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4 Communication-Human Information Processing Stages in Consumer Product Warnings

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CONTENTS

4.1 INTRODUCTION

Research on warnings has grown considerably over the last three decades (e.g., see Laughery and Wogalter 2006; Miller and Lehto 2001; Wogalter and Laughery 2005). During this time period, researchers have investigated a wide variety of variables. The communication-human information processing (C-HIP) model provides a framework to organize and structure the seemingly disparate research literature by bringing coherence to the field. It also reveals needed research to fill gaps in knowledge (Wogalter, DeJoy, and Laughery 1999a). Most previous descriptions of C-HIP have focused on its broad generality. Some descriptions of the model demonstrate particular applicability to other more specific situations such as warning signs in the workplace (Conzola and Wogalter 2001) or for one specific category of consumer products such as pharmaceuticals or beverage

alcohol (Wogalter and Sojourner 1999; Wogalter and Young 1998). No previous review of C-HIP has specifically focused on consumer product warnings. C-HIP has applicability to a wide assortment of consumer products.

In describing C-HIP and its component stages, this chapter reviews research of some of the influential factors found at each stage. After going through the stages of the model, another benefit of the C-HIP model is described, namely, it can serve as an investigative tool for helping determine why a warning failed to be effective.

The C-HIP model has two major sections, each with several component stages. A representation of the model can be seen in Figure 4.1. The first section of the framework employs the basic stages of a simple communication model. McGuire (1980) provides a detailed description of communication theory with respect to warnings. Here, the model focuses on a warning message being sent from one entity to another, i.e., sent by a source (sender) through some channel(s) to a receiver.

The second major 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 through several stages: from attention switch, attention maintenance, comprehension and memory, beliefs and

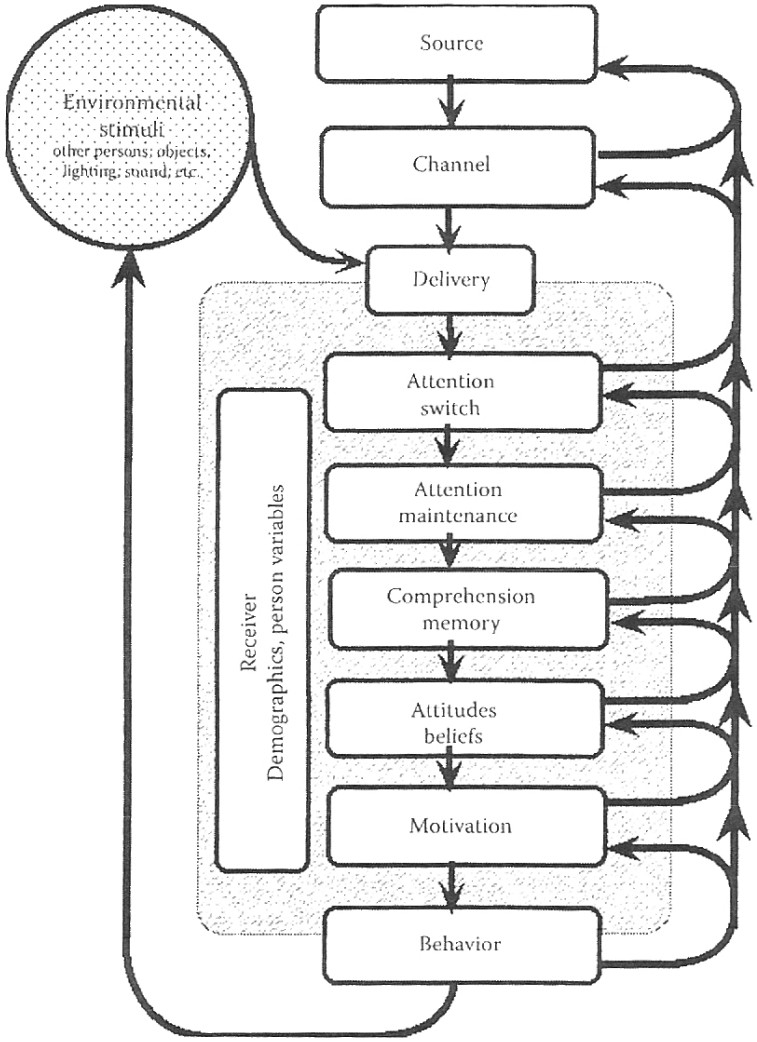

FIGURE 4.1 Communication-human information processing (C-HIP) model.

attitudes, motivation, and possibly ending in behavior. Similar information processing models have been discussed by others (Lehto and Miller 1986; Rogers, Lamson, and Rousseau 2000). Cameron and DeJoy (2006) and Lehto (2006) have reviewed other process models with respect to warnings.

4.1.1 How the Communication-Human Information Processing Model Has Evolved

One of the main benefits of the C-HIP model is that it serves as a guiding framework for organizing diverse findings in the warning research literature. Over the years, the body of research has grown to the extent that it now requires fairly substantial books to describe and summarize the literature (e.g., Wogalter, DeJoy, and Laughery 1999b; Wogalter 2006a). This chapter gives an overview of research findings relevant to each stage of C-HIP with specific focus on consumer products and their associated warnings. The purpose of the present chapter is to demonstrate that the C-HIP model is a useful conceptualization about warning processing across a wide area of consumer products. Both Wogalter et al. (1999) and Wogalter (2006a) have individual detailed chapters on most of the model's stages. The model has evolved over time. The model that pre-dated the C-HIP (Wogalter and Laughery 1996) simply presented some of the main human information processing stages (i.e., in the receiver section); in other words, only the second section of the stages of the eventual C-HIP model. The Wogalter et al. (1999) version of C-HIP added the first section from communication theory (source and channel). The most recent model from Wogalter (2006b) (i.e., Figure 4.1) is different in four ways from Wogalter et al.'s (1999) C-HIP model. First, in the current model the attention stage is split into two separate stages, attention switch and attention maintenance. The reason for the split is that these two stages are different (and often confused), and they are affected by different variables. The second major difference in the models is that there is now the stage of delivery (Williamson 2006). Delivery refers to the point of warning reception where information is provided to the receiver via one or more channels. The third change in the current model is an explict reference to the influence of other environmental stimuli. Environmental influences are aspects other than the product warning itself that could affect how the warning is processed. They are extrinsic to the warning. Environmental influences can include other information on the product label, the product itself, other people's involvement, other warnings, and other aspects in the environment including illumination and background noise (Vredenburgh and Helmick-Rich 2006). The fourth major change from the Wogalter et al. (1999) C-HIP model to the current model is greater emphasis on the receiver's personal characteristics (e.g., demographics) and task involvment (Smith-Jackson 2006, 2007; Wogalter and Usher 1999). Both the third and the fourth changes serve to emphasize how context (outside the person and warning, and internal aspects of the target person) can influence the processsing of warning content.

4.2 HOW THE COMMUNICATION-HUMAN INFORMATION PROCESSING MODEL WORKS

The C-HIP model is both a stage model and a process model. The 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 additonal 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, then low motivation (to carry out the warning's instructed behavior) could cause a blockage. If all of the stages are successful, the warning process ends in safety behavior (compliance) attributable to the warning information. While the

processing of the warning may not make it all 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.

