

Hazard Perception Based on Safety Words and Colors: An Indian Perspective

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Globalization and trade among developed and developing countries has increased the need of risk communication at the workplace. The purpose of this study was to examine differences in risk communication and perception in various countries. It looked at hazard perception associated with colors and safety words among Indian industry workers. Fifty workers participated in the study focused on hazard rating of 9 safety words and 7 colors. In one part of the study the participants were asked to associate colors with safety words through recalling them from their long-term memory; in another they were asked to associate safety words with given colors. The results showed that certain words and colors implied different hazard rating at the workplace. The rank ordering of safety words and colors varied significantly in different countries. Hence population factors should be taken into consideration when designing standards for hazard communication.

hazard perception safety color safety words

1. INTRODUCTION

Safety at the workplace is a prime concern in manufacturing industries. To prevent accidents and to warn workers about potential hazards, safety words and colors are widely used. Moreover, the American National Standards Institute (ANSI) and the U.S. Occupational Safety and Health Administration (OSHA) cite guidelines aimed at providing uniformity in safety communications and color codes to be used in industries [1, 2, 3, 4, 5, 6, 7, 8]. Perceived severity of consequences has a strong influence on behavior. The more a priori perception of hazard, the more likely people will look for and read warnings and comply by taking precautions [9]. Hazard rating among diverse

populations depends on factors such as gender, age, social status, culture and country [9, 10, 11, 12]. Safety concerns among individuals are universal but priority given to safety or safety-related decision-making may vary among or within countries. Although ANSI has given guidelines about safety and OSHA has issued a standard for color-coding in industries, one should be careful about making broad generalizations about safety words and color perception [13, 14, 15]. In the context of safety and, even more specifically, hazard rating there is a need to understand hazard perception among different populations [11, 12, 13, 15].

Even in the era of globalization and fast industrialization India lacks an agency which would document the country's policies, laws and

regulations about hazard communication. A fully harmonized hazard communication system must be constituted. In the absence of such an agency this research is undertaken to explore hazard rating of safety words and colors by Indian people.

2. LITERATURE SURVEY

There is ample literature on colors and words as a factor in safety communication. Researchers are continuously working on various issues related to hazard communication. For example, Laughery and Brelsford (1993) (as cited in Sattler, Lippy and Jordan [14]) found that the effectiveness of a warning or label depends on people's perception of hazard associated with a product or situation. Purswell, Schlegel and Kejriwal (1993) and Sashi (1993) also proved that perceived implications of hazard could influence one's behavior [14]. Some researchers reported that the greater the hazard rating, the more people will look for a warning label and the chances of taking precautions are increased. Additionally, the more explicit the warning is about the consequence of injury, the greater the hazard rating and retention of warning information (Godfrey, Allender, Laughery, et al. [1983]; Donner and Brelsford [1988]; Friedman [1988]; as cited in Sattler et al. [14]).

Kotwal and Lerner (1995) did a comprehensive review of literature and summarized research pertaining to users' age, gender, hazard rating and familiarity with product as part of hazard communication. They discussed the various experimental studies and their findings in detail [14]. Sattler et al. did a similar extensive review and submitted the resulting draft report to OSHA [14]. This endeavor draws the attention of the international community towards the development of a global hazard communication program [14]. Gender was a variable in hazard communication research in Godfrey and Laughery's (1984) experiment [14]. In this research, women's awareness of the hazards of tampon use, knowledge of the symptoms of the toxic shock syndrome and the awareness of warnings were surveyed and measured. It was found that women who were more familiar with tampon products were less likely to notice warnings when they

switched brands. In a closely-related work, Leonard, Matthews and Karnes (1986) studied how the population interpreted warning signals [14]. They examined whether different signal words produced different perceptions of risk. The results showed that when participants were given a description of the hazard they were being warned against, they did not rate risk differently as a function of signal words. Perception of risk seemed to be predicted on the basis of the information content of the safety words. The conclusion was that information regarding consequences might increase perception of risk. Leonard, Ponsi, Silver, et al.'s (1989) experiment determined people's willingness to read warnings on household pest-control products and their likelihood of purchasing those products. The authors examined whether several objective measures of the readability of warning would be related to the willingness-to-read variable. It was concluded that hazard rating was an important determinant of the willingness to read a warning. The data also suggested that warning with more information and with more difficult material may cause perception of hazard [14].

