

5 Creating Inclusive Warnings

The Role of Culture in the Design and Evaluation of Risk Communications

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CREATING INCLUSIVE WARNINGS: ROLE OF CULTURE IN THE DESIGN AND EVALUATION OF RISK COMMUNICATIONS

Warnings are risk communications used to inform people about hazards and to provide instructions so as to avoid or minimize undesirable consequences such as death, injury, or property damage. Warnings are used in a variety of contexts for numerous kinds of potential hazards. For instance, a product warning might be used to inform users about the electrocution hazard associated with a kitchen appliance, whereas an environmental warning might be used to advise people to evacuate the area where a hurricane is expected to make landfall. While these examples of warnings might appear to be very different, they share a number of commonalities because they are both persuasive safety communications used to guide the behavior of those who receive them.

Based on the classic work of Lasswell (1948) and Hovland, Janis, and Kelley (1953), all persuasive communications should be analyzed in terms of *source* (the entity that initiates communication), *message* (content of communication), *channel* (how the message is communicated), *receiver* (target of the communication), and *effect* (desired behavioral change). These components of risk communications have been studied in depth over the past several decades (see Lindell and Perry, 2004; Wogalter, 2006 for extensive reviews). The present chapter focuses on one of these components, receivers. The characteristics of the person being warned are subdivided into topics that are discussed.

Although it is often recognized that warning effectiveness depends on the extent to which these risk communications have been designed to match the needs and capabilities of the target audience, it is equally important to understand that the characteristics of message recipients vary from one individual receiver to the next; therefore, warning designers need to understand that their target audience may not be homogeneous (Smith-Jackson, 2006a). For instance, a number of researchers such as Goldhaber and deTurck (1988) and Flynn, Slovic, Mertz, and Carlisle (1999) have investigated the role of gender on warning compliance and risk perception. Others have investigated chronological age as an individual difference when people encounter warnings and other risk communications (Mayhorn and Podany, 2006; Rousseau, Lamson, and Rogers, 1998; Young, Laughery, Wogalter, and Lovvoll, 1999). Unfortunately, not all receiver characteristics have been as extensively studied. In particular, there is a demonstrated paucity of research in the area of understanding how cultural attributes of receivers impact warning effectiveness (Reid, 1995; Smith-Jackson, 2006b). As will be discussed later in the chapter, the

communication–human information processing model (C-HIP) will be used to expose the need for consideration of cultural ergonomics because there are serious gaps in the current warning literature.

CULTURE, SUBCULTURE, AND ETHNICITY: DEFINITIONS AND DISTINCTIONS

Perhaps one explanation for the relative lack of research regarding culture in this context comes from an incomplete (and often contentious) understanding of how the term *culture* can be defined. For instance, Kroeber and Kluckhohn (1952) identified 164 separable definitions of culture within the anthropological literature alone. Fortunately, the design and evaluation of warnings does not require all of the finely honed theoretical distinctions made by anthropologists. From a sociological perspective, culture is the aggregation of experiences, values, beliefs, and attitudes that are communicated by social groups (Hofstede, 1997). Consistent with the purposes of this book as a whole, “culture” within this chapter will follow the definition of cultural psychologists Goldberger and Veroff (1995) as being “a system of shared meanings that ... provide a common lens for perceiving and structuring reality for its members” (p. 11). Because a population often includes large numbers of people who share different cultures, subcultures often coexist within groupings such as national boundaries or communities. Subcultures can be defined using a variety of dimensions, but one of the most significant in terms of warning and risk communication is ethnicity.

According to Yinger (1994), membership in an ethnic group is defined by the following characteristics: (1) others in the society perceive the group members to be different, (2) members identify themselves as different, and (3) members participate in shared activities related to their perceived common origin or culture (p. 3). Moreover, ethnic groups are often defined in terms of national origin, race, language, and religion (Gudykunst and Kim, 1997). In the development of warnings, the need for understanding how people of different ethnicities will interact with safety-related information is critical because members of subcultures typically share many of the values of the culture, but they “also have some values that differ from the larger culture” (Gudykunst, 1998, p. 43). Thus, efforts to protect the safety of the public from potential hazards must consider the heterogeneity of the people who receive the warning.

To illustrate the need for better understanding of how cultural attributes might impact the design and evaluation of warnings, consider the following demographic trends within the United States. Recent data from the US Census Bureau (2009) indicates that the American population totals approximately 304 million and that the most populous ethnic minority groups include those reporting Hispanic origin (15.4%), African Americans (12.9%), and Asians (4.5%). Population estimates indicate that by 2015, the number of those reporting Hispanic origin will increase to more than 57 million, the number of African Americans will increase to more than 42 million, and the number of Asians will increase to more than 16.5 million (U.S. Census, 2008). Thus, the ability to inform and protect all subgroups and ethnicities within our culture is dependent on understanding how these cultural attributes might affect warning effectiveness and related issues.

MODELING BEHAVIOR: HOW PEOPLE INTERACT WITH WARNINGS

A number of models could be used to serve as the basis of this discussion on warnings and culture (e.g., Edworthy and Adams, 1996; Lehto and Miller, 1986; Lindell and Perry, 2004; Rogers, Lamson, and Rousseau, 2000); however, the communication–human information processing (C-HIP) model described by Wogalter and associates (e.g., see Wogalter, 2006) provides a reasonable framework that is both comprehensive and consistent with the aforementioned persuasive communications models. In this chapter, C-HIP will be used to provide a theoretical framework for the discussion of cultural attributes. It is the context within which culture is discussed.

The C-HIP model has two major sections each with several component stages. A representation of the model can be seen in Figure 5.1. The first section of the framework uses some of the basic stages of a persuasive communication model (Hovland, Janis, and Kelley, 1953; Lasswell, 1948). To illustrate how these general

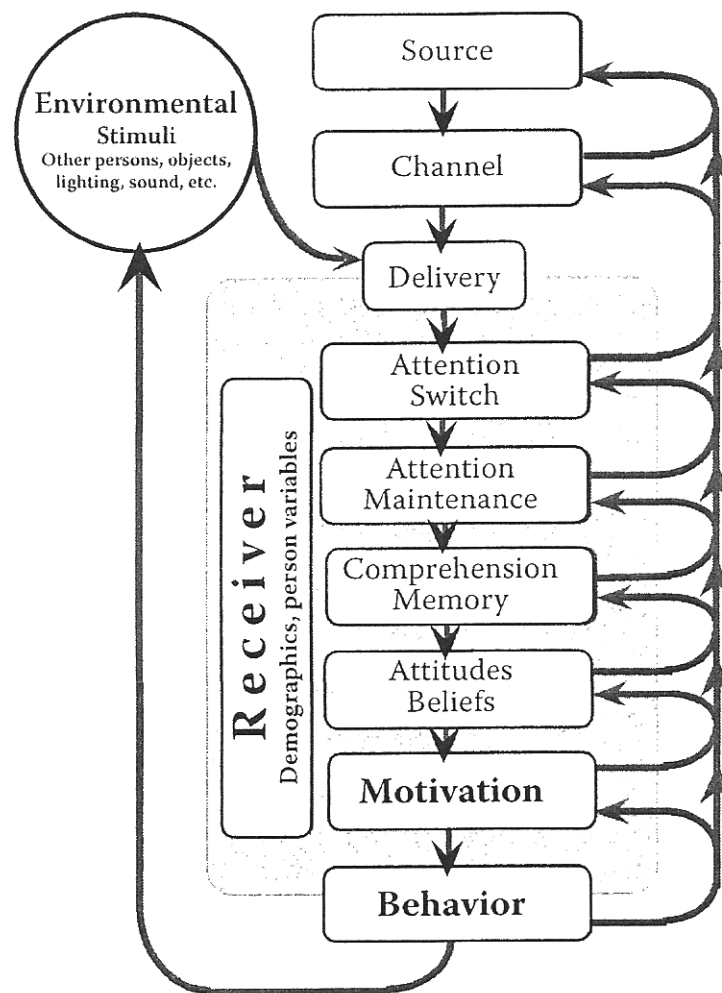


FIGURE 5.1 Communication-human information processing (C-HIP) model.

communication models can be altered to understand the warning process, McGuire (1980) provides a detailed description of communication theory with respect to warnings. Thus, the general framework for the C-HIP model focuses on a warning message being sent from one entity to another, that is, sent by a source (sender) through some channel(s) to a receiver. To place these C-HIP components within a cultural context, the Institute of Medicine (2002) suggests that cultural diversity should be considered when planning communication efforts by selecting credible sources, choosing message strategies, and determining channels for the delivery of safety information.

The second main section of the model focuses on the receiver and how people internally process information. This section interfaces with the first through effective delivery of the warning to individuals who are part of the target audience. When warning information is delivered to the receiver, processing may be initiated, and if not blocked in some way, will continue across several stages: from attention switch, attention maintenance, comprehension and memory, beliefs and attitudes, motivation, and possibly ending in behavior. Cultural attributes can be considered as an individual difference variable because each person who receives a warning belongs to a particular culture, and this varies from one individual to the next because the population is heterogeneous and diverse. The cultural aspect can be expected to operate at all levels of information processing within the receiver.

C-HIP MODEL

The C-HIP model is both a stage model and a process model. The C-HIP model is useful in describing a general sequencing of stages and the effects warning information might have as it is processed. If information is successfully processed at a given stage, the information “flows through” to the next stage. If processing at a stage is unsuccessful, it can produce a bottleneck, blocking the flow of information from getting to the next stage. If a person does not initially notice or attend to a warning, then processing of the warning goes no further. However, even if a warning is noticed and attended to, the individual may not understand it, and as a consequence, no additional processing occurs beyond that point. Even if the message is understood, it still might not be believed, thereby causing a blockage to occur at this point. If the person believes the message but is not motivated (to carry out the warning’s instructed behavior), then the final stage involving compliance behavior might not occur. Successful processing in all stages results in safety compliance. While the processing of the warning may not make it all of the way to the behavioral compliance stage, it can still be effective at earlier stages. For example, a warning might enhance understanding and beliefs but not change behavior. While there are other aspects of the model (e.g., feedback loops), this basic model and its organization serves to provide a framework for our discussion of culture and warnings.

In the sections following, factors affecting each stage of the C-HIP model are described. The first three sections concern the section of C-HIP concerning communication from the source via some channel(s) to the receiver. Later sections concern analysis of information processing factors that are internal to the receiver.