Although the model tends to emphasize a linear sequence from source to behavior, there are feedback loops from later stages in the process that can impact earlier stages of processing, as illustrated on the right side of Figure 4.1. For example, when a warning stimulus becomes habituated from repeated exposures over time, less attention is given to it on subsequent occasions. A more specific example could be given in terms of over-the-counter (OTC) pharmaceuticals (Cheatham and Wogalter 2002, 2003). If a new hazard is added to a warning, people may not notice it if they have read the previous warning version and used the drug many times in the past. Here, memory affects an earlier stage, attention. A second example of feedback effects concerns the influence of beliefs on attention. Some individuals may not believe that a given product is hazardous, and as a result not think about looking for a warning. Thus, if people believe that a common and familiar analgesic can cause no harm, they will be less likely to read a warning that accompanies the drug. Thus, a later stage, beliefs and attitudes, affects an earlier stage of attention.

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

4.2.1 Source

The source is the initial transmitter of the warning information. The source can be a person or an organization (e.g., company, government). With respect to consumer products, the source is usually the manufacturer (although in cases of imported products, the importer/distributor in the United States may be responsible). One critical role that the source assumes is to determine if there are hazards present that necessitate a warning. Such a determination requires some form of hazard analysis (Frantz, Rhoades, and Lehto 1999; Young, Frantz, and Rhoades 2006). If a hazard is identified, the source must first determine if there are better methods of controlling it than the use of warnings, such as eliminating or designing out the hazard or guarding against it by using design and engineering procedures (see Laughery and Wogalter 2006). There are several general principles to guide when to employ a warning:

1. There is a hazard that cannot be designed out or guarded
2. The hazard, consequences, and appropriate safe modes of behavior are not known to persons at risk
3. The hazards are not open and obvious; that is, the appearance of the product or environment does not clearly expose the hazards
4. A reminder is needed to promote awareness of the hazard at the proper time

There are other considerations, such as the specific characteristics of the consumer product involved. Some products are inherently more dangerous than others. For instance, a manufacturer of drain cleaner will have a different role to play than a manufacturer of orange juice. Even relatively safe products such as orange juice can have hazards. It is the responsibility of the manufacturer to mitigate potential consumer risks, which might include the use of warnings.

If the need for a warning exists, then the source (generally the manufacturer) needs to determine how consumers should be warned, e.g., what channel(s) to use (see section below) and the warning's intrinsics characteristics. In addition, the perceived characteristics of the source can influence people's beliefs, credibility, and relevance (Cox 1999; Wogalter, Kalsher, and Rashid 1999). Information from a reliable, expert source is usually given greater credibility. It is generally assumed that the manufacturer is expert with regard to the product they produce. It is expected that they know or seek to learn

about hazards and keep them at bay. That is their role. If the source does not carry out its role satisfactorily, persons can be injured, and in some cases, depending on the country and legal jurisdiction, the manufacturer can be sued, fined, and the product recalled. Additional information on the source stage is given in Cox and Wogalter (2006). Note that some research concerning the source is properly classified as beliefs and attitudes and will be discussed further in that section of the C-HIP model.

4.2.2 Channel

The channel is the medium and modality in which information is transmitted from the source to one or more receivers. Consumer product warnings can be transmitted in many ways. Warnings can be presented in labels directly on the product, on product containers, in product manuals, in package inserts, on posters/placards, in brochures, and as part of audio-video presentations in various media such as the internet. Most commonly, warnings use the visual (text and symbols) and auditory (alarms and voice) modalities as opposed to the other senses. There are exceptions, e.g., an odor added to petroleum-based gases to enable leak detection by the olfactory sense, and the rough vibration of a product that is not mechanically functioning well, which would give tactual, kinesthetic, and haptic sensation (Mazis and Morris 1999; Cohen et al. 2006).

4.2.2.1 Media and Modality

There are two dimensions of the channel. The first concerns the media in which the information is embedded (e.g., label, video). The second dimension is the sensory modality of the receiver (visual, auditory). Some media involve one modality (e.g., product manual involves the visual sense) and others involve two modalities (e.g., videos often have both visual and auditory). Visual presentation can be composed of both or either text and symbols. Auditory presentation can be non-verbal (noise, beeps, buzzers) and verbal (voice/speech) sounds. For example, traditional smoke alarms produce non-verbal signals whereas "talking" smoke alarms, such as those depicted in Figure 4.2, produce speech warnings.

Research comparing the effectiveness of language-based warnings presented visually (text) versus auditorily (speech) is conflicting (Cohen et al. 2006). One can be better in certain circumstances with the reverse being true in other circumstances (e.g., video presentation of visual print is better than speech in terms of comprehension and memory, while audio presentation of voice is better

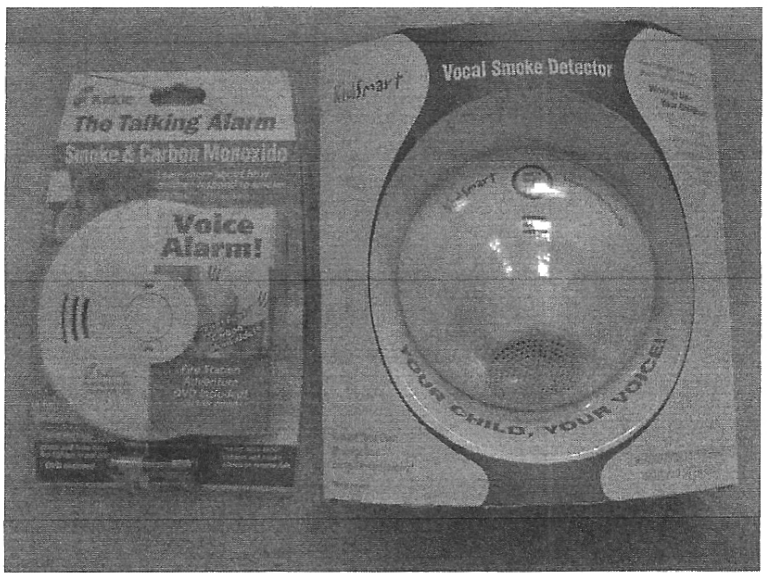

FIGURE 4.2 "Talking" smoke alarms that deliver verbal warnings.

than some signage in open environments to capture attention). However, most published research results are fairly consistent in showing that presentation in either modality is better than no warning presentation whatsoever (Edworthy and Hellier 2006). Also, warnings presented in two or more modalities are generally more effective than those presented in a single modality. This finding is applicable for the design of warnings associated with television and internet advertising as is done with prescription pharmaceuticals in the United States (Wogalter et al. 2002). Thus, a video-based warning is better if the words are shown on a screen compared to giving the same information orally or just visually (Barlow and Wogalter 1993; Kalsher and Wogalter 2007).

Multi-modal warnings provide redundancy. If an individual is not watching a visual display, he/she can still hear it (Barlow and Wogalter 1993; Wogalter and Young 1991). If the individual is blind or deaf, the information is available in the other modality. In addition, if an individual sees and hears warning information, there is a greater likelihood that the message will be delivered to otherwise vulnerable receivers (e.g., both deaf and blind persons will be satisfied and persons overloaded in one modality could receive it in another modality). Also, there is a well-supported theory in cognitive psychology and education that multi-modal presentation enhances learning because the information is richer and may link to greater or better internal representational nodes (Paivio 1971).