Wogalter, Desaulniers and Brelsford (1986) found an important predictor of hazard rating. They developed a list of products and asked participants to rate each product on attributes such as hazard rating, likelihood of injury, frequency of use, familiarity and level of knowledge of hazards. The results indicated that severity of injury was the best single predictor of hazard rating. It was also concluded that frequency of use and familiarity could also influence hazard rating. In another study by the same authors, participants were provided a list of products; they were asked to rate perceived hazard and to indicate possible accident scenarios associated with each product, including type, severity and likelihood of injury. It was found that knowledge about a product reduced chances of reading warnings and hazard rating was the most important determinant of willingness to read warnings [14].

Purswell, Schlegel, Kejriwal, et al. (1993) observed that there were few research studies on measuring risk-taking behavior [14]. A model was developed for predicting consumers' safe

use of products as a function of 16 individual variables. Participants were presented with four consumer products to use in an experimental setting, in which the true purpose of the study was concealed. Finally, a model classifying categories of safe or unsafe behavior was developed.

Yu, Chan and Salvendy reported an experiment with Chinese safety words for determining the level of stimulus generation among Chinese workers [12]. The results indicated that words could imply different levels of hazard. Luximon, Chung and Goonetilleke observed differences in perceived hazard ratings between the Chinese and westerners [13]. Participants were asked to complete a safety-related questionnaire. Each participant was given one of three types of questionnaires (English, Chinese or a bilingual version) at random. It was found that hazard rating was significantly different when Chinese and bilingual versions were used. The implied hazard rating in bilingual (Chinese and English) versions was similar to that in Chinese only. It was suggested that Chinese words received more emphasis when a bilingual safety label was read.

Martin examined the cultural differences in risk and hazard rating between people in the USA and in Ghana [15]. In a similar study, Banda and Sichilongo examined rating and understanding of hazards among Zambian people on the basis of signal words, colors and symbols [11]. Both studies concluded that there were significant differences between cultures in the way individuals perceived risk as well as in hazard rating associated with symbols, colors and words.

3. RESEARCH METHODOLOGY FOR PILOT STUDY

3.1. Motivation and Research Objective

The purpose of the study was to find out how safety words and colors influenced Indian people's rating of implied hazard at the workplace and to investigate if there were any distinct differences between them and people from other countries in this respect. The study set the ground for potential design and redesign of warnings and risk communications used internationally.

3.2. Research Instrument

The survey questionnaire was designed with awareness of previous survey reports and questionnaires as well as in consultation with safety officers. Four questions were asked on hazard implied by nine safety words, association of safety words with colors by recalling colors, hazard implied by seven colors and pair matching of safety words and colors. The first section requested participants to rank hazard rating of nine common safety words on a 9-point scale (9—*highest*, 1—*lowest*). The second section asked them to associate a color with a given safety word. The participants were asked to recall a color stored in their long-term memory for this purpose. The third section required hazard rating of seven colors widely used in safety communication, using a 7-point scale (7—*highest*, 1—*lowest*). In the last section the participants were asked to associate safety words and colors from a list.

3.3. Survey Administration

The participants were individually given a verbal description of the purpose of the study. They were provided with a questionnaire pertaining to their age, gender, qualifications, job title, etc. Following the collection of demographic data, the four groups of tasks described in section 3.2. were given to evaluate hazard implied by safety words and colors by Indians.

3.4. Respondents' Profiles

College students rather than industry workers were the participants of most previous studies. Fifty male employees (mean age of 32 years) from Indian industries participated in this study. They were chosen such that they had been exposed to warning signals in industrial risk areas; they were from L & T Cement, Chandrapur, M.S., India (a cement manufacturing company), Raymond Denim Ltd., Yavatmal, M.S., India (the textile industry) and Eicher Motors, Indore, M.P., India (an automobile manufacturing company). Each participant had a minimum work experience of 6 months.