SOURCE

A warning source is the entity or agency responsible for initiating hazard communication with the public. Sources can be government authorities, product manufacturers, media figures, or peers such as friends and relatives (Lindell and Perry, 2004; Wogalter, 2006). When an individual first encounters a warning, he or she judges the credibility of the source. Warnings originating from credible sources are likely to promote warning compliance, whereas less credible sources are likely to prompt information seeking. This process is known as warning confirmation and entails seeking information from other warning messages and different sources (Danzig, Thayer, and Galater, 1958). Because credibility varies between individuals, some have suggested that environmental warnings may be more believable to a larger segment of the population if they come from a mixed panel of scientists, public officials, reputable organizations, and familiar persons (Drabek and Stephenson, 1971). In fact, people are more likely to pay attention to warnings when they perceive that the source of information is “in the same boat” that they are; thus, shared involvement between the source and the receiver is likely to enhance risk perception (Aldoori and Van Dyke, 2006). Likewise, Weinstein’s (1988) precaution adoption model suggests that the realization that a problem affects others “like you” can stimulate people to think about hazards and might lead them to plan to take preventative action by complying with a warning.

As source credibility is inherently tied to the concept of “trust,” it is not surprising that trust is a topic of considerable discussion with no universally accepted scholarly definition (Rousseau, Sitkin, Burt, and Camerer, 1998). Although definitions of trust vary from one academic discipline to another, one finding from a growing body of research is particularly robust: trust and message credibility varies quite significantly by racial and ethnic status (Spence, Lachlan, and Griffin, 2007). For instance, African Americans frequently cite a distrust of government institutions and describe incidents of past exploitation such as the Tuskegee syphilis trials or Hurricane Katrina as explanations for an unwillingness to attend to or believe messages (Andrulis, Siddiqui, and Gantner, 2007; Freimuth et al., 2001). Likewise, differences in warning information exchange and dissemination have been observed between Mexican Americans, Caucasian Americans, and African Americans (Fothergill, Maestas, and Darlington, 1999).

To combat these deleterious effects of trust, obtaining community engagement during warning development is essential (Palenchar and Heath, 2007). Generally, such efforts have been described as one option for underrepresented segments of the population to take “community control” in an effort to counterbalance the power of the majority (Hacker, 1995). Thus, engaging participatory techniques that entail active collaboration between communities and other stakeholders such as government entities and aid organizations should provide a means of achieving this goal (George, Green, and Daniel, 1996). For instance, the formation of a community advisory board that includes faith-based organizations, community leaders, and community-outreach workers might be predicted to be useful in facilitating emergency risk communications such as warnings (Andrulis et al., 2007; Vaughan and Tinker, 2009). This approach where community leaders in refugee camps acted as

part of an early warning system was demonstrated to be useful in preventing the outbreak of infectious diseases in Darfur (Pinto et al., 2005). Moreover, the interaction between credibility and source is further supported by research that suggests that local sources such as friends, family, and local news media might be considered “insider influences,” which can be trusted more than “outsider influences,” such as federal government entities or environmental groups (Baxter, 2009; Riley, Newby, and Leal-Almeraz, 2006).

CHANNEL

Warning channels refer to the communications medium used to transmit hazard information. Warnings can be transmitted in many ways. For instance, product warnings can be presented on labels directly on the product, on containers, in product manuals or inserts, on posters/placards, in brochures, and as part of audio–video presentations on various media (e.g., DVD or Internet). By contrast, environmental warnings might be disseminated via face-to-face contact, telephone, siren, radio, newspapers, television, and the Internet (e.g., Facebook, Twitter). Most commonly, warnings of either type use the visual (text and symbols) and auditory (alarms and voice) modalities as opposed to the other senses. There are exceptions, for example, an odor added to petroleum-based gases to enable detection by the olfactory sense, and the rough vibration of a product that is not mechanically functioning well can provide tactual, kinesthetic, and haptic sensation (Mazis and Morris, 1999; Cohen, Cohen, Mendat, and Wogalter, 2006).

Each of these channels varies in terms of the precision of dissemination and the specificity of the message (Lindell and Perry, 1987). For instance, a television or radio broadcast containing a flood warning might quickly reach the intended at-risk segment of the population, but dissemination is imprecise because the reception area for the station is larger than the risk area such that others who are not at risk will also receive the hazard information and erroneously believe themselves to be at risk. Also, recent evidence suggests that channel might interact with credibility such that incorrect information obtained from the Internet might be trusted, whereas correct information might be viewed with suspicion (Wogalter and Mayhorn, 2008). Face-to-face warnings can be much more targeted than mass media broadcasts. Given these shortcomings for each of the channels, it is often suggested that multiple channels be used to communicate with all members of society. For instance, recommendations regarding health communications about pandemic influenza suggest that authorities target several of the aforementioned channels as well as “ethnic radio and TV” (Vaughan and Tinker, 2009).

DELIVERY

While the source may try to disseminate warnings in one or more channels, the warnings might not reach some of the targets at risk (Williamson, 2006). Delivery refers to the point of reception where a warning arrives with the receiver. It is shown as a separate stage in the current C-HIP model shown in Figure 5.1 to emphasize its importance. A warning that a person sees or hears is a warning that has been

delivered. Safety information provided on a DVD that is produced but never reaches the individual would be delivery failure. The reasons for failure to deliver the warning to targeted individuals can be multifold. The DVD may not have been distributed and sitting in bulk boxes in a warehouse. Or the distribution could be haphazard reaching some intended persons and not others. But even if individuals receive the video (e.g., via the Internet) they may not receive the needed information. For instance, groups with high rates of poverty may not have the playback equipment to see it or there might be a language barrier (e.g., limited proficiency in English). Of course, even if the person does see the video, it may not include the necessary warning. Thus, it may be necessary to distribute warning information in multiple ways to reach receivers at risk. The point is that if warnings given by a source do not reach the targets at risk, then the warning will have no or limited effects on the receiver.

Because technology is becoming ubiquitous in our society, the Internet is a constantly evolving channel for the delivery of safety information (Wogalter and Mayhorn, 2005). Although some portion of a population may have ready access to the Internet and frequently act in a proactive manner to search for information, others simply may not know that there is safety material (e.g., a list of recalled consumer products) that could be accessed. Thus, the existence of a digital divide must be recognized along with other disadvantages (and advantages) when Internet delivery is being considered as a mechanism for disseminating safety information to the public. Advantages might include the potential for timely, targeted, multimedia presentation of safety information that includes a gateway for further information seeking, whereas disadvantages might include the potential for inadvertently creating passivity as information is “pushed” to people thereby reducing interactivity with knowledgeable others (e.g., government officials). Ultimately, these advantages and disadvantages need to be investigated via empirical research to determine whether the benefits exceed the costs in terms of safety.

ENVIRONMENTAL STIMULI

Besides the subject warning, other stimuli are usually simultaneously present. These stimuli may be other warnings or a wide assortment of nonwarning stimuli. These stimuli compete with the warning for the person’s attention (described further below). With respect to a given warning, these other stimuli may be described as “noise” that could potentially interfere with warning processing. For example, a cellular telephone ringing or a baby crying just when an individual begins to examine a warning may cause distraction and lead to the warning not being fully read. The environment can have other effects. The illumination can be too dim to read the warning. In these cases of distraction or legibility, warnings of greater salience (e.g., light source added) could have better capability to attract and hold a person’s focus.

Environmental influences often include other people as described in the social amplification of risk framework (Kasperson et al., 1988) that illustrates how interpersonal interactions in a social context can influence perception of risk. Awareness about what other people are doing in the local environment and elsewhere can affect warning compliance positively or negatively. As research by Masuda and Garvin (2006) illustrates, situated experiences of place can act as conflicting cultural

worldviews that lead some individuals to act as risk amplifiers while others attenuate risk. For example, risk amplifiers might conclude that the risk of head injury is high, based on their observations that other people are wearing safety helmets on bicycles. Likewise, risk attenuators might conclude that the same risk is relatively low if they are surrounded by advertisements depicting people not wearing needed protective equipment, even though the product warning requires its use. Clearly then, the environment can have effects on warning processing. It shows a way of demonstrating or modeling ongoing processing. The source, receiver, other entities, and the environment can act on the situation and change it.

RECEIVER

The receiver is the person(s) or target audience to whom the warning is directed.

For a warning to effectively communicate information and influence behavior, the warning must first be delivered. Then attention must be switched to it and maintained long enough for the receiver to extract the necessary information. Next, the warning must be understood and must concur with the receiver's existing beliefs and attitudes. Finally, the warning must motivate the receiver to perform the directed behavior. The next several sections are organized around these stages of information processing.

ATTENTION SWITCH

An effective warning must initially attract attention, and to do so, it needs to be sufficiently salient (conspicuous or prominent). Warnings typically have to compete with other stimuli in the environment for attention. Several design factors influence how well warnings may compete for attention (see Wogalter and Leonard, 1999; Wogalter and Vigilante, 2006).

Larger is generally better. Increasing the overall size of the warning, its print size and contrast, generally facilitates warning conspicuousness. Context also plays an important role. It is not just the absolute size of the warning, but also its size relative to other displayed information. Color is an important attribute that can facilitate attention attraction (Bzostek and Wogalter, 1999; Laughery, Young, Vaubel, and Brelsford, 1993). However, recent evidence suggests that the interpretation of hazard severity associated with color varies by culture such that Chinese participants differed significantly from participants in the United States when both were asked to rank order colors in terms of perceived hazards (Lesch, Rau, Zhao, and Liu, 2009). Beyond interpretation of colors and their semantic meanings, other evidence suggests that perception of colors may also vary across cultures (Hupka, Zaleski, Otto, Reidel, and Tarabrina, 1997). Moreover, other problems unrelated to culture such as the presence of color blindness in some individuals suggests that color alone should not be relied on to attract attention yet color remains a frequently used design component in warnings.

Warning standards often use color as one of several components of the signal word panel to attract attention. Other design components in the signal word panel include an alert symbol, the triangle/exclamation point, and one of three hazard connoting signal words (DANGER, WARNING, and CAUTION). Context again can

also play a role with respect to color as a salience feature. An orange warning on a product label located on an orange product will have relatively less salience than the same warning conveyed using a different color. The color should be distinctive in the environment in which it is placed.

Symbols can also be useful for capturing attention. One example already mentioned is the alert symbol (triangle enclosing an exclamation point) used in the signal word panel in ANSI Z535 (2002; Bzostek and Wogalter, 1999; Laughery, 1993). This symbol only serves as a general alert. Bzostek and Wogalter (1999) found results showing people were faster in locating a warning when it was accompanied by an icon. Other kinds of symbols may be used to convey more specific information. This latter purpose is discussed in the comprehension section (discussed later), but the point here is that a graphic configuration can also benefit the attention switch stage.

