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16. Abstract

This field study investigated the efficiency of color coding for peripheral identification of vehicle signals. Specifically, the study dealt with identification of stimuli as "yellow" or "red" when presented at intensities corresponding to typical turn signal lamps and side marker lamps. Turn signal lamps were studied both during bright, sunny conditions and at night, while side marker lamps were studied at night only. We used two different yellow stimuli and two different red stimuli. For each color category, one stimulus was relatively far from the contrasting color category while the other stimulus was relatively near. Four viewing angles were used: 0, 10, 20, and 30 degrees from visual fixation. A total of 28 subjects participated, ranging from 21 to 78 years old.

Nighttime identification of colors was perfect at all viewing angles for stimuli representing turn signal lamps. On the other hand, there were strong effects of viewing angle for turn signals in the daytime and for side marker lamps at night. Although in these two conditions performance deteriorated for stimuli in both color categories, it did so more for the red stimuli. This finding is consistent with the previously reported finding that peripherally presented red stimuli often appear yellow.

The present findings imply that coding signals yellow and red is not sufficient for their peripheral identification under the two most difficult conditions tested (turn signals during bright daytime and side marker lamps during nighttime). To the extent that peripheral discriminability is important in actual driving, efficient signaling should rely on other coding parameters (e.g., intensity, and flashing versus steady burning).

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INTRODUCTION

Color (red vs. yellow) is one of the coding variables currently used in vehicle signaling.[1] However, the restrictions on the use of color vary in different parts of the world. The major differences involve turn signal lamps and side marker lamps. For example, European regulations require turn signal lamps to be yellow both in the front and in the rear (ECE, 1993a). On the other hand, U.S. regulations, although requiring yellow in the front, allow either yellow or red in the rear (NHTSA, 1998). The situation with respect to side marker lamps is quite different. In Europe, side marker lamps are optional equipment for passenger cars (ECE, 1993b). However, if they are used, both front and rear lamps have to be yellow. (An exception involves a situation in which rear side marker lamps are grouped, combined, or incorporated with other red lamps, such as stop lamps. In such cases, the rear side marker lamps can be red.) In the U.S., side marker lamps are required equipment, and they have to be yellow in the front and red in the rear (NHTSA, 1998).

The European requirement for yellow rear turn signal lamps is based on the argument that a color difference will improve differentiation between stop and turn signals (both during the daytime and nighttime). (The evidence from reaction-time studies concerning this issue is not consistent [e.g., Mortimer and Sturgis, 1975; Luoma et al., 1995], and the one available accident study does not favor the use of one color over the other [Taylor and Ng, 1981].) Analogously, the U.S. requirement of red rear side marker lamps is designed to facilitate nighttime differentiation between the front and the rear of a vehicle when viewed from the side. A counterargument, being used in Europe, states that to facilitate perception of the orientation of vehicles red should be reserved for signals at the rear of vehicles, and should not be used on the sides at all.

Additionally, Europe and the U.S. place slightly different restrictions on what is meant by red and yellow. Specifically, in comparison to the U.S. regulations, the European regulations for yellow are somewhat more restrictive in all three principal directions (toward red, green, and white). On the other hand, although the European regulations for red are more restrictive toward white, they are less restrictive toward yellow.

During the last decade, major effort has been devoted to worldwide harmonization of vehicle standards. Progress has been made in several lighting areas (e.g., Sivak and

[1] In vehicle signaling, there is no consistent distinction between the use of the terms “yellow” and “amber.” Here we follow the usage in SAE (1995) and ECE (1993a; 1993b), which refer to and define “yellow.” The results of the present study apply equally well to NHTSA (1998), which uses the term “amber.”

Flannagan, 1994). From the harmonization perspective, the worldwide differences in color requirements for rear turn signals and rear side marker lamps raise the issue of optimal color for each, both in terms of the major color category (red or yellow), as well as specific chromaticity boundaries for the selected color.

Complicating the matter is the finding from basic research on vision that the sensitivity of color vision declines as the peripheral angle is increased (e.g., Moreland and Cruz, 1959). However, what is not known is the degree of decline of color vision in the applied conditions of interest. Therefore, it is not clear how effective the use of color is in differentiating signals when they are viewed in the periphery of the visual field. Consequently, the present series of three experiments was designed to address the issue of color identification in the visual periphery. Specifically, these experiments were intended to be relevant to the daytime and nighttime peripheral identification of yellow and red turn signal lamps, as well as to the nighttime identification of yellow and red side marker lamps.

BACKGROUND

Peripheral color vision in the red/yellow region

Changes in perceived color as a function of peripheral angle were noted as early as 1825 by Purkinje (1825). These changes are of two major types. First, there is a general decrease in saturation (e.g., Moreland and Cruz, 1959). Second, there tend to be systematic hue changes; of interest in the present context is a tendency for red to appear progressively more yellowish with increased eccentricity. For example, in his review of the literature, Lythgoe (1931) stated that when "a red light is viewed more and more peripherally, it looks first orange and then yellow" (p. 197). Similarly, Moreland and Cruz (1959) found that at 30° the hue of long wavelength (red) stimuli shifts towards yellow. Boynton, Schafer, and Neun (1964) pointed out that while color perception at 20° differs little from that in the fovea, "somewhere between 20 and 40° there is a marked attenuation of red and green responses and a predominance of yellow and green responses" (p. 668).

