection (one vehicle moving at 30 mph).

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TABLE 2  
ANALYSIS OF VARIANCE: DISTANCE VERSUS  
NOTICEABILITY

| Variable        | SS    | df | MS  | F   | Level of Significance |
|-----------------|-------|----|-----|-----|-----------------------|
| Light condition | 335   | 1  | 335 | 168 | 0.01                  |
| Distance        | 931   | 5  | 186 | 93  | 0.01                  |
| Error           | 10    | 5  | 2   | —   | —                     |
| Total           | 1,276 | 11 | —   | —   | —                     |

Notes: 1. Arcsine transformation applied to percentages in Table 1 to equalize variance.  
2. Interaction is ignored because (a) it is confounded with the error and (b) the curves of Figure 3 are approximately parallel (i.e., little interaction).