Longer, more complex messages may be better presented visually because reading language is generally faster and allows easier review and re-review of the material. However, shorter, less complex messages presented auditorily can be more effective than the same messages presented visually. Also, the presentation of an auditory signal is generally better for switching attention (a stage described below). An implication from this analysis is that a short auditory warning, pointing to more detailed information accessible elsewhere would be beneficial for capturing attention as well as enabling the processing of longer and more complex information. An example demonstration of this is the "talking box" used in Conzola and Wogalter (1999).

4.2.2.2 Warning System

As the above discussion suggests, the conceptualization of warnings solely as static labels is too narrow a view of how warning information may be transmitted for a consumer product (Laughery and Wogalter 1997; Wogalter and Mayhorn 2005). For many consumer products, warnings may be transmitted by manufacturers via many media and be received at different times. Warning systems for a particular product may consist of a number of components. For example, a warning system for a prescription acne medication, such as Accutane, may consist of several components: a printed statement on the outside packaging or box, on a bottle or blister pack, and a sheet insert (Mayhorn and Goldsworthy 2007, 2009). Television advertisements for prescription drugs in the United States also may contain warnings (Vigilante, Wogalter, and Mayhorn 2007). The manufacturer's web site and other web sites may have warnings (Hicks, Wogalter, and Vigilante 2005; Vigilante and Wogalter 2005) or replacement product manuals that are available for consumers. An example web page with downloadable manuals is shown in Figure 4.3. The physician who prescribed it and the pharmacist who fills the prescription are other potential sources of warnings. Organizations including government agencies such as the U.S. Food and Drug Administration and the U.S. Consumer Product Safety Commission and consumer and trade groups such as Consumers Union and Underwriters Laboratories could provide additional materials.

The purpose and content of the components of a warning system are not necessarily identical. For example, some components may be designed for the purpose of capturing attention and direct the person to another component containing more information for comprehension or to affect beliefs and attitudes, or may be intended for different target audiences. The multiple components of the warning system can provide the advantages (e.g., redundancy) of multiple media and modalities described above.

4.2.2.2.1 Direct and Indirect Communications

The distinction between direct and indirect effects of warnings concerns the routes by which information gets to the target person (Wogalter and Feng in press). A direct effect occurs as a result of the

NATIONAL MOWER COMPANY

SINCE 1919

Maintenance Manuals	Acrobat Reader PDF file
68 Triplex-CE owners manual	Complete file (1.47MB)
8400 Owners manual	Complete file (2.17MB)
8400 Owners manual (Pages 01–10)	Pages 01–10 (459K)
8400 Owners manual (Pages 11–20)	Pages 11–20 (679K)
8400 Owners manual (Pages 21–30)	Pages 21–30 (426K)
8400 Owners manual (Pages 31–40)	Pages 31–40 (399K)
8400 Owners manual (Pages 41–52)	Pages 41–52 (430K)
84 Triplex owners manual	Complete file (1.65MB)
84 Triplex owners manual (Pages 01–11)	Pages 01–11 (489K)
84 Triplex owners manual (Pages 12–23)	Pages 12–23 (390K)
84 Triplex owners manual (Pages 24–35)	Pages 24–35 (490K)
84 Triplex owners manual (Pages 36–45)	Pages 36–45 (424K)
Hydro 70 owners manual	Complete file (1,029K)
Hydro 70 owners manual (Pages 01–12)	Pages 01–12 (329K)

FIGURE 4.3 Dissemination of replacement owner's manuals via the internet.

person being directly exposed to the warning. Warnings can also be delivered indirectly. One example is learning about a hazard in a conversation with a family member or friend. To illustrate this point, Tarn and Greenfield (2010) provided evidence that exposure to alcohol warnings may be instrumental in preventing incidences of drunk driving by others. Likewise, the employer or physician who reads warnings and then verbally communicates the information to employees or patients are also examples. Adults who have responsibility for the safety of children are another important category. Figure 4.4 is an illustration of a warning for infant caregivers concerning fall hazards associated with inappropriate use of a child seat. (Unfortunately it is not very salient so many caregivers might not notice it.)

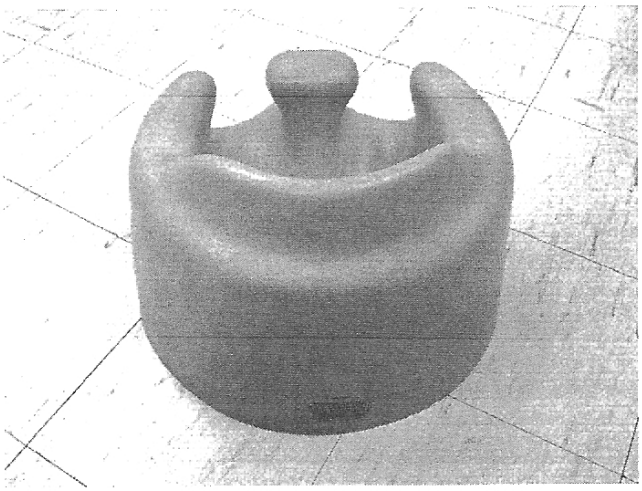

FIGURE 4.4 Child seat with warning located on the rear.

Potentially, a warning put out by a manufacturer could be useful even if an individual does not see the warning if it is communicated via another person who viewed it. With respect to C-HIP, the material sent from the source (usually the manufacturer) to the receiver through some channnels provides the direct communication of warnings to the receiver. Indirect effects involve the delivery (discussed below) of that warning information by others, which according to the current C-HIP model is part of from the environment component shown in Figure 4.1.

4.2.3 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 at the receiver. To emphasize its importance, it is shown as a separate stage in the current C-HIP model shown in Figure 4.1. A warning that a person sees or hears is a warning that has been delivered. A safety video that is produced but never reaches the individual would be delivery failure. The reason for the failure to deliver the warning to targeted individuals can be multifold. The video may be sitting in bulk boxes in a warehouse and not have been distributed. Or the distribution could be haphazard, reaching some intended persons and not others. But even if individuals receive the video, they may not receive the needed information. They may not have the time or playback equipment to see it. 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. As stated above, warnings disseminated by the souce can have indirect effects, e.g., the warning information from a disseminated safety video may be conveyed by someone who viewed it. The point is that if warnings given by a source do not reach the targets at risk either directly or indirectly, then the warning will have no or limited effects on the receiver.

4.2.4 Environmental Stimuli

Besides the subject warning, other stimuli are almost always simultaneously present. They may be other warnings or a wide assortment of non-warning 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. Several examples can illustrate. A cellular phone ringing just when an individual begins to examine a warning may cause distraction and lead to the warning not being fully read. Likewise, a crying infant during mealtime may prevent a parent from comprehending the almost illegible warning information on

the child seat illustrated in Figure 4.4. The environment can have other effects. The illumination can be too dim to read the warning. In such cases of distraction or legibility, another warning of greater salience could have the capability to attract and hold a person's focus instead.