Relative brightness of different colors

Photometrically matched chromatic (colored) stimuli are perceived to be brighter than achromatic (white, gray, or black) stimuli—a phenomenon sometimes referred to as the Helmholz-Kohlrausch effect. Furthermore, the brightness follows a U-shaped function of dominant wavelength. Of relevance for present purposes, photometrically matched red stimuli are perceived to be brighter than yellow stimuli (e.g., Schumann, Sivak, Flannagan, Traube, Hashimoto, and Kojima, 1996; Venable and Hale, 1996). A practical consequence of this effect is that when both red and yellow lights can be used for the same function, the photometrical requirements are greater for the yellow lights. This pattern is evident in Table 1, which lists the U.S. requirements at H,V for rear turn signal lamps and side marker lamps. (By comparison, the European regulations require the [yellow] turn signal lamps to have a minimum of 50 cd and a maximum of 350 cd [ECE, 1993a], and the optional [yellow] side marker lamps to have a minimum of 0.6 cd (ECE, 1993b]. In the European regulations, the Helmholz-Kohlrausch effect is not directly illustrated because red and yellow are not both used for the same function.)

Table 1
U.S. photometric requirements (at H,V in candelas) for rear turn signal lamps and side marker lamps (NHTSA, 1998).

Function	Color		Ratio (yellow/red)
	Yellow	Red	
Rear turn signal lamps, minimum	130	80	1.6
Rear turn signal lamps, maximum	750	300	2.5
Side marker lamps, minimum	0.62 (front)	0.25 (rear)	2.5

EXPERIMENT 1:
DAYTIME IDENTIFICATION OF TURN SIGNAL COLOR

Method

Task. The subject's task was to identify the color of a briefly presented light as red or yellow. The light was presented either directly in the center of vision (the fovea) or at one of three peripheral angles.

Experimental setup. Schematic diagrams of the experimental setup and the subject's view are shown in Figures 1 and 2. The subject was seated in a stationary late-model sedan. Directly ahead, at a distance of 30 m, there was a large white panel (1.56 m by 1.22 m). An aperture in the panel revealed a lamp that was mounted just behind the panel. The panel provided a surround to the lamp that was similar to that of a white body panel of a vehicle.

The lamp used an incandescent light source (the main filament of an 1157 bulb) and a dispersion lens to create a relatively uniform luminance. The luminous area of the lamp was 10 cm by 5.5 cm. Inserts containing combinations of colored and neutral density filters, inserted just in front of the lamp (but behind the panel), were used to change the color of the lamp. The center of the lamp was 82 cm above the ground.

The lamp was energized for 0.33 s using a regulated power source that was run at 12.8 V. (The U.S. regulations require turn signals to flash 60 to 120 times per minute with a 30 to 75% current on time [NHTSA, 1998]. A stimulus presentation of 0.33 s represents one half cycle at 90 flashes per minute with a 50% on time.) The presentation of the stimuli was controlled by an electronic timer. The lamp was aimed prior to each day of testing by using a laser that was integrated with the lamp.

To the right of the lamp and at a distance of 30 m from the subject there were three smaller, white panels (41 cm by 41 cm), each with a black number on it (2, 3, or 4). These numbers were offset 10, 20, and 30° to the right of the lamp and at the same height as the lamp; they functioned as fixation points for the peripheral viewing conditions.

The subject was facing south and the lamp was facing north. This arrangement prevented direct sun illumination from reaching the lamp. Additionally, a shield around the lamp extended 13 cm from the white panel toward the subject and the lamp lens was recessed 43 cm behind the panel, thus minimizing the amount of ambient light reaching the lamp. The surface between the subject's vehicle and the test lamp was asphalt, while the surface where the fixation panels were positioned was grass.