3.5. Variables

In this study nine safety words and seven colors were used as independent variables. The dependent variable for the study was hazard rating of safety words and colors. The independent variables were chosen on the basis of previous studies and the ANSI Z535 standard [1, 2, 3, 13, 15]. The words were WARNING, CAUTION, DANGER, ATTENTION, THINK, BEWARE, GO, NOTICE and SAFE; the colors were RED, ORANGE, YELLOW, BLUE, WHITE, BLACK and GREEN.

3.6. Hypotheses

Words and colors have a significant level of difference in hazard rating and these can impact the warning value in risk or hazard communication. Different colors and words are expected to have significant as well as different effect on hazard rating. The significance of the relationships between words and colors needs to be examined in the Indian context. The following hypotheses were formulated.

- H_0 : There is no difference in hazard rating among safety words for Indians.
- H_1 : There is a significant difference in hazard rating among safety words for Indians.
- H_0 : There is no difference in hazard rating among safety colors for Indians.
- H_2 : There is significant difference in hazard rating among safety colors for Indians.

H_0 : There is no association between safety words and colors for Indians.

H_3 : Indians strongly associate safety words with different safety colors.

3.7. Hypotheses Testing

To test hypothesis 1, respondents were asked to rank hazard implied by different safety words. Table 1 presents the results of a chi-square test. The calculated value was much greater than the table value; hence the null hypothesis was rejected. Thus there was a significant difference in hazard rating of different words for Indians (e.g., for DANGER as the word with the highest hazard rating, i.e., 9th rank, $\chi^2 = 140.50$, whereas for ATTENTION as the word with the highest hazard rating $\chi^2 = 4.38$).

To test hypothesis 2, respondents were asked to rate hazard implied by different colors. Table 2 presents the results of a chi-square test. The calculated value was much greater than the table value; hence the null hypothesis was rejected. Thus there was a significant difference in hazard rating of different colors for Indians (e.g., for GREEN as the color with the lowest hazard rating, i.e., 1st rank, $\chi^2 = 44.99$, whereas for BLUE as the color with the lowest hazard rating $\chi^2 = 3.80$).

To test hypothesis 3, respondents were asked to rank hazard implied by different colors. Table 3 presents the results of a chi-square test. The calculated value was much greater than the table value; hence the null hypothesis was rejected. Thus Indians strongly associate safety words and

TABLE 1. Value of χ^2 for Hypothesis 1

Hypothesis	Significance Level	df	χ^2	
			Calculated	Table
H_0 : There is no difference in hazard rating among safety words for Indians.	.05	64	465.95	83.67
H_1 : There is significant difference in hazard rating among safety words for Indians.				

TABLE 2. Value of χ^2 for Hypothesis 2

Hypothesis	Significance Level	df	χ^2	
			Calculated	Table
H_0 : There is no difference in hazard rating among safety colors for Indians.	.05	36	341.801	43.08
H_2 : There is significant difference in hazard rating among safety colors for Indians.				

TABLE 3. Value of χ^2 for Hypothesis 3

Hypothesis	Significance Level	df	χ^2		Pearson Coefficient of Contingency
			Calculated	Table	
H_0 : There is no association between safety words and colors for Indians.	.05	48	491.36	67.50	.752
H_3 : Indians strongly associate safety words with different safety colors.					

colors used in risk and hazard communication (e.g., for DANGER associated with RED $\chi^2 = 115.6$, whereas for DANGER associated with BLACK $\chi^2 = 0.28$). To find the correlation between colors and safety words, Pearson coefficient of contingency was calculated. At .752, it indicated that Indians strongly associated safety words with colors.

