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Cultural Ergonomics in Ghana, West Africa: A Descriptive Survey of Industry and Trade Workers' Interpretations of Safety Symbols

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Globalization and technology transfer have led to the diffusion of risk communications to users from cultures that were not initially viewed as the target users. This study examined industry and trade workers' overall impressions of symbols used to convey varying degrees of hazardousness. Six symbols, including symbols from the American National Standards Institute (ANSI) Z535 Standard (ANSI, 1998) and the International Organization for Standardization (ISO) 3864:1984 Standard (ISO, 1984) were selected. With the exception of the SKULL symbol, results showed wide discrepancies between users' perceptions of the symbols and their intended meanings. Implications for cross-cultural research on warning components and risk communications are discussed.

cultural ergonomics safety symbols culture and organizations cross-cultural research and safety

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1. INTRODUCTION

Risk perception, attitudes regarding safety and compliance, and injury rates have long been known to differ between individuals and groups. Empirical evidence exists that links group differences in self-efficacy, locus of control, and perceived stress (Droomers, Schrijvers, van de Mheen, & Mackenbach, 1998; Lachman & Weaver, 1998; Lu & Chen, 1996; Mirowsky, Ross, & Van Williges, 1997) to differences in risk perception as well as workplace injury. Besides designing safer environments and guarding employees from hazards, effective risk communications such as warnings and safety instructions are a critical part of hazard control protocols. Since product markets are becoming increasingly globalized, it is important to develop warning labels and instructions that can be comprehended by users from diverse cultures.

Symbols or pictorials are an important component of risk communications. Many countries export products and processes used in workplace environments to other cultures that differ on a number of critical dimensions. Despite efforts by the International Organization for Standardization (ISO) to standardize symbols, large groups of target users are not routinely considered when designing symbols to communicate hazards. To ensure that standards such as workers' right-to-know and worker protection are upheld in all countries, more research should be conducted to determine how warning components used in the USA and internationally are interpreted in a cross-cultural context.

2. CULTURAL ERGONOMICS

Kaplan (1995) described the interplay between culture and work, describing culture as the mediator between the user and the system or technology. Referring to culture in the sociological sense, it is the aggregation of values, experiences, beliefs, and attitudes. Culture is communicated through constructs developed by the social group (Hofstede, 1997). Constructs are ideas that have a shared meaning and are products of the cultures that define them. In that regard, culture is a prominent factor within the social ecology affecting the meaning and representations assigned to such constructs as words, symbols, and colors used in safety communications.

The social ecology is the collection of all environmental factors surrounding the phenomenon in question. Applying the work of Stokols (1987), an understanding of risk communication design (e.g., symbols, colors, text)

must be preceded by an understanding of the environment or social ecology in which the safety information is embedded. Thus, culture is an important part of the social ecology. Interpretations and meanings are embedded in the context of culture, which in turn, mediates the interaction between the user and the system or technology. Risk communications are technologies or cultural artifacts. The successful diffusion of these technologies is driven by the developers' understanding of the target users' culture (Laughery & Brelsford, 1991; Rogers, 1995; Smith-Jackson & Wogalter, 2000a). Systematic consideration of cultural factors when designing risk communications is analogous to, but broader than, the "environmental scan" component of macroergonomic analysis and design (Hendrick & Kleiner, 2001; Kleiner, 1999).

Few studies have examined how individuals assign meaning to words, symbols, and colors. Current research in schema theory does examine the role of shared experiences, language, and mental models in the representation of meaning (Carroll, 1994; Clancey, 1993; Clark, 1985), but few studies have specifically examined the role of these same cognitive constructs in the interpretation of what is hazardous or dangerous. Those studies that have isolated cultural differences related to risk communications include Hsee and Weber (1999), Huer (2000), Savage (1993), Vaughan (1995a, b), and Vaughan and Nordenstam (1991). Despite this gap in the knowledge domain, some researchers have begun to examine general differences in hazard connotations of warning components.

Smith-Jackson and Wogalter (2000b) and Wogalter, Frederick, Herrera, and Magurno (1997) found differences in hazard connotations of colors and symbols among primary Spanish- and English-speakers in the USA. In a sample of 553 Ivory Coast citizens, Kouabenen (1998) found that fatalistic beliefs were directly related to risk perception, risk-taking behavior, and attributions regarding the cause of accidents. Trait factors that vary by culture such as pessimistic acceptance, defeatism, self-efficacy, locus-of-control, and religiosity have been shown to influence attitudes about safety and perception of risk (Earley, Gibson, & Chen, 1999; Neff & Hoppe, 1993; Schulz & Heckhausen, 1999). Similarly, studies conducted by linguistic anthropologists identified both similarities and differences in perceptions of color across cultures (Hupka, Zaleski, Otto, Reidl, & Tarabrina, 1997). When environmental constraints such as resources and organizational culture combine with these trait factors, social ecology becomes a primary factor in risk perception and compliance behavior (Stokols, 1987).