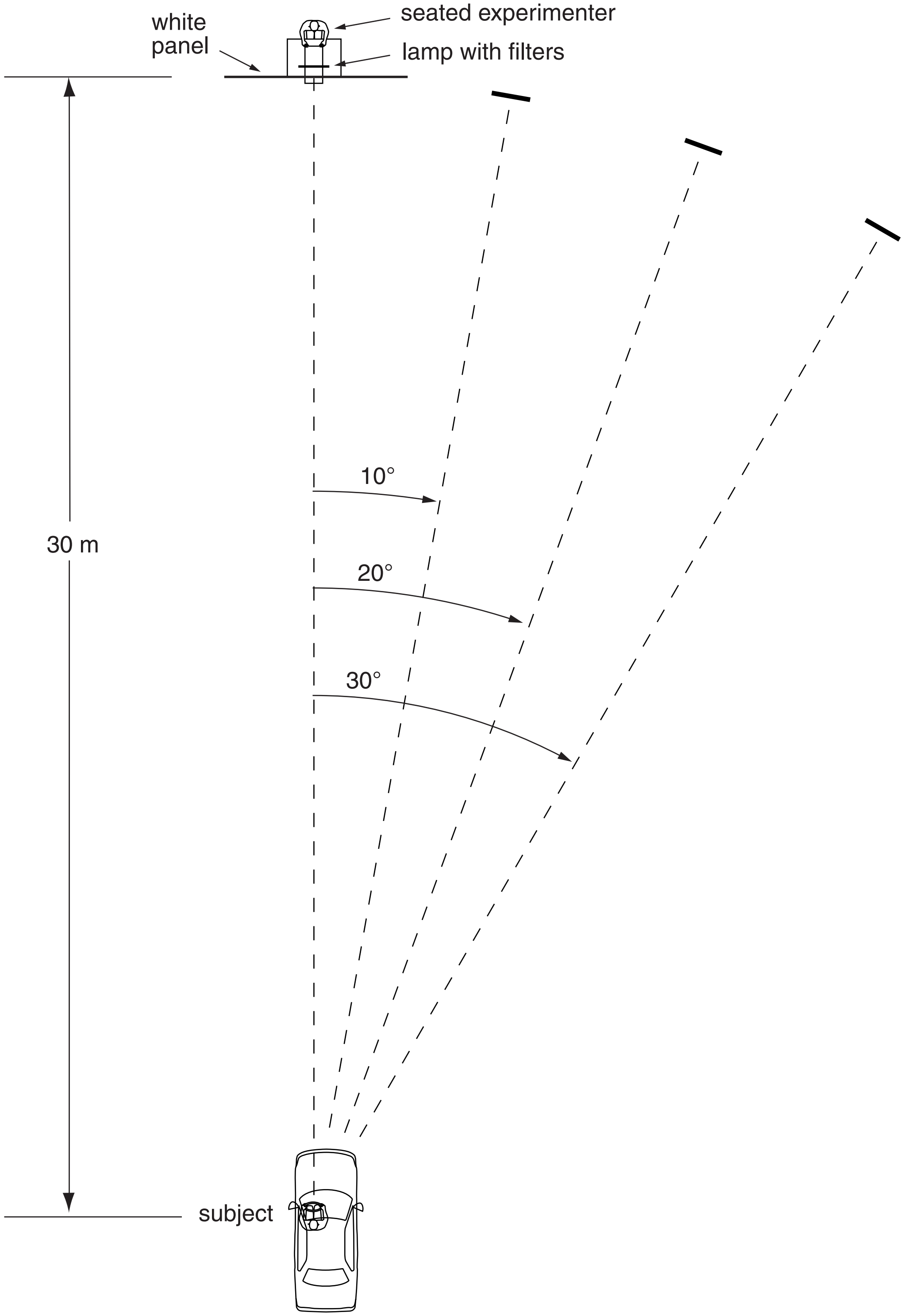

Figure 1. A schematic of the experimental setup.

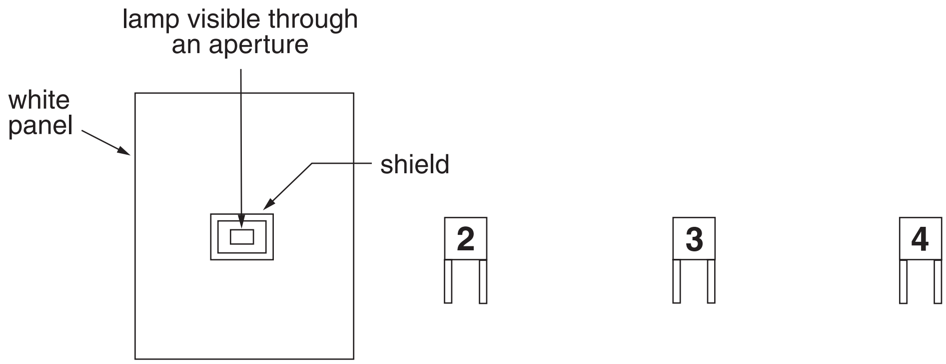

Figure 2. A schematic of the subject's view.

Stimuli. Four combinations of color and neutral density filters were used to create the four stimuli. The luminous intensities directed to the eyes of the subject are listed in Table 2, along with the corresponding chromaticity coordinates. There were two red and two yellow stimuli. They were selected to represent colors that varied in their locations within the currently allowable regions in the U.S. regulations (see Figure 3). Specifically, stimulus R1 was near the center of the allowable region for red, while R2 was at the short-wavelength (toward yellow) end; stimulus Y1 was at the short-wavelength (toward green) end of the allowable region for yellow, while Y2 was at the long-wavelength (toward red) end. Thus, stimulus R1 was relatively far from the allowable yellow region, and stimulus Y1 was relatively far from the allowable red region. On the other hand, stimuli R2 and Y2 were each relatively close to the allowable region of the contrasting color category.

In terms of the intensity directed towards the eye of the observer, the values selected (see Table 2) were close to the minima allowable in the U.S. for turn signal lamps. (The resultant intensity ratio between the yellow and red stimuli averaged 1.7, as compared to the ratio of 1.6 for the minima required [see Table 1].)

Ambient conditions. The study was run only on bright, sunny days. The ambient illumination was evaluated before the start of each experimental session. Illuminance (in lux on a vertical surface) just in front of the lamp (and in front of the shield) averaged 14,678 lux. Illuminance (also on a vertical surface) at the subject's eyes inside the subject's vehicle averaged 3,018 lux.

Table 2
Photometric and colorimetric properties of the four stimuli used.

Stimulus	Intensity (cd)	Chromaticity coordinates		
		x	*y*	*z*
R1 (red)	84	0.698	0.299	0.003
R2 (red)	80	0.665	0.328	0.007
Y1 (yellow)	146	0.561	0.430	0.009
Y2 (yellow)	139	0.589	0.407	0.004

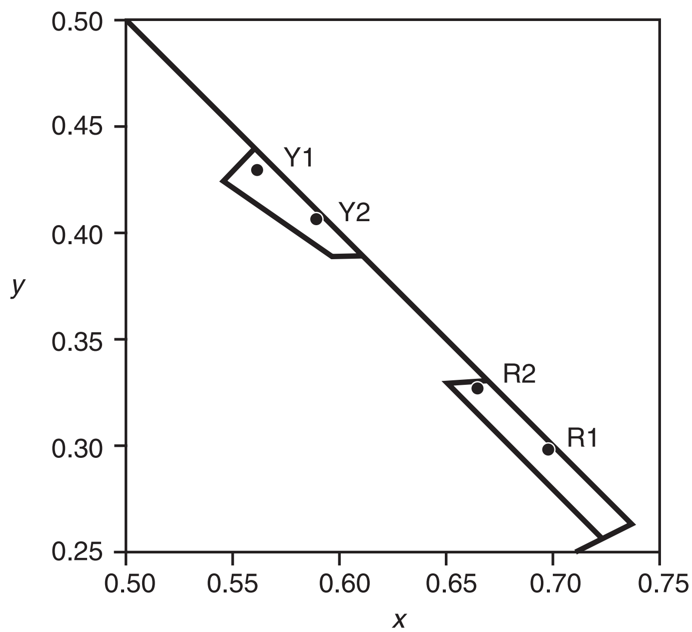

Figure 3. A portion of the CIE 1931 color space showing the locations of the four stimuli. The two enclosed areas illustrate the current U.S. restrictions on yellow and red.