4. SURVEY RESULTS AND DISCUSSION

4.1. Data Analysis for Hazard Rating of Safety Words

Industry employees ranked DANGER (72%) 9th on a 9-point scale, followed by WARNING

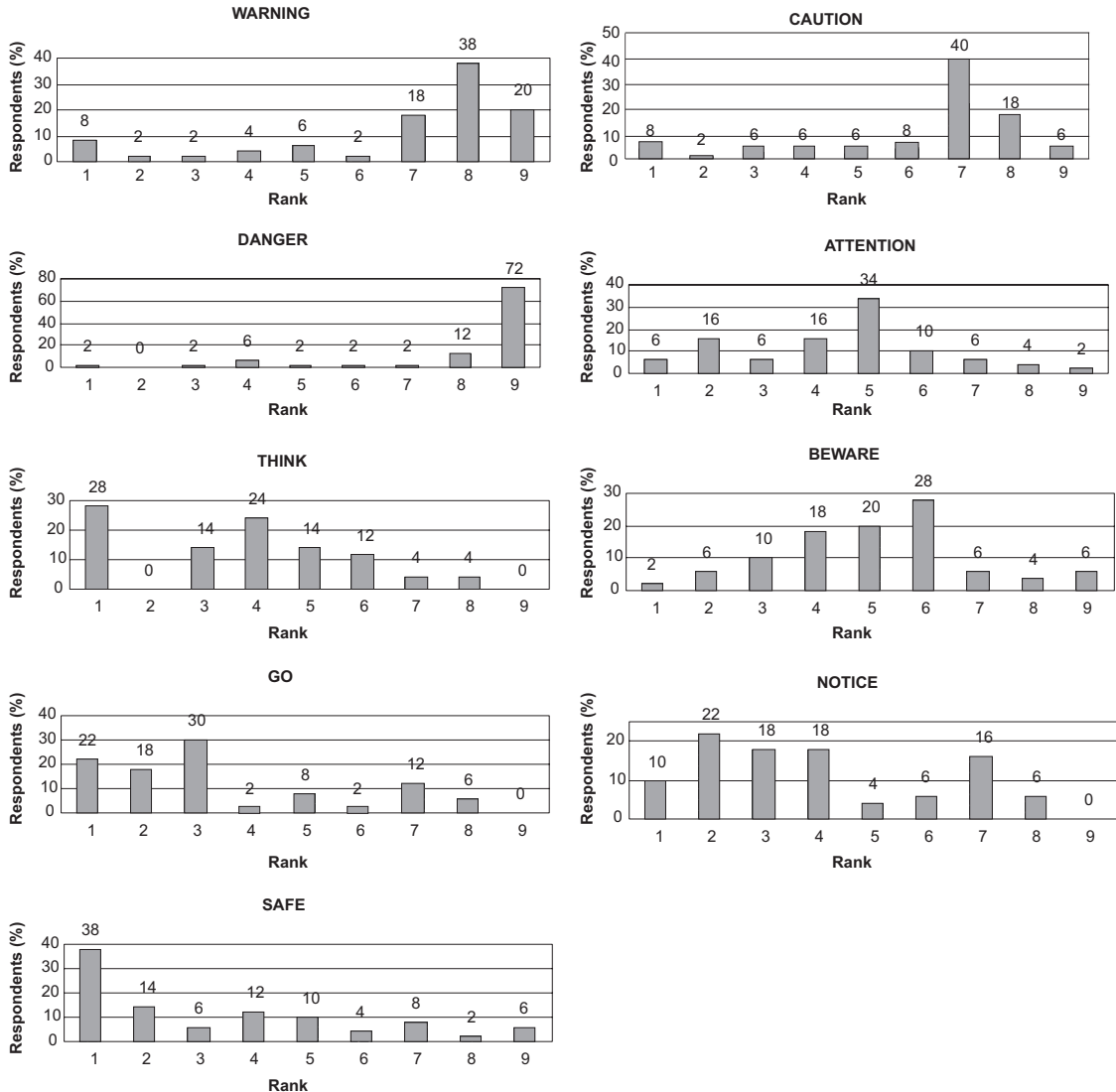


Figure 1. Rating of hazard words. Notes. 1—lowest, 9—highest.

