Users' Hazard Perceptions of Warning Components: An Examination of Colors and Symbols

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ABSTRACT

This study examined color and symbol hazard ratings among participants whose primary language was English and who were monolingual. Participants rated perceived hazards of ten ANSI safety colors and six symbols. RED, followed by YELLOW, BLACK, and ORANGE, were given the highest hazard ratings. The skull, prohibition (circle-slash), and the shock symbols produced the top three hazard ratings. The results of this study were compared to a previous study by Wogalter et al. (1997) which examined hazard ratings among participants whose primary language was Spanish. Comparisons supported general similarities between certain color and symbol hazard ratings among Spanish and English language users.

INTRODUCTION

Given the increasing globalization of product markets, the need to develop warning labels that can be read and comprehended by users with diverse reading and language abilities has increased substantially. Over 32 million people in the United States are bilingual (routinely use two or more languages; Bialystok & Hakuta, 1994), which introduces not only language differences but differences in the interpretation of information components such as colors, symbols, and words (Carroll, 1994; Clark, 1985). Of this group, the degree of proficiency in the secondary language (which is often English) varies from person to person. This variety in language proficiency is not unique to the U.S., but is common within many other countries. Given the variety in language proficiency, determining agreement among users of different languages will support the selection of design components that are more meaningful across cultures.

In order to uphold the right-to-know ethic and to increase product safety and use, product label design may need to include signal words, symbols, and colors that communicate levels of risk consistently across cultures. Language and culture influence schema development, and ultimately, attitudes, perceptions, reasoning, and decision-making (Han & Shavit, 1994; Shade, 1989). Current cognitive theory holds that culture is a manifestation of shared cognitive representations and meanings. Shared representations and meanings can, for instance, facilitate communication between individuals from identical cultures and interfere with communication between individuals from different cultures (Perez-Arce, 1999; Romney & Moore, 1998). Language and cultural differences in risk perception and possible cultural differences in perception caused by phrasing, idioms, symbolic representations or cultural schemas may lead to differences in the level of risk communicated by a warning label. "Technological frames," a term often used in human-computer interaction literature (similar to, but more specific than mental models), can be applied to explain potential cultural differences in how warnings are processed. Orlikowski (1997) described technological frames as schemas or cognitive frameworks applied by users to impose meaning upon an interface. These technological frames develop on the basis of past experience, values, and interactive styles, and influence the manner in which information is processed and how the individual responds to the interface. Likewise, it is proposed that users also apply cognitive frameworks to process and act on safety related information, and these frameworks are influenced by culture and experience.

Although the American National Standards Institute (1998) Z535 standard specify the use of warning components such as colors, symbols, and words, it has not been determined that the levels of risk communicated by specific warning components is universal across cultures and languages within the U.S. Color, symbol, and signal word components used in warnings or other safety-related information may be more effective in enhancing comprehension and safety if the meanings or representations

elicited by the components are shared cross-culturally. Besides increased comprehension and safety, another potential benefit of using warning designs that are more universal is redundancy gain—using more than one cue to communicate a hazard. Multilingual users, and to a certain extent, monolingual users, will be exposed to more than one risk cue, and this redundant exposure can enhance recognition and, in turn, facilitate safer use of the product. Although the extent to which users will process and comprehend warning labels in another language or use culture-based icons has not been explored, it is possible that repeated exposure to signal words, even in different languages, can serve to provide further opportunities to communicate hazards. If shared perceptions of hazards exist for warning components, then additional standards that make use of more features that convey risk to users in culture- or language-diverse environments can be developed. Studies are needed to determine the feasibility and manner in which standards with cross-cultural relevance can be developed.

To date, few studies have examined the universality of warning signal words, icons, and colors. Marin (1997) examined awareness of product warning labels among Hispanic consumers. Product familiarity enhanced awareness of product warning labels (determined by knowledge of warning content). Marin also found that lower literacy levels were related to low awareness of product warning labels. Most studies that have examined hazard perceptions have focused on English-language signal words (Wogalter & Silver, 1995; Wogalter, Jarrard, & Simpson, 1994). Wogalter, Frederick, Magurno, and Herrera (1997) examined perceived hazards of Spanish and English signal words, colors, and symbols by users whose first language was Spanish. Not surprisingly, Spanish speakers understood more Spanish signal words than English signal words. Interestingly, the term commonly used in U.S. warning labels to communicate the highest level of hazard, PELIGRO, was given relatively lower hazard ratings by Spanish speakers compared to other words such as EXPLOSIVO, MORTAL, VENENO, and PELIGROSO.