According to Hofstede (1991) "symbols are words, gestures, pictures or objects that carry a particular meaning, which is only recognized by those who

share the culture (p. 7)." Hofstede's (1997) research examined cross-cultural differences in characteristics known to impact organizational effectiveness, such as power relationships, acceptance of uncertainty, and collectivism. One important application of human factors and more specifically, cognitive ergonomics (Hollnagel, 1997) and cultural ergonomics (Kaplan, 1995), is to understand the extent to which cognitive and cross-cultural differences should be considered in the design of technologies such as warnings and other risk communications (e.g., safety instructions, hazard prevention training manuals).

According to Chapanis (1974), current western-centric methods used in safety related research do not effectively capture variables that can be used to determine how culture impacts interpretation and comprehension. As with all systems, warning designers should know their users, and in particular, designers should understand population characteristics that may influence the comprehension of symbols. This study used an exploratory and descriptive approach to examine perceptions or meanings attached to existing symbols that appear in risk communications in order to understand cross-cultural interpretations of safety symbols and the degree to which a target culture interprets symbols in a manner consistent with their intended meaning.

3. PURPOSE AND METHOD

A field survey of trade and industry workers in Accra-Tema, Ghana (West Africa) was conducted to identify meanings or representations found in symbols commonly used in the USA and internationally, as well as symbols that have been proposed for possible inclusion in international standards related to the design of warnings and other risk communications. Accra-Tema is the most industrialized area. Tema is a planned industrial city and the main harbor of Ghana. Accra is the capital city of Ghana and it is metropolitan. The Accra-Tema metropolitan area serves as the hub of trade and industrial activity in Ghana. Accra's attraction to several ethnic groups in the country is due to its standing as an administrative, educational, industrial and commercial center (Department of Geography and Resources Development, 1990). The Accra-Tema metropolitan area imports many products, services, and processes. The literacy rate among trade and industry workers is not significantly different from the national literacy rate of 66% for urban areas compared to 41% for rural areas (Ghana Statistical Service, 2000).

The attempt was to gather an "overall impression" of each symbol from individuals in their occupational settings. Leonard, Otani, and Wogalter (1999) suggest that using basic symbols that convey overall hazardousness may be useful if it is difficult to develop a symbol that can fully and specifically convey the intended meaning. This study attempted to identify users' overall impressions by asking them to interpret the meaning of general symbols commonly found in the USA and used to convey overall hazardousness.

The symbols were tested in the absence of contextual information. Although the use of contextual cues is recommended to gain a more ecologically valid method to test symbol comprehension (Young & Lovvoll, 2000), symbols in this study were displayed without context. Since all occupational and population characteristics were varied across a wide-spectrum of occupational situations, it would have been difficult to provide contexts meaningful to all participants interviewed. In addition, the main purpose was to gather information about overall impressions of existing symbols and the hazardousness communicated by a symbol. A field study approach was selected to identify areas requiring further study in cultural ergonomics (Vanwonterghem & De Beeck, 1996).

3.1. Participants

Participants were selected from a large marketplace in the central and industrial districts of Accra-Tema. A total of 31 adults were interviewed (11 females, 20 males). Three respondents were police officers, two were employees of a multinational manufacturing company, six were employees of a farming implements company, and the remaining participants were trade workers in the central business district. All females interviewed were trade workers.

3.2. Procedure

As English is the official language of Ghana, most of the respondents were fluent in English. However, it was expected that trade workers might be better interviewed in their primary language of Twi. A Twi-English interpreter from the University of Ghana-Legon established rapport with participants and then translated the questions, prompts, explanations, and responses during the course of the interview.