ATTENTION MAINTENANCE

Individuals may notice the presence of a warning but not stop to examine it. A warning that is noticed but fails to maintain attention long enough for its content to be encoded might serve as being of very little direct value. Attention must be maintained on the message for some length of time to extract meaning from the material. During this process, the information is encoded or assimilated with existing knowledge in memory.

With brief text or symbols, the warning message may be grasped very quickly, sometimes maybe as fast as a glance. For longer, more complex warnings, attention must be held for a longer duration to acquire the information. So to maintain attention in these cases, the warning needs to have qualities that generate interest so that the person is willing to maintain attention to it instead of something else. The effort necessary to acquire the information should be reduced as much as possible. Thus, there is a desire to enable the information to be grasped as easily as possible. Some of the same design features that facilitate the switch of attention also help to maintain attention. For example, large print not only attracts attention, but it also tends to increase legibility, which makes the print easier to read.

People will more likely maintain attention if a warning is well designed (i.e., aesthetic) with respect to formatting and layout. Research with western cultures suggests that people generally prefer warnings that are in a list outline format as opposed to continuous prose text (Desaulniers, 1987). Also, text messages presented in all caps are worse than mixed-case text in glance legibility studies (Poulton, 1967) and centered-line formatting is worse than left justified text (Hooper and Hannafin, 1986). Moreover, visual warnings formatted with plenty of white space and containing organized information groupings are more likely to hold attention than a single chunk of dense text (Wogalter and Vigilante, 2003; 2006). Interestingly, the lack of research with diverse samples may limit the potential usability of such design guidelines. For instance, the recommendations regarding the use of all caps may not be applicable to people who use pictoform languages such as Chinese, Japanese, or Korean. Likewise, suggestions regarding the use of left-justified text may not be applicable to readers of Arabic or Hebrew languages. Thus, there is an obvious need to test warning design features with other cultures.

Because individuals may decide it is too much effort to read large amounts of text, structured formatting could be beneficial in lessening the mental load and perception of difficulty. With perceptions of too much text, many prefer to direct their attention to something else. Formatting can make the visual display aesthetically pleasing to help hold people's attention on the material. Formatting can help process the information by "chunking" it into smaller units. Formatting can also show the structure or organization of the material, making it easier to search for and assimilate the information into existing knowledge and memory (Hartley, 1994; Shaver and Wogalter, 2003). Again, these recommendations are the result of very limited testing with homogeneous samples, and there is no guarantee that information will be processed similarly across cultures. Even if information processing is similar, research using the Cultural Sensitivity Assessment Tool to evaluate health-related information regarding cancer that targets African Americans suggests that readability is often reduced for these groups because efforts to use formatting and visual presentation are consistently underdeveloped (Guidry, Fagan, and Walker, 1998).

COMPREHENSION AND MEMORY

Comprehension concerns understanding the meaning of something, in this case, the intended message of the warning. Comprehension may derive from several components: subjective understanding such as its hazard connotation, understanding of language and symbols, and an interplay with the individual's background knowledge. Background knowledge is relatively permanent long-term memory structure that people carry with them. The sections below contain short reviews of some major conceptual research areas with respect to warnings and the comprehension stage. Again, much of this information is derived from limited testing that has not been validated across cultures; therefore, this section might be considered a set of "lessons learned" in investigating the use of various components of warning messages written in English.

Signal Words

Aspects of a warning can convey a level of subjective hazard to the recipient. The ANSI (2002) Z535 standard recommends three signal words to denote decreasing levels of hazard when US English is the language of the warning: DANGER, WARNING, or CAUTION (see also FMC Corporation, 1985; Peckham, 2006; Westinghouse Electric Corporation, 1981). The DANGER panel should be used when serious injury or death *will* occur if the directive is not followed. A WARNING panel is used when serious injury or death *may* occur if the directive is not followed. The CAUTION panel is used when less severe personal injuries or property damage may occur if the directive is not followed. While the standard describes CAUTION and WARNING with different definitions, numerous empirical research studies indicate that people do not readily distinguish between the two. The term DEADLY has been shown in several research studies to connote significantly higher hazard than DANGER (e.g., see Hellier and Edworthy, 2006; Wogalter, Kalsher, Frederick, Magurno, and Brewster, 1998; Wogalter and Silver, 1990, 1995).

While these general recommendations made in the ANSI standard (2002) are often used to construct safety messages for warning recipients within the United

States, cross-cultural safety research involving international populations suggests that differences in comprehension of signal word and color combinations might exist (Lesch et al., 2009). For instance, Lesch et al. (2009) found that US participants provided significantly higher mean ratings of perceived hazards to signal words than did the Chinese participants. Interestingly, other evidence suggests that hazard connotations assigned to colors and signal words might also vary between English-only and Spanish-speaking participants; therefore, warning designers within the United States might also exercise caution by examining the effects of culture (Wogalter, Frederick, Herrera, and Magurno, 1997).

Message Content

The content of the warning message should include information about the hazard, instructions on how to avoid the hazard, and the potential consequences if the hazard is not avoided (Wogalter, Godfrey, Fontenelle, Desaulniers, Rothstein, and Laughery, 1987).

- a. *Hazard information.* At a minimum, the warning should identify the safety problem. Often, however, warnings might require more information regarding the nature of the hazard and the mechanisms that produce it.
- b. *Instructions.* Warnings should instruct people about what to do or not do. The instructions should be specific inasmuch as reasonable to tell what exactly should be done or avoided. A classic nonexplicit warning statement is “Use with adequate ventilation.” Two others are “May be hazardous to health” or “Maintain your tire pressure.” These statements are inadequate by themselves to apprise people what they should or should not do. In the case of the statement “inadequate ventilation,” does it mean to open a window, two windows, use a fan, or something more technical in terms of volume of airflow per unit time? In each case, without more information, users are left making inferences that may be partly or wholly incorrect (Laughery and Paige-Smith, 2006; Laughery, Vaubel, Young, Brelsford, and Rowe, 1993). Clearly, the use of certain terminology will be dependent on the language of the target audience. For instance, speakers of American or Canadian English are likely to recognize the term *truck* and make appropriate inferences, whereas speakers of British English, being more familiar with the term *lorry*, may not.
- c. *Consequences.* Consequences information concerns what could result. It is not always necessary to state the consequences. However, one should be cautious in omitting it, because people may make the wrong inference. A common shortcoming of warnings is that the consequences information is not explicit, that is, it is lacking important specific details (Laughery and Paige-Smith, 2006; Laughery et al., 1993). The statement “May be hazardous to your health” in the context of an invisible radiation hazard is insufficient by itself as it does not tell what kind of health problem could occur. The reader could believe it could lead to minor burns not thinking that it could be something more severe, like cancer and perhaps death. In a later section, the telling of severe consequences is discussed as a factor in motivating compliance behavior.

The information contained in a warning message is also likely to influence public perception of situational risk associated with a particular hazard. Although much research has been conducted with receivers who speak English, it remains unclear whether such results (as illustrated below) can be generalized to other populations. With this caveat in mind, warning message content generally represents a source's assessment of the existence and seriousness of a threat as well as what the public should do to protect themselves (Lindell and Perry, 2004). Stylistic considerations governing the communication of warning content in English include certainty and clarity. Simply worded warning messages understandable to the public should be delivered with a high degree of certainty concerning the likelihood of hazard occurrence and the need to take preventative action (Perry, Lindell, and Greene, 1982). When message content is specific, warning recipients are likely to believe that the threat is credible and to personalize the risk that increases the likelihood that they will take some preventative action (Drabek and Stephenson, 1971). To illustrate, 80% of the approximately one million residents of New Orleans evacuated safely once they encountered dramatically worded warning messages that used strong statements such as "The area will be uninhabitable for weeks" and "Water shortages will make human suffering incredible by modern standards" (McCallum and Heming, 2006). Although the forecast and warning components of Hurricane Katrina have been described as well constructed, the post-Katrina relief and aid efforts were shameful in that they exposed complex societal issues linked to culture. For instance, even though the warnings were excellent, African Americans and those with a lower socioeconomic status were later identified as being particularly vulnerable to this disaster because they lacked the resources to evacuate. This instance clearly illustrates that just because a warning may work for one culture or income group it may not be applicable to others.

Symbols

Safety symbols may also be used to communicate the above-mentioned information in lieu of or in conjunction with text statements (e.g., Dewar, 1999; Mayhorn and Goldsworthy, 2007; Mayhorn and Goldsworthy, 2009; Mayhorn, Wogalter, and Bell, 2004; Wolff and Wogalter, 1998; Young and Wogalter, 1990; Zwaga and Easterby, 1984). Potentially, they can contribute to understanding when illiterates or nonreaders of the primary language are part of the target audience.

Comprehension is important for effective safety symbols (Dewar, 1999). Symbols that directly represent concepts are preferred because they are usually better comprehended than more abstract symbols (Magurno, Wogalter, Kohake, and Wolff, 1994; Wogalter, Silver, Leonard, and Zaikina, 2006; Wolff and Wogalter, 1993). Less directly represented concepts cannot always be developed, but with abstract and arbitrary symbols (Lesch, 2004; Wogalter, Sojourner, and Brelsford, 1997), the meaning has to be learned via training. Despite these apparent potential benefits to using symbols to convey hazard information, there have been a number of studies that show cultural differences in how people interpret the meaning of symbols. One example of such cultural differences was documented by Casey (1993) when he described a case report of Kurd villagers in northern Iraq. A skull and crossbones symbol was prominently displayed on containers of grain intended only for planting

but not eating. Despite seeing the symbol, some Kurd villagers consumed the grain and became seriously ill because they thought that the picture of the skull and crossbones was just a logo of some company.

Interestingly, cultural differences in symbol comprehension have been well documented by other researchers as well. When ANSI symbols were tested for comprehension in Ghana, severe interpretation discrepancies were noted for a number of symbols and their intended meanings (Smith-Jackson and Essuman-Johnson, 2002). Other research found that drivers from Canada, Israel, Finland, and Poland displayed large comprehension differences with traffic signs (Shinar, Dewar, Summala, and Zakowska, 2003). As already mentioned, Chinese and US participants varied in their interpretation of perceived hazards in a variety of warning component configurations. Likewise, residents of Hong Kong had difficulty interpreting the meaning of some safety signs used in mainland China (Chan and Ng, 2010). Thus, symbols should be tested for comprehension within the intended target audience (even when the perceived subcultures are geographically proximal to one another) prior to deployment in a public warning system.