In addition to language comprehension, symbols and colors communicate risks and perceptions may differ cross-culturally. Results of Wogalter, Kalsher, Frederick, Magurno, and Brewster (1998) using English-speakers indicated that RED connoted the greatest hazard as a solid color, followed by YELLOW, ORANGE, and BLACK. In the Wogalter et al. (1997) study, Spanish speakers' ratings of colors assigned the highest hazard ratings to RED, followed by YELLOW, BLACK, and ORANGE. In the same study Spanish speakers rated the Skull symbol highest, followed by the Shock symbol and the Prohibition symbol.

Studies in linguistic anthropology have identified differences and similarities in cross-cultural perceptions of color. For instance, in a study involving participants from five different countries, Hupka, Zaleski, Otto, and Reidl (1997) found commonalities in associations of the color black and red with certain negative emotions, but all other color associations differed across cultures. Grieve (1991) found no differences in color associations between Western cultures and Black South Africans.

Numerous studies have examined the role of culture in interpretation of symbols. Generally, studies support cross-cultural differences in interpretation of various symbols, the amount of information assumed to be communicated by symbols, and the influence of complexity and concreteness on recognition and comprehension (Choong & Salvendy, 1998; McDougall, Curry, & de Bruijn, 1999; Tzeng, Trung, & Reiber, 1990).

Considering the possible contributions of culture to risk perceptions of colors and symbols, it is important to determine shared representations and meanings across cultures. In order to begin this type of exploration, this study was designed to explore cross-cultural hazard perceptions by examining monolingual English-speakers' and comparing their hazard perceptions of colors and symbols to Spanish-speakers' hazard perceptions revealed by the Wogalter et al. (1997) study.

Although participants also evaluated Spanish and English signal words, only the results of the symbol and color evaluations are reported here.

METHOD

Participants

Forty-eight community volunteers attending a flea market in Raleigh, NC participated (Mean age = 34.33, *SD* = 12.28). The sample consisted of 17 females and 31 males. Participants were divided into three age categories, 17 to 24 (M = 21.54, SD = 2.26, n = 15), 25 to 39 (M = 30.35, SD = 5.40, n = 17), and 40 and over (M = 48.94, SD = 5.47, n = 16). All participants reported English as their first language and had minimal-to-no familiarity with Spanish. Participants were given a small gift as compensation.

Materials and Procedure

After informed consent was acquired, participants completed a short, demographic questionnaire. Participants were then provided with general instructions on how to use the rating scales to report perceived hazards.

Ten colors from the ANSI Z535.1 safety color standard were presented to participants. The colors were: RED, YELLOW, BLACK, ORANGE, MAGENTA, BLUE, BROWN, GREEN, WHITE, and GRAY. Colors were cut from the ANSI Standard and presented as 1.27 cm X 3.18 cm (length and width, respectively) rectangles on 27.94 cm X 6.48 cm (length and width, respectively) white cardboard. Six symbols were also presented; these are described in Table 1. The symbols were chosen because they could possibly serve as signaling icons on the signal word panel (in place of the alert symbol specified in ANSI Z535.2 and Z535.4). The Mr. Yuk symbol was adapted from a symbol developed by the Pittsburgh Poison Control Center.

Color and symbol lists were presented separately in two random orders to participants. Two random orders were also used within each stimulus list. Participants were asked to indicate how careful they would be if they saw the color or symbol on a sign, poster, or label using numbers from 0 (not at all careful) to 8 (extremely careful). This rating method has

been previously shown to be highly correlated with perceived hazard (Wogalter & Silver, 1995).

Table 1: Warning symbol descriptions

Symbol	Description
SKULL	Human skull
PROHIBITION	Circle with diagonal slash, prohibitive symbol
SHOCK / JAGGED	Lightning bolt surrounded by a triangle
ALERT	Exclamation point surrounded by a triangle; used in ANSI Z535 Standard
ASTERISK	Asterisk surrounded by a triangle
MR. YUK	Circular face with furrowed brow and protruding tongue

RESULTS

A 10 (colors) X 6 (symbols) X 3 (age category) X 2 (gender) mixed model ANOVA on the carefulness ratings was used. The results associated with colors and symbols are reported here.

Colors

The ANOVA on the carefulness ratings of the colors was significant, F (9, 33) = 29.40, $p < .0001$. The mean ratings and orders are included in Table 2 in descending order. As indicated, RED received the highest mean ratings, followed by YELLOW, BLACK, and ORANGE. Paired comparisons using Tukey's HSD revealed that the five most highly rated colors -- RED, YELLOW, BLACK, ORANGE, and MAGENTA -- differed significantly from each other ($ps < .05$), except YELLOW and BLACK. The remaining colors -- BLUE, BROWN, GREEN, WHITE, and GRAY -- did not differ significantly from each other.

