Young, S. L., Laughery, K. R., Wogalter, M. S., & Lovvoll, D. (1999). Receiver characteristics in safety communications (Chap 39, pp. 693-706). In W. Karwowski and W. S. Marras (Eds.), *Occupational Ergonomics Handbook*, Boca Raton, FL: CRC Press.

39

Receiver Characteristics in Safety Communications

Stephen L. Young
Liberty Mutual Research Center for Safety & Health

Kenneth R. Laughery
Rice University

Michael S. Wogalter
North Carolina State University

David R. Lovvoll
Rice University

39.1 Introduction

An interesting aspect of the warning process occurs when people pick up a prescription drug at a pharmacy. In many cases, these medications are accompanied by a patient package insert (PPI). PPIs contain detailed information about the nature of a drug, potential side effects, prescriptions and proscriptions for use, and a wealth of other details about the chemical makeup of the drug. PPIs are similar in scope and detail to the information contained in drug reference books (e.g., *Physician's Desk Reference*). One look at these documents will tell you that they are not designed for the layperson, but rather they are designed to provide the kinds of information and the level of detail that would primarily benefit an individual with substantial medical training. Because of the level of sophistication required to acquire relevant information from PPIs, pharmacies will often provide a briefer and simpler summary of the relevant information for use by the lay customer. The purpose of the summary is to provide the end user with the most important information necessary to use the drug properly.

While a central tenet of warning theory is that it is important to provide people with information so they can make informed choices regarding their behavior, it is not necessarily true that more information is better. Table 39.1 shows the information provided in a PPI and in a pharmacy summary for the same drug. It is clear that the information is targeted for two different audiences. Physicians are provided detailed information, because they need it to make proper prescribing decisions. However, patients (for the most part) will not find much of the detail helpful, and they could find it difficult and confusing. It may actually make the extraction of relevant information *more* difficult.

This example demonstrates, in a very basic way, that one must consider who is the audience when designing, producing, and delivering safety-related information. Other examples might include the presentation of information in material safety data sheets (MSDSs) and in OSHA regulations.

0-8493-2641-9/99/$0.00+$.50

TABLE 39.1 Example of Pharmaceutical Information Provided to Physicians and Patients

Information Category	Physicians	Patients
Dosage	Adult: 3-4 g/day in evenly divided doses Child (>2): 40–60 mg/kg/day in 3–6 evenly divided doses	Take two tablets twice daily. Take this medicine with meals or a snack. Try to space your doses evenly over each 24 hour period. If you miss a dose of this medicine, take it as soon as possible. If it is almost time for your next dose, skip the missed dose and go back to your regular dosing schedule. Do not take 2 doses at once.
Adverse Reactions	Cardiovascular — Vasculitis, pericarditis with or without tamponade CNS — Headache, transverse myelitis, convulsions, meningitis, transient lesions of the posterior spinal column, cauda equina syndrome, Guillain-Barre syndrome, peripheral neuropathy, mental depression, vertigo, hearing loss, insomnia, ataxia, hallucinations, tinnitus, drowsiness Genitourinary — Oligospermia, infertility Gastrointestinal — Anorexia, nausea, vomiting, gastric distress, hepatitis, pancreatitis, diarrhea, stomatitis, abdominal pains, neutropenic enterocolitis Hematological — Heinz body anemia and hemolytic anemia, aplastic anemia, agranulocytosis, leukopenia, megaloblastic (macrocytic) anemia, purpura, thrombocytopenia, hypoprothrombinemia, methemoglobinemia, congenital neutropenia	Side effects, that may go away during treatment, include headache, nausea, loss of appetite, or indigestion. If they continue or are bothersome, check with your doctor. CHECK WITH YOUR DOCTOR AS SOON AS POSSIBLE if you experience sore throat, fever, rash, tightness of chest or difficulty breathing. If you notice other effects not listed above, contact your doctor, nurse or pharmacist.
Cautions	Drug-induced hypersensitivity reactions, blood dyscrasias, neuromuscular and CNS reactions, hepatotoxicity, nephrotoxicity, or fibrosing alveolitis may result in death. Watch for clinical signs suggesting a serious blood dyscrasia; obtain a CBC frequently. To prevent crystalluria and lithiasis, perform a urinalysis, including a careful microscopic examination, frequently and instruct patients to maintain an adequate fluid intake. Caution patients that their skin or urine may turn orange-yellow during therapy. Contraindications include hypersensitivity to sulfasalizine, sulfapyridine, or other sulfonamides or to 5-aminosalicylic acid or other salicylates.	TELL YOUR DOCTOR OR PHARMACIST if you are allergic to sulfa drugs. Keep all medical appointments while receiving this medicine. Drinking extra fluids while you are taking this medicine is recommended. Check with your doctor or nurse for instructions. This medicine may cause increased sensitivity to the sun. Avoid exposure to the sun or sunlamps until you know how you react to this medicine. Use a sunscreen or protective clothing if you must be outside for a prolonged period. This medicine may cause a harmless, yellow-orange discoloration of the urine or skin.

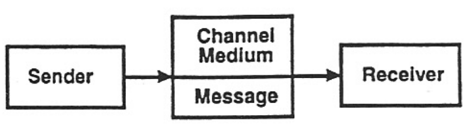

FIGURE 39.1 Basic communication model.