Given these apparent cultural differences, it is important to assess safety symbol comprehension. What is an acceptable level of comprehension for safety symbols? Symbols should be designed to have the highest level of comprehension attainable; however, a quantitative metric would be useful to guide those tasked with developing such warning symbols. ISO 9186 (2001) provides comprehension criteria (see Deppa, 2006; Peckham, 2006) and specifies that testing should be conducted in at least three countries that vary by culture. Within the United States, the ANSI (2002) Z535 standard suggests a goal of at least 85% comprehension using a sample of 50 individuals representative from the target audience for a symbol to be used without accompanying text. If 85% cannot be achieved, the symbol may still have utility (e.g., for attention capture) as long as is not badly misinterpreted. According to the ANSI (2002) Z535 standard, an acceptable symbol within the United States must produce less than 5% critical confusions (opposite meaning or a meaning that would produce unsafe behavior). For instance, the pharmaceutical warning (see Figure 5.2)



FIGURE 5.2 Accutane warning.

used on Accutane regarding the potential for birth defects if the substance is taken during pregnancy might be wrongly interpreted such that the text “Do Not Get Pregnant” in combination with the symbol (circle/slash image superimposed over a pregnant female body) means that the substance is for birth control (Mayhorn and Goldsworthy, 2007; 2009).

Level of Knowledge

The levels of knowledge and understanding of the warning recipients should be taken into consideration. Three cognitive characteristics of receivers that may vary by culture are important: language skill, reading ability, and technical knowledge.

In general, reading levels should be as low as feasible. For the general population in the United States, the reading level probably should be approximately the skill level of grades 4 to 6 (expected ability of 10- to 12-year-old readers), yet it should be recognized that other nations and cultures may utilize a different school system. Unfortunately, functional illiteracy pervades society on a worldwide scale. For example, in the United States, there are estimates of more than 16 million functionally illiterate adults. In other areas of the world such as Ghana, national literacy rates can be as low as 41% in rural areas (Ghana Statistical Service, 2000). If so, successful warning communication may require more than simply keeping reading levels to a minimum. The use of symbols, speech warnings, and special training programs may be beneficial adjuncts. Moreover, these potential methods may also benefit literate persons. A related consideration is that different subgroups within a population may speak and read different languages, or in other words, they are culturally different from the majority in a region or nation. Interestingly, measures of culture reveal remarkable diversity between geographic locations within relatively small regions (Hofstede, de Hilal, Malvezzi, Tanure, and Vinkin, 2010). Using the Hofstede Values Survey Module, these researchers found that one nation, in this case Brazil, could be decomposed into as many as five cultural regions that illustrated distinct differences due to the presence of Afro-Brazilian and indigenous Indian roots. Thus, these results suggest that an effective warning within a country must be able to cross cultural and language barriers. One such attempt within the United States was assessed by Lim and Wogalter (2003), who concluded that culturally inclusive warnings require the use of multiple languages, combined graphics, and transmission through multiple methods to reach various subpopulations that receive it.

BELIEFS AND ATTITUDES

Beliefs and attitudes is the next major stage of the C-HIP model, and it is here that cultural diversity plays an especially significant role in human information processing. As the classic work of Douglas and Wildavsky (1982) suggests, risk is a collective belief that is subject to cultural and social contexts. Beliefs refer to an individual's knowledge that is accepted as true (although some of it may not actually be true). It is related to the previous stage in that beliefs are formed from memory structure derived from social interactions with those who share their culture. Specifically, interpersonal interactions in a social context can influence perception of risk (Kasperson et al., 1988; Masuda and Garvin, 2006). In some respects, beliefs

tend to be more global and overarching compared to specific memories. An attitude is similar to a belief except it includes more affect or emotional involvement. Past research suggests that risk attitudes vary across culture (Smith-Jackson, 2006b). For instance, culture-specific fatalism, defined as the belief that safety outcomes are predetermined and externally controlled by others, was a powerful determinant of safety-related behavior in the Ivory Coast, West Africa (Kouabenan, 1998). More recently, Latino farmworkers reported higher risk perception associated with the use of pesticides and lower perceived control of their work environments than Americans of European descent (Smith-Jackson, Wogalter, and Quintela, 2010).

People's benign experiences with a potentially hazardous product can produce beliefs that a product is safer than it is. This quickly changes after being involved in some way with (or seeing) a serious injury event. According to the C-HIP model, a warning will be successfully processed at the beliefs and attitudes stage if the message concurs (or at least is not discrepant) with the receiver's current beliefs and attitudes. However, if the warning information does not concur, then beliefs and attitudes may need to be altered so that they concur before a person can have some motivation to carry out the warning's directed behavior. The message and/or other information needs to be persuasive to override existing incorrect beliefs and attitudes. Methods of persuasion are commonly used in advertising and have been empirically explored in the social and cognitive psychology literatures.

Perhaps one of the largest areas of research involves tailoring warning messages to meet the needs and capabilities of a specific target audience (Wogalter and Mayhorn, 2005). Efforts to engage in this use of persuasive messaging can be observed in the area of health-related communication. For instance, Uskul and Oysterman (2010) suggest that message frames or wording should be culturally salient and momentarily salient in convincing people to comply with persuasive safety messages. In this work, health communications were tailored to meet the cultural aspects of the audience members (i.e., Americans of European or Asian descent) to create self-relevance, termed *cultural salience*, whereas delivery of the matched messages following presentation of culturally relevant themes made the messages situationally relevant or "momentarily salient." To create these message characteristics, this research relied heavily on the cultural distinction that suggests that western cultures tend to possess an individualistic orientation that focuses on individual achievements and independent decision making, whereas eastern cultures tend to be collectivist cultures that value group relationships (Han and Shavitt, 1994; Triandis, 1995). Consistent with this concept, Uskul and Oysterman (2010) found that European Americans found individualistic message frames more persuasive than collectivist message frames, yet the opposite trend was true for Asian Americans. Further evidence suggests message tailoring can be used to alter antitobacco advertising in terms of theme and language to specifically target bicultural Mexican American youth, thereby resulting in changes to tobacco-related attitudes that were found to be moderators for a behavioral decrease in smoking (Kelly, Comello, Stanley, and Gonzalez, 2010).

Two relevant and interrelated factors associated with the beliefs and attitudes stage are hazard perception and relevance (see DeJoy, 1999; Riley, 2006; Vredenburg and Zackowitz, 2006). Investigations of hazard perception suggests that the greater the perceived hazard, the more responsive people will be to warnings, as in looking

for, reading, and complying with them. The converse is also true. People are less likely to look for, read, or comply with a warning for products that they believe are low in hazard. For instance, poisonous substances such as mercury are frequently used during cultural and religious practices by Latino and Caribbean communities that practice Santeria (Riley, Newby, and Leal-Almeraz, 2006). Not surprisingly, many of these religious users and practitioners did not perceive the material as being hazardous. Because the health-related consequences of mercury exposure are often delayed following exposure, many people may not tie the hazard to the consequence. This is important because the level of perceived hazard is also closely tied to beliefs about injury severity. People that perceive a product to be hazardous are more likely to act cautiously when they understand that injuries can be severe (Wogalter, Young, Brelsford, and Barlow, 1999). In contrast to these environmental hazards, injury likelihood is a much less important factor in perceptions of risk or hazard for more mundane consumer products (Wogalter, Brelsford, Desaulniers, and Laughery, 1991; Wogalter, Brems, and Martin, 1993).

In such cases where perceived risk is low, it is especially important that warning recipients perceive that a safety message is being directed to them and that the warning content is applicable to them. If perceived as irrelevant, the individual may instead attribute the warning as being directed to others and not personally. For example, men may utilize pharmaceutical substances such as Propecia (for male pattern baldness) that might cause birth defects if pregnant female family members come into contact with this medication. Ideally, men should be made aware of this aspect yet they might not believe pregnancy warnings apply to them (Mayhorn and Goldsworthy, 2007, 2009). In this particular case, there is a failure of comprehension because men may not understand their role in preventing female family members from coming in contact with the drug. One way to counter this is to personalize the warning so that it gets directed to relevant users and conveys facts that indicate that it is relevant (Wogalter, Racicot, Kalsher, and Simpson, 1994). Similarly, efforts to make health-related information culturally specific via tailoring (based on individual levels of religiosity, collectivism, racial pride, and time orientation) has resulted in stimulating information processing for African-American women exposed to cancer prevention and screening information (Kreuter and Haughton, 2006).

MOTIVATION

Motivation energizes the individual to carry out an activity. Some of the main factors that can influence the motivation stage of the C-HIP model are cost of compliance, severity of injury, and social influence. These topics are discussed below.

Compliance generally requires that people take some action, and usually there are costs associated with doing so. When faced with a warning, people frequently consider what compliance will cost them in terms of resources such as money, time, and effort (Kalsher and Williams, 2006). When describing their failure to evacuate from Hurricane Charley in 2004, many elderly Americans stated that they had nowhere to evacuate to (social cost), and they lived on a fixed income and lacked the financial resources (e.g., car, money) to evacuate (Mayhorn and Watson, 2006). Likewise, many people often cite their fear of looters as a reason to ignore

evacuation orders (Mayhorn and Watson, 2006; McCallum and Heming, 2006). Practical interventions that might be used to rectify these concerns by alleviating fears might include assurances of security from authority figures as well as heightened awareness of free shelters.

The costs of noncompliance can also exert a powerful influence on compliance motivation. With respect to warnings, a main cost for noncompliance is severe injury consequences. Previous research suggests that people report higher willingness to comply with warnings when they believe there is high probability for incurring a severe injury (e.g., Wogalter et al., 1991, 1993, 1999). In fact, cultural differences in motivation and compliance lessen if people are convinced that a warning is accurate and risk is high (Perry and Lindell, 1991). When archival data for three ethnicities (i.e., Caucasians, African Americans, and Mexican Americans) were evaluated for evacuation compliance following a hazardous chemical spill, ethnicity was not a predictor of motivation to engage in protective action behavior.

Another motivator is social influence (Wogalter, Allison, and McKenna, 1989; Edworthy and Dale, 2000). For instance, seeing others not comply lessens the likelihood of compliance. However, when people see others comply with a warning, they are more likely to comply themselves (Cox and Wogalter, 2006). Often, group compliance might be considered an essential component of healthcare interventions. Previous research also suggests that the development of culturally targeted smoking cessation programs is more effective than traditional 12-step smoking cessation programs with African-American smokers (Matthews, Sanchez-Johnson, and King, 2009).

BEHAVIOR

The last stage of the sequential process is for individuals to carry out the instructions for warning-directed safe behavior (Kalsher and Williams, 2006; Silver and Braun, 1999). Warnings do not always affect behavior because of processing failures at earlier stages. Most research in this area focuses on the factors that affect compliance likelihood.