Subjects. Sixteen paid subjects participated in this experiment. There were eight younger subjects (ranging from 21 to 36 years old, with a mean of 27) and eight older subjects (ranging from 66 to 77 years old, with a mean of 72). Each age group included four males and four females. All subjects had normal color vision, as determined by using pseudoisochromatic plates (Ichikawa, Hukami, Tanabe, and Kawakami, 1978) under controlled lighting conditions (Macbeth® Examolite® D7500). All subjects were licensed drivers.

Design. Subjects were tested individually in sessions lasting about 40 minutes each. Each session consisted of 96 trials presented in 6 blocks. Each block contained all 16 combinations of the 4 stimuli and the 4 viewing angles, in a randomized order. Thus, a complete session included 6 replications of each combination of stimulus and viewing angle.

Procedure. Two experimenters were involved in running this experiment. One experimenter was seated behind the white panel with the lamp (out of the view of the subject). He controlled the stimuli presented by inserting filters in front of the lamp (but behind the panel), and initiated each trial by pressing a button that controlled the timer. The other experimenter was seated in the right rear seat of the subject's vehicle. He instructed the subject concerning where to look on each trial, monitored compliance with the instructions, and recorded the subject's responses. At the beginning of each trial he called out either "lamp" or one of three numbers—2, 3, or 4. "Lamp" indicated that the subject was to fixate directly on the lamp; numbers 2, 3, or 4 indicated the respective panels to be fixated on (see Figure 2).

The subject was instructed that each trial would consist of a red or yellow light, and that the task was to indicate orally which of the two colors was being shown. (In other words, there were only two possible responses, "red" and "yellow.") The instructions indicated that there would be several different shades of each color. Prior to the actual testing, each subject was shown all four stimuli in central vision. However, the presentation of the four stimuli was prefaced by stating that they were examples of lights to be presented. (In other words, the subjects were not told that during the study they would be presented with only these four stimuli.) Each of the four sample stimuli was labeled as red or yellow by the experimenter.

Results

An analysis of variance was performed on the proportion of correct responses. The independent variables were as follows:

- viewing angle (0, 10, 20, or 30°)
- color category (red or yellow)
- location within a color category relative to the other color category (far or near); the far stimuli were R1 and Y1; the near stimuli were R2 and Y2 (see Figure 3)
- subject age group (younger or older)

The effect of viewing angle was statistically significant, $F(3,42) = 55.0$, $p = .0001$. (For this and all other tests in this study involving within-subject independent variables with more than two levels, the Greenhouse-Geiser adjustment was used.) As expected, color identification was best in the fovea, and it worsened as the viewing angle increased (see Figure 4).

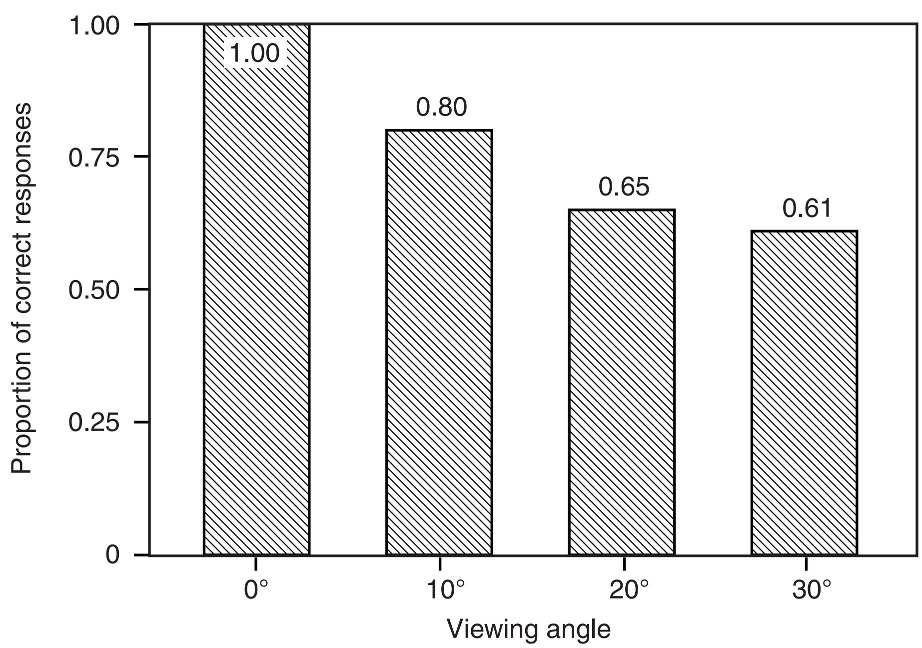

Figure 4. The effect of viewing angle on color identification.

The effect of color category was also statistically significant, $F(1,14) = 13.8$, $p = .002$, with the yellow stimuli being identified correctly more often than the red stimuli (see Figure 5). Importantly, however, the interaction of viewing angle and color category was also statistically significant, $F(3,42) = 9.3$, $p = .0003$. Specifically, the differences between the yellow and red stimuli were confined to viewing angles of 20 and 30°; there were no differences between the two color categories at viewing angles of 0 and 10° (see Figure 6).