The task of communicating warning information to an individual, whether through product warnings, safety signs, auditory warnings, etc., can be described in terms of communication theory (Lehto and Miller, 1986). Using this theoretical context, McGuire (1980) defined warnings as communications designed to influence behavior with respect to a product. Figure 39.1 shows a simple, generic communications model, which includes four primary components: the sender, the message, the medium, and the receiver.

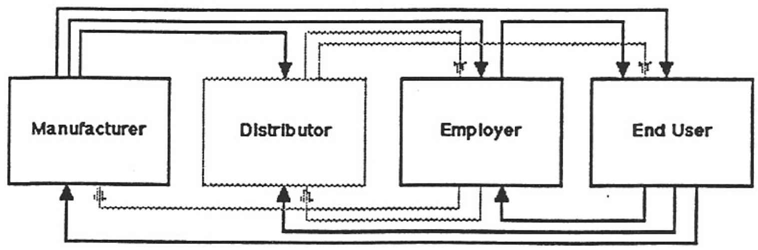

FIGURE 39.2 Complex warning communication system.

The sender, or source, represents the originator of the communication. With respect to warnings, the message is the relevant information that is to be transmitted via some medium. The message could (and preferably would) contain information about the nature of the hazard, consequences of exposure to the hazard, and/or instructions on how to avoid the hazard. The medium refers to the channel or route by which information moves from the source to the receiver. Media for warnings can include MSDSs, on-product labels, package inserts, signs, oral instructions, and so forth. The receiver refers to any and all persons who are at risk and to whom the warning should be directed. Characteristics of each of these components may, and often do, play a critical role in the effectiveness of a warning.

In the most simple application of this model to the warning process, a manufacturer of a product (the source) attempts to relay some warning message using one or more media to an end user of the product (the receiver). However, the process of conveying warning information is not always so straightforward. For example, Figure 39.2 represents the elements of a more complex warning communication system for a product being used in an industrial setting. Here the product might be marketed through a distributor (or a series of distributors) to an employer (the business and its management) who in turn communicates in various ways with the end user (employee). Communication from the manufacturer to the end user may be direct, such as labels on the product, or indirect, through various intermediaries (e.g., distributors). The media through which the information is communicated may also be quite varied. Feedback between various components may be involved, such as an employer notifying the manufacturer about a safety problem associated with the use of the product.

Even more complex warning systems could have several receivers, including distributors, employers, and end users. These receivers might differ markedly in several important respects. For example, an employer's industrial toxicologist who may be a receiver in the communication process will probably have a great deal more technical knowledge than a laborer working in the plant who is the end user of the product. This knowledge difference may have implications for the warning system associated with the product. A parallel example, is that given at the outset of the chapter, where there are at least two kinds of users with respect to medications manufactured by a drug company (e.g., a prescribing physician, pharmacists, and a patient who are all targeted receivers of safety information).

Whether the circumstances are simple or complex, the success of a warning communication system depends on accounting for the properties of the various system components. Previous research has examined issues related to the source, the medium, and the message. In this chapter, we focus on the receiver. We review the literature on the most commonly addressed receiver characteristics and present warning-design implications that stem from these characteristics. This chapter is organized into four sections: demographic variables, competence, familiarity, and risk perception. Finally, we offer observations that warning designers should consider with respect to the receiver.

39.2 Demographic Variables

Demographics are statistical characteristics of individuals that can be used for the purpose of grouping. It is easy to collect such data and many warning-related studies have done so in the past. Two common demographic variables are gender and age.

Gender

Research indicates that there are gender differences in the perception of product hazards and in willingness to read and comply with warnings. Where gender differences are found, it appears that females report being more likely to look for and read warnings than are males (Godfrey et al., 1983). However, in many instances, the results do not provide a clear picture regarding the exact nature and cause of gender differences. Much of this confusion may result from the fact that many of the sex differences reported in the literature come from *post hoc* analyses. That is, gender effects are not manipulated *a priori* but are simply analyzed after the data are collected.

Post Hoc Analyses of Gender Effects

For example, Donner (1990) manipulated warning modality (written versus oral versus both) and formality (informal versus formal) for two different products (fabric protector versus a bench grinder). Compliance with the warning information, as well as noticing and reading the warning, was reported. The results showed a strong product effect, with no significant effect of warning modality or formality. After these analyses (which were the primary focus of the study), an evaluation of gender effects was conducted. Donner found gender differences in previous experience with the product (e.g., females had greater experience with the fabric protector), but this variable did not affect compliance with the product warning. This type of analysis is common among studies that report gender effects. After the primary analyses are performed, a *post hoc* analysis is conducted to determine how gender interacted with or influenced the findings.

Studies employing *post hoc* analyses of gender have produced mixed results. Dorris and Tabrizi (1978) had male and female subjects rate the hazardousness of different products and found very small effects of gender. Godfrey et al. (1983) showed that females were more likely to look at warnings than were males. Silver and Braun (1993) found no gender differences in preference for font size and style in warning labels. Green and Pew (1978) and Laux, Mayer, and Thompson (1989) found that females produced lower accuracy in safety symbol comprehension than males, but only under certain conditions (e.g., gender effects interacted with previous training) and with certain symbols. Leonard, Hill, and Karnes (1989) reported that females were more likely to wear seatbelts than were males. Other research shows that females would be more likely to report complying with warnings than would males (Desaulniers, 1991; Viscusi et al., 1986).