Some researchers have used “intentions to comply” as the method of measurement as a proxy to behavioral measurement because it is usually quite difficult to conduct behavioral tests. The reasons include the following difficulties: (a) researchers cannot expose participants to real risks because of ethical and safety concerns; (b) events that could lead to injury are relatively rare; (c) the construction scenario must appear to have a believable risk, yet at the same time must be safe; and (d) conducting behavioral compliance research is costly in terms of time and effort. Nevertheless, actual compliance is an important criterion for determining which factors work better than others to boost warning effectiveness and, consequently, safety behavior. Additionally, many products are used inside homes where access to determine how the product was used and whether a warning was complied with is difficult. In the future, it is likely that virtual reality will play a role in allowing research to be conducted in simulated conditions that avoid some of the above problems (Duarte,

Rebello, and Wogalter, 2010). Unfortunately, these tools are not in widespread use and may not yet be available to many other researchers interested in cultural ergonomics.

Below, the following section on teratogenic warnings serves as a case study to illustrate the current, commonly available methodology and analysis techniques that can be used to assess the affects of culture on warning exposure. Consistent with the definition of culture used by Goldberger and Veroff (1995), young adult women constitute a culture in the sense that they share demographic/physical characteristics that separate them from males and they possess a system of attitudes regarding their own reproductive health that might impact how they perceive risks posed by pharmaceutical products.

REFINING TERATOGEN WARNING SYMBOLS: A CASE STUDY IN INCLUSIVE WARNING DESIGN AND EVALUATION METHODOLOGY

Medications such as Accutane, Propecia, and Thalidomide are used to treat a variety of clinical conditions such as acne, male pattern baldness, and cancer yet they share teratogenic properties that are known to cause severe birth defects. These properties are so toxic that even brief exposure to these medications during pregnancy or prior to conception can cause significant harm to the fetus (Meadows, 2001; Perlman, Leach, Dominguez, Ruszkowski, and Rudy, 2001). One approach to mitigating this increased risk of accidental exposure to teratogenic substances is to improve warnings that appear on pharmaceutical labels.

Unfortunately, previous research conducted at the Centers for Disease Control and Prevention (CDC) suggests that the teratogen warning that appeared on Accutane (up until it was recalled from U.S. markets in 2009) may be confusing to those who encounter it (Daniel, Goldman, Lachenmayr, Erickson, and Moore, 2001). Illustrated in Figure 5.2, the warning consists of a symbol showing a circle and a slash mark superimposed over a graphic representation of a pregnant woman with the accompanying text “Do Not Get Pregnant.” Results reported by Daniel and her colleagues indicated that only 21 percent of the women exposed to the current warning were able to correctly interpret it. Moreover, 27 percent of those tested misinterpreted the warning to mean that the medication was a form of birth control.

As addressed above, a well-established benefit associated with the use of symbols is that people who cannot understand printed text warnings might be able to take advantage of pictorial safety information. Given the increasing cultural diversity of the U.S. population, the use of pictorial safety symbols has the potential to be “culturally neutral” (Edworthy and Adams, 1996). Unfortunately, assumptions of cultural neutrality cannot be relied upon unless verified by empirical investigation.

Given the shortcomings of the warning, efforts to improve patient comprehension through iterative design were implemented. Using such a technique, prototype warnings should be developed and tested for comprehension with a sample of the at-risk population. Warnings that do not meet acceptable levels of comprehension should be redesigned based on feedback from earlier test participants and retested for comprehension in an iterative process (design, test, redesign, test, etc.) until a

satisfactory level of comprehension is reached. To demonstrate and carry out the process, Goldsworthy and Kaplan (2006a) described a process where rapid prototyping, expert review, and user-centered design techniques were utilized to develop alternate teratogen warnings. Later, a field trial solicited open-ended interpretation of six candidate symbols from 300 participants (Goldsworthy and Kaplan, 2006b). These initial findings were promising because they revealed that participants' abilities to correctly interpret the meanings of several of the alternate warnings exceeded that of the existing warning, with several candidates emerging as viable alternatives to the existing warning. The candidates were further refined based on the results and a second, larger-scale field study ($N = 700$) was conducted to further validate these alternative warnings (Mayhorn and Goldsworthy, 2007). Results indicated that two of the alternate symbols exceeded 85% comprehension, and none exceeded 5% critical confusion. Also, the same two alternate symbols consistently elicited accurate responding in terms of message interpretation, target audience, intended action, and perceived consequences of ignoring the warning.

While these findings are useful in illustrating how warnings and other risk communications might be designed and evaluated, a related topic includes efforts to target a specific audience for communications purposes. To this end, audience analysis is a recognized technique that has been used for identifying the appropriate people and subgroups within a population that receive a warning (Smith-Jackson, 2006b). The section below offers an illustration of analytical tools that can be used to accomplish this task.

AUDIENCE ANALYSIS USING LATENT CLASS ANALYSIS

It is well known that audiences vary by a wide range of characteristics—some obvious, others not. It has become increasingly common to examine message interpretation not only by whether audiences get it right, but by who is getting it more or less right. For instance, risk perceptions associated with pesticide warning labels was found to differ between two ethnicities of farmworkers. The likelihood of warning compliance was found to be higher for European-American farm workers than for Latino farmworkers (Smith-Jackson, Wogalter, and Quintela, 2010). Similarly, in a study that examined several possible birth defects warning labels among a diverse group of women of childbearing age, both accuracy of warning interpretation and warning preference varied significantly by participant characteristics (Goldsworthy and Kaplan, 2006a; Mayhorn and Goldsworthy, 2007). These analyses typically examine common audience characteristics, such as age, gender, race and/or ethnicity by using simplistic statistical analytical tools such as Chi-square or Fisher's Exact Test to determine whether "correctness" or rates of particular responses vary by those demographic characteristics.

Such analytical approaches are useful in providing more information than simple descriptive statistics regarding percentages of correctness or types of responses across a sample. However, other statistical tools can provide a richer picture of audience segmentation, especially, but not only, when the hazardous situation involves multiple informational or behavioral components, when a sizable number of beliefs might be implicated in engagement (or disengagement) in a particular hazardous

action, or when a complex set of demographic characteristics is suggested by previous research or previous researcher experience. For instance, Lim and Wogalter (2003) found that the perceptions of lengthiness and print size varied when Spanish and English speakers assessed multilingual warnings. With the realization that it is not always possible to generate different warnings for all subgroups of the population, one methodological approach that may be useful in identifying pertinent receiver characteristics for those interested in cultural ergonomics is latent class analysis (LCA).

LCA is part of a broad class of analyses that also includes latent profile analysis, latent class growth analysis, latent transition analysis, growth mixture modeling, and general growth mixture modeling (Muthén, 2001). The common denominator in these analyses is that respondents are assumed to come from different populations or subpopulations rather than from a single uniform population of respondents; accordingly, this family of analyses attempts to estimate and account for group membership as part of the analytic process. In practice, LCA is a method of grouping respondents into homogeneous subgroups based on their responses to a measure of interest. Thus, behavior and attitudes rather than demographic variables might offer a more precise description of culture and it pertains to safety-related contexts.

Research by Goldsworthy, Mayhorn, and Meade (2010) examined the prescription medication loaning and borrowing behavior of 700 participants for 13 hypothetical scenarios. Examination of item endorsement probabilities and odds-ratios for all items included in the LCA revealed four distinct classes of medication loaners/borrowers. Class 1 members had extremely low probabilities of ever having loaned or borrowed medicine and were very unlikely to share or borrow medicine under any hypothetical circumstance. For this reason, this class was labeled “Abstainers.”

Class 2 respondents were very likely to have loaned or borrowed prescription medicines in the past. All Class 2 members indicated that they would share a medicine if they received it from a family member. Members of this class were also highly likely to share when they had the same problem as the person with the medicine or already had a prescription but ran out or did not have it with them. They would also be likely to share or borrow if they had an emergency, could not afford to buy the medicine, or wanted to help a friend. Conversely, respondents in this class were far less likely to share or borrow medicine when they wanted to relax or feel good, had heard a lot about the medicine from commercials, or wanted something to help them sleep. They were evenly split on whether they would share or borrow medicine for pain. Because medication history indicated a high probability of having previously loaned or borrowed medicine and the pattern of endorsement indicated that sharing likely occurred (or would occur) for pragmatic, situation-specific reasons, this group was labeled “Pragmatic Frequent Sharers.”

Class 3 respondents were evenly split in their probability of having loaned or borrowed medicine during the past. However the probabilities of endorsing hypothetical situations under which they would share or borrow were very high. That is, while Class 3 respondents were somewhat less likely than Class 2 respondents to indicate previous loaning or borrowing, they were more likely than members of all other classes to say that they would share in each situation (with the exception of “got it from a family member”). Class 3 respondents were not only likely to endorse

pragmatic reasons for loaning/borrowing, but they were also likely to endorse sharing situations that have little to do with access: they would borrow medicine to relax or feel good, help them sleep, or for pain. The probability of endorsing these items was much higher for Class 3 than for any other class. Members of Class 3 were also far more likely than members of other classes to indicate they would share or borrow a prescription medication that they had heard about from advertisements. Given the somewhat lower frequency of actual reported loaning/borrowing but the high probability of loaning or borrowing in the future in both pragmatic and outcome-based situations, this group was labeled "At-Risk Sharers." The At-Risk Sharers were significantly more likely than the other three classes to report making less than \$25,000/year, despite showing no differences in employment status. The At-Risk Sharers also had a higher percentage of respondents, indicating that they were Hispanic and spoke Spanish as their primary language.

Finally, Class 4 respondents were unlikely to have loaned or borrowed medicine in the past and were generally unlikely to share or borrow in the future. The low probability of having previously loaned clearly differentiates this class from Class 2, as do the generally lower probabilities of future sharing associated with the hypothetical scenarios. However, unlike Class 1 Abstainers, this group would be somewhat likely to share under some circumstances (e.g., emergencies). Class 4 was labeled "Emergency Sharers."

The identification of latent classes based on behaviors of interest to warnings researchers facilitates tailoring warning messages to specific groups that can improve the cultural sensitivity of warnings as described above. Such targeting could increase the effectiveness of these warnings thereby promoting safety behavior for all segments of the population. For example, in this study, four types of medication sharers were identified based on patterns of endorsement: Abstainers, Pragmatic Frequent Sharers, At-Risk Sharers, and Emergency Sharers. Because each of these groups demonstrates different medication loaning and borrowing behaviors, they are likely to respond in different ways to messages about medication sharing.