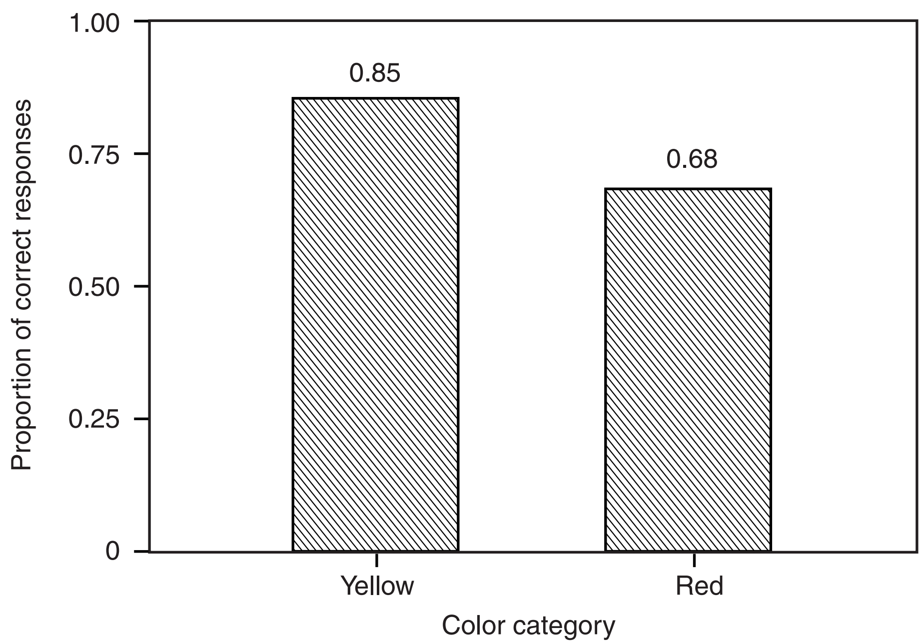

Figure 5. The effect of color category on color identification.

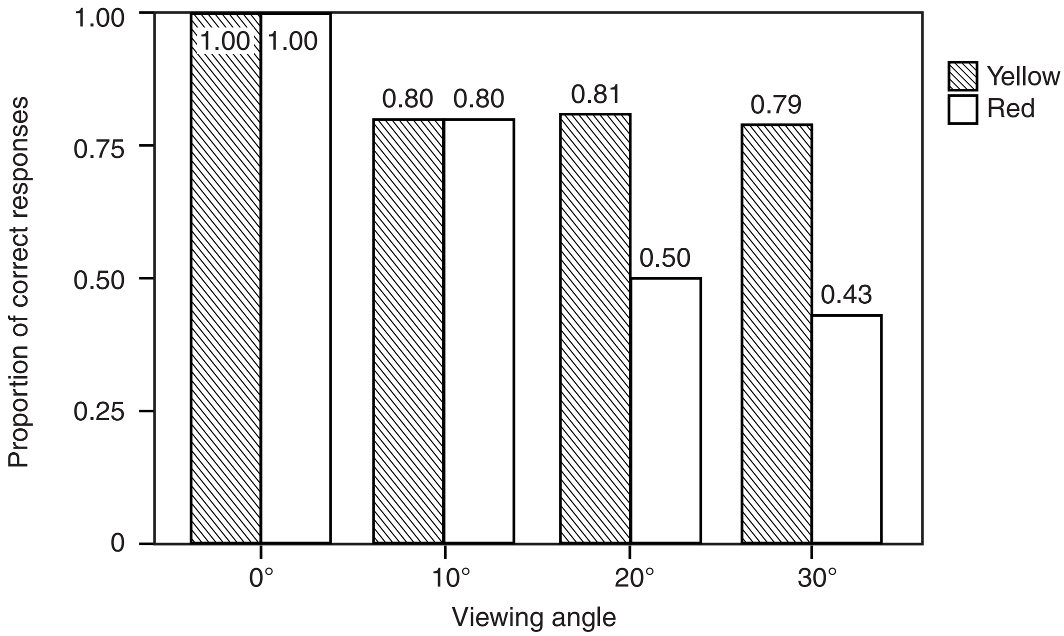

Figure 6. The interaction of viewing angle and color category on color identification.

The effect of location within a color category was statistically not significant, $F(1,14) < 1$. This implies that color identification did not differ between the colors that were far from the contrasting color category and those that were near the contrasting color category. (The interaction of location within a color category and color category was also statistically not significant.) No other main effects or interactions (including the effect of age) were statistically significant.

EXPERIMENT 2:
NIGHTTIME IDENTIFICATION OF TURN SIGNAL COLOR

Method

The method was the same as in Experiment 1, with the following exceptions.

Ambient conditions. The experiment was run at night, starting at least one hour after the sunset. The low beam headlamps of the subject's vehicle were on throughout the study. Illuminance just in front of the test lamp averaged 6.3 lux. Illuminance at the subject's eyes inside of the subject's vehicle averaged 0.16 lux. The subjects were allowed to dark adapt for 10 minutes prior to actual testing.

Subjects. The experiment was terminated after running four paid subjects because the results were identical for all four of them. There were two younger subjects (25 and 26 years old) and two older subjects (69 and 71 years old). Each age group included one male and one female. All subjects were color normal, and they were all licensed drivers.

Results

Each subject was 100% correct in identifying each stimulus at each peripheral angle.

EXPERIMENT 3:
NIGHTTIME IDENTIFICATION OF SIDE MARKER COLOR

Method

The same as in Experiment 2, with the following exceptions.

Ambient conditions. Illuminance just in front of the lamp averaged 5.8 lux. Illuminance at the subject's eyes inside of the subject vehicle averaged 0.15 lux.

