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# AGE AND THE PERCEPTION OF A MODULATING TRAFFIC SIGNAL LIGHT IN A FIELD LOCATION

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## ABSTRACT

Young, middle, and older drivers were motored towards a traffic signal face and were required to report whether the illuminated signal lens was modulating. No significant differences were found among the three age groups in the distance at which modulation was first reported nor in the change of the modulation pattern as they approached the signal face. The modulating of the illuminated green lens was perceived significantly further away than was the red lens. These distances increased during trials associated with inclement weather. Seventy-four percent of the observers indicated that the modulation attracted their attention. Of these, 64% reported a preference for the use of the modulating light in the traffic signals as compared with the standard light source. Implications for improving safety at intersections for the older driver are discussed.

## INTRODUCTION

At intersections controlled by a traffic signal light the ability to detect the presence of a signal face and respond appropriately is a critical activity in a vehicular oriented environment. However, on occasion, drivers and pedestrians may respond inappropriately. These situations may be the result of risk taking, inattention, distraction, or looking but failing 'to see (Hills, 1980), and these are compounded by competing environmental arrays that reduce the conspicuity of the illuminated signal lens.

The use of flashing lights has been successfully used to improve the conspicuity of two traffic control devices. Strybel & Nassi (1986) improved the recognition of a lane reversing signal under conditions of sun glare by placing a rotating beacon above the signal; and a strobe light strip has been attached to the face of the rea lens and pulses when the red signal illuminated (MUTCD, 1988). Although effective, a potential problem exists. These alerting devices are tangential to the signals and their failure could result in misidentification of the signal lights from observers who are familiar with their operation.

Recently, Brugger (1989) designed a dual-filament traffic signal light bulb where the warning was inherent in the signal's normal lighting pattern. By alternately energizing each filament, a modulation pattern was generated which observers describe as a "flickering or shimmering" light. Preliminary research with observers who were not informed of the shimmering light responded appropriately to the red and green signal lights. A rate of four hertz was identified as this rate produced the maximum distance for viewing modulation and was not confused with a "blinking" traffic signal light. The observers independently reported that the modulation pattern was qualitatively different from what they have previously experienced. Guzy, Suib, Leibowitz, and Brugger (1990) examined the effects of this light source in a traffic signal face under conditions of simulated

sun backlighting. No errors involving recognition and driving were found with the modulating light source in the red or green lenses. Several errors were found with the standard traffic signal bulb. Here, the drivers incorrectly identified the illuminated lens and either stopped for a green light or passed a red light.

As compared with younger drivers, older drivers may benefit more from the modulating light source placed in the signal head. Whereas accidents involving younger drivers are attributed to such factors as speeding and driving while intoxicated, the older driver fails to heed signs, yield the right of way, or turn properly (Planek, 1973; Huston & Janke, 1986). The modulating light bulb may improve signal recognition and reduce such driving errors. The present research was designed to examine whether age related visual changes affect the recognition, distance, and quality of the modulation effect. As older drivers prefer daylight hours for driving, the research was conducted under photopic conditions.

## Method

Subjects. Twenty-eight licensed men and women drivers were paid $5.00 for their participation. Subjects formed three age groups: a) young-ages 20 to 32, n = 9, mean age of 22 years, b) mid-ages 38 to 54, n = 9, mean age of 46 years, and c) older-ages 59 to 80, n = 10, mean age of 66 years. Nine men were found to be red-green color deficient. Each age group had at least two red-green color deficient observers.

Visual Screening. Visual acuity was determined with a Bausch and Lomb Orthorater using only the far visual acuity plates. Color deficiencies were identified with the Dvorine Pseudo-Isochromatic Plates color vision test.

Procedure. Observers sat on the passenger side of a full-sized vehicle driven at a speed of approximately 26 km. toward a three light traffic signal face. The bottom of the signal face was 4.92 m. from the road surface. Green and red lenses, 30.5 cm. dia., of the traffic light were illuminated by either a 150 watt Hytron bulb or a dual filament bulb modulating at a rate of 4 hz. Bulbs were matched for brightness.