Note that in these studies, gender was not a formal variable under study, nor was gender crossed with the other experimental variables. In such *post hoc* analyses, there is often little reasoning provided as to why gender might influence the results. Gender analyses are presented because the authors thought to do them and because they could be done. It is possible that many studies do not report *post hoc* analyses of gender because of a lack of observed differences. Thus, it is not really surprising that gender has produced mixed results.

A Priori Analyses of Gender Effects

Several studies have examined sex differences as a primary focus of the study. These studies have, for the most part, demonstrated differences between males and females with regard to several safety-related variables. For example, Goldhaber and deTurck (1988a; 1988b) reported that, while females were less likely to recall a "No Diving" warning sign posted around a swimming pool, they were significantly less likely to actually dive than were males. LaRue and Cohen (1987) had males and females rate different consumer products according to several questions. Reported familiarity and perceptions of product hazardousness were statistically similar between males and females in this study. However, females reported being significantly more likely to read warnings for the products than males. Young, Martin, and Wogalter (1989) had males and females rate consumer products according to several questions. The products in this study were classified from the ratings as being either masculine or feminine. Product ratings were then examined as a function of subject gender. The results demonstrated a main effect of product's masculinity/femininity and an interaction between this variable and the subject's gender. According to the interaction, males and females judged the hazardousness of feminine products similarly, but females rated the masculine products as significantly more hazardous than did the males.

Although gender was the variable of interest in these studies, it remains unclear as to whether gender is truly responsible for the observed results. Specifically, gender may simply act as a proxy or alias for another variable or group of variables (e.g., familiarity). Young et al. (1989) demonstrated that greater hazard ratings were given by females to products that they used infrequently. Other studies have shown that familiarity and product hazard ratings are negatively correlated (Otsubo, 1988; Young, 1996; Wogalter et al., 1987; Young et al., 1990). It may be that females and males would rate product hazards similarly if females only used the products more frequently and/or had greater knowledge about them generally or their hazards specifically. However, other studies suggest that this hypothesis may not be true. For example, Godfrey and Laughery (1984) showed that females underestimated the risks associated with tampon use due, in part, to their familiarity with the product. Karnes and Leonard (1986) examined male and female knowledge of hazards associated with a contraceptive device (an IUD) based on a safety-related pamphlet. Males were included in the subject sample specifically because it was assumed (whether true or not) that they would serve as a low-familiarity control to the females. Females in this study perceived the risks to be significantly higher than did the males.

Conclusions: Gender

These studies suggest that gender effects may or may not be observed in research that does not specifically address gender issues. Evidence tends to suggest that females are more willing to act safely with products (e.g., read or comply with warnings) than are males. However, it is unclear whether this trend would be observed in all situations and with all products. It is also unclear whether gender is the true source of observed differences in product perceptions or whether those differences are related to more basic considerations (e.g., knowledge of the hazards, familiarity, frequency of use, etc.). Further systematic research, which accounts for confounding variables (e.g., familiarity, etc.), is needed before design considerations with regard to warnings can be provided.

Age

When considering age, it is generally believed that (a) older people tend to be more risk averse and (b) younger people (especially younger males) tend to be predisposed to taking greater risks. Smith and Watzke (1990) demonstrated that older people (30 to 59 years, 60 to 75 years, and over 75 years old) more carefully consider the risks and are more cautious than younger adults (under 30 years of age). The authors suggest that cautiousness may be a characteristic of older adults and that this characteristic may start to exhibit itself in the middle years of life (between 30 and 59 years of age). If it is true that people are more or less risk averse depending on their age, then this should manifest itself in safety-related behaviors (e.g., looking for, reading, and complying with warnings). For example, older people (> 25 years old) are more likely to wear seatbelts than younger individuals (< 25 years old) (Leonard et al., 1989). Desaulniers (1991) found that older people, 40 and above, reported being more likely to take precautions in response to warnings.

There are many hypotheses as to why age may influence risk perceptions and/or safety-related behaviors, but the most reasonable ones surmise that younger people do not actually take risks in a formal sense. Specifically, they do not consider an action with a conscious view toward the costs and benefits of acting one way over another (see Lehto, 1991; Wagenaar, 1992). As such, their behavior may appear to be nonrational and more dangerous than the types of judgment-based behavior exhibited by older individuals. While a great deal of evidence for risk-taking in younger people can be found in the literature on traffic accidents (see Edwards and Ellis, 1976; Leonard et al., 1989), there is somewhat less evidence of this phenomenon in day-to-day behaviors. Thus, it is not surprising that the literature is not entirely consistent in demonstrating age effects.