Environmental influences can include other people. Awareness about what other persons are doing in the local environment and elsewhere can affect warning compliance positively or negatively. Seeing other people wearing safety helmets on bicycles and motorcycles suggests it is proper behavior to wear them. But seeing adverisements with persons not wearing goggles, gloves, or other needed protective equipment while apparently using a hazardous product can suggest that such protection is not needed, even though the product's warning requires its use. Such a disconnect between warning materials and advertisements located on packaging materials is apparent on the box pictured in Figure 4.5 of the aforementioned child seat. While the warning text located on the product states "never use on a raised surface," the packaging materials portray pictures of children at a birthday party, positioned on a table (raised surface) while sitting in the child seat. Arguably, this apparent inconsistency in safety information might be confusing to parents and may lead to an infant being injured. Clearly then, the environment can have effects on warning processing.

4.2.5 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 following sections are organized around these stages of information processing.

4.2.5.1 Attention Switch

An effective warning must initially attract attention. 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 conspicousness. 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 matters.

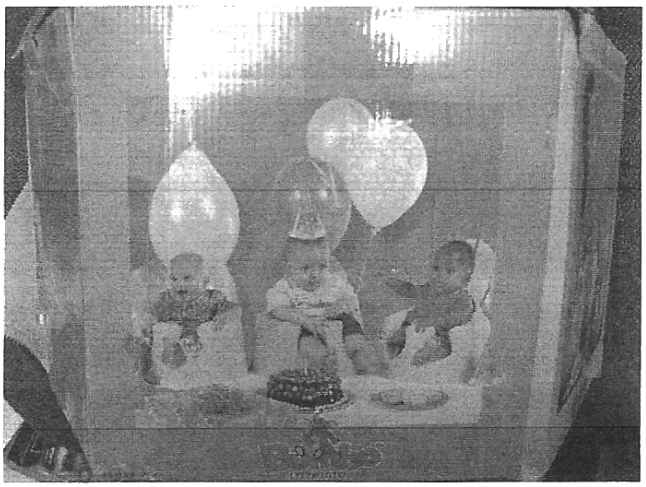

FIGURE 4.5 Advertising photograph located on the packaging of a child seat.

Consider the can of hairspay depicted in Figure 4.6. Here, the warning text regarding the flammability hazard is considerably smaller than the advertising pronouncement that the buyer gets "33.5% more free" when this product is purchased.

For some products, the available surface area is limited, e.g., small product containers such as pharmaceuticals. Putting all of the hazards on the primary on-product (container) label could reduce the salience of the most critical information (e.g., by decreasing print size). Solutions include expanding the surface area, including the addition of tags, peel-off labels (Barlow and Wogalter 1991; Wogalter, DeJoy, and Laughery 1999b; Wogalter and Young 1994), or ancillary sheets.

Color is an important attribute that can facilitate attracting attention (Bzostek and Wogalter 1999; Laughery, Young et al. 1993). While there are potential problems with using color as the only method of conspicuity, such as color blindness in some individuals, color is a frequently used design component to attract attention. The ANSI Z535 (2002) warning standard uses color as one of several components of the signal word panel to attract attention. Other design components in the ANSI Z535 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 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 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 (Bzostek and Wogalter 1999; Laughery et al. 1993). This symbol serves as a general alert. Bzostek and Wogalter (1999) found results showing people were faster in locating a warning when it was accompied by an icon. Other kinds of symbols may be used to convey more specific information. This latter purpose is discussed in the later comprehension section, but the point here is that a graphic configuration can also benefit the attention switch stage.

Warnings located proximal to the hazard, both temporally and physically, generally increase the likelihood of attention switch (Frantz and Rhoades 1993; Wogalter, Barlow, and Murphy

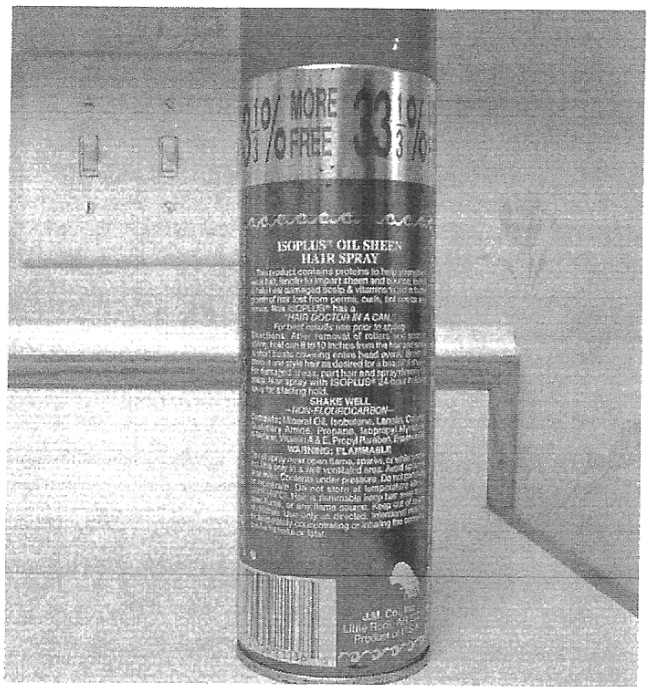

FIGURE 4.6 Warning on a can of hairspray.

1995). Warnings should be located to maximize the chance that they will be encountered. This aids in delivery. For instance, a parent interacting with a child who is sitting in the child seat depicted in Figure 4.4 is unlikely to encounter the warning located on the rear of the product. To further illustrate this point, a warning about carbon monoxide (CO) hazards on a gas-powered electrical generator is more likely to be effective than one located in a separate, sometimes displaced (e.g., in a file or possibly lost or never received) product manual (Mehlenbacher, Wogalter, and Laughery 2002). Generally, placement directly on the product or its primary container is preferred, particularly if the product is potentially highly dangerous (Wogalter et al. 1991; Wogalter, Barlow, and Murphy 1995). There may be exceptions to the proximity rule, such as where the warning is presented too close in location and/or time to the hazard, and the individual sees or hears it too late to avoid the hazard.

Repeated, long-term exposure to a warning may result in a loss of its ability to evoke an attention switch at later times (Thorley, Hellier, and Edworthy 2001). This process or state of habituation can eventually occur even with well-designed warnings; however, better designed warnings with salient features can slow the habituation process. Where feasible, changing the warning's appearance may be useful in reinvigorating attention switch previously lost due to habituation.

Tasks that the individual may be performing and other stimuli in the environment may absorb attention and may compete with the warning for attention capture (Wogalter and Usher 1999). Thus, the warning should have characteristics to make it highly salient in context.

4.2.5.2 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 may be 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 as fast as a glance. For longer, more complex warnings, attention must be held for a longer duration to acquire the information. 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 the material. The effort necessary to acquire the information should be as little as possible. Thus, a goal is 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, it also tends to increase legibility, which makes the print easier to read.

It is not difficult to find products with print on labels that is too small for older adults with age-related vision problems to read without a magnifying glass (Wogalter, DeJoy, and Laughery 1999b; Wogalter and Vigilante 2003). Not only might people not read a warning due to the effort involved, they may also believe that the material is relatively unimportant, otherwise the print would be larger.

Print legibility can be affected by numerous factors including choice of font, stroke width, letter compression and distance between them, resolution, and justification (see Frascara 2006). Although there is not much research to support an unequivocal preference for particular fonts, the general recommendation is to use relatively plain, familiar alphanumerics. It is sometimes suggested that sans serif font like Helvetica, Futura, and Univers for large text sizes and a serif font like Times, Times Roman, and New Century Schoolbook be used for smaller-sized text. A chart with print sizes for expected reading distances in good and degraded conditions can be found in the ANSI (2002) Z535.4 product warning standard.

