Safety Signal Words and Color Codes: The Perception of Implied Hazard by Chinese People

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Abstract

Standards and guidelines suggest the use of appropriate words and color codes in order to convey different intensities of hazard. RED, YELLOW and BLUE are indicative of a decreasing intensity of hazard. Similarly, DANGER, WARNING and CAUTION are used to indicate hazards in decreasing intensity even though some studies have found no significant difference in the mean hazard rating between the words WARNING and CAUTION. However, these findings have not been validated across different cultures. Since the color stereotypes in the East-Asian region are different, we attempted to evaluate the implied hazard rating of the Chinese people using eighty-eight local subjects.

The words and color codes used in our study are the same as those used in previous research. The words, DANGER, WARNING, CAUTION, ATTENTION, THINK, BEWARE and NOTICE, and the colors, RED, ORANGE, YELLOW, BLUE, GREEN, and WHITE were used. Apart from evaluating the implied hazard ratings, the language effect was also evaluated using three versions of questionnaire: English, Chinese and Bilingual (English and Chinese together).

*Results from the analysis showed that RED had the highest perceived hazard level. YELLOW and ORANGE were perceived as having a medium hazard level. BLUE, GREEN and WHITE had the lowest perceived hazard level. There was no significant language effect. On the other hand, results from the analysis of words showed a significant effect for word and the word*language interaction. The result showed that the perceived level of hazard was different for the different questionnaires. The implied hazard rating for the Bilingual questionnaire was similar to the Chinese questionnaire. With the English questionnaire, there was no significant difference between WARNING and DANGER.*

RED, YELLOW and BLUE can be used to indicate different levels of hazard even for the Chinese people. However, it is recommended that bilingual (Chinese and English) words be used in safety labels.

Keywords:

Color stereotype, Safety words, Hazard perception, Cultural differences, Hazard rating.

Introduction

Color is one component that is critical in panel design [1]. Various studies [1,2,3] have shown relationships between colors and perceived hazard ratings. RED Labels have more implied hazard rating than labels printed in black [2]. RED, YELLOW and BLUE can be used to indicate three levels of hazard [3].

DANGER, WARNING and CAUTION are recommended in many guidelines for conveying high to low intensities of hazard [4]. However, people do not discriminate between WARNING and CAUTION [1,3,4,5].

Only a few studies have considered the cultural differences in hazard perception. Study [3] had 1169 subjects and a questionnaire written in American English was used. The subjects in that study were categorized on the basis of their native language and residence. The native language categories included American English, British English, French, German/Austrian, Scandinavian languages, Spanish/Portuguese, and others. The residence categories included Canada, Europe, and United States. Results from the study showed that there were some cultural differences. For the color codes, only YELLOW was significantly different among the different language groups, while YELLOW and ORANGE were significantly different among the different residence

groups. The researchers proposed the use of RED, YELLOW, BLUE or GREEN to indicate three different levels of hazard [3]. For words, WARNING, CAUTION, BEWARE, and ATTENTION had significant difference among the different language groups and the different residence groups. THINK had significant difference among the different language groups, and NOTICE had significant difference among the different residence groups. In that study, the implied hazard rating for color-codes among the language and residence groups were very consistent. They recommended that DANGER, CAUTION and NOTICE be used to convey three different hazard levels [3].

In our study, the words and colors used in [3] were used to evaluate the implied hazard rating of Chinese subjects. In addition, three versions of questionnaire were used to study the language effect.

Methodology

Subjects

Eighty-eight Chinese subjects from Hong Kong and China participated in the experiment. All were students at the Hong Kong University of Science and Technology between the ages, 20-30 years.

Material

Eighteen English, thirty-nine Chinese, and thirty-one Bilingual questionnaires were rated. The English questionnaire was similar to that of [3]. The Chinese questionnaire was a direct translation of the English version. Complex Chinese and safety words common in Hong Kong were used in the translation. In the bilingual version of questionnaire, the English words were written first, followed by the Chinese translation.

Procedure

The subjects were asked to complete a safety-related questionnaire. Each subject was given one of the three types of questionnaires (English, Chinese or Bilingual version) randomly. In the questionnaire, subjects had to rate the degree of implied hazard for different safety words and safety color-codes on a 1 (Lowest hazard) to 5 (Highest Hazard) discrete scale. The order of the words and colors were randomized in the questionnaires.