The researcher and the interpreter approached participants individually and the purpose of the survey was explained. Once verbal consent was given, the survey question was posed to the participant. The question was stated as follows:

> *If you saw this symbol on a sign, label, or product such as a food or chemical, what would it mean to you?*

Six symbols were used (Figure 1). Symbols were selected from the American National Standards Institute (ANSI) Z535 Standard (ANSI, 1998) and the ISO 3864:1984 Standard (ISO, 1984). The Mr. Yuk symbol was first proposed by the Children's Hospital of Pittsburgh (see Leonard et al., 1999). The symbols were identical to those used by Smith-Jackson and Wogalter (2000b) and Wogalter et al. (1997) to examine differences between primary Spanish- and English-speaking users. Table 1 (from Smith-Jackson & Wogalter, 2000b) provides a description of each of the symbols displayed to participants.

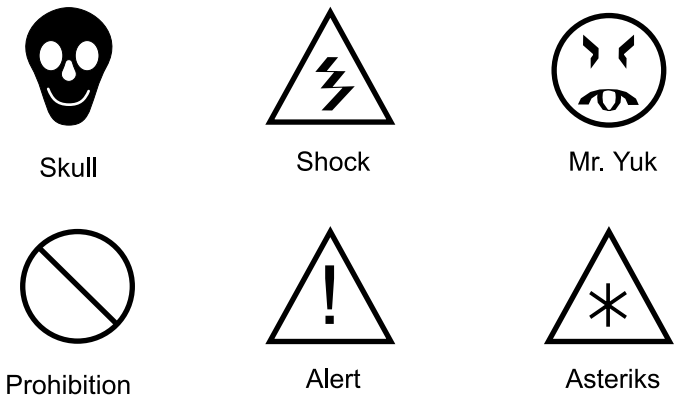

Figure 1. Symbols shown to participants.

TABLE 1. Warning Symbol Descriptions

Symbol	Description
SKULL	Human skull
PROHIBITION	Circle with diagonal slash
SHOCK/JAGGED	Lightning bolt surrounded by a triangle
ALERT	Exclamation point surrounded by a triangle
MR. YUK	Circular face with furrowed brow and protruding tongue
ASTERISK	Asterisk surrounded by a triangle

Two random orders of the symbols were generated and the two lists were alternately presented to participants. Respondents were given a 21.59 × 27.94 cm sheet with the symbols printed in a left vertical column. The symbols were printed in black on a white background. The intended meanings of the symbols are included in Table 2.

TABLE 2. Warning Symbols and Intended Meanings

Symbol	Intended Meanings
SKULL	Poison, toxicity
PROHIBITION	Prohibition, general prohibition ban
SHOCK	Electric shock or hazardous voltage
ALERT	Alert symbol or general danger
MR. YUK	Poison, toxicity
ASTERISK	Alert, attention capture symbol

If participants provided a response that indicated ''no comprehension'' without further elaboration, they were prompted to provide their interpretation of or reaction to the symbol. A prompt was designed to provide a scenario and to rephrase the question without introducing response bias. The prompt used as a follow-up to a non-response or ''no comprehension'' response was as follows:

Suppose you saw this symbol posted on something. What would the symbol mean to you?

The meanings communicated by participants were recorded. After providing interpretations of each symbol, participants were thanked, debriefed, and given a small gift for participation.

4. RESULTS AND DISCUSSION

All except two respondents were familiar with at least one of the six symbols shown. Responses were summarized into categories. Responses such as ''I am not familiar with this symbol'' or ''No meaning to me'' were placed in the ''Did not know'' category, if, after further prompting, the respondent could not provide further elaboration.

The SKULL symbol yielded the most consistent overall impressions among this sample of users, with 81% responding that it was a symbol used

to communicate danger, poison, or deadly (Table 3). Although the generalisability of these results is tentative, the SKULL symbol seems to elicit a high level of hazardousness in this population.

TABLE 3. Responses to the Meaning of the SKULL Symbol

Response	Percentage
Did not know	16
Danger, poison, deadly	81
Do not enter	3

Fifty-eight percent of the respondents interpreted the PROHIBITION symbol in a manner that was at least similar to its intended meaning (Table 4). Ten percent reported some relationship to traffic signs or vehicles. It is possible that the circular shape of some signs used in Ghana and other areas to mark bus stops and to display traffic warnings was the basis for this interpretation. Almost 30% of the sample were unable to attach any meaning to the PROHIBITION symbol.