Efforts to tailor safety-related messages for At-Risk Sharers might include the following examples. Because At-Risk Sharers are less likely to have previously shared but are more likely to do so in a wider variety of circumstances than all other groups, they should be made aware of the wide range of issues associated with specific types of sharing. Interestingly, the results also confirmed previous findings that low-income and Hispanic individuals may be disproportionately at risk for engaging in risky sharing behaviors than are other individuals. Given the high representation of low-income and Hispanic individuals in the At-Risk class and the finding that At-Risk Sharers are more likely to share when having heard about a medicine in advertisements, it seems important to note that drug advertisement disclaimers about risks and side effects are usually presented verbally in English, without visual accompaniment. It is reasonable to presume that such verbal messages are not discerned, much less understood, by non-English speakers. Changing these messages to more clearly communicate the potential side effects may be an important step toward mitigating risk broadly as well as specifically within these groups.

CONCLUSIONS AND RECOMMENDATIONS

The preceding review of the warnings literature was organized around the C-HIP model (Wogalter, 2006) and demonstrated how cultural factors can impact safety-related information transmitted via risk communications. This model divides the processing of warning information into separate stages that must be successfully completed for compliance behavior to occur. A bottleneck at any given stage can hinder processing at subsequent stages. Feedback from later stages can affect processing at earlier stages. Moreover, culture can influence information processing and interaction with safety-related information at any of the stages described in C-HIP. The model is valuable in describing some the processes and organizing a large amount of research.

In this chapter, the C-HIP model was used to demonstrate the rather sizable gaps that exist in our knowledge of warning diverse populations. While a number of the examples from the literative review did not measure culture *per se*, they did illustrate how communicating with diverse populations can be challenging. Using C-HIP to provide context, a number of general recommendations can be made to inform the design and evaluation of culturally inclusive warnings.

IDENTIFYING THE TARGET AUDIENCE

Before a warning can be effectively targeted to a particular segment of the population, efforts at audience analysis should be conducted to gather information regarding past behavior as well as the many dimensions of culture, including ethnicity, gender, socioeconomic status, age, and literacy (Smith-Jackson, 2006b). Ethnographic research methods such as interviews and participant observation (Riley, Newby, and Leal-Almeraz, 2006) or focus groups (Mayhorn, Nichols, Rogers, and Fisk, 2004) can be used to gain insight into existing audience characteristics such as risk perception and attitudes regarding particular hazards. To verify that the targeted groups are vulnerable to injury, some recent efforts have used focus groups in combination with archival analysis of national injury databases (McLaughlin and Mayhorn, *in press*). It makes sense to understand whether a hazardous situation exists or is probable prior to taking the time and effort to generate a warning. If such injury databases already exist (and researchers can gain access to them) to confirm the existence of a safety-related problem, it should be possible to analyze for behavioral differences that exist by common audience characteristics (e.g., ethnicity, gender, and age) through the use of descriptive statistical tools or latent-class analysis as described by Goldsworthy, Mayhorn, and Meade (2010). It should be recognized that sometimes the absence of such informational databases does not necessarily mean that a warning is not needed. Moreover, not all researchers or warning designers around the world have access to or understand complex statistical analyses.

USING PARTICIPATORY DESIGN TECHNIQUES TO RECRUIT PARTICIPANTS AND ENGAGE THE COMMUNITY

Because cultural factors may be particularly associated with source credibility and variables related to message delivery, it is important to gain the confidence and active

participation of the members of the target audience (George, Green, and Daniel, 1996; Palenchar and Heath, 2007). Not only will this relationship be useful in recruiting participants for later warning evaluation efforts, but it will also be useful in engaging the community in safety-related issues. Participatory ergonomics is an approach that has been widely used to understand the preexisting knowledge and experience of those who comprise the target audience (Kuorinka, 1997; van Eerd et al., 2010), and this has been particularly useful in promoting “safety culture” (Bentley and Tappin, 2010). For instance, the formation of a community advisory board that includes faith-based organizations, community leaders, and community-outreach workers should be an effective means of communicating with the target audience and potentially recruiting research participants who represent this population of interest (Smith-Jackson, 2006b; Vaughan and Tinker, 2009). In effect, such efforts will allow safety practitioners to become a part of the credible “insider influences” that can be trusted, thereby enabling access to members of different cultures (Baxter, 2009; Riley, Newby, and Leal-Almeraz, 2006).

DEVELOPING AND EVALUATING THE WARNING CONTENT VIA ITERATIVE DESIGN

Once the characteristics and activities of the target audience are known from previous interactions with the target audience via consumer testing and interviews, efforts to develop the content of safety communications can begin. Using what is known about the message frames or wording combinations that are most culturally salient (and understandable/credible, etc.), warning content can be tailored to meet the needs of the target audience (Uskul and Oysterman, 2010). Prototype warnings should be developed and tested for comprehension with multiple samples such as different ethnic and cultural subgroups of the target audience in an iterative fashion (design, test, redesign, test, etc.). Warnings that do not meet acceptable levels of comprehension should be redesigned based on feedback from earlier test participants and retested for comprehension until a satisfactory level of comprehension is reached (Goldsworthy and Kaplan, 2006a, 2006b; Mayhorn and Goldsworthy, 2007, 2009).

FOLLOW-UP EVALUATION AFTER WARNING DEPLOYMENT

Once a prototype warning has undergone the aforementioned iterative process and it has been deployed to the public, the job of a safety communications practitioner is *not yet* complete. Efforts should be made to conduct a follow-up evaluation of warning message comprehension using a diverse, random sample of the target audience. While ANSI (2002) specifies that a minimum of 50 participants and ISO (2001) specifies that participants should come from at least three different countries, pictorial symbol comprehension testing needs to be culturally inclusive; therefore, stratified sampling methods that consider ethnicity, gender, age, and literacy should be implemented (Smith-Jackson, 2006b).

CONCLUSION

Along with the realization that culture can interact with any of the stages of the model, C-HIP can also be a valuable tool in systematizing the assessment process

to help determine why a warning is not effective for particular portions of the target audience. It can aid in pinpointing where the bottlenecks in processing may be occurring and suggest solutions to allow processing to continue to subsequent stages. Warning effectiveness testing can be performed using methods described in the previous research. Evaluations of the processing can be directed to any of the stages described in the C-HIP model: source, channel, environment, delivery, attention, comprehension, attitudes and beliefs, motivation, behavior, and receiver variables. In effect, the model can be used as an investigative tool to determine why a warning is inadequately carrying out its function. In this chapter, C-HIP was used as a framework to highlight existing gaps of knowledge associated with the affect of culture as a receiver characteristic during the warning process.

In closing, there is an increasing recognition that culture plays an important role in risk communication (Kreuter and McClure, 2004). While the discussion presented here was not meant to provide a comprehensive review on all the ways that culture could potentially influence warning compliance, it was meant to act as a primer to inform those interested in cultural ergonomics of existing methodological and analytical techniques that might be employed to develop inclusive warning systems. The goal was to provide direction for future warning development and research. While much empirical work remains to be done, the promise of more culturally sensitive warning systems should be effective in promoting safety for all members of the public.

REFERENCES

- Aldoory, L., and Van Dyke, M. A. (2006). The roles of perceived "shared" involvement and information overload in understanding how audiences make meaning of news about bioterrorism. *Journalism and Mass Communication Quarterly*, 83(2), 346–361.
- Andrulis, D. P., Siddiqui, N. J., and Gantner, J. L. (2007). Preparing racially and ethnically diverse communities for public health emergencies. *Health Affairs*, 26(5), 1269–1279.
- ANSI (2002). *Accredited Standards Committee on Safety Signs and Colors. Z535.1-5*, National Electrical Manufacturers Association, Arlington, VA.
- Baxter, J. (2009). A quantitative assessment of the insider/outsider dimension of the cultural theory of risk and place. *Journal of Risk Research*, 12(6), 771–791.
- Bentley, T., and Tappin, D. (2010). Incorporating organizational safety culture within ergonomics practice. *Ergonomics*, 53 (10), 1167–1174.
- Bzostek, J. A., and Wogalter, M. S. (1999). Measuring visual search time for a product warning label as a function of icon, color, column, and vertical placement. *Proceedings of the Human Factors and Ergonomics Society*, 43, 888–892.
- Casey, S. (1993). *Set Phasers on Stun: And Other True Tails of Design, Technology, and Human Error*. Santa Barbara, CA: Aegean.
- Chan, A. H. S., and Ng, A. W. Y. (2010). Investigation of guessability of industrial safety signs: Effects of prospective-user factors and cognitive sign features. *International Journal of Industrial Ergonomics*, 40 (6), 689–697.
- Cohen, H. H., Cohen, J., Mendat, C. C., and Wogalter, M. S. (2006). Warning channel: Modality and media. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 9: pp. 123–134.
- Cox, E. P., III, and Wogalter, M. S. (2006). Warning source. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 8: pp. 111–122.

- Daniel, K., Goldman, K., Lachenmayr, S., Erickson, J., and Moore, C. (2001). Interpretations of a teratogen warning symbol. *Teratology*, 64, 148–153.
- Danzig, E. R., Thayer, P. W., and Galater, L. R. (1958). *The Effects of a Threatening Rumor on a Disease Stricken Community (National Research Council Disaster Study No. 10)*, Washington D.C.: National Academy of Sciences.
- DeJoy, D. M. (1999). Beliefs and attitudes. In M. S. Wogalter, D. M. DeJoy, and K. R. Laughery (Eds.), *Warnings and Risk Communication*. London: Taylor & Francis, pp. 183–219.
- Deppa, S. W. (2006). U.S. and international standards for safety symbols. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 37: pp. 477–486.
- Desaulniers, D. R. (1987). Layout, organization, and the effectiveness of consumer product warnings. *Proceedings of the Human Factors Society*, 31, 56–60.
- deTurck, M. A., and Goldhaber, G. M. (1988). Consumers' information processing objects and effects of product warning. *Proceedings of the Human Factors Society*, 32, 445–449.
- Dewar, R. (1999). Design and evaluation of graphic symbols. In H. J. G. Zwaga, T. Boersema, and H. C. M. Hoonhout (Eds.), *Visual Information for Everyday Use: Design and Research Perspectives*. London: Taylor & Francis, pp. 285–303.
- Douglas, M., and Wildavsky, A. (1982). *Risk and Culture*. Berkeley, CA: University of California Press.
- Drabek, T. E., and Stephenson, J. S. (1971). When disaster strikes. *Journal of Applied Social Psychology* 1(2), 187–203.
- Duarte, E., Rebelo, F., and Wogalter, M. (2010). Virtual reality and its potential for evaluating warning compliance. *Human Factors and Ergonomics in Manufacturing and Service Industries*, 20(6), 526–537.
- Edworthy, J., and Adams, A. (1996). *Warning Design: A Research Prospective*. London: Taylor & Francis.
- Edworthy, J., and Dale, S. (2000). Extending knowledge of the effects of social influence in warning compliance. *Proceedings of the XIVth Triennial Congress of the International Ergonomics Association and 44th Annual Meeting of the Human Factors and Ergonomics Society*. Santa Monica, CA: Human Factors and Ergonomics Society, vol. 4, 107–110.
- Edworthy, J., and Hellier, E. (2006). Complex nonverbal auditory signals and speech warnings. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 15: pp. 199–220.
- Flynn, J., Slovic, P., Mertz, C. K., and Carlisle, C. (1999). Public support for earthquake risk mitigation in Portland, Oregon. *Risk Analysis*, 19(2), 205–216.
- FMC Corporation (1985). *Product Safety Sign and Label System*, FMC Corporation, Santa Clara, CA.
- Fothergill, A., Maestas, E. G. M., and Darlington, J. D. (1999). Race, ethnicity and disasters in the United States: A review of the literature. *Disasters*, 23(2), 156–173.
- Frascara, J. (2006). Typography and the visual design of warnings. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 29: pp. 385–406.
- Freimuth, V. S., Quinn, S. C., Thomas, S. B., Cole, G., Zook, E., and Duncan, T. (2001). African American's views on research and the Tuskegee syphilis study. *Social Science and Medicine*, 52, 797–808.
- George, M. A., Green, L. W., and Daniel, M. (1996). Evolution and implications of P. A. R. for public health. *Promotion and Education*, 3(4), 6–10.
- Ghana Statistical Service. (2000). *Ghana Living Standards Survey 4*. Accra, Ghana: Author.
- Goldberger, N. R., and Veroff, J. B. (1995). *The Culture and Psychology Reader*. New York: New York University Press.
- Goldhaber, G. M., and deTurck, M. A. (1988). Effects of consumer's familiarity with a product on attention and compliance with warnings. *Journal of Products Liability*, 11, 29–37.