Experimental setup. The lamp lens was masked down to a size of 5 cm by 2.5 cm, and additional filters were used to reduce the lamp output.

Stimuli. The luminous intensities directed from each of the four stimuli to the eyes of the subject are listed in Table 3. (The resultant intensity ratio between the yellow and red stimuli averaged 1.8.) Table 3 also lists the corresponding chromaticity coordinates. Comparisons of the chromaticity coordinates with the current U.S. regulations for red and yellow are shown in Figure 7. (As is evident from the information in Tables 2 and 3, the chromaticity coordinates of these stimuli were virtually identical to those in Experiments 1 and 2.)

Subjects. Eight paid subjects participated in this experiment. There were four younger subjects (ranging from 28 to 33 years old, with a mean of 30) and four older subjects (ranging from 64 to 78 years old, with a mean of 72). Each age group included two males and two females. All subjects were color normal, and all subjects were licensed drivers.

Table 3
Photometric and colorimetric properties of the four stimuli.

Stimulus	Intensity (cd)	Chromaticity coordinates		
		x	*y*	*z*
R1 (red)	0.47	0.699	0.298	0.003
R2 (red)	0.45	0.665	0.326	0.009
Y1 (yellow)	0.86	0.562	0.429	0.009
Y2 (yellow)	0.77	0.590	0.405	0.005

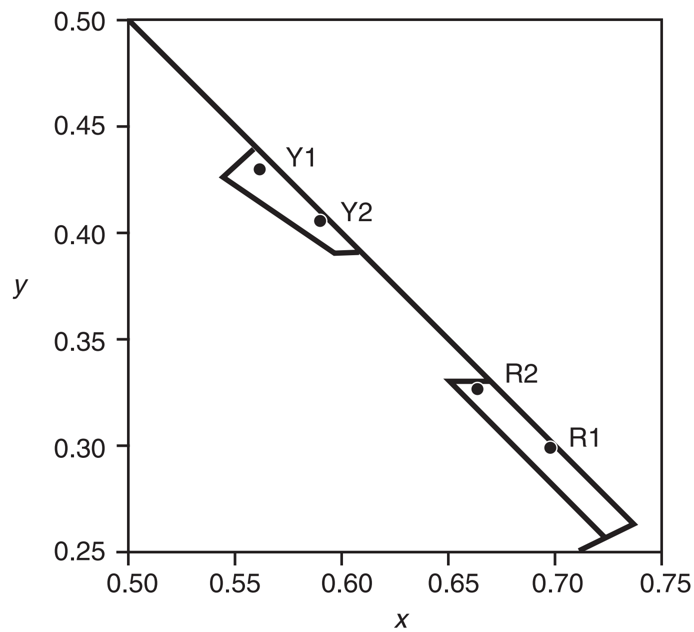

Figure 7. A portion of the CIE 1931 color space showing the locations of the four stimuli. The two enclosed areas illustrate the current U.S. restrictions on yellow and red.

Results

An analysis of variance was performed on the probability of correct responses. The independent variables were as follows:

- viewing angle (0, 10, 20, or 30°)
- color category (red or yellow)
- location within a color category relative to the other color category (far or near); the far stimuli were R1 and Y1; the near stimuli were R2 and Y2 (see Figure 7)
- subject age group (younger or older)

The effect of viewing angle was statistically significant, $F(3,18) = 32.1$, $p = 0.0001$. Specifically, color identification was best in the fovea, and it worsened as the viewing angle increased (see Figure 8).

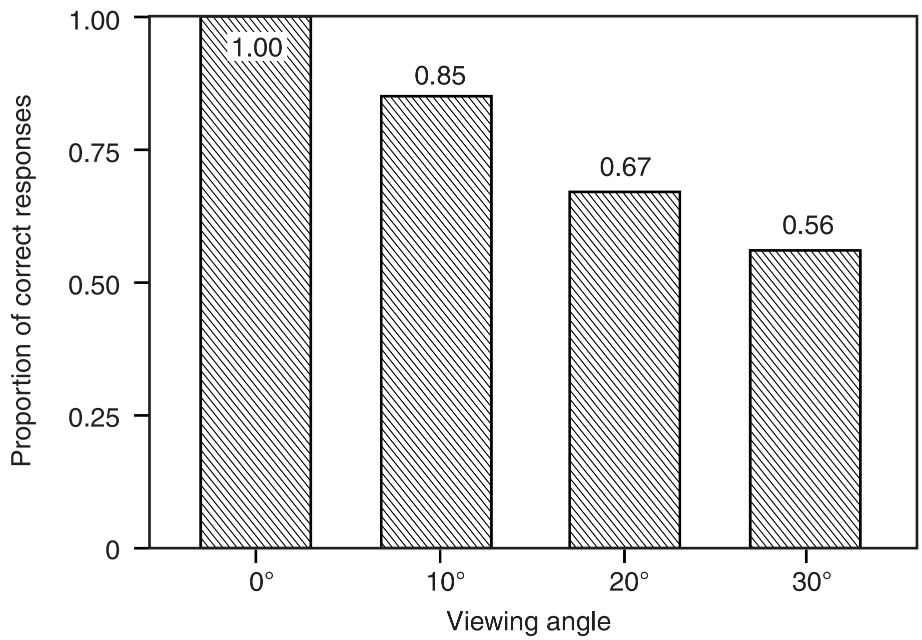

Figure 8. The effect of viewing angle on color identification.

