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A Method for Measurement of Perceptual Time on the Highway

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Introduction

A major handicap for studies of perceptual time on the highway has been the lack of an adequate means of simultaneously starting a chronoscope and exposing a highway situation to a subject. The problem is better appreciated when it is realized that on the one hand the subject's vision must be restricted from the situation to be exposed. On the other hand he must be permitted to view the road for a certain distance ahead of the car. The latter is necessary to allow for adjustment of the eyes to the existing level of illumination and for adaptation of the eyes to a distant point of fixation.

Two methods for measuring perception and judgment time on the highway were proposed by Forbes (1939). He was concerned with the problem of determining the time required for making a decision to pass a vehicle ahead after rounding a curve. One method was to have a person other than the driver start a timer when he felt that first clear vision was possible after negotiating a curve. The timer was stopped by the sudden depression of the accelerator which was considered as an indication of the decision to pass. The second method was to take aerial photographs of the same situation. The time was determined from the number of frames taken between a point marking the spot where first clear vision was possible and where the vehicle started to move into the other lane to pass.

As these methods are quite restricted in their use it has been the purpose of the writer to design an apparatus which could be used in a variety of situations.

Apparatus

A tachistoscopic and short time exposure device was designed. This consists of a ten by fifteen inch aluminum shutter which rotates on a horizontal axis as shown in Figure I. The power to rotate the shutter is supplied by a coil spring which permits repetition of several trials before the apparatus requires resetting. The control of the shutter is effected through a solenoid-driven lever operating on a ratchet wheel. One wheel is designed to permit the shutter to rotate ninety degrees after it is released. When the shutter is in the vertical position and adjusted in accordance with the height of the

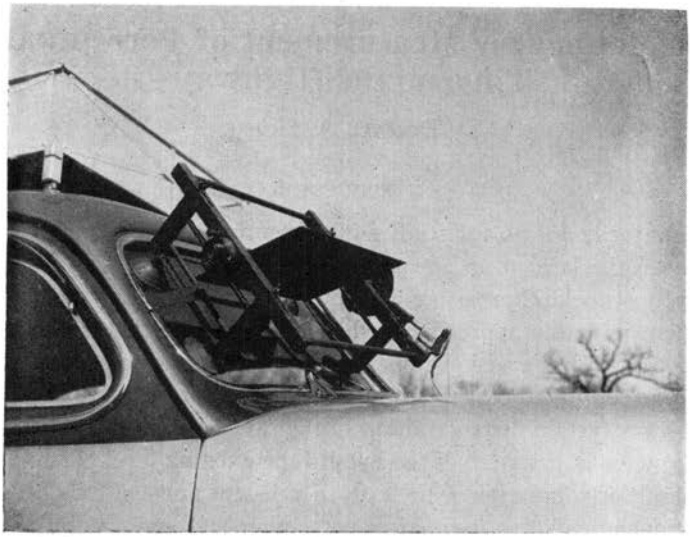

Figure I. Tachistoscopic and short time exposure apparatus mounted on a car. On the left side is the coil spring, center the aluminum shutter, and on the right the solenoid, lever, and ratchet wheel.

subject's eyes it restricts the view to a short distance ahead of the car. Upon release the shutter rotates ninety degrees and thus permits a clear view of the road. (See Figure I) The relays for activating the solenoid and starting the chronoscope are in the same circuit which permits simultaneous exposure and starting of the chronoscope. The time of exposure may be controlled through the use of an interval timer, or the time can be measured between the instant of exposure and the response of a subject. When verbal responses are desired an electronic voice key is used (Kjerland and Lauer 1950).

Another ratchet is designed to permit the shutter to rotate one hundred and eighty degrees after it is released. This allows tachistoscopic exposures of a situation. A number of possibilities for calibrating the exposure time are being considered. Limitations of the apparatus are that the time of the instantaneous exposure cannot be easily varied, and every exposure must be made with the same amount of tension on the coil spring.

Use of this Apparatus in a Certain Highway Problem

A study of possible factors which operate in rear-end accidents has been inaugurated as one phase of a major project on night driving at Iowa State College. A report from the Los Angeles, California Police Department states that "Studies of accidents on

our freeways reveal that rear-end collisions are most frequent where there is a high speed differential between vehicles. . . ." From this and other observations it appears that the ability to perceive a decrease or increase in distance between two vehicles traveling in the same direction is an important factor in avoiding rear-end accidents.

For night driving there is some question as to the value of taillights now legally in use as functional cues for the perception of change in distance or relative speed. On *a priori* grounds it seems that the use of reflectorized materials on the back of vehicles would provide excellent cues for sensory discrimination. The following experimental procedure has been designed to evaluate this generalized hypothesis.

Experimental Procedure

The time required for perception of any change in distance between two vehicles traveling in the same direction is used as a criterion to evaluate the various factors of discrimination involved.

The procedure requires the use of two vehicles. (See Lauer and Kjerland, 1950) The leading vehicle is equipped to make it possible to place panels with various reflection characteristics on its rear. It is also equipped with conventional taillights. The trailing vehicle, in which the subject rides in the right front seat, is equipped with the exposure device described above and a chronoscope and other apparatus as described by Kjerland and Lauer.

The subject is instructed that whenever the leading vehicle is exposed he is to report as quickly as possible whether the distance is "decreasing," "increasing" or "constant." An electronic voice key stops the chronoscope when he reports. At the same time a wire recorder transcribes auxiliary remarks which may be used as a protocol for later study.

A typical experimental trial is conducted as follows. If the distance is to be decreasing the space between the vehicles is greater than the distance (700 feet) at which the leading vehicle is to be exposed. With the trailing vehicle traveling at a constant speed the leading one stops or abruptly slows to a constant speed. When the distance has decreased to 700 feet the leading vehicle is exposed and the chronoscope is started. When the subject responds "decreasing" the chronoscope stops, the exposure device is closed, and the time for that trial is recorded. Additional comments as to estimation of distance and speed differential are recorded on the wire recorder.

With the necessary variations in the speed of the leading vehicle, the reflectorized panels and taillights on the rear of the leading

vehicle, trials are repeated for other conditions. The order of the trials is rotated from subject to subject to offset the effects of practice and fatigue.

To determine the statistical significance of any differences the data are submitted to the t-test and analysis of variance. The experiment is of the conventional nature such as is used in small sampling statistics.

Summary

A mobile apparatus is described for presenting instantaneous or short time exposures of motor vehicles, pedestrians, trains or other complex patterns of stimuli on the roadway. It is used in connection with other mobile equipment.

Literature Cited

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