Legibility is also benefitted by high contrast between objects, such as text lettering, relative to their background. Consider the poor contrast between the warning text on the vaporizer illustrated in the gray scale photo in Figure 4.7. Both the text and the background are in the same color, blue. In this instance, it is unlikely that consumers will notice let alone maintain their attention with this particular warning. Black on white or the reverse has the highest contrast, but legibility can be

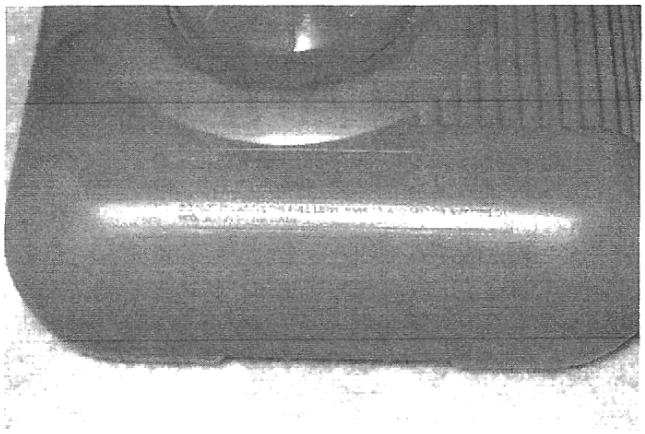

FIGURE 4.7 Warning on a vaporizer.

adequate with other combinations, such as black print on yellow (as in the ANSI Z535.4 "CAUTION" signal word panel) and white print on red (as in the ANSI Z535.4 "DANGER" signal word panel).

People will more likely maintain attention if a warning is well designed (i.e., aesthetic) with respect to formatting and layout. Research suggests that people prefer warnings that are in a list outline format as opposed to continous 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 formatting is worse than left justified text (Hooper and Hannafin 1986). In terms of formatting, the warning text of the child seat illustrated in Figure 4.8 is poor with respect to several of these characteristics, and it is unlikely to maintain the attention of a parent using the product with his or her child. 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). Research also shows that people like the added formatting, but a more important need for older adults was having adequate print size on labels so that they could read it (even if it loses the chunked structure provided because of the removal of white space). Younger readers do not have trouble reading smaller sizes, so formatting through white spacing is a useful add-on for this age group.

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. Formatting can make the visual display aesthetically pleasing to help hold people's attention on the material.

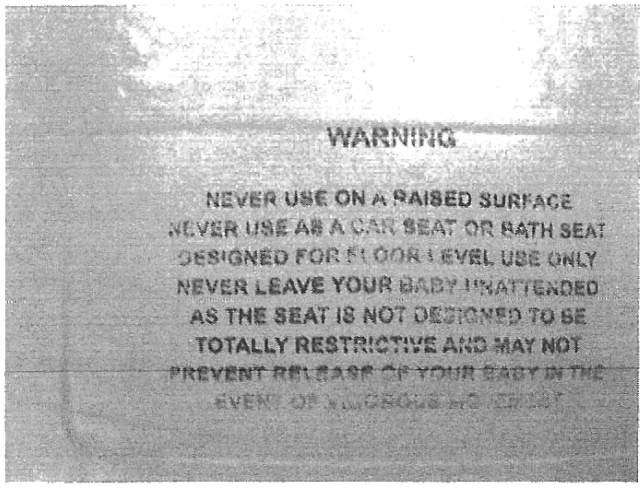

FIGURE 4.8 Warning text located on a child seat.

Formatting can help process the information by "chunking" it into smaller units. Formatting can also show the structure or organization of the material, thus making it easier to search for and assimilate the information into existing knowledge and memory (Hartley 1994; Shaver and Wogalter 2003). Figure 4.9 illustrates an example of the "Drug Facts" format used to communicate safety information on OTC drugs that is currently mandated by the U.S. Food and Drug Administration (U.S. FDA 2001).

4.2.5.3 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 refers to relatively permanent long-term memory structure. The following sections contain short reviews of some major conceptual research areas with respect to warnings and the comprehension stage.

4.2.5.3.1 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 different levels of hazard: DANGER, WARNING, or CAUTION (see also FMC Corporation 1985; Peckham 2006; Westinghouse Electric Corporation 1981). According to ANSI Z535, 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. Although the term DEADLY has been shown in several research studies to connote significantly higher hazard than the standard's highest level DANGER, the use of DEADLY is not part of ANSI Z535 (e.g., see Hellier and Edworthy 2006; Wogalter, Kalsher et al. 1998; Wogalter and Silver 1990, 1995).

According to ANSI Z535, the signal word panels for DANGER, WARNING, and CAUTION are assigned specific colors: red, orange, and yellow, respectively. This assignment provides a form of redundancy due to the presence of more than one cue. However, most people do not reliably distinguish different levels of hazard associated with the colors orange and yellow (Chapanis 1994; Mayhorn, Wogalter, and Shaver 2004; Wogalter et al. 1998). The signal word panels also contain the alert symbol (triangle/exclamation point), which indicates it is a warning (Wogalter et al. 1998;

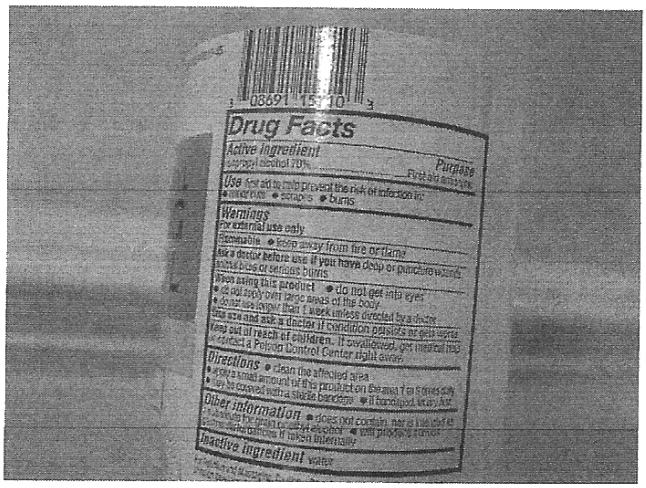

FIGURE 4.9 "Drug facts" formatting.

Wogalter, Jarrard, and Simpson 1994). Instead of the alert symbol, the older version of the ANSI Z535.2 (1991) standard had a different kind of shape cue co-occuring within the signal word panel (DANGER had a red, white, and black oval, and WARNING was surrounded by a hexagonal border).