The effect of color category was also statistically significant, $F(1,6) = 6.0$, $p = .05$, with the yellow stimuli being identified correctly more often than the red stimuli (see Figure 9). However, the interaction of viewing angle and color category was also statistically significant, $F(3,18) = 4.1$, $p = 0.04$. Specifically, the better performance for the yellow was confined to viewing angles of 10, 20, and 30°, and the differences between color groups increased with increased viewing angle (see Figure 10).

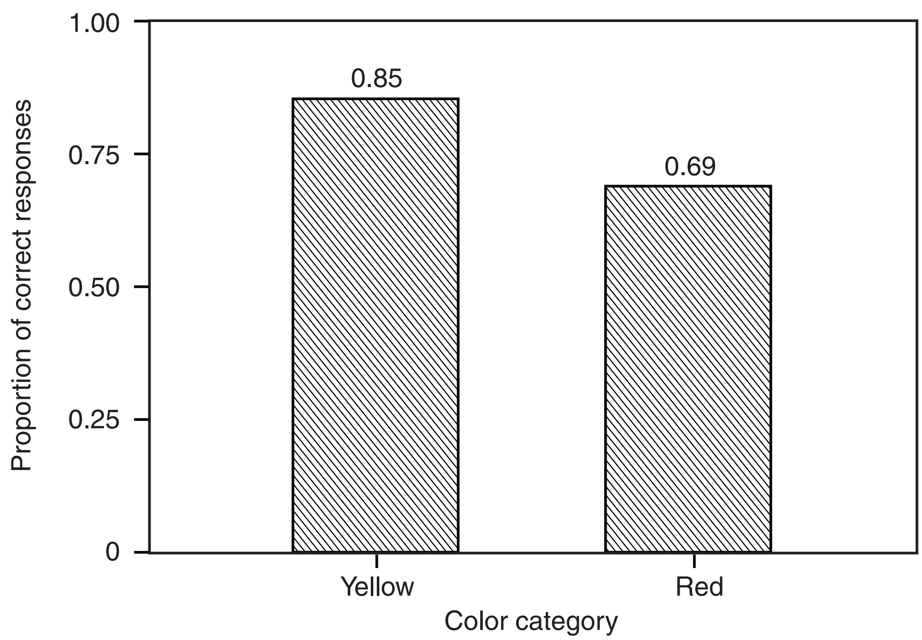

Figure 9. The effect of color category on color identification.

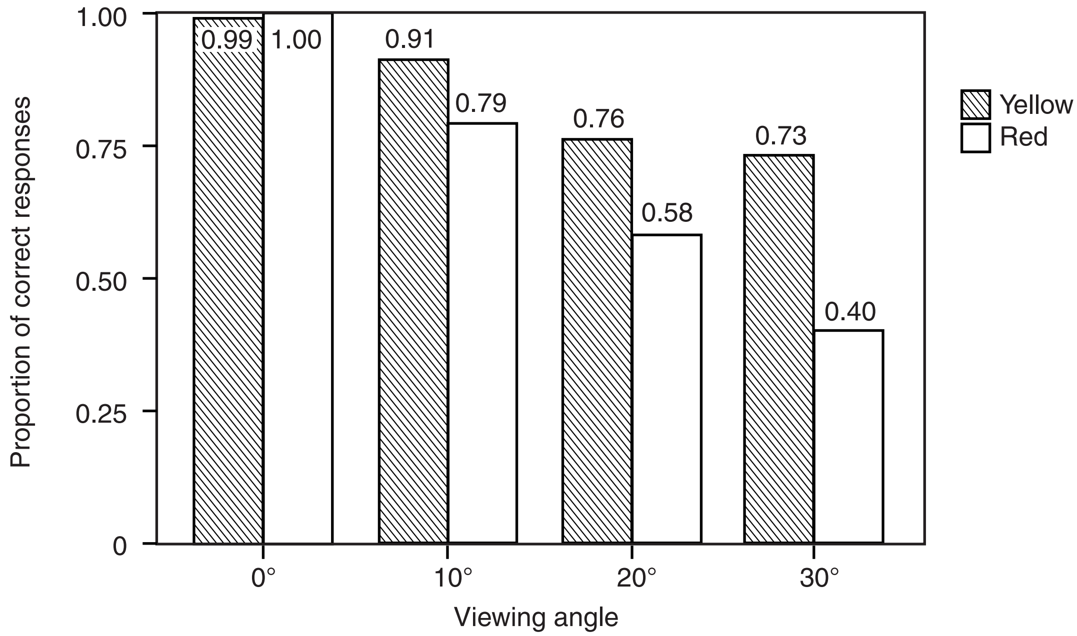

Figure 10. The interaction of viewing angle and color category on color identification.

The effect of location within a color category was statistically not significant, $F(1,6) = 1.8$, $p = .23$. (The interaction of location within a color category and color category was also statistically not significant.) No other main effects or interactions (including the effect of age) were statistically significant.

DISCUSSION

Color identification of turn signal lamps

Daytime. In the fovea (viewing angle of 0°), color identification was virtually perfect for both the yellow and red stimuli (see Figure 6). (Out of 384 foveal trials, there was only one incorrect response [to a red stimulus], possibly because of blinking or momentary inattention.) At 10°, the proportion of correct responses dropped to 0.80 for both the yellow and red stimuli. For the yellow stimuli, performance remained at this level even at viewing angles of 20 and 30° (0.81 and 0.79 respectively). However, for the red stimuli the performance dropped further to 0.50 at 20° and to 0.43 at 30°.

Nominally, in a two-alternative forced choice paradigm, such as the one employed in the present study, performance is at a chance level if the proportion of correct responses is 0.5. In other words, a pure guessing strategy would lead to a performance of 0.5. Performance below 0.5 in our study implies a shift in the perceived color or a shift in response bias.

