AN EVALUATION OF A REAR-MOUNTED VEHICLE SPEED INDICATOR

Clinton Jolliffe, Carl Graf, and David Alden,
Honeywell, Inc.

ABRIDGMENT

• THE primary purpose of vehicular taillights at night is to alert drivers to the presence of a vehicle ahead. Once the taillights are detected, the driver processes such visual clues as taillight size, height, motion, luminance level, and apparent inter-taillight separation. Intervehicle distance and speed information is extracted from these clues, and the driver then reacts accordingly.

The existing rear vehicular lighting systems have many shortcomings, as shown by highway accident statistics indicating that 15 percent of all vehicular collisions are of the rear-end type. It has been suggested that a rear signal light should be of dual purpose, i.e., convey vehicle speed information directly in addition to its primary task of alerting the following driver. Hence, it was decided to construct a speed indicator signal system and compare it with a conventional taillight system in terms of a subject's ability to assess the speed and intervehicular distance of a car being overtaken at night.

SPEED INDICATOR DESIGN

The bar-type speed indicator was constructed by mounting 14 amber signal lamps on a board 70 in. long. Each signal lamp had a luminous intensity rating of 2 candlepower. The speed indicator was mounted on the rear of a pickup truck at a height of 45 in. above ground level and 12 in. above the taillights.

The outer two lamps served as reference lamps and were always on. As the speed of the vehicle increased, the signal lights were switched on in pairs at 10-mph increments. That is, for vehicle operation in the 0- to 10-mph speed range, only the two central lamps were on; for the 10- to 20-mph speed range, the four central lamps were on; and so forth until all 12 speed indicator lamps were switched on, which indicated that the vehicle's speed was exceeding 50 mph (Fig. 1). Thus, the width of the bar indicated vehicle speed, and the rate of expansion or contraction corresponded to rate of acceleration or deceleration.

EXPERIMENTAL PROCEDURE

To conduct the study, three vehicles and five persons were employed. The lead vehicle was occupied by a driver and one operator who controlled the signal lights mounted on the rear of the vehicle. Next in line was a "blind" car that had its rear window draped with black cloth. The purpose of this vehicle was to prevent the exposure of the speed indicator or taillight signals to the following subject car until the desired intervehicle distance was achieved. The subject car was occupied by the subject who drove and an experimenter who instructed the subject and recorded the subject's judgments.

The pilot study was conducted at a dragstrip located in a rather isolated rural area; thus there were few extraneous light sources. The dragstrip was 1 mile long and had distance markers posted every 100 ft.

The experiment was structured to obtain subject judgments of the lead car's speed and distance over intervehicle distances that ranged between 100 and 1,000 ft. Four

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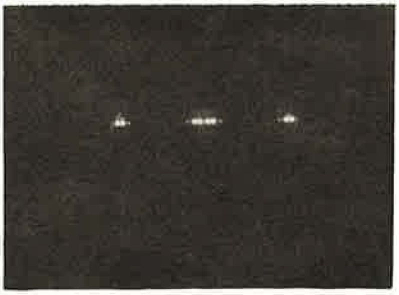
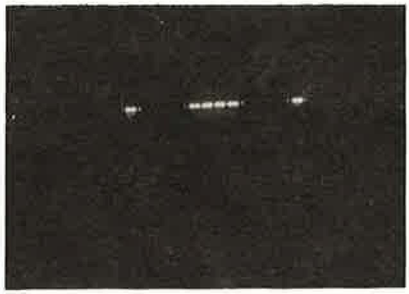
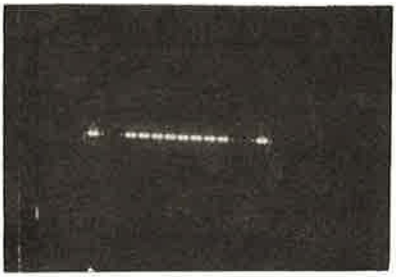