TABLE 4. Responses to the Meaning of the PROHIBITION Symbol

Response	Percentage
Did not know	29
Prohibition-related	58
Cancelled	
Do not use	
Is not good. Bad to do	
Should not enter	
No parking	
Road sign	10
Traffic sign	
Car is coming	
Road sign	
Belt hook	3

The SHOCK symbol elicited no associations or meanings in a majority of the participants interviewed. The symbol was associated with lightning, power, electricity, or thunder and lightning by 19% of the respondents (Table 5). Two respondents associated the symbol with lightning and thunder. However, 16% of respondents interpreted the symbol to mean

a rough, winding road. Upon further observations of Ghanaian signs, there are several circular road signs with an s-shaped symbol warning drivers of winding roads. Because of the relatively poor condition of many of the roads, a number of these signs are posted, so users may have applied a pre-existing schema to their interpretation of the SHOCK symbol.

TABLE 5. Responses to the Meaning of the SHOCK Symbol

Response	Percentage
Did not know	65
Power, electricity	13
Thunder and lightning warning	6
Rough or winding road	16

The ALERT symbol elicited responses related to attention or warning among 38% of the respondents (Table 6). Sixty-two percent of the respondents could not attach meaning to this symbol, or related the symbol to something with relatively minimal hazards (e.g., a droplet of water).

TABLE 6. Responses to the Meaning of the ALERT Symbol

Response	Percentage
Did not know	39
Attention, warning	38
Ditch or dead end	10
Do not litter, bus stop, water droplet	13

Eighty-four percent of respondents were unable to elicit any meaning from the ASTERISK symbol even after further prompting (Table 7). One respondent reported that the asterisk meant caution, which is the meaning it

TABLE 7. Responses to the Meaning of the ASTERISK Symbol

Response	Percentage
Did not know	84
Caution	3
Related to light, light beams	10
Alert for broken down car	3

was intended to convey. Thirteen percent of the respondents referred to the ASTERISK as a light of some kind (e.g., light beams). The basis of this interpretation is unclear, however, some symbols used to describe lasers have the appearance of an asterisk. Whether respondents were familiar with laser warning symbols is not known.

For the MR. YUK symbol, 68% could not elaborate or provide an interpretation after further questioning (Table 8). The remaining respondents reported that the MR. YUK symbol looked like a face, the face of a cow, a man with a mustache, or something relating to food or baby products. Only 10% of respondents reported that the symbol was related to something hazardous, thus, the overwhelming majority of respondents did not have an overall impression of the hazardousness that this symbol was intended to convey. Although the protruding tongue and furrowed brow invoke a negative connotation among individuals in the USA, the same connotation was not found within this sample of Ghanaians. Of greater concern is the number of participants (22%) who reported positive connotations for this symbol.

TABLE 8. Responses to the Meaning of the Mr. YUK Symbol

Response	Percentage
Did not know	68
Dangerous	10
Should not be handled	
Be very careful. Will be hurt	
Dangerous chemical	
It is a face	13
Can use or accept it	
Something good	
It is the face of a cow (2 responses)	
Food-related or product	9
It is a food label. It can be eaten	
This is something you should eat	
Something that should go on a baby product	

With the exception of the SKULL symbol, very few of the symbols were comprehended. For most of the symbols, the subsequent interpretations did not match the intended meaning of the symbols. Although all six symbols are designed to convey a significant degree of overall hazardousness, most of the responses did not convey any significant overall impression of hazardousness.

5. CONCLUSIONS

Industry and trade workers in Ghana are exposed to products, labels, and environments that use symbols to convey meaning. Although user-centered design activities are becoming more common, more emphasis should be placed on identifying similarities and differences in meanings and representations of symbols and hazards across cultures. Standardization and usage efforts should be driven by a technology transfer model, given that symbols are a technology. Shahnavaz (2000) highlighted the importance of transferring technology only after careful consideration of culture, local needs, and resources. As most industrially developing countries have yet to establish comprehensive safety cultures within the work environment, one cannot assume that the transferred technologies will be used and comprehended in a manner consistent with the intent of the designers.

To ensure adequate user-centered design, cognitive ergonomic approaches that quantitatively and qualitatively capture meanings and representations across cultures must be used. Employers should provide employees with effective and consistent training to understand risk communications used in the workplace. In addition, a database of cross-cultural interpretations, hazard connotations, and critical confusions (Leonard et al., 1999) should be developed so that designers and standards committees can make informed decisions based upon user-centered factors.

Finally, this research also demonstrates the need for workplace environments to provide adequate training on relevant components of risk communications. Employers can evaluate potential risk communications to be used in the workplace to ensure that they can be successfully transferred to a specific cultural context. Support, in the form of evaluation of employee interpretations and training to match employee mental models with risk communication intent, will increase the safety of workplace environments. Responsibility also rests with the designer, who should design and evaluate risk communications so that they are consistent with the mental models of the target cultural group.

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