In the Background section of this report, we noted a general finding that when a red stimulus is viewed more and more peripherally, its hue shifts towards yellow (e.g., Lythgoe, 1931; Moreland and Cruz, 1959; Boynton et al., 1964). The present data are consistent with such a shift. The shift first occurred at 20° and increased at 30°.

Nighttime. Color identification remained perfect even at the greatest viewing angle tested (30°).

Color identification of side marker lamps

Only nighttime trials were run for side marker lamp stimuli, because side marker lamps are not energized during the daytime. (They are energized only when the headlamps are turned on.) Furthermore, during daytime the visibility of the vehicle itself is likely to be better than the visibility of energized side marker lamps.

In the fovea (viewing angle of 0°), color identification was virtually perfect for both the yellow and red stimuli (see Figure 10). (Out of 192 foveal trials, there was only one incorrect response [to a yellow stimulus].) At 10°, the proportion of correct responses dropped to 0.91 for the yellow stimuli and 0.79 for the red stimuli. Performance further worsened with further increases in viewing angle; at 30° the proportion of correct responses was 0.73 (above chance) for the yellow stimuli and 0.40 (below chance) for the red stimuli. Similarly to the daytime data for turn signals, these data are consistent with a perceptual shift of red to yellow at large viewing angles.

Importance of chromatic restrictions on what is "yellow" and what is "red"

This study was not designed to evaluate the relative benefits of the specific restrictions on yellow and red imposed by the U.S. and European regulations. However, to provide some information concerning the importance of tight chromatic restrictions on individual colors, in all three experiments we used two different yellow stimuli and two different red stimuli. For each color category, one stimulus was relatively far from the contrasting color category while the other stimulus was relatively near. The two yellow stimuli spanned about 2/3 of the length of the current box for yellow in the U.S.; the two red stimuli spanned about 1/2 of the length (see Figures 3 and 7). The results were consistent across all three experiments: There were no differences in identification of the two different stimuli within each of the two color categories. These results imply that peripheral color identification is not very sensitive to chromatic changes in the regions studied. Although this finding supports a rather liberal policy on chromatic restrictions on signaling colors, it does not provide direct guidance concerning the desirable color boundaries.

Caveats

Importance of foveal versus peripheral color vision. The underlying rationale for this research was that the intended function for color coding of signals is to aid not only foveal but also peripheral identification of signals. A corollary assumption is that it is not sufficient to be able to discriminate signals when they are fixated, but that drivers need to discriminate among them in the visual periphery as well. However, although this is a reasonable assumption, there is no empirical evidence concerning how often drivers rely solely on peripheral vision to identify *any* signals. It is possible that peripheral vision is used to *detect* abrupt changes in some of the properties of the signal (e.g., presence/absence, intensity change, or possibly color change), but that *identification* of what the abrupt change signifies might require foveal vision. This is a potentially fruitful area of future inquiry.

Validity of the method used. This study investigated color perceptions of briefly presented stimuli. The exposure duration selected was 0.33 s. This duration corresponds to the “on” phase of typical turn signals in the U.S. Thus, the two experiments dealing with color coding of turn signal lamps tested a scenario in which a decision about the nature of the signal needs to be made before the “off” phase (and thus without the benefit of flashing). This appears to be a valid scenario for turn signals.

Although side marker lamps are steadily burning signals, we used the same exposure duration (0.33 s) in investigating color coding of side marker lamps. There were two reasons for this decision. First, we aimed to minimize the number of parameters that we changed from one experiment to another. Second, an exposure of 0.33 s simulates a driving situation where a rapid decision needs to be made.

The relative intensities selected for the yellow and red stimuli. Because yellow stimuli are perceived as dimmer than photometrically matched red stimuli, current regulations require yellow lights to be more intense than red lights for those functions where both colors can be used. In the U.S., the ratio between the photometric minima of yellow and red rear turn signal lamps is 1.6; the corresponding ratio for the photometric maxima is 2.5. Analogously, the ratio between the photometric minima of yellow (front) and red (rear) side marker lamps is 2.5 (see Table 1). For both the turn signal and side marker experiments, we used stimuli whose luminous intensities were close to the allowable minima; the average yellow-to-red intensity ratio was 1.7 for the turn signal lamps and 1.8 for the side marker lamps. It is possible that an increase or a decrease in this ratio would have an effect on signal identification, but such an effect would be a consequence of changes in the relative brightness of the stimuli and not color per se. Because the intensity ratios used reflect realistic values, the present results are applicable to the current status quo in the U.S. (The European regulations do not allow the use of either red rear turn signals or red side marker lamps. Consequently, the European regulations do not incorporate any yellow-to-red intensity ratios for the same signaling functions.)

CONCLUSIONS AND IMPLICATIONS

There are two important findings from the present study that do not bode well for the use of color coding in vehicle signaling in general, and for the use of red and yellow in particular. First, color identification was found to be highly sensitive to the viewing angle for both turn signal lamps during daytime and side marker lamps during nighttime. While for these two conditions the performance was virtually perfect at 0°, at a viewing angle of 10° the proportion of correct responses averaged only 0.82. Further increases in viewing angles led to additional decreases in performance. Specifically, the proportion of correct responses dropped (on average) to 0.66 at 20° and to 0.59 at 30°. Second, the present data for large viewing angles are consistent with the previously reported shift of color perception in which peripherally presented red stimuli appear yellow. (The majority of subjects made spontaneous comments to this effect after the study.)

These findings imply that coding signals yellow and red is not sufficient for their peripheral identification under the two most difficult conditions tested (turn signal lamps during bright daytime and side marker lamps during nighttime). To the extent that peripheral discriminability is important, efficient signaling should rely on other coding parameters (e.g., intensity, and flashing versus steady burning).

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