Independent variables

1. Safety words were: DANGER (危險), WARNING (警告), CAUTION (小心), ATTENTION (注意), BEWARE (留意), NOTICE (告示) and THINK (三 思).
2. Safety color-codes were: BLUE (藍), YELLOW (黃), WHITE (白), ORANGE (橙), GREEN(綠) and RED (紅).
3. Questionnaire language: English, Chinese and Bilingual (English and Chinese).

Dependent variable

Implied hazard rating.

Hypothesis

1. There is a significant difference among colors for Chinese.
2. There is a significant difference among words for Chinese.
3. There is a significant difference among colors for each language.
4. There is a significant difference among words for each language.

Analysis and Results

The SAS statistical software was used for all analyses. Results from the ANOVA using 6 (color) * 3 (language) showed that the mean hazard rating for different colors was significantly different ($F(5,510) = 180$; $p=0.0001$). There were no language and interaction effects. The results from the *post-hoc* Student Newman Keuls test (SNK) are shown in Figure 1. The perceived hazard grouping is different from that found in the literature. In [3], only WHITE and GREEN were significantly different, whereas in our study the mean hazard rating of BLUE, GREEN and WHITE are not significantly different from each other. In addition, YELLOW and ORANGE are not significantly different. Even though the perceived hazard grouping is different from [3], the mean hazard ratings are similar, except the color-code ORANGE (Figure 2). Chinese gave a lower rating for ORANGE. Even for the Chinese, RED, YELLOW and BLUE can be used to indicate three levels of hazard as reported previously [3].

RED	YELLOW	ORANGE	BLUE	GREEN	WHITE

An underline indicates that the means are not significantly different at $p < 0.05$

Figure 1. SNK Analysis of safety color codes

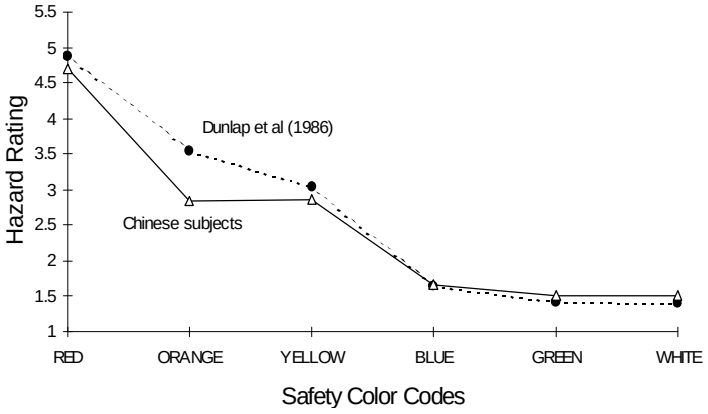

Figure 2. Mean hazard rating for colors

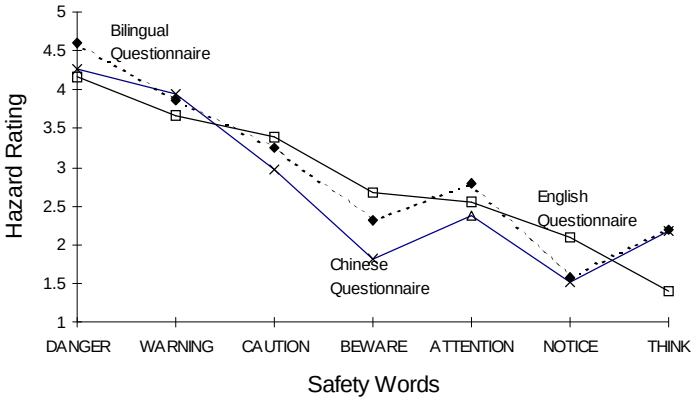

Figure 3. Mean hazard rating of words for each version of questionnaire

A second ANOVA using 7 (word) * 3 (language) was performed. Results from the analysis of the different words showed that there was a significant difference between the words ($F(6,595) = 107$; $p=0.0001$). The other main effect of language was not significant. However, the word*language interaction ($F(12,595)=2.3$; $p=0.002$)) was statistically significant. The interaction graphs and the SNK comparison of means are shown in Figures 3, and 4 respectively. Figure 3 shows some similarities between the Chinese and Bilingual questionnaires. This may be an indication that the Chinese people rely more on the Chinese words when they encounter a bilingual safety label. Moreover, it may be seen from the comparison of means (Figure 4) that there is no significant difference in mean hazard rating for WARNING and CAUTION with the English questionnaire. This finding is in agreement with the literature [1,3,4,5]. However, there are differences between these two words when a Chinese or Bilingual questionnaire is used.