- Goldsworthy, R. C., and Kaplan, B. (2006a). Warning symbol development: A case study on teratogen symbol design and evaluation. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 739–754.
- Goldsworthy, R. C., and Kaplan, B. (2006b). Exploratory evaluation of several teratogen warning symbols. *Birth Defects Research. Part A, Clinical and Molecular Teratology*, 76(6), 453–460.
- Goldsworthy, R. C., Mayhorn, C. B., and Meade, A. W. (2010). Warnings in manufacturing: Improving hazard mitigation messaging through audience analysis. *Human Factors and Ergonomics in Manufacturing and Service Industries*, 20 (6), 484–499.
- Gudykunst, W. B. (1998). *Bridging Differences: Effective Intergroup Communication*. Thousand Oaks, CA: Sage.
- Gudykunst, W. B., and Kim, Y. (1997). *Communicating with strangers*. New York: McGraw-Hill.
- Guidry, J., Fagan, P., and Walker, V. (1998). Cultural sensitivity and readability of breast and prostate cancer education materials targeting African Americans. *Journal of the National Medical Association*, 90, 165–169.
- Hacker, A. (1995). *Two Nations: Black and White, Separate, Hostile, Unequal*. New York: Ballantine Books.
- Han, S., and Shavitt, S. (1994). Persuasion and culture: Advertising appeals in individualistic and collectivistic societies. *Journal of Experimental Social Psychology*, 30, 326–350.
- Hartley, J. (1994). *Designing Instructional Text* (3rd ed.). London: Kogan Page/East Brunswick, NJ: Nichols.
- Hellier, E., and Edworthy, J. (2006). Signal words. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 30: pp. 407–417.
- Hofstede, G. (1997). *Cultures and Organizations: Software of the Mind*. New York: McGraw-Hill.
- Hofstede, G., de Hilal, A. V. G., Malvezzi, S., Tanure, B., and Vinken, H. (2010). Comparing regional cultures within a country: Lessons from Brazil. *Journal of Cross-Cultural Psychology*, 41 (3), 336–352.
- Hooper, S., and Hannafin, M. J. (1986). Variables affecting the legibility of computer generated text. *Journal of Instructional Development*, 9, 22–28.
- Hovland, C., Janis, I., and Kelley, H. (1953). *Communication and Persuasion*. New Haven, CT: Yale University Press.
- Hupka, R. B., Zaleski, Z., Otto, J., Reidl, L., and Tarabrina, N. V. (1997). The colors of anger, envy, fear, and jealousy: A cross-cultural study. *Journal of Cross-Cultural Psychology*, 28, 156–171.
- Institute of Medicine (2002). *Speaking of Health: Assessing Health Communication Strategies for Diverse Populations*. Washington, DC: National Academy Press.
- ISO (2001). *Graphical Symbols—Test Methods for Judged Comprehensibility and for Comprehension, ISO 9186*, International Organization for Standards.
- Kalsher, M. J., and Williams, K. J. (2006). Behavioral compliance: Theory, methodology, and results. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 21: pp. 289–300.
- Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., Kasperson, J. X., and Ratick, S. (1988). The social amplification of risk: A conceptual framework. *Risk Analysis*, 8(2), 177–187.
- Kelly, K., Comello, M. L. G., Stanley, L. R., and Gonzalez, G. R. (2010). The power of theme and language in multi-cultural communities which tobacco cessation messages are most persuasive to Mexican-American youth. *Journal of Advertising Research*, 50 (3), 265–278.
- Kouabenan, D. R. (1998). Beliefs and the perceptions of risks and accidents. *Risk Analysis*, 18, 243–252.

- Kreuter, M. W., and Haughton, L. T. (2006). Integrating culture into health information for African American women. *American Behavioral Scientist*, 49(6), 794–811.
- Kreuter, M. W., and McClure, S. M. (2004). The role of culture in health communication. *Annual Review of Public Health*, 25, 439–455.
- Kroeber, A., and Kluckhohn, C. (1952). *Culture*. New York: Random House.
- Kuorinka, I. (1997). Tools and means of implementing participatory ergonomics. *International Journal of Industrial Ergonomics*, 19, 267–270.
- Lasswell, H. (1948). The structure and function of communication in society. In L. Bryson (Ed.), *The Communication of Ideas*. New York: Harper, pp. 32–51.
- Laughery, K. R. (1993). Everybody knows: Or do they? *Ergonomics in Design*, July, 8–13.
- Laughery, K. R., and Paige-Smith, D. (2006). Explicit information in warnings. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 31: pp. 419–428.
- Laughery, K. R., Young, S. L., Vaubel, K. P., and Brelsford, J. W. (1993). The noticeability of warnings on alcoholic beverage containers. *Journal of Public Policy and Marketing*, 12, 38–56.
- Lehto, M. R., and Miller, J. M. (1986). *Warnings: Volume 1. Fundamentals, Design and Evaluation Methodologies*. Ann Arbor, MI: Fuller Technical Publications.
- Lesch, M. F. (2004). Comprehension and memory for warning symbols: Age-related differences and impact of training. *Journal of Safety Research*, 34, 495–505.
- Lesch, M. F., Rau, P. P., Zhao, Z., and Liu, C. Y. (2009). A cross-cultural comparison of perceived hazard in response to warning components and configurations: US vs. China. *Applied Ergonomics*, 40, 953–961.
- Lim, R. W., and Wogalter, M. S. (2003). Beliefs about bilingual labels on consumer products. *Proceedings of the Human Factors and Ergonomics Society*, 47, 839–843.
- Lindell, M. K., and Perry, R. W. (2004). *Communicating Environmental Risk in Multiethnic Communities*. Thousand Oaks, CA: Sage Publications.
- Lindell, M. K., and Perry, R. W. (1987). Warning mechanisms in emergency response systems. *International Journal of Mass Emergencies and Disasters*, 5, 137–153.
- Magurno, A., Wogalter, M. S., Kohake, J., and Wolff, J. S. (1994). Iterative test and development of pharmaceutical pictorials. *Proceedings of the 12th Triennial Congress of the International Ergonomics Association*, Vol 4, 360–362.
- Masuda, J. R., and Garvin, T. (2006). Place, culture, and the social amplification of risk. *Risk Analysis*, 26 (2), 437–454.
- Matthews, A. K., Sanchez-Johnson, L., and King, A. (2009). Development of a culturally targeted smoking cessation intervention for African American smokers. *Journal of Community Health*, 34(6), 480–492.
- Mayhorn, C. B., and Goldsworthy, R. C. (2009). “New and improved”: The role text augmentation and the application of responses interpretation standards (coding schemes) in a final iteration of birth defects warnings development. *Birth Defects Research Part A: Clinical and Molecular Teratology*, 85(10), 864–871.
- Mayhorn, C. B., and Goldsworthy, R. C. (2007). Refining teratogen warning symbols for diverse populations. *Birth Defects Research Part A: Clinical and Molecular Teratology*, 79(6), 494–506.
- Mayhorn, C. B., Nichols, T. A., Rogers, W. A., and Fisk, A. D. (2004). Hazards in the home: Using older adults’ perceptions to inform warning design. *Journal of Injury Control and Safety Promotion*, 11(4), 211–218.
- Mayhorn, C. B., and Podany, K. I. (2006). Warnings and aging: Describing the receiver characteristics of older adults. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 26: pp. 355–362.