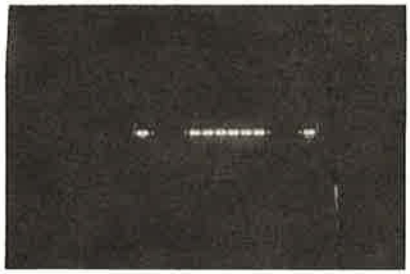
(a) 0 to 10 mph



(b) 10 to 20 mph



(c) 20 to 30 mph



(d) 30 to 40 mph

Figure 1. Photographs of speed indicator as observed from subject vehicle for four speed conditions.

test speeds (10, 20, 30, and 40 mph) were selected, and the subject was informed that his speed judgment must be one of those assigned speeds. The speed of the subject car was 40 mph under all conditions. Three intervehicle distance categories (far, mid, and near) were established to vary as well as was possible the distances over the specified range. Thus, 24 combinations existed (four speeds, three distance categories, and a taillight or speed indicator). Each condition was run twice for a total of 48 runs per session. The order of the combinations was randomized, with each subject receiving the same random order of runs.

For the test situation, the lead car assumed one of the four selected car speeds. At the appropriate intervehicle distance, the operator signaled the blind car to move into the left lane by turning on either the taillights or speed indicator. The driver in the subject car was then exposed to the rear signal lights for about 2 sec, at which time the rear signal lights were switched off. This signaled the subject to make a speed judgment followed by an intervehicle distance judgment. In addition, this served as a signal for the experimenters in the lead and subject cars to drop a small sandbag from the vehicle's right window for intervehicle distance markers.

Three subjects, ranging in age from 25 to 35 years, were employed for this study. Each subject demonstrated normal color vision, had a visual acuity of 1.0, and had between 10 and 15 years of driving experience.

RESULTS AND DISCUSSION

Chi-square tests indicated no statistically significant relationships between the number of speed judgment errors and intervehicle distance, direction of judgment error and vehicle speed, or distance judgments versus signal type. However, a highly significant relationship ($P < 0.001$) was found between direction of speed judgment error and signal type (Fig. 2). The high significance level was primarily a result of the judgments based on the speed indicator, which were almost consistently overestimated speed judgments.

A sign test of correlated samples indicated that there were significantly fewer speed judgment errors (without regard to sign) with the speed indicator ($P < 0.05$) versus the conventional taillight system.

One can only speculate as to why subject errors were almost consistently in the direction of overestimation with the speed indicator. Because the subjects were given only a brief orientation period during which time they were able to relate bar length with announced vehicle speed, learning may be a factor. Yet, if it were only a learning factor, one may expect as many errors of underestimation as overestimation. What could have contributed to the bias is that the subjects may also have used apparent vehicle motion as a visual clue to vehicle speed. If this were the case, the speed indicator, due to its greater illumination level, would provide more motion clues for the subject driver and thus account for the evident judgment bias.

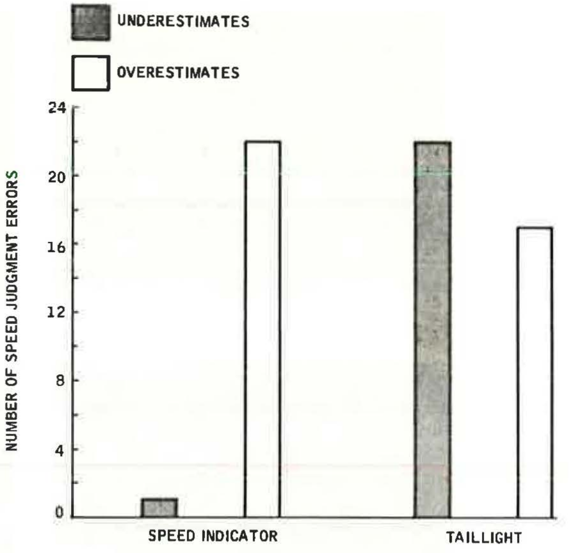


Figure 2. Number and direction of speed judgment errors for each signal type.

As a final comment, we recognize that this pilot study only grazes the surface of the much larger and more complex problem of adequate rear vehicular lighting. We do feel that the concept of a dual-purpose rear signal system of this type is sound and that our findings suggest the need for further study and evaluation.