(38%) ranked 8th, CAUTION (40%) ranked 7th, BEWARE (28%) ranked 6th, ATTENTION (34%) ranked 5th, THINK (24%) ranked 4th, GO (30%) ranked 3rd, NOTICE (22%) ranked 2nd and SAFE (38%) ranked 1st. Thus the study found that DANGER had the highest hazard rating, followed by WARNING. However, there was no significant difference for hazard rating of the words WARNING and CAUTION. SAFE was the word with the lowest hazard rating (Figure 1).

4.2. Data Analysis for Association of Colors With Words

The colors recalled from long-term memory and associated by the industrial employees with the safety words were as follows: DANGER = RED (84%), WARNING = RED (54%), CAUTION = YELLOW (24%), BEWARE = ORANGE (26%) and BLUE (24%), ATTENTION = YELLOW (34%), THINK = WHITE (30%), GO = GREEN (58%), NOTICE = BLACK (36%) and SAFE = GREEN (60%). These results indicated

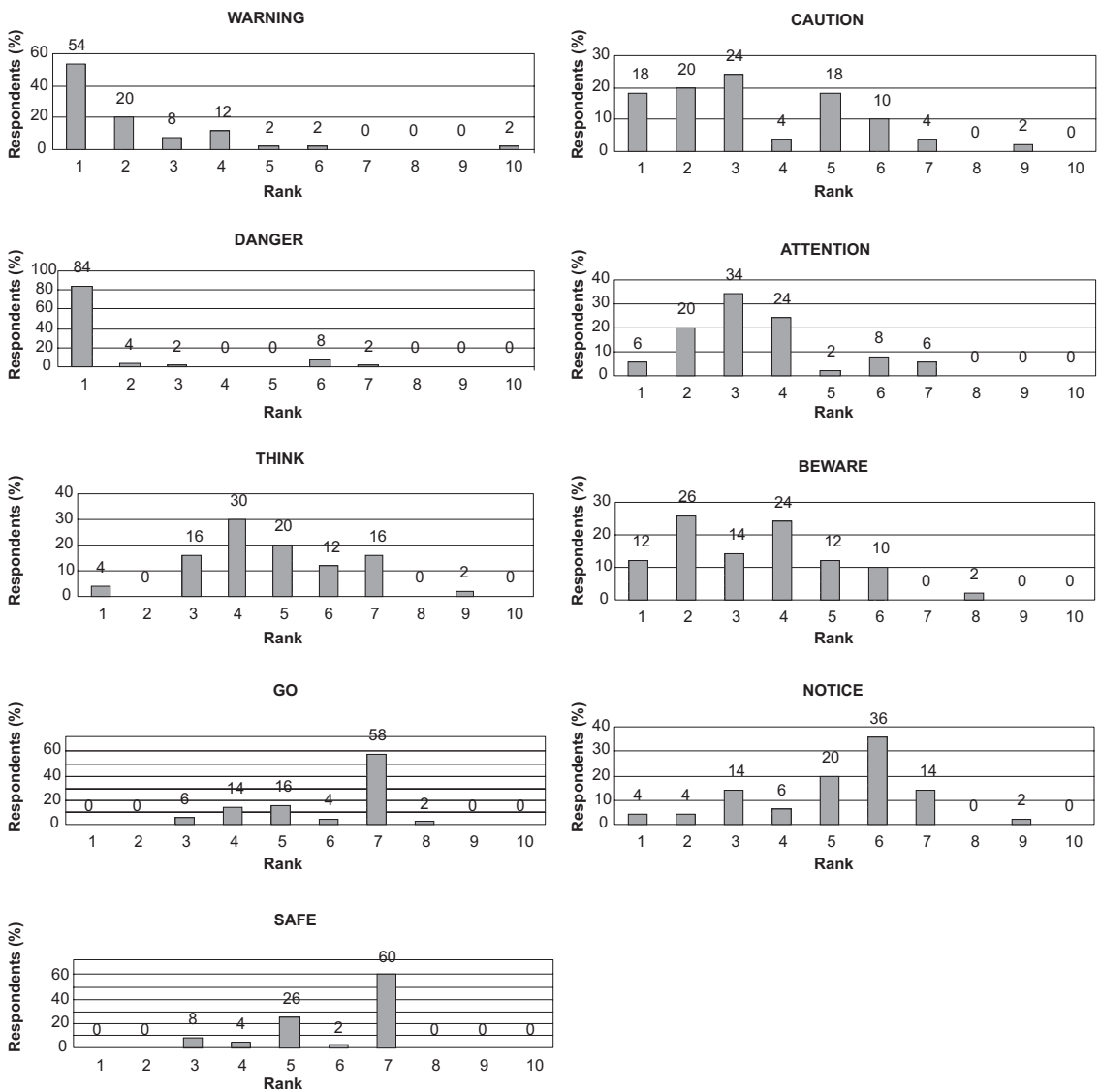


Figure 2. Association of colors and safety words through recalling colors or words stored in the participants' long-term memory. Notes. 1—red, 2—orange, 3—yellow, 4—blue, 5—white, 6—black, 7—green, 8—gray, 9—pink, 10—violet.

that employees mostly associated RED with DANGER and WARNING, while GREEN was associated with GO and SAFE. Surprisingly, with a minimal difference, ORANGE and BLUE were both associated with BEWARE (Figure 2).

4.3. Data Analysis for Hazard Rating of Colors

The color that was perceived by the participants as signifying the greatest hazard was RED (76%), ranked 7th on a 7-point scale, followed by ORANGE (40%) ranked 6th, BLACK (30%) and YELLOW (28%) ranked 5th, BLUE (26%)

ranked 4th and 3rd, WHITE (28%) ranked 2nd and GREEN (50%) ranked 1st (Figure 3).

4.4. Data Analysis for Pair Matching of Colors and Words

When the options for associating safety words with colors were provided, the results were as follows: DANGER = RED (88%), WARNING = RED (52%), CAUTION = ORANGE (28%), BEWARE = ORANGE (28%), ATTENTION = YELLOW (34%), THINK = BLUE (28%), GO = GREEN (58%), NOTICE = BLACK (34%) and SAFE = GREEN (62%) (Figure 4).