4.2.5.3.2 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 et al. 1987). There are exceptions when the hazard is: (a) general knowledge; (b) known from previous experience; or (c) "open and obvious," i.e., apparent to everyone (except very young children).

a. *Hazard information*. At a minimum, the warning should identify the safety problem. Oftentimes, 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 non-explicit warning statement is "Use with adequate ventilation." Two others are "may be hazardous to health" or "maintain your tire pressure." By themselves these statements are inadequate to apprise people of what they should or should not do. In the case of "inadequate ventilation," does it mean to open a window, two windows, use a fan, or something more technical in terms of volume of air flow per unit time? The statement "may be hazardous to health" does not tell the mechanism by which injury may occur and the severity of the injury nor its probability. The statement "maintain your tire pressure" does not tell that there is an injury potential (as opposed to tread wear). 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 et al. 1993).
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, i.e., 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 a toxic vapor hazard is insufficient by itself as it does not tell what kind of health problem could occur. The reader might believe it could lead to minor throat irritation not thinking that it could be something more severe, like permanent lung damage and perhaps death. To illustrate a poor example of consequence information communication via a warning, consider the depilatory product warning depicted in Figure 4.10. Here, the only consequence information regarding potential eye injuries states that "if irritation occurs" following eye contact, consumers should seek medical attention. From this, people might not readily infer that there is real potential for serious eye injury, possibly permanent blindness, resulting from this product. In a later section of this chapter, the specification of severe consequences is discussed as a factor in motivating compliance behavior.

4.2.5.3.3 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, 2009; Mayhorn, Wogalter, and Bell 2004; Wolff and Wogalter 1998; Young and Wogalter 1990; Zwaga and Easterby 1984). Such symbols can contribute to understanding when illiterates or non-readers 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 et al. 1994; Wogalter et al. 2006; Wolff and Wogalter 1993). With abstract and

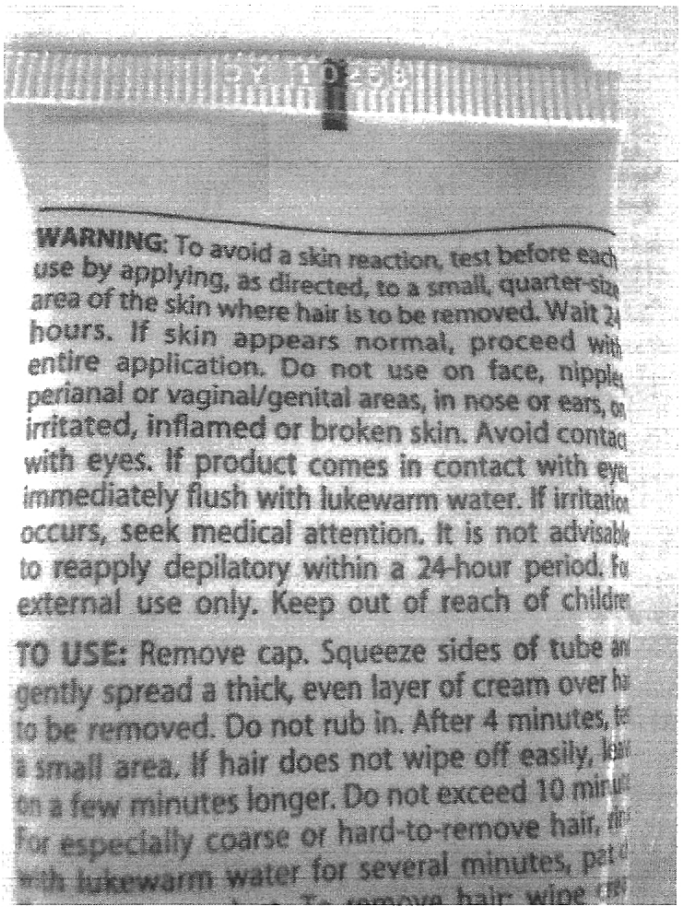

FIGURE 4.10 Warning on a depilatory product.

arbitrary symbols (Lesch 2003; Sojourner and Wogalter 1997, 1998; Wogalter, Sojourner, and Brelsford 1997), the meaning typically has to be learned via training.

What is an acceptable level of comprehension for safety symbols? In general, symbols should be designed to have the highest level of comprehension attainable. The ANSI (2002) Z535.3 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 it is not likely to be misinterpreted. According to the ANSI (2002) Z535.3 standard, an acceptable symbol must produce less than 5% critical confusions (opposite meaning or a meaning that would produce unsafe behavior). For example, the pharmaceutical warning shown in Figure 4.11 (circle/slash image superimposed over a pregnant female body) currently in use on the drug Accutane regarding the potential for birth

FIGURE 4.11 Pharmaceutical warning on Accutane.

defects if the substance is taken during pregnancy might be wrongly interpreted as meaning that the drug is for birth control (Mayhorn and Goldsworthy 2007, 2009). ISO (2001) has similar comprehension criteria (see Deppa 2006; Peckham 2006).

Repeated exposure to an unchanged warning over time will not only result in it being less effective in switching attention, but also less effective for maintaining attention. As mentioned earlier, even a well-designed warning will eventually become habituated if repeatedly encountered. Fortunately, habituation as a memory concept implies that the person has learned some amount of information from the warning to "know" to ignore it. Unfortunately, only part of the warning may actually be known. Some techniques for reducing habituation include: (a) using salient features, and (b) periodically varying the warning's appearance (and content, if feasible and appropriate).

Although individuals may have knowledge about a hazard, they may not be aware of it at the time they are at risk. People have vast stores of knowledge in long-term memory based on an accumulation of experience in their lives. Despite this amazing memory storage space, at any given time only a small portion of it is consciously available. As people are doing their tasks in daily life and at work, their minds are not always actively accessing risk information. Thus, while a person may have some or an extensive store of risk knowledge, this information and related knowledge may not be activated unless there is an external cue to activate it. Consider the electrical hazard tag on hair dryers. Because of its presence, people are more likely to be reminded to keep away from water than if the tag were not secured to the electrical cord. Of course, seeing this tag every day results in habituation where it is infrequently noticed. But its presence is better than its absence, as for example it may serve as a reminder to some persons. So, despite habituation, the presence of a warning may serve to cue relevant hazard information. Some cues can activate large amounts of knowledge, so a single word or symbol may evoke much more than its literal interpretation. Without a reminder, known risk knowledge is less likely to be brought to mind.

In summary, information in long-term memory can be cued by the presence of a warning and bring forth related, previously dormant knowledge into conscious awareness. Reminders may be appropriate in situations: (a) where the hazard is infrequently encountered in which forgetting may be an issue, and (b) when there are foreseeable distractions or high task-load involvement that could pull attention away from normative hazard considerations.

4.2.5.3.4 Level of Knowledge

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

With regard to pharmaceuticals, it is not unusual for consumers to be given textual warnings beyond their reading skill. In general, reading levels should be as low as feasible. For the general population, the reading level probably should be approximately the skill level of grades 4–6 (expected ability of 10 to 12-year-old readers). There are large numbers of functionally illiterate persons, even in some of the most technologically advanced countries. For example, in the United States there are estimates of over 16 million functionally illiterate adults. Thus, 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. Also, a related consideration is that different subgroups within a population may speak and read different languages. Because of increasing international trade and travel and the need to cross language barriers, this problem might require the use of multiple languages, graphics, and transmission through multiple methods (Lim and Wogalter 2003). An example is illustrated in Figure 4.12, which depicts the warning on a heat gun used to remove wall paper and paint. It shows a pictorial of a fire and text in both English and French, and further on the right slide is Spanish.