- Mayhorn, C. B., and Watson, A. M. (2006). Older adult decision making during hurricane hazard preparation: To evacuate or shelter-in-place. *Proceedings of the 16th World Congress of the International Ergonomics Association*. Maastricht, The Netherlands.
- Mayhorn, C. B., Wogalter, M. S., and Bell, J. L. (2004). Are we ready? Misunderstanding homeland security safety symbols. *Ergonomics in Design*, 12(4), 6–14.
- Mazis, M. B., and Morris, L. A. (1999). Channel. In M. S. Wogalter, D. M. DeJoy, and K. R. Laughery (Eds.), *Warnings and Risk Communication*. London: Taylor & Francis, chap. 6.
- McCallum, E., and Heming, J. (2006). Hurricane Katrina: An environmental perspective. *Philosophical Transactions of the Royal Society, Series A*, 364, 2099–2115.
- McGuire, W. J. (1980). The communication-persuasion model and health-risk labeling. In L. A. Morris, M. B. Mazis, and I. Barofsky (Eds.), *Banbury Report 6: Product Labeling and Health Risks*. Cold Spring Harbor, New York: Cold Spring Harbor Laboratory, pp. 99–122.
- McLaughlin, A. C., and Mayhorn, C. B. (In press). Avoiding harm on the farm: Human factors. *Gerontechnology*.
- Meadows, M. (2001). The power of Accutane. The benefits and risks of a breakthrough acne drug. *FDA Consumer Magazine*, 35(2), 18–23.
- Muthén, B. O. (2001). Latent variable mixture modeling. In G. A. Marcoulides and R. E. Schumacker (Eds.), *New Developments and Techniques in Structural Equation Modeling*. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 1–34.
- Palenchar, M. J., and Heath, R. L. (2006). Strategic risk communication: Adding value to society. *Public Relations Review*, 33, 120–129.
- Peckham, G. M. (2006). ISO design standards for safety signs and labels. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 21: pp. 455–462.
- Perlman, S. E., Leach, E. E., Dominguez, L., Ruszkowski, A. M., and Rudy, S. J. (2001). “Be smart, be safe, be sure”: The revised Pregnancy Prevention Program for women on isotretinoin. *Journal of Reproductive Medicine*, 46(2 Suppl.), 179–85.
- Perry, R. W., Lindell, M. K., and Greene, M. R. (1982). Threat perception and public response to volcano hazard. *Journal of Social Psychology*, 116, 119–204.
- Perry, R. W., and Lindell, M. K. (1991). The effects of ethnicity on evacuation decision-making. *Int. J. Mass Emerg. Disasters*, 9, 47–68.
- Pinto, A., Saeed, M., El Sakka, H., Rashford, A., Colombo, A., Valenciano, M., and Sabatinelli, G. (2005). Setting up an early warning system for epidemic-prone diseases in Darfur: A participative approach. *Disasters*, 29(4), 310–322.
- Poulton, E. (1967). Searching for newspaper headlines printed in capitals or lower-case letters. *Journal of Applied Psychology*, 51, 417–425.
- Reid, P. T. (1995). Poor women in psychological research: shut up and shut out. In N. R. Goldberger and J. B. Veroff (Eds.), *The Culture and Psychology Reader*. New York: New York University Press, pp. 184–204.
- Riley, D. M. (2006). Beliefs, attitudes, and motivation. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 21: pp. 289–300.
- Riley, D. M., Newby, C. A., and Leal-Almeraz, T. O. (2006). Incorporating ethnographic methods in multidisciplinary approaches to risk assessment and communication: Cultural and religious uses of mercury in Latino and Caribbean communities. *Risk Analysis*, 26(5), 1205–1221.
- Rogers, W. A., Lamson, N., and Rousseau, G. K. (2000). Warning research: An integrative perspective. *Human Factors*, 42, 102–139.
- Rousseau, D. M., Sitkin, S. B., Burt, R. S., and Camerer, C. (1998). Not so different after all: A cross-discipline view of trust. *Academy of Management Review*, 23, 393–404.

- Rousseau, G. K., Lamson, N., and Rogers, W. A. (1998). Designing warnings to compensate for age-related changes in perceptual and cognitive abilities. *Psychology and Marketing*, 15(7), 643–662.
- Shaver, E. F., and Wogalter, M. S. (2003). A comparison of older v. newer over-the-counter (OTC) nonprescription drug labels on search time accuracy. *Proceedings of the Human Factors and Ergonomics Society 47th Annual Meeting*, Santa Monica, CA: HFES.
- Shinar, D., Dewar, R. E., Summala, H., and Zakowski, L. (2003). Traffic symbol comprehension: A cross-cultural study. *Ergonomics*, 46(15), 1549–1565.
- Silver, N. C., and Braun, C. C. (1999). Behavior. In M. S. Wogalter, D. M. DeJoy, and K. R. Laughery (Eds.), *Warnings and Risk Communication*. London: Taylor & Francis, pp. 245–262.
- Smith-Jackson, T. L. (2006a). Receiver characteristics. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 24: pp. 335–344.
- Smith-Jackson, T. L. (2006b). Culture and warnings. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 27: pp. 363–372.
- Smith-Jackson, T. L., and Essuman-Johnson, A. (2002). Cultural ergonomics in Ghana, West Africa: A descriptive study of industry and trade workers' interpretations of safety symbols. *International Journal of Occupational Safety and Ergonomics*, 8(1), 37–50.
- Smith-Jackson, T., Wogalter, M. S., and Quintela, Y. (2010). Safety climate and risk communication disparities for pesticide safety in crop production by ethnic group. *Human Factors and Ergonomics in Manufacturing*, 20(6), 511–525.
- Spence, P. R., Lachlan, K. A., and Griffin, D. R. (2007). Crisis communication, race, and natural disasters. *Journal of Black Studies*, 37(4), 539–554.
- Triandis, H. C. (1995). *Individualism and Collectivism*. Boulder, CO: Westview Press.
- U.S. Census Bureau (2009). *Monthly Resident Population Estimates by Age, Sex, Race, and Hispanic Origin for the United States*. Washington, DC: U.S. Government Printing Office.
- U.S. Census Bureau (2008). *2008 National Population Projections*. Washington, DC: U.S. Government Printing Office.
- Uskul, A. K., and Oysterman, D. (2010). When message-frame fits salient cultural-frame, messages feel more persuasive. *Psychology and Health*, 25(3), 321–337.
- Van Eerd, D., Cole, D., Irvin, E., Mahood, Q., Keown, K., Theberge, N., Village, J., St Vincent, M., and Cullen, K. (2010). Process and implementation of participatory ergonomic interventions: A systematic review. *Ergonomics*, 53 (10), 1153–1166.
- Vaughan, E., and Tinker, T. (2009). Effective health risk communication about pandemic influenza for vulnerable populations. *American Journal of Public Health*, 99(S2), S324–S332.
- Vredenburg, A. G., and Zackowitz, I. B. (2006). Expectations. In M. S. Wogalter (Ed.), *Handbook of Warnings* (Chap. 25: pp. 345–354). Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press).
- Weinstein, N. (1988). The precaution adoption process. *Health Psychology*, 7, 355–386.
- Westinghouse Electric Corporation (1981). *Product Safety Label Handbook*. Trafford, PA: Westinghouse Printing Division.
- Williamson, R. B. (2006). Fire warnings. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 56: pp. 701–710.
- Wogalter, M. S. (2006). *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press).
- Wogalter, M. S., Allison, S. T., and McKenna, N. (1989). Effects of cost and social influence on warning compliance, *Human Factors*, vol. 31, pp. 133–140.

- Wogalter, M. S., Brelsford, J. W., Desaulniers, D. R., and Laughery, K. R. (1991). Consumer product warnings: The role of hazard perception. *Journal of Safety Research*, 22, 71–82.
- Wogalter, M. S., Brems, D. J., and Martin, E. G. (1993). Risk perception of common consumer products: Judgments of accident frequency and precautionary intent. *Journal of Safety Research*, 24, 97–106.
- Wogalter, M. S., DeJoy, D. M., and Laughery, K. R. (Eds.). (1999). *Warnings and Risk Communication*. London: Taylor & Francis.
- Wogalter, M. S., Frederick, O. L., Herrera, A. B., and Magurno, A. (1997). Connoted hazard of Spanish and English warning signal words, colors, and symbols by native Spanish language users. *Proceedings of the 13th Triennial Congress of the International Ergonomics Association*, IEA '97, 3, 353–355.
- Wogalter, M. S., Godfrey, S. S., Fontenelle, G. A., Desaulniers, D. R., Rothstein, P. R., and Laughery, K. R. (1987). Effectiveness of warnings. *Human Factors*, 29, 599–612.
- Wogalter, M. S., Kalsher, M. J., Frederick, L. J., Magurno, A. B., and Brewster, B. M. (1998). Hazard level perceptions of warning components and configurations. *International Journal of Cognitive Ergonomics*, 2, 123–143.
- Wogalter, M. S., and Leonard, S. D. (1999). Attention capture and maintenance. In M. S. Wogalter, D. M. DeJoy, and K. R. Laughery (Eds.), *Warnings and Risk Communication*. London: Taylor & Francis, pp. 123–148.
- Wogalter, M. S., and Mayhorn, C. B. (2008). Trusting the Internet: Cues affecting perceived credibility. *International Journal of Technology and Human Interaction*, 4(1), 76–94.
- Wogalter, M. S., and Mayhorn, C. B. (2005). Providing cognitive support with technology-based warning systems. *Ergonomics*, 48(5), 522–533.
- Wogalter, M. S., Racicot, B. M., Kalsher, M. J., and Simpson, S. N. (1994). The role of perceived relevance in behavioral compliance in personalized warning signs. *International Journal of Industrial Ergonomics*, 14, 233–242.
- Wogalter, M. S., Silver, N. C., Leonard, S. D., and Zaikina, H. (2006). Warning symbols. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 12: pp. 159–176.
- Wogalter, M. S., Sojourner, R. J., and Brelsford, J. W. (1997). Comprehension and retention of safety pictorials. *Ergonomics*, 40, 531–542.
- Wogalter, M. S., and Silver, N. C. (1995). Warning signal words: Connoted strength and understandability by children, elders, and non-native English speakers. *Ergonomics*, 38, 2188–2206.
- Wogalter, M. S., and Silver, N. C. (1990). Arousal strength of signal words. *Forensic Reports*, 3, 407–420.
- Wogalter, M. S., and Vigilante, W. J., Jr. (2003). Effects of label format on knowledge acquisition and perceived readability by younger and older adults. *Ergonomics*, 46, 327–344.
- Wogalter, M. S., and Vigilante, W. J., Jr. (2006). Attention switch and maintenance. In M. S. Wogalter (Ed.), *Handbook of Warnings*. Mahwah, NJ: Lawrence Erlbaum Associates (Boca Raton, FL: CRC Press), chap. 18: pp. 245–266.
- Wogalter, M. S., Young, S. L., Brelsford, J. W., and Barlow, T. (1999). The relative contribution of injury severity and likelihood information on hazard-risk judgments and warning compliance. *Journal of Safety Research*, 30, 151–162.
- Wolff, J. S., and Wogalter, M. S. (1998). Comprehension of pictorial symbols: Effects of context and test method. *Human Factors*, 40, 173–186.
- Young, S. L., Laughery, K. R., Wogalter, M. S., and Lovvoll, D. (1999). Receiver characteristics in safety communications. In W. Karwowski and W. S. Marras (Eds.), *The Occupational Ergonomics Handbook*, Boca Raton, FL: CRC Press, pp. 693–706.
- Young, S. L., and Wogalter, M. S. (1990). Comprehension and memory of instruction manual warnings: Conspicuous print and pictorial icons. *Human Factors*, 32, 637–649.
- Yinger, M. (1994). *Ethnicity*. Albany: State University of New York Press.

- Zwaga, H. J. G., and Easterby, R. S. (1984). Developing effective symbols or public information. In R. S. Easterby and H. J. G. Zwaga (Eds.), *Information Design: The Design and Evaluation of Signs and Printed Material*. New York: John Wiley & Sons.