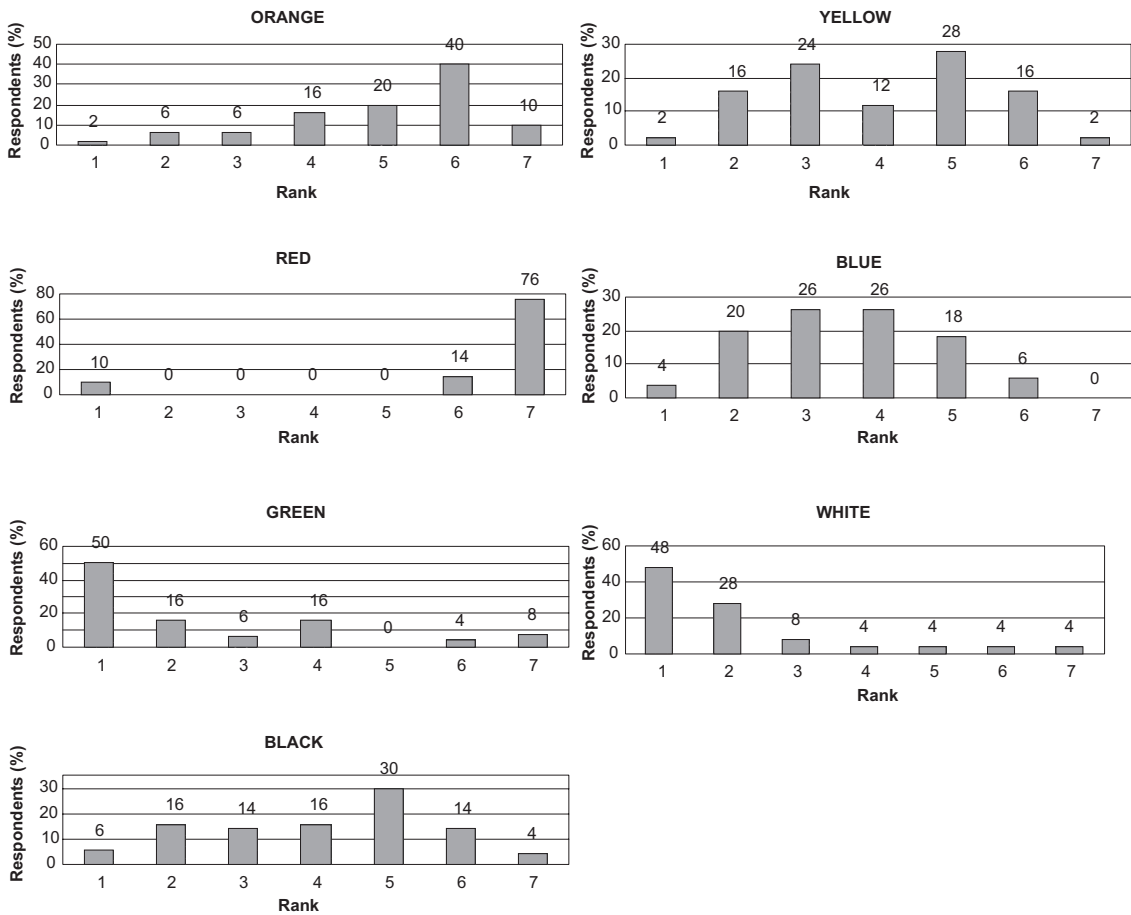


Figure 3. Rating of hazard colors. Notes. 1—lowest, 7—highest.

