



# Connoted hazard and perceived importance of fluorescent, neon, and standard safety colors



O.A. Zielinska, C.B. Mayhorn<sup>\*</sup>, M.S. Wogalter

Department of Psychology, North Carolina State University, USA

## ARTICLE INFO

*Article history:*  
Received 17 January 2017  
Received in revised form  
18 July 2017  
Accepted 20 July 2017

*Keywords:*  
Warnings  
Color  
Safety  
Hazard  
Risk  
Importance

## ABSTRACT

*Objective:* The perceived hazard and rated importance of standard safety, fluorescent, and neon colors are investigated.

*Background:* Colors are used in warnings to enhance hazard communication. Red has consistently been rated as the highest in perceived hazard. Orange, yellow, and black are the next highest in connoted hazard; however, there is discrepancy in their ordering. Safety standards, such as ANSI Z535.1, also list colors to convey important information, but little research has examined the perceived importance of colors. In addition to standard safety colors, fluorescent colors are more commonly used in warnings. Understanding hazard and importance perceptions of standard safety and fluorescent colors is necessary to create effective warnings.

*Methods:* Ninety participants rated and ranked a total of 33 colors on both perceived hazard and perceived importance.

*Results:* Rated highest were the safety red colors from the American National Standard Institute (ANSI), International Organization for Standardization (ISO), and Federal Highway Administration (FHWA) together with three fluorescent colors (orange, yellow, and yellow-green) from 3 M on both dimensions. Rankings were similar to ratings except that fluorescent orange was the highest on perceived hazard, while fluorescent orange and safety red from the ANSI were ranked as the highest in perceived importance.

*Conclusion:* Fluorescent colors convey hazard and importance levels as high as the standard safety red colors.

*Application:* Implications for conveying hazard and importance in warnings through color are discussed.

© 2017 Elsevier Ltd. All rights reserved.

## 1. Introduction

Hazards, such as toxic chemicals, pinch points in machinery, and electrocution are present in the environment. When hazards are not designed out or guarded against, warnings are frequently used to convey information about the hazard, consequences and instructions to avoid property damage, injury, or death (Chapanis, 1994; Wogalter et al., 2015). Color can influence warnings and other hazard communications in several ways. They can serve to capture attention and add conspicuousness to signs to help them stand out from the environment (Burns and Pavelka, 1995; Wogalter and Vigilante, 2006; Wogalter et al., 2015). In addition to capturing attention, adding color to warnings can make them

easier to comprehend and more memorable than their achromatic counterparts (McDougald and Wogalter, 2014; Young and Wogalter, 1990). Participants were more likely to remember a warning that was presented with orange highlighting than a warning that was non-highlighted (Young and Wogalter, 1990). Lastly, color present in warnings can influence behavioral compliance (Braun and Silver, 1995). Participants who interacted with a pool water test kit were more likely to wear gloves when there was a red warning present than when the warning was presented in black; however, there was no difference in behavioral compliance between a warning printed in black or printed in green (Braun and Silver, 1995). These results suggest that colors can enhance warnings, but different colors connote different levels of hazard.

Red is consistently rated as the highest in perceived hazard compared to other colors (Braun and Silver, 1995; Borade et al., 2008; Griffith and Leonard, 1997; Smith-Jackson and Wogalter, 2000; Wogalter et al., 1998). After red, then the next highest rated

<sup>\*</sup> Corresponding author.

E-mail address: [chris\\_mayhorn@ncsu.edu](mailto:chris_mayhorn@ncsu.edu) (C.B. Mayhorn).

colors are orange, yellow, and black; however, various studies find somewhat different ordering within this group (Braun and Silver, 1995; Borade et al., 2008; Griffith and Leonard, 1997; Smith-Jackson and Wogalter, 2000; Wogalter et al., 1998). Orange was rated the second highest color in a few studies followed by yellow and/or black (Braun and Silver, 1995; Borade et al., 2008); while other studies did not find a significant difference in the rankings of orange and yellow (Chapanis, 1994). The remaining studies found yellow as the next highest connoted hazard after red (Griffith and Leonard, 1997; Smith-Jackson and Wogalter, 2000; Wogalter et al., 1998). After these three colors (orange, yellow, and black), the next highest are magenta, blue, brown, green, white, and gray (Smith-Jackson and Wogalter, 2000; Wogalter et al., 1998). Although there is discrepancy on the levels of perceived hazard of colors, standards have provided guidelines of connoted hazard levels.

Colors are often paired with signal words in warnings. ANSI Z535.1 specifies pairs of words and specific colors to indicate different levels of hazard. Red is paired with the word DANGER to indicate the highest of 3 levels. It is intended to indicate a hazardous situation that if not avoided will result in death or serious injury. The middle level of hazard according to the ANSI system, orange, is paired with the signal word, WARNING, to indicate a hazardous situation that if not avoided could result in death or serious injury. The lowest level of hazard in the ANSI system is the color, yellow. It is paired with the signal word, CAUTION, to indicate a hazardous situation that if not avoided could result in minor or moderate injury (Wogalter et al., 2015; ANSI Z535.1, 2012). The recommendations of the standard do not necessarily match what has been found in previous studies. Red and DANGER were rated the highest in connoted hazard; however there is no difference between the orange/WARNING and yellow/CAUTION combinations (Chapanis, 1994). The discrepancy in hazard connotations of the colors requires further investigation.