For example, Mazis, Morris, and Gordon (1978) showed that a sample of premenopausal females preferred longer and more detailed information regarding the risks associated with oral contraceptives, but that this trend was more pronounced for younger subjects (e.g., college-age students) than for older subjects. Purswell, Schlegel, and Kejriwal (1986) demonstrated that older people (>30 years old) exhibited safer behaviors than younger subjects (<30 years old) with a router, but that the opposite pattern was observed with an electric knife. Leonard, Ponsi, Silver, and Wogalter (1989) found minor differences between older (M = 37 years) and younger (M = 18 years) subjects on willingness to read warnings for pest-control products. Wright, Creighton, and Threlfall (1982) observed no effect of age (ages in the sample ranged from under 30 years old to over 50) with regard to willingness to read instructions.

As with the evidence regarding gender effects, findings associated with age in warnings research have not been entirely consistent. Much of the conflicting data may result from the fact that a majority of analyses are *post hoc* evaluations. There is an additional problem associated with research on age: defining "younger" and "older" categories in research. These terms can vary widely in meaning from one study to the next. The "older" group of subjects in one study could be the "younger" group in another. Because of these issues, the effect of age on risk perceptions and safety-related behaviors is inconclusive. It appears as though younger adults may be a more difficult group to warn because of their lack of (formal) consideration of risks and benefits in the decision-making process. Relative to younger people (and possibly younger males in particular) older adults may be more likely to comply with safety-related information. However, this hypothesis needs additional testing, with systematic research that controls for confounding variables (e.g., knowledge and familiarity with products, etc.).

39.3 Competence

Competence can be defined as possessing the capacity to meet the demands of a particular task. There are many dimensions of receiver competence that may be relevant to the design of warnings. We discuss three here: sensory, physical, and cognitive capabilities.

Sensory Capabilities

It is obvious that the blind person cannot see a written warning, nor would the deaf person receive an auditory warning. Although these extreme examples are obvious, we also know that sensory capabilities lie along a continuum. Consider that many older adults, who use more medications as a group, cannot read medication labels because of age-related visual decrements. Yet many over-the-counter pharmaceutical labels have print that is too small for older adults to read. One way to solve this problem is to design product labels to accommodate larger type (see Wogalter and Young, 1994). Another way is to provide relevant safety information in the form of pictorial symbols. However, several studies have demonstrated that older adults have greater difficulty in interpreting safety-related symbols (Collins and Lerner, 1982; Easterby and Hakiel, 1981; Ringseis and Caird, 1995).

Physical Capabilities

This topic deals with the extent to which the user will be physically capable of carrying out a task. For example, older adults may not have the dexterity to grab hold of a three-point manual seat belt or they may not be able to generate the torque necessary to open small medicine containers. Wogalter and Young (1994) demonstrated that different label designs, while increasing the size of warning information (and thereby making it easier to read), could provide the user with a greater surface area on which to apply force. If special equipment is required to comply with the warning, it must be available or obtainable. For example, some hair dyes contain warnings that direct the use of gloves during application. Rather than imposing on the user to find and/or purchase gloves separately, plastic gloves are generally included in the package with the dye. If special skills are required, they must be present in the receiver population. To some extent, as with the sensory limitations of receiver populations, the behavioral limitations that may be involved could be considered rather obvious, although we are constantly amazed at the number of warnings that violate such considerations — especially in the behavioral domain where basic product instructions (e.g., for assembly/installation) are often difficult to carry out.

Cognitive Capabilities

Examples of cognitive competence include requisite technical capacity, language, and reading ability.

Technical Capacity

One of the primary issues in warning design with respect to competence concerns the level of technical information to be communicated. Comprehension of such information is generally a function of the receiver's existing technical knowledge of the domain. Here we are referring to conceptual knowledge that includes both factual information and process understanding (the receiver's mental model). Some examples include: (a) medications where knowledge of physiology may be relevant, (b) chemical reactions that require an understanding of what not to mix with what, and (c) mechanical properties where knowledge is needed to understand the hazards of handling certain kinds of equipment. In formulating warnings, it is important to take into account the relevant technical knowledge of the receiver. Further, the problem may be more complicated in the sense that warnings regarding a particular product hazard may be directed to multiple groups (or receivers) differing in knowledge.

The point to be emphasized here is that the level or levels of knowledge and understanding must be considered. Of course, it is also a valid concern that variability in knowledge about facts and processes exists within the target audience for a particular product warning. There may be various approaches to address these concerns. One approach is to construct a single warning system that will be understood at a range that reaches as many people in the target audience as possible. Another approach is to develop a multiple-component warning system where different components are directed at subgroups varying in technical knowledge. The second approach, as shown in the example provided at the beginning of the chapter, is the one selected for presentation of drug-related information by pharmacies. Physicians receive detailed information about prescription drugs and patients receive summaries of that information.

Language

A second cognitive issue with respect to competence is language. The target audience may know a language different from the majority. A warning printed in only one language is much less likely to be accessible to all potential users. Attempts to deal with this problem include the use of pictorial symbols and printing the message in multiple languages. The latter technique is commonly employed in instruction booklets that accompany various electronic products such as watches and calculators. Signs printed in multiple languages must be either increased in size to accommodate the extra material or, if the size is held constant, they must be more cluttered or dense. Neither of these alternatives is desirable. Also, selection of languages to appear on these signs may not be so straightforward. How many languages does one need in order to cover all potential users? The number could be prohibitively high.