Table 2 also includes mean carefulness ratings of colors from the Wogalter et al. (1997) study.

Symbols

The ANOVA on the carefulness ratins of the symbols was significant, F (5, 38) = 21.86, p < .0001). Means are provided in Table 3 in descending order. Based upon pairwise comparisons using Tukey's HSD, the Skull symbol received significantly higher hazard ratings than all other symbols, followed by the Shock symbol and the Prohibition symbol. The Shock and Prohibition symbols did not differ significantly and the Alert nor did the Alert and Mr. Yuk symbols. The remaining comparisons were significantly different.

Table 3 also includes Spanish-speaking users' mean carefulness ratings of colors from the Wogalter et al. (1997) study for comparison.

Table 2: Means and standard deviations of hazard ratings for colors by English- and Spanish-language users.

English	Mean[1]	SD	Spanish[2]	Mean	SD
RED	7.02	1.61	RED	6.65	1.77
YELLOW	5.06	2.62	ORANGE	4.27	2.48
BLACK	4.96	2.70	BLACK	4.17	2.68
ORANGE	3.30	2.58	YELLOW	4.12	2.39
MAGENTA	2.49	2.49	GREEN	3.17	2.50
BLUE	2.35	2.30	MAGENTA	2.85	2.30
BROWN	2.26	2.22	BLUE	2.83	2.41
GREEN	2.23	2.10	BROWN	2.62	2.37
WHITE	2.02	2.66	GRAY	2.60	2.35
GRAY	1.91	1.79	WHITE	2.35	2.22

[1] n = 46, [2]Wogalter et al. (1997) study

Table 3: Means and standard deviations of hazard ratings for symbols by English- and Spanish-language users.

English	Mean	SD	Spanish*	Mean	SD
Skull	7.54	1.37	Skull	7.33	1.46
Shock	5.92	2.23	Shock	5.21	2.28
Prohibition	5.58	1.98	Prohibition	4.21	2.02
Mr. Yuk	4.56	2.53	Asterisk	3.67	2.49
Alert	4.29	2.05	Alert	3.62	2.45
Asterisk	3.35	2.50	Mr. Yuk	3.17	2.72

*Wogalter et al. (1997) study

DISCUSSION

Consistent with Spanish speakers' hazard perceptions (Wogalter et al., 1997) RED was given the highest hazard ratings. In both studies, BLACK and YELLOW did not differ significantly in hazard ratings. Primary English speakers perceived YELLOW to be the second highest hazard color, while Spanish speakers rated ORANGE as the second highest hazard color. The order of YELLOW and ORANGE in the present study is opposite the order specified by ANSI Z535.1. Similar to a previous study by Chapanis (1994), YELLOW and ORANGE did not differ significantly in hazard perception. YELLOW and ORANGE

seem to have similar hazard connotations, and thus, apparently can be used interchangeably to communicate risk.

Both groups rated the Skull symbol significantly higher than all other symbols. Users rated the Shock and Prohibition symbols second and third in terms of level of hazard. Interestingly, both groups perceived the Alert symbol as second to last in hazard level, yet this symbol is used in many warning labels as recommended by ANSI. This finding is similar to a Wogalter et al. (1998) study and Wogalter et al. (1994) which found only minimal hazards associated with the Alert symbol.

This research provides some support for the role of culture in the perception of colors and symbols and suggests more consideration should be taken when designing labels for more than one language group. However, given that some of the comparative differences between the studies involved ratings that, within each study, were not significantly different (i.e., Mr. Yuk and Alert among English-language users and the Asterisk and Alert symbol among Spanish-language users), only tentative conclusions can be drawn. It is difficult to draw conclusions based upon cross-cultural comparisons between levels of hazard associated with components that did not differ significantly. As such, the results suggest the need for further research because the differences found between the studies do not, alone, support actions to modify existing protocols on the basis of culture.

Despite the inconsistencies, the colors RED, BLACK, ORANGE, and YELLOW connote hazard across cultures within the U.S. The Skull, Shock, and Prohibition symbols were consistently given higher hazard ratings across both groups. Because both cultures associated higher hazard levels with these symbols, the symbols may be more effective in strongly bilingual areas such as the Southern United States, or in some Latin-American cities (e.g., those with high levels of bilingualism). In particular, the Skull symbol held high hazard connotations for the two target cultures, and thus, should be used.

An organized research effort, possibly supported by the business sector, should be undertaken to build a database of cross-cultural perceptions of various warning components.

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