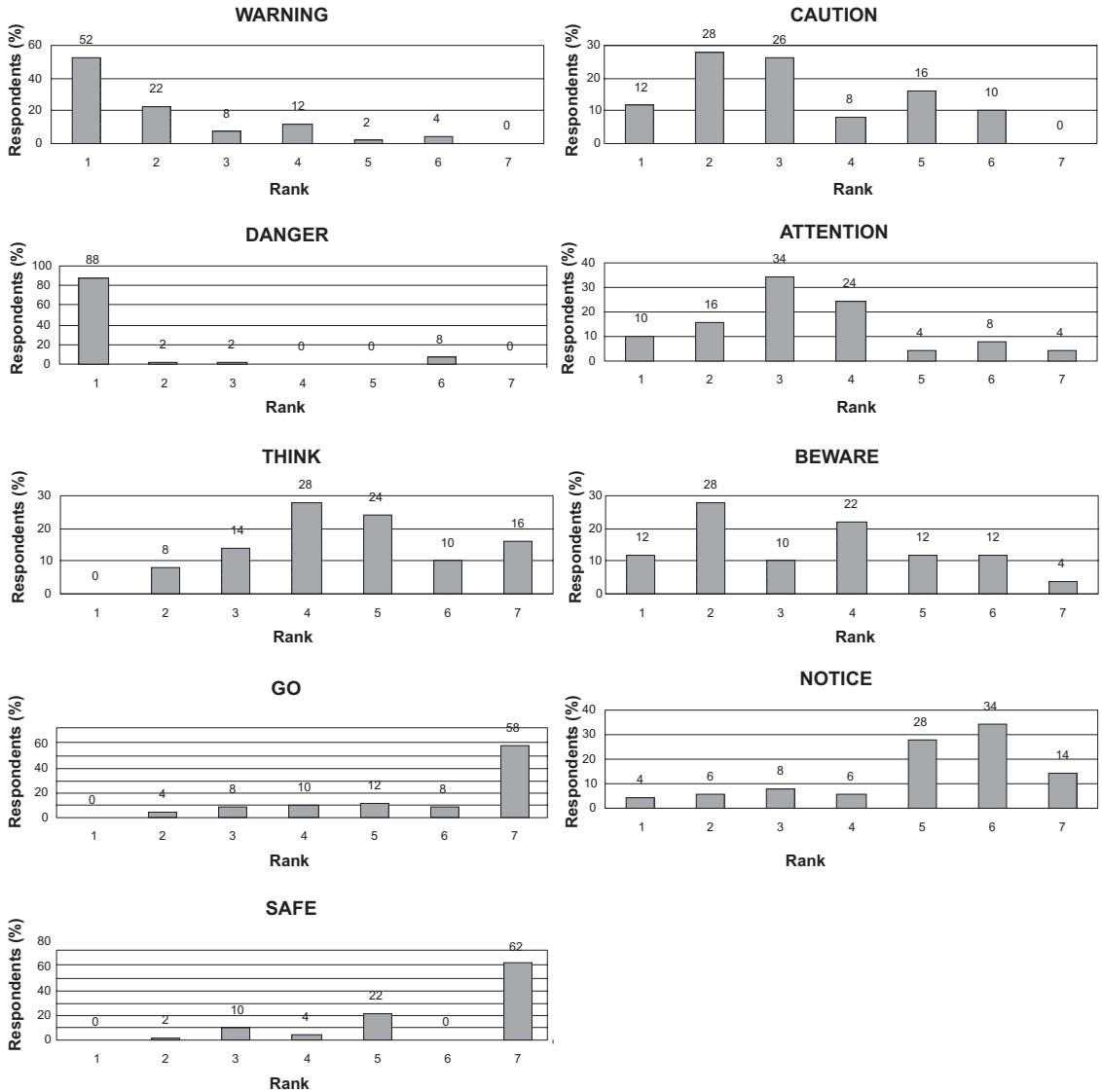


Figure 4. Association of safety words and colors from a given list. Notes. 1—red, 2—orange, 3—yellow, 4—blue, 5—white, 6—black, 7—green.

4.5. Discussion

The results clearly indicated that Indians perceive DANGER as the word that indicated the greatest hazard and increased the warning value for individuals at the workplace.

Although WARNING was ranked higher than CAUTION, there was a marginal difference in perceived hazard. NOTICE was a safety word with the second lowest hazard rating, with many participants not finding a significant difference between THINK and NOTICE. SAFE had the lowest hazard rating. Similarly, RED had the highest hazard rating followed by ORANGE.

Surprisingly, YELLOW was ranked below ORANGE compared to the results obtained worldwide. There was no significant difference in the ranking of YELLOW and BLACK, which meant BLACK was also perceived as a color with the highest hazard rating at the workplace. GREEN was considered to have the lowest hazard rating but in this study the participants considered WHITE, too, as a color with the lowest hazard rating.

The study showed that RED was associated with DANGER, which was consistent with ANSI and OSHA regulations [3, 7, 8], but

WARNING was also associated with RED in contrast to ORANGE, as given by OSHA. The participants associated YELLOW with CAUTION, which OSHA standards recommend, too; it was also associated with ATTENTION in place of BLUE as recommended by OSHA. BLUE was associated with BEWARE and THINK as recommended by OSHA; ORANGE was associated with BEWARE, and WHITE was associated with THINK. GREEN was associated with GO and SAFE as suggested by OSHA. Surprisingly, BLACK was associated with NOTICE. Those results were obtained by having the participants recall colors stored in their long-term memory. When options of relating color with safety words were given, the workers did not notice any significant difference. The only difference found was for CAUTION and BEWARE, which were associated with ORANGE.

5. CONCLUSION

The results demonstrated that hazard information communicated with different safety words and colors followed a consistent pattern with prior studies conducted with different ratings and slight differences. There is a need to fully harmonize hazard communication systems; therefore, careful consideration is required while designing and developing those systems for different populations. We did not take into account gender, age, race, social status, etc., which could also be contributing factors. We believe that, as Martin [15] suggested, the aforementioned results are the consequence of lack of exposure or overexposure or overinterpretation of certain safety words and colors.

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