Symbols, on the other hand, provide the promise of non-verbal communication — a method of conveying safety-related information regardless of the language spoken in the population. Research has demonstrated that symbols are effective in attracting user attention (Young, 1991; Laughery and Young, 1991; Wogalter et al., 1996; Young and Wogalter, 1990) and in conveying safety information (Collins, 1983; Collins and Lerner, 1982; Laux et al., 1989). However, the promise of completely non-verbal communication has not been and may not be fully realized. Symbols necessarily involve an abstraction of some message. This method of information display is easier for certain safety-related concepts (e.g., slippery floor) than with others (e.g., biohazard, cancer). Designing symbols to convey information that can be interpreted accurately under many different circumstances can be difficult.

Reading Ability

Many warnings require high levels of reading ability on the part of the receiver. The usual recommendation for general target audiences is a reading level near the elementary school range. An exception to this rule is found in Leonard et al. (1989), who found that college students and other highly educated individuals reported being more likely to read complex warnings than simple ones. The complex warnings in this study were used primarily for more hazardous products. Perceived hazardousness is a factor that (as we will see in the next section) has a strong relationship to willingness/likelihood of reading warnings. Obviously, if comprehension of a warning is to be achieved, the material should be written at the level that accommodates the readership. One way to evaluate the readability of safety-related information is to conduct some type of readability analysis of the materials. A discussion of reading level measures and their application in the design of instructions and warnings can be found in Duffy (1985). It should be noted that readability formulas are only indications of comprehensibility, and they may be less suitable with short messages like those that commonly appear in warning signs. Readability scores and comprehension measures are not always highly correlated. Thus, readability formulas should be used with caution and probably as only a first step in determining the material's understandability.

The problem of warning readability may require more than simply keeping reading levels to a minimum. There are a very large number of functionally illiterate adults in the population who cannot read written (verbal) warnings at any level. We offer no simple solutions to this problem, but certainly pictorial symbols, oral warnings, special training programs, etc. may be important ingredients of warning systems for such populations.

Conclusions: Competence

There are many factors that influence the capacity of individuals to meet the task of acting safely around products. Sensory, physical, and cognitive capabilities can influence whether users are capable of accessing, understanding, and using safety-related information. These characteristics of potential users must be considered when designing warnings.

39.4 Familiarity and Experience

One of the issues that has received substantial attention in research concerns the familiarity and/or experience that people have with products and how such factors influence the effectiveness of warnings. Familiarity has been defined in many ways, but we define it here as a state of being intimate or closely acquainted with a product and its hazards. Familiarity is not a dichotomous state. People may be unfamiliar with a product. They may be familiar with a product generally (i.e., they have heard *about* the product) or they may be familiar with it specifically (i.e., they have used the product). Users can become familiar with a product indirectly (i.e., through the acquisition of knowledge about it) or directly (i.e., through direct use). Familiarity is a belief and it is most commonly measured through ratings where people express their familiarity with a product on a Likert-type scale (e.g., 0 = "not at all familiar" to 7 = "extremely familiar"). Experience, on the other hand, can be operationally defined in terms of time and/or frequency of use. A distinction between familiarity and experience has been noted by Wogalter et al. (1986, 1987). We do not consider the familiarity and experience to be synonymous, but we will discuss them together here for the purpose of dealing with users' knowledge-based product perceptions.

Familiarity

Numerous studies have explored the effect of familiarity on safety-related product perceptions and behavior. In general, higher levels of product familiarity or experience are associated with decreases in the probability that warnings will influence user behavior. The reasons for this conclusion are varied, but they tend to revolve around the notion that as people use a product and become more familiar with and knowledgeable about it, they perceive it to be less dangerous. Desaulniers (1989) showed that people perceived more familiar products as less hazardous. Karnes and Leonard (1986) showed that subjects with greater experience riding ATVs considered them to be less dangerous than did subjects with less experience.

The utility of warning information may be reduced as people come to see the products as less hazardous. Thus, users may not seek out or read relevant information. Godfrey and Laughery (1984) showed that females reported being less likely to read warnings for products with which they are familiar (e.g., tampons). Johnson (1992) showed that willingness to look for and read warning information for scaffolds was negatively related to the number of times workers had previously used scaffolding. Morris, Mazis, and Gordon (1977) showed that about 78% of females read a PPI for oral contraceptives the first time they used the drug, but that less than 11% read the insert when it accompanied subsequent prescriptions. However, other research suggests that unwillingness to look for and read warnings is not exclusively related to familiarity. Leonard et al. (1989) demonstrated that willingness to read warnings for a pest-control product was unrelated to familiarity with that product. In addition, Godfrey et al. (1983) demonstrated that familiarity was not related to subjects' reported willingness to look for warning labels on products perceived as hazardous. However, they also reported being more willing to look for warnings on unfamiliar products when the hazard level was perceived as being low. Thus, familiarity may be one factor, along with other perceptions, that influence the extent to which users may seek information.

Behavioral effects of familiarity have also been demonstrated. Goldhaber and deTurck (1988a, b) showed that previous experience with diving into pools was related to lower likelihood of noticing a "No Diving" sign, a higher likelihood of diving into shallow water, and a lower perception of the risks associated with such activities. Otsubo (1988) showed that people with less experience were more likely to read the warnings for two types of saws.