Despite considerations at the minimal end, reading levels should be consistent with the reading abilities of the receivers. A warning to trained health care professionals should use standard verbiage expected by that population. These technical experts have a more complete understanding

Photo file no. 98-4460244 Date taken: 12/5/00
Description: Heat gun

FIGURE 4.12 Warning on a heat gun.

of domain-specific hazards and can perform their jobs better with area-appropriate technical data. A warning to the general consuming public does not have the luxury of knowing that the receivers have an extensive background. The short standardized text in the U.S. FDA's Drug Facts labels (see Figure 4.9) on OTC (or non-prescription) drugs is a simplified, less extensive description of the drug than a physician or other health professional may receive. Training depends on the type of occupation. A tire salesperson or tire buster (professional installer of tires) cannot be expected to have extensive training on the hazards and warnings associated with tire choice and installation. Any schooling or training on the topic is likely to be no more than a short course or two, and probably less, such as on-the-job training. Here, the warnings might not be much more different in level of difficulty than those transmitted to the public.

It is not usually necessary to give highly technical warning information to a general target audience of end users. Indeed, it can sometimes be counterproductive in the sense that encountering such information may result in little or no attention being given to the material. Reasons have already been discussed in the section on attention maintenance stage. Instead, pharmaceutical information directed to general consumers needs to give its indications for use, contraindications, side effects, and how to use it safely (i.e., hazard, consequences, and instructions as described above). When there are multiple groups of people with different characteristics, different parts of the warning system can be used to communicate to different groups.

4.2.5.4 Beliefs and Attitudes

Beliefs and attitudes is the next major stage of the C-HIP model. 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. 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.

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 before a person will be motivated 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. Sometimes, unequivocal and explicit statements can be used to persuade, but also the features of the warning may convey a higher level of importance. Such persuasion is important when a product is more hazardous than people believe. While changing people's beliefs may present some challenges, the task is even more difficult when other communications (e.g., through marketing and advertising, or simply poor news reporting) lead people to believe that the product is more safe than it is. For example, Figure 4.13 illustrates how advertising materials located on the packing materials of a child seat might invoke beliefs about product safety when it includes assertions about awards conferred by various organizations and language stating that physicians recommend it to improve the well being of a child. In the following paragraphs, several relevant and interrelated factors associated with the beliefs and attitudes stage: hazard perception, familiarity, prior experience, and relevance, are discussed (see DeJoy 1999; Riley 2006; Vredenburgh and Zackowitz 2006).

Hazard perceptions influence processing at the beliefs and attitudes stage. 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 do not believe are hazardous. Perceived hazard is closely tied to beliefs about injury severity. People perceive a product is more hazardous and act more cautiously when injuries could be severe (Wogalter, Young et al. 1999). Interestingly, however, injury likelihood is a much less important factor in perceptions of risk or hazard for consumer products (Wogalter et al. 1991; Wogalter, Brems, and Martin 1993).

Familiarity beliefs are formed from past similar experiences stored in memory. It is the belief that almost everything that needs to be known about a product or situation is already known. A person believing that they are adequately familar with a product might assume that a different, but similar, product operates in the same way and has the same hazards (which may not be true), reducing the likelihood that he or she will look for or read a warning (Godfrey and Laughery 1984; Goldhaber and deTurck 1988; Wogalter et al. 1991). For example, women with prior tampon usage reported a reduced likelihood of reading a warning on more absorbant (and more hazardous) tampons (Godfrey and Laughery 1984).

Research indicates that hazard perception is more important than familiarity with respect to warnings (Wogalter et al. 1991). This is probably due to two factors. First, people more familiar with a situation or product may have more knowledge about the hazards and how to avoid them. Second, greater use also tends to increase exposure to warnings, which increases the opportunity to be influenced by them.

FIGURE 4.13 Advertising materials depicted on the packaging of a child seat.

Related to familiarity is prior experience. The concepts are somewhat different in that familiarity is a belief (that may or may not be true), and prior experience is an objective quantity that could potentially be measured. Prior experience can be influential in hazard perceptions. Having experienced some form of injury or having personal knowledge of someone else being injured enhances hazard perceptions (Wogalter, Brems, and Martin 1993). For instance, older adults who were personally familiar with the hazards associated with household products, such as cleaning solutions and small appliances, or who were aware of injuries to someone else were able to produce more effective hazard avoidance strategies (Mayhorn et al. 2004). Similarly, the lack of such experiences may lead to underestimating dangers, or not thinking about them at all. Warnings that give vivid explicit consequences may convince people to change beliefs when they have inappropropriate low levels of perceived hazard. For instance, the Canadian cigarette warning illustrated in Figure 4.14 contains much more explicit information regarding the likelihood of nicotine addiction than is currently in cigarette warnings in the United States.

Perceived relevance is the belief that something is applicable to the person. If the individual does not believe that the warning is relevant to them, then the warning may fail to fufill its intended purpose. The individual may instead attribute the warning as being directed to others and not to himself or herself. 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 in contact with it. While men may be made aware of this property, they obviously will not believe that pregnancy warnings apply to them (Mayhorn and Goldsworthy 2007, 2009). 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 et al. 1994).

A point related to beliefs and attitudes and more specifically, familiarity, concerns the problem of experts overestimating what lay persons know, which in turn may affect what kinds of warnings are produced (Laughery 1993). Experts in a domain can be so facile with their knowledge about a topic that they fail to realize that non-experts do not have similar knowledge. What is "obvious" to them may not be as obvious to end users. Without consumer input into the design of warnings, there may be a tendency to produce warnings that fail to meet the needs of end users.

4.2.5.5 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, social influence, and stress. These topics are discussed below.

Compliance generally requires that people take some action, and usually there are costs associated with doing so. The costs of complying may include time and effort to carry out the behavior (Wogalter et al. 1987; Wogalter, Allison, and McKenna 1989). When people perceive the costs of compliance to be too high, they are less likely to perform the safety behavior. This problem is

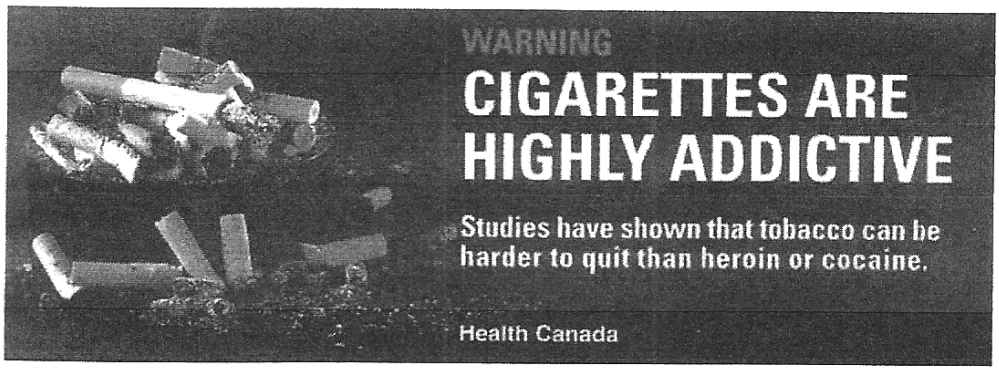

FIGURE 4.14 Canadian cigarette warning.

commonly encountered in warnings with instructions directing behaviors that are inconvenient, difficult, or occasionally impossible to carry out. One way to reduce cost is to make the directed behavior easier to perform. For example, if hand protection is required when using a product, the presence of gloves should be as simple, easy, and convenient as possible (Dingus, Hathaway, and Hunn 1991).