In addition to hazardousness, ANSI Z535.1 specifies signal words that are intended to indicate non-hazardous conditions, paired with non-hazardous colors such as green and blue. Examples of warnings that are informative, but not hazardous, are roadway signs with a blue background and a white letter H in the center of them. This type of sign is used to inform drivers about the location of a nearby hospital, which is generally not considered a hazard, but is important when needed. Color perception research has focused on connoted hazard of colors and there has been limited research examining the perceived importance of colors. Therefore, this research was developed to understand whether color can be used to connote different levels of importance.

Finally, in recent decades, there has been an increase in the use of fluorescent colors in highway sign contexts (Hawkins et al., 2000; Wogalter et al., 2015). Ultraviolet (UV) light interacts with fluorescent colors making them appear brighter and more conspicuous than non-fluorescent colors (Burns and Pavelka, 1995). Research by Scheiber et al. (2006) found that fluorescent colors elicited more initial fixations than non-fluorescent highway colors, suggesting they are more salient and more likely to attract attention. Although fluorescent colors have these characteristics, little is known about their connoted hazard or perceived importance.

Only one study has investigated the perceived hazard of fluorescent colors as compared to non-fluorescent colors (Tomkinson and Stammers, 2000). Participants rated fluorescent red the highest in perceived hazard, followed by fluorescent orange, fluorescent yellow, and orange, which were equal in ratings, and then red, fluorescent green, yellow, and green. This study, however, did not fully specify the details of the colors used. Consequently, it is difficult to replicate the method and stimuli used in the study. These researchers also did not investigate the perceived

importance of fluorescent colors. With the expanding number of colors used to convey hazard, it is important to examine the perception of each color.

This study investigates the perceived hazard and importance of fluorescent and safety colors. The primary focus of this study is to assess the connoted hazard and perceived importance ratings of standard safety and fluorescent colors. This study will also expand on previous color rating research by assessing a secondary dimension: color ranking. Both color ratings and color rankings have been used to assess perceived hazard (Chapanis, 1994). Similar trends of perceived hazard were found between the rating and ranking data; however, the results have yet to be replicated. This study will examine the pattern of hazard and importance ratings and rankings to determine whether these measures could potentially be used interchangeably.

## 2. Method

### 2.1. Materials

Colors were chosen from the American National Standard Institute (ANSI Z535.1), International Organization for Standardization (ISO 3864-4), United States Department of Transportation Federal Highway Administration (FHWA), 3 M Company, and Pantone neon colors.

Munsell Color (Grand Rapids, Michigan) produces 8.5 × 11 in (22 × 28 cm) sheets of safety colors per the specifications listed in ANSI Z535.1 (2012), a U.S. standard for color use in warning signs, labels and tags. The following colors were used: safety red, safety orange, safety yellow, safety green, safety blue, safety purple, safety brown, safety gray, safety black, and safety white.

Natural Color System (NCS), European Color Standard (RAL), Munsell, and British Standard (BS 5252) color equivalents are listed for the International Organization for Standardization (ISO 3864-4: Graphical Symbols – Safety Colours and Safety Signs (2011)) safety colors. RAL color sheets were used. Specifically, the following colors were used: RAL 3001, RAL 1003, RAL 6032, RAL 5005, RAL 9003, and RAL 9004 for red, yellow, green, blue, white, and black, respectively. Additionally, RAL 2010 (signal orange), not listed in the ISO standard, was used for testing to remain consistent with other safety color groups.

Pantone® (Pantone LLC, Carlstadt, NJ) colors were used for the Federal Highway Administration (FHWA) and the Neon color groups. Color specifications for FHWA are listed in their *Manual on Uniform Traffic Control Devices* webpage (2013) to accurately print the colors used in their pavement-marking and sign materials. The following FHWA colors and corresponding Pantone shades were used: red (187), orange (152), yellow (116), green (342), blue (294), pink (198), purple (259), yellow-green (382), and brown (469). Prior to 2010, Pantone LLC printed a set of fluorescent colors available in the Fluorescents and Metallic category. In 2010, Pantone rebranded and moved the fluorescent colors into their Neons and Pastels Collection. From this point forward, these fluorescent colors will be referred to as the Neon colors. The color names and shades included were green (802), blue (801), purple (814), and yellow green (809). The FHWA and Neon colors were printed using a Pantone certified printer in the North Carolina State University (NCSU) Design School. Color accuracy was confirmed with the Pantone Formula Guide obtained from the North Carolina State University Design Library.

The 3 M Company (St. Paul, Minnesota) provided 4 × 6 inch (10 × 15 cm) samples of colors for use in this study. The three colors in this group were fluorescent orange, fluorescent yellow, and fluorescent yellow-green. Table 1, below, provides a summary of the colors used in this study along with the color system, color

Download English Version:

<https://daneshyari.com/en/article/4971960>

Download Persian Version:

<https://daneshyari.com/article/4971960>

[Daneshyari.com](https://daneshyari.com)