The above review suggests that the more people become familiar with a product, the less likely they will be to engage in safe behaviors (and vice versa). While this relationship may be linear (or at least monotonic), there is some evidence to suggest that the relationship is nonlinear. Bettman and Park (1980) found that subjects with a moderate level of knowledge or experience relied most on external information when making a product-related decision. People with low and high levels of previous knowledge relied to a greater extent on this external information. The authors suggested that users with high levels of experience did not need the information and that users with low levels did not have the capacity to use it properly. Johnson and Russo (1980) demonstrated that both the linear and nonlinear ("inverted-U") functions were observed in different decision-making tasks.

Conclusions: Familiarity

Research generally suggests that lower levels of familiarity are associated with higher levels of perceived hazard and greater reported willingness to act with caution (and vice versa). The most common explanation for this finding is that greater familiarity is associated with greater knowledge of and appreciation for the product's hazards. However, familiarity with a product is not synonymous with knowledge of the hazards associated with it. People may report being familiar with a product and yet have little or no knowledge of its hazards. Familiarity lies along a continuum — people can have indirect, general familiarity with a product or they can have more direct, specific familiarity (i.e., from lower to higher forms of familiarity). Subjects who provide ratings of familiarity in research studies may not make the distinction between the two types. Thus, they might report a high degree of familiarity with a product that they have very little personal knowledge of or experience with (e.g., they may have heard a lot about a product, but have no direct experience with it).

High levels of perceived familiarity may lull people into thinking that they have greater knowledge of and control over product hazards than they actually have and/or that the products are less hazardous. This perception, coupled with the fact that familiarity may reduce information-seeking behaviors on the part of users, can produce a dangerous situation and a special challenge to safety professionals. That challenge is to make warning information salient (i.e., to attract the attention of familiar users) and to make the information seem relevant. A considerable body of research has addressed various forms of salience. However, there is much less research dealing with relevance issues. Ways to make warnings more relevant can include prioritizing warning information based on users' needs and presentation of information to specific users at intermittent schedules.

39.5 Risk Perception

Risk perception in the present context refers to the way people understand and consider the hazards associated with products and the ways in which these perceptions influence people's behavior when using them. A consistent finding in warning research is that people's perception of the risk associated with a product or situation is an important determinant of warning effectiveness — the greater the risk, the more likely people will look for, read, and comply with warnings (Donner and Brelsford, 1988; Friedmann, 1988; Godfrey et al., 1983; LaRue and Cohen, 1987; Leonard et al., 1986; Otsubo, 1988; Wogalter et al., 1991). While most of the research on risk perception has evaluated the nature of the products themselves, some research has examined subject characteristics.

One study (Young, 1996) had subjects rate a list of consumer products according to several different rating questions:

- How hazardous is this product?
- How frequently do you use this product?
- How likely are you to be injured while using this product?

As in other studies of risk perception, the results demonstrated that subjects' risk perceptions varied as a function of the product being evaluated, with some products being considered more hazardous (as a whole) than others. However, the risk ratings also varied as a function of the subject. Specifically, there were differences in the way different subjects perceived the hazard for individual products (e.g., chain saw).

Based on the ratings in this study, Young (1996) partitioned the subjects into three distinct groups which varied in terms of how they perceived the products in general and in terms of the information they accessed when evaluating product risks. The first group of subjects was labeled *Fearful*, because they subjects considered the products as a whole to be quite hazardous while having only average knowledge of the risks and average familiarity with the products. The second group of subjects, labeled *Fearless*, considered the products as a whole to be nonhazardous despite having little knowledge of the products' risks and little familiarity with them. The third group of subjects was labeled the *Informed* group. These subjects considered the products as a whole to be nonhazardous, but they also knew a great deal about the risks associated with the products and they were very familiar with them as well. This group is similar to the internal locus-of-control subjects reported in Laux and Brelsford (1989) in that these subjects believe they are capable of controlling the hazards. One interesting demographic relationship was the finding that subjects in the *Fearless* group were significantly younger than were subjects in the *Fearful* group.

Young (1996) also demonstrated that these subject groups considered different kinds of information when forming risk perceptions. The *Fearful* group considered products to be risky if they had severe potential injury consequences, if an injury was likely, if the number of different risks associated with the product was high, and/or if the subject had been injured or had known someone who had been injured with the product in the past. The *Fearless* group considered products to be dangerous only if they had the potential to injure or kill many people at a time and if the product hazards were encountered involuntarily. When considering product hazards, the *Informed* group not only looked at the potential for catastrophe, but they also weighed information about the benefits provided by the product and the degree of control they exercised over the hazards. Thus, subjects not only perceived the products differently, but they accessed different information when forming perceptions of the risk associated with consumer products.