The costs of non-compliance can also exert a powerful influence on compliance motivation. With respect to warnings, a main cost for non-compliance is severe injury consequences. Previous research suggests that people report higher willingness to comply with warnings when they believe there is a high probability of incurring a severe injury (e.g., Wogalter et al. 1991, 1999; Wogalter, Brems, and Martin 1993).

Another motivator is social influence (Wogalter, Allison, and McKenna 1989; Edworthy and Dale 2000). When people see others comply with a warning, they are more likely to comply themselves. Likewise, seeing others not comply, lessens the likelihood of compliance. Other factors affecting motivation are time stress (Wogalter, Magurno et al. 1998) and mental workload (Wogalter and Usher 1999). Under high stress and workload, competing activities take resources away from processing warning information.

4.2.6 Behavior

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

Some researchers have used "intentions to comply" as the method of measurement because it is usually quite difficult to conduct behavioral tests. The difficulties include the following: (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 scenario must appear to have a believable risk, yet at the same time must be safe; and (d) running such research is costly in terms of time and effort. Nevertheless, compliance is an important criterion for determining which factors work better than others to boost warning effectiveness and, consequently, safe behavior. Additionally, many products are used inside homes where access to determine how a product is used and whether a warning was complied with is difficult. Virtual reality may play a role in allowing research to be conducted in simulated conditions that avoid some of the above problems (Duarte, Rebello, and Wogalter 2009). Also, compliance can be measured indirectly. For example determining whether protective gloves have been worn can be gleaned from whether they appear to be used or stretched in appearance (Wogalter and Dingus 1999; Kalsher and Williams 2006). Likewise, medication adherence to prescription pharmaceuticals can be assessed by using a hidden electronic chip in the cap that records each opening of the container lid (Park et al. 1992).

4.2.6.1 Receiver Variables

The receiver's characteristics and task workload can affect warning effectiveness (Young et al. 1999). Indeed, evidence supporting this has already been discussed. Person variables (Rogers, Lamson, and Rousseau 2000) such as the individuals' existing knowledge, beliefs, and language skill were noted in earlier sections as affecting whether and how a warning is processed. Mayhorn and Podany (2006) describe research findings showing age-related declines in sensory and cognitive processing that affect warning processing, particularly in attention switch and memory/comprehension stages. Although not much systematic warning research has been conducted with respect to children, Kalsher and Wogalter (2007) provide an overview of the existing research. In some studies, gender differences have been noted (e.g., see Laughery and Brelsford 1991; Smith-Jackson 2006) with women being somewhat more likely to look for and read warnings (e.g., Godfrey et al. 1983; LaRue and Cohen 1987; Young, Martin, and Wogalter 1989). Other research indicates that risk

perception varies by ethnicity such that Latino farm workers reported higher risk perception associated with the use of pesticides than Americans of European descent (Smith-Jackson, Wogalter, and Quintela in press). Two other individual differences variables have been noted in the literature: self-efficacy (Lust, Celuch, and Showers 1993) and locus of control (Donner 1991; Laux and Brelsford 1989). It is not completely clear whether the relative paucity of research on personality variables and warning-related measures is due to the correlations being relatively small or that they simply have not attracted researchers as a topic of study (see also Lesch 2006).

Lastly, warning processing occurs in the context of other potential processing given other stimuli in the environment and the individual's ongoing and ever-changing task behavior. Whether and how a warning is processed can depend on mental workload (Wogalter and Usher 1999), time stress (Wogalter et al. 1998), and processing strategy (deTurk and Goldhaber 1988). An individual thinking about other information, under time pressure, and who is not in an information-seeking mode is less likely to fully process a warning compared to situations when not under those restraints. When such task loading can be anticipated (e.g., in emergency situations), the warning system may have to be highly salient to attract attention. For instance, people faced with televised warnings about impending natural hazards such as hurricanes or floods may be less likely to extract all pertinent protective action information when updates are transmitted (Mayhorn, Yim, and Orrock 2006). Because news tickers at the bottom of a screen may not be salient, attention must be directed to those updates, perhaps via the announcer occupying the fuller screen component.

4.3 SUMMARY AND UTILITY OF THE COMMUNICATION-HUMAN INFORMATION PROCESSING MODEL

The above review of the warning literature as applied to consumer products was organized around the C-HIP model. 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. The model is valuable in describing some of the processes and organizing a large amount of research.

The C-HIP model can also be a valuable tool in systematizing the assessment process to help determine why a warning is not effective. 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 similar to those used in 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. Some of the methods for doing this evaluation are briefly described below.

Evaluating the source necessitates an attempt to determine whether the manufacturer has documented the potential hazards and has issued warnings. It is fundamental that manufacturers should analyze their product to determine whether there are foreseeable potential hazards associated with its use and misuse. When hazards are discovered, manufacturers have an obligation to employ methods to try to control the hazards to reduce personal injury and property damage. If a manufacturer is going to sell a product in which the hazard has not been eliminated through design or physical guarding, then it should provide effective warning(s) to consumers and users. One important question to address here is whether there is anything missing from the current warning that should be there? Hazard analysis is needed to answer this question (Young, Frantz, and Rhoades 2006).

Evaluating the channel mainly addresses questions relating to how warnings are sent to end users. One question to ask is what media and modalities are being used and are they adequate. Similarly, assessment regarding delivery asks whether end users receive the warnings. If not, other channels of distribution of warning materials may need to be considered.

To assess attention switch, the main question is whether end users see or hear the warnings. The answer could involve placing a warning on a product and having people carry out a relevant task and

asking them later whether they saw it. Eye movement and response time paradigms can be used to measure what people tend to look at and how quickly.

To assess comprehension, there are several well-established methodologies involving memory tests, open-ended response tests, structured interviews, etc. These assessments can be valuable for determining what information was or was not understood and for suggesting revisions to warning text or symbols. To assess beliefs and attitudes, a questionnaire could be used to determine people's pre-existing beliefs on the topics of perceived hazard and familiarity with the product, task, or environment. For example, if people's perceived hazard is too low, greater persuasiveness may be needed.

To assess motivation, measures of behavioral intentions can be used. Low intentions to comply may indicate that consequence information should be enhanced (e.g., by being more explicit) or that cost of compliance should be reduced. To assess behavioral compliance, systematic observation can be used in both laboratory and field settings. As mentioned earlier, measurement of behavioral compliance is generally more difficult than any of the other methods; it may involve ethical issues such as participants' exposure to risk. However, in situations where the negative consequences are substantial, the effort and resources may be warranted. Sometimes behavioral intentions are measured as a proxy for overt behavioral compliance—however, some caution should be exercised, as noted earlier.

By using the above investigative methods (and others) in a systematic manner, the specific causes of a warning's failure may be determined. Resources would then be better directed at fixing the aspects that are limiting the warning's effectiveness.

In summary, the C-HIP model describes the processing of warnings in a series of stages that could block the processing of warnings. Although it has linear components from source to compliance behavior, there are feedback loops that account for later processing stages affecting earlier stages. The C-HIP model also serves as a useful framework in organizing the growing body of research in the area. Lastly, the model can be used as an investigative tool to determine why a warning is inadequately carrying out its intended purpose.

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Uses and Applications

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