Figure 5 shows the SNK grouping when using words. Figure 6 shows a comparison of the mean hazard rating between this study and that of [3]. It shows that DANGER and BEWARE have a somewhat lower implied hazard rating for the Chinese. The results show that there are some differences in the hazard rating between Chinese and Westerners.

The words DANGER, CAUTION and NOTICE could be used for high, medium and low hazard levels respectively as proposed in [3], irrespective of the type of questionnaire. However, there are differences between WARNING and CAUTION when using Chinese or Bilingual languages. But, this is not true with the English words.

Chinese questionnaire DANGER WARNING CAUTION ATTENTION THINK BEWARE NOTICE
English questionnaire DANGER WARNING CAUTION BEWARE ATTENTION NOTICE THINK
Bilingual questionnaire DANGER WARNING CAUTION ATTENTION BEWARE THINK NOTICE

An underline indicates that the means are not significantly different at $p < 0.05$

Figure 4. SNK Analysis of safety words for each questionnaire

DANGER WARNING CAUTION ATTENTION BEWARE THINK NOTICE

An underline indicates that the means are not significantly different at p <0.05

Figure 5. SNK Analysis of safety words

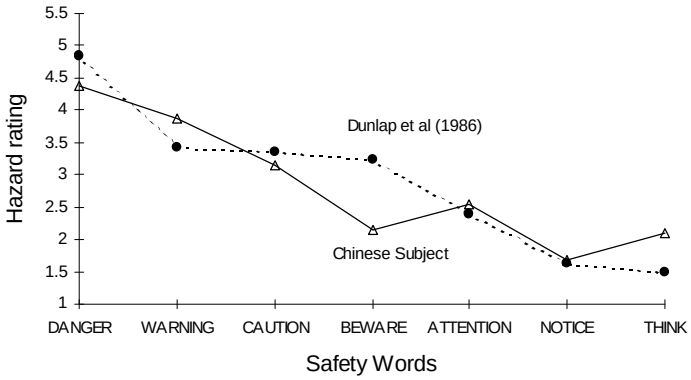

Figure 6. Mean hazard rating of words

Conclusion

Even though there are differences in perceived hazard ratings between the Chinese and Westerners, the words and colors that can be used to indicate various intensity levels of hazard are somewhat similar. The colors, RED, YELLOW and BLUE can still be used to indicate three levels of hazard intensities. Similarly, DANGER, CAUTION and NOTICE can still be used to indicate three levels of decreasing intensities.

The major difference is in the hazard perception of the color, ORANGE. Chinese rate ORANGE somewhat lower. Previous research [3] has reported that ORANGE and YELLOW have significantly different ratings among the different location groups, while color YELLOW was significantly different among the different language groups. This indicates a cultural variation between the colors.

The mean hazard ratings for the words WARNING and CAUTION are not significantly different with the English language. This is similar to that found by other researchers [1, 3, 4, 5]. However, the mean implied hazard rating for WARNING and CAUTION is significantly different when Chinese and Bilingual language is used. The implied hazard rating with bilingual (Chinese and English) is similar to that with Chinese only. This result seems to suggest that the Chinese words have more emphasis when reading a bilingual safety label. For three levels of hazard, DANGER, CAUTION and NOTICE can be used even for the Chinese, as proposed in [3]. From the results of this study, we may conclude that it is better to use bilingual safety labels. With bilingual safety signs, the Chinese people can perceive DANGER, WARNING, and CAUTION at three different hazard levels as specified in [4]. In addition, it satisfies the grouping proposed in [3]. Furthermore, if more hazard levels are needed, then DANGER; WARNING; CAUTION or ATTENTION; BEWARE or THINK; and NOTICE can be used to indicate different levels of hazard when Chinese and English are used together.

References

1. Young, S. L. (1998). Connotation of hazard for signal words and their associated panels, *Applied Ergonomics*, **29**, 101-110
2. Adams, A. S. and Edworthy, J. (1995). Quantifying and predicting the effects of basic text display variables on the perceived urgency of warning labels: tradeoffs involving font size, border weight and colour, *Ergonomics*, **38**, 2221-2237.
3. Dunlap, G. L., and Granda, R. E. and Kustas, M. S. (1986). Observer Perceptions of Implied Hazard: Safety Signal Words and Color Words, *IBM Technical Report TR 00.3428*.
4. Wogalter, M. S., and Silver, N. C. (1990), Arousal strength of signal words, *Forensic Reports*, **3**, 407-420.
5. Bresnahan, T. F. and Bryk, J. (1975). The Hazard association values of accident-prevention signs, *Professional Safety*, 17-25.