The results of this work demonstrated that at least some variance of risk perceptions could be attributed to how people perceive consumer products as a whole. The results suggest that information in warnings could be designed to suit the informational needs of the targeted audience. For instance, with the *Fearful* group, one could provide information about the nature of the hazard and the potential severity of injury associated with it. One way to accomplish this is to provide explicit information regarding injury consequences. Research has demonstrated that the explicitness with which the consequence information is expressed is an important determinant of perceived hazard and of recall of warning information (Laughery and Stanush, 1989; Sherer and Rogers, 1984). As expected, the more explicit the consequence information, the greater the perceived hazard and the more information recalled. This would hold true for the *Fearful* group of subjects. However, different information may be needed for the other groups. For the *Fearless* and *Informed* groups, information about the potential catastrophic nature of the hazard, about the extent to which exposure to the hazard is voluntary, and/or about the degree of personal control over the hazard may be necessary for these subjects to develop a proper appreciation of the risks.

39.6 Conclusions and Recommendations

In this chapter we have focused on characteristics of receivers that are important in the design of warnings. There are several principles or guidelines that appear warranted on the basis of the analyses presented.

Principle #1 — Know thy receiver. This statement may seem trivial and obvious; yet, as noted earlier, warnings are often designed with little or no regard for characteristics of the people to whom they are directed. Examples include warnings that require reading levels greater that the receiver's capability and that contain unfamiliar, technical terminology. Gathering knowledge and data about relevant characteristics of target audiences may require time, effort and money, but without such information, the warning designer and ultimately the receiver will be at a serious disadvantage. Analyzing existing data, such as demographic information, or collecting new data by conducting surveys may be necessary.

Principle #2 — When variability exists in the target audience, design for the low end of that audience. Whether the variability exists in competence, technical knowledge, familiarity, perception of hazardousness, or other receiver characteristics, it is important that warnings not be designed for the average. While it would be desirable to choose a criterion for warning designs that would include up to 99% of the population, there are several instances in which this may not be possible. For example, warning about such hazards as radon gas will necessarily involve information that may not be understood by all people. It is inappropriate to suggest that warning information should not be provided simply because the information may not be understood by 100% of the population. The point is to consider the variability in the target audience and to design the safety information so that it can be used by as many people in the target audience as is practical.

Principle #3 — When the target audience consists of subgroups that differ in relevant characteristics, consider employing a warning system that includes different components designed for the different subgroups. As in the prescription drug example provided at the beginning of the chapter, different types of information and different levels of detail are provided to different groups of receivers. This information is tailored to the needs and capabilities of these receivers.

A corollary to this principle is: do not try to accomplish too much with a single warning. Consider the current OSHA guidelines regarding the variety of subgroups in the target audience for material safety data sheets (MSDSs). These subgroups include toxicologists, safety engineers, managers, physicians, and end users (such as the laborer using the product). It is unlikely that one warning or pamphlet will be sufficient to meet the informational needs and capabilities of all these users. If the warning system does not include communications designed for the capabilities (both the strengths and weaknesses) of each group, it is probably destined to fail.

Principle #4 — Warnings should be tested using samples of potential receivers. Warning design guidelines (e.g., ANSI, 1991; FMC, 1985; Westinghouse Electric Corporation, 1985) can be used to develop candidate warnings for testing, thereby limiting the number of items that need to be tested. However, it is not always possible to use these guidelines to design a perfect warning system. The guidelines presented here can enable one to develop a preliminary warning. Testing of the warning system could assist the designer in refining and developing an effective system by providing information on ways to modify and improve the warnings. These tests might consist of "trying it out" on a target audience sample to assess comprehension and/or behavioral intentions. Our experience indicates that even such *minimal efforts* are seldom part of the warning design process, but would benefit the produced warning had they been taken.

Last, warnings should be viewed within the context of a communication *system* that includes the message, the medium, and the receiver. This chapter has sought to demonstrate that it is important to consider the capabilities and limitations of the receiver when designing the warning message. The most well-researched receiver characteristics were discussed in this chapter. Other receiver characteristics have been reported in the literature (e.g., locus of control, risk taking as a personality trait), but thus far they have received much less attention. The essential point of the chapter is that receiver characteristics should be considered in the warning design process in order to maximize effectiveness for their intended target audience.

References

ANSI (1991). *American National Standard for Product Safety Signs and Labels, ANSI Z535.4-1991.* Washington, D.C.: National Electrical Manufacturers Association.

Bettman, J.R. and Park, C.W. (1980). Effects of prior knowledge and experience and phase of the choice process on consumer decision processes: A protocol analysis. *Journal of Consumer Research, 7,* 234-248.

Collins, B.L. (1983). Evaluation of mine-safety symbols, in *Proceedings of the Human Factors Society 27th Annual Meeting* (pp. 947-949). Santa Monica, CA: The Human Factors Society.

Collins, B.L. and Lerner, N.D. (1982). Assessment of fire-safety symbols. *Human Factors,* 24, 75-84.

Desaulniers, D.R. (1989). Consumer product hazards: What will we think of next? In *Interface '89: The Sixth Symposium on Human Factors and Industrial Design in Consumer Products* (pp. 115-120). Santa Monica, CA: The Human Factors Society.

Desaulniers, D.R. (1991). *An Examination of Consequence Probability as a Determinant of Precautionary Intent.* Doctoral dissertation, Rice University, Houston, TX.

deTurck, M.A. and Goldhaber, G.M. (1991). A developmental analysis of warning signs: The case of familiarity and gender. *Journal of Products Liability, 13,* 65-78.