Subjects began viewing the traffic light from a distance of 262 m. and were required to identify the color and amount of flicker, if any, using a five point scale, and any other unusual aspects of the traffic light. Distances from the light were recorded with a NuMetrics Roadstar Model 20 computer connected to the vehicle's transmission.

Eight different lighting conditions were administered twice for a total of sixteen trials. Each colored lens was placed in the top position of the traffic signal face for eight trials and in the bottom for the remaining 8 trials. The modulating and standard bulbs appeared equally often in each of these positions. Trials were block randomized. A post-test interview focused on observers impressions of the modulating light bulb.

## RESULTS

The modulating effect of the dual-filament bulb produced reports of both quantitative and qualitative changes as subjects approached the traffic signal face. No significant difference were found among the three age groups. Within each age group large intersubject variability was found.

With the Orthorater, visual performance on the far distance plates decrease with increasing age. However, the perception of the modulation pattern showed no relationship with Orthorater performance.

The modulating pattern in the green and red lenses produced differential distance effects. The green lens was perceived as showing "some" modulation significantly further away (171 m., sd = 38.8) than was the red lens (130.8 m., sd = 53.5), $E(1,54)=16.2$, $p<.001$). A change in the reported modulation

pattern to "more" followed a similar pattern, $F(1,51)=8.6$, $p<.05$.

During inclement weather, i.e., rain, fog, and overcast skies, the modulation pattern was seen further away than under sunny conditions. A significant inverse relationship was found between the report of "some" modulation and weather for both the green and red lenses, $r=-.47$, $df=26$, $p(.01$ and $r=-.35$, $df=26$, $p<.05$, respectively.

A post-test interview showed that 64% of the subjects preferred the modulating light over the standard light. Two observers reported that the modulating light "attracted their r attention" and found it "annoying".

Of the nine red/green color deficient participants, none incorrectly identified the color of the illuminated lens regardless of the lens' position in the traffic signal face. All of these observers reported a preference for the modulating red lens while the normal color visioned subjects were mixed with respect to their preference.

## DISCUSSION

The modulation effect showed no differences among the three age groups in either the range of modulation or in the qualitative changes associated with the modulation pattern.

The large variabilities found within each age group may be attributed to the difficulty in conveying precise terminology to characterize the modulating light pattern and any subsequent changes as viewing distance decreased. When asked to supply their own descriptors to define the effect, observers showed little consistency. The most commonly elicited terms included "shimmering", "flickering", and "modulating".

Changes in the weather from photopic to mesopic conditions increased the range of influence of the modulating light. Regardless of the weather conditions, the overall range of the modulating light was limited. However, perception of the modulation would allow amply time for drivers to initiate an approriate response under both normal and degraded viewing conditiions.

In the present study, with uncompromised viewing conditions, 64% of the subjects indicated a preference for the modulating light in the traffic signal face. In a previous study which used a degraded viewing condition involving simulated sun backlighting of the traffic signal lenses, twelve of fourteen subjects who reported seeing the modulation were unanimous in their preference for the modulation. Of the two subjects who could not recall seeing the modulation, one committed several recognition and driving errors with the standard light source, but not with the modulating light (Guzy, et al., 1990).

The difference in preferences may be attributable to a difference in procedures. In the earlier study, subjects were required to drive a three-wheeled vehicle along a prescribed route, identify signs placed along a simulated roadway, report the color of the illuminated lens, and at a simulated intersection respond accordingly, i.e., drive through or stop. The procedure in this study required the subject to identify the presence of modulation and to report any changes. Several of the passengers indicated that they had fixated on the illuminated lens for the entire duration of the trial (approx. 35 seconds) to the exclusion of all other visual information. Without these distractor tasks, the singular task of viewing the illuminated signal may account for the reduced preference and in two cases, annoyance.

Given the difficulties associated with the older drivers, eg., heeding signs and responding to information in the periphery (Kosnik, Sekuler, & Kline, 1990), the use of the modulating light may possibly improve intersection safety by enhancing the detection of the traffic signal face and

recognition of the illuminated lens.

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For specific information on modulating bulb characteristics contact Richard Brugger, P.E., Industrial Control Associates, P.O. Box 82, Erie, Pa. 16512.

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