Donner, K.A. (1990). *The Effects of Warning Modality, Warning Formality, and Product on Safety Behavior.* Masters thesis, Rice University, Houston, TX.

Donner, K.A. and Brelsford, J.W. (1988). Cueing hazard information for consumer products, in *Proceedings of the Human Factors Society 32nd Annual Meeting* (pp. 532-535). Santa Monica, CA: The Human Factors Society.

Dorris, A.L. and Tabrizi, M.F. (1978). An empirical investigation of consumer perception of product safety. *Journal of Products Liability,* 2, 155-163.

Duffy, T.M. (1985). Chapter 6: Readability Formulas: What's the Use? In T.M. Duffy and R. Waller (Eds.), *Designing Usable Texts.* (pp. 113-140). Orlando: Academic Press, Inc.

Easterby, R.S. and Hakiel, S.R. (1981). The comprehension of pictorially presented messages. *Applied Ergonomics,* 12, 143-152.

Edwards, M.L. and Ellis, N.C. (1976). An evaluation of the Texas driver improvement training program. *Human Factors,* 18, 327-334.

FMC (1985). *Product Safety Sign and Label System.* Santa Clara, CA: FMC Corporation.

Friedmann, K. (1988). The effect of adding symbols to written warning labels on user behavior and recall. *Human Factors,* 30, 507-515.

Godfrey, S.S., Allender, L., Laughery, K.R. and Smith, V.L. (1983). Warning messages: Will the consumer bother to look? In *Proceedings of the Human Factors Society 27th Annual Meeting* (pp. 950-954). Santa Monica, CA: Human Factors Society.

Godfrey, S.S. and Laughery, K.R. (1984). The biasing effect of familiarity on consumer's awareness of hazard, in *Proceedings of the Human Factors Society 28th Annual Meeting* (pp. 483-486). Santa Monica, CA: Human Factors Society.

Goldhaber, G.M. and DeTurck, M.A. (1988a). Effects of consumers' familiarity with a product on attention to and compliance with warnings. *Journal of Products Liability,* 11, 29-37.

Goldhaber, G.M. and deTurck, M.A. (1988b). Effectiveness of warning signs: Gender and familiarity effects. *Journal of Products Liability,* 11, 271-284.

Green, P. and Pew, R.W. (1978). Evaluating pictographic symbols: An automotive application. *Human Factors,* 20, 103-114.

Johnson, D. (1992). A warning label for scaffold users, in *Proceedings of the Human Factors Society 36th Annual Meeting* (pp. 611-615). Santa Monica, CA: The Human Factors Society.

Johnson, E.J. and Russo, J.E. (1980). Product Familiarity and Learning New Information, in K.E. Monroe (Ed.) *Advances in Consumer Research.*

Karnes, E.W. and Leonard, S.D. (1986). Consumer product warnings: reception and understanding of warning information by final users, in W. Karwowski (Ed.) *Trends in Ergonomics/Human Factors III, Part B: Proceedings of the Annual International Industrial Ergonomics and Safety Conference* (pp. 995-1003).

LaRue, C. and Cohen, H. (1987). Factors influencing consumers' perceptions of warning: an examination of the differences between male and female consumers, in *Proceedings of the Human Factors Society 31st Annual Meeting* (pp. 610-614). Santa Monica, CA: The Human Factors Society.

Laughery, K.R. and Stanush, J.A. (1989). Effects of warning explicitness on product perceptions, in *Proceedings of the Human Factors Society 33rd Annual Meeting* (pp. 431-435). Santa Monica, CA: The Human Factors Society.

Laughery, K.R. and Young, S.L. (1991). An eye scan analysis of accessing product warning information, in *Proceedings of the Human Factors Society 35th Annual Meeting* (pp. 585-589). Santa Monica, CA: The Human Factors Society.

Laux, L.F. and Brelsford, J.W. (1989). Locus of control, risk perception and precautionary behavior, in *Interface 89: The Sixth Symposium on Human Factors and Industrial Design in Consumer Products* (pp. 121-124). Santa Monica, CA: Human Factors Society.

Laux, L.F., Mayer, D.L. and Thompson, D.B. (1989). Usefulness of symbols and pictorials to communicate hazard information, in *Interface 89: The Sixth Symposium on Human Factors and Industrial Design in Consumer Products* (pp. 79-83). Santa Monica, CA: Human Factors Society.

Lehto, M.R. (1991). A proposed conceptual model of human behavior and its implications for design of warnings. *Perceptual and Motor Skills,* 73, 595-611.

Lehto, M.R. and Miller, J.M. (1986). *Warnings, Volume 1.* Ann Arbor, MI: Fuller Technical Publications (p. 18).

Leonard, S.D., Hill, G.W. and Karnes, E.W. (1989). Risk perception and use of warnings, in *Proceedings of the Human Factors Society 33rd Annual Meeting* (pp. 550-554). Santa Monica, CA: The Human Factors Society.

Leonard, S.D., Matthews, D., and Karnes, E.W. (1986). How does the population interpret warning signals? In *Proceedings of the Human Factors Society 30th Annual Meeting* (pp. 116-120). Santa Monica, CA: Human Factors Society.

Leonard, D.C., Ponsi, K.A., Silver, N.C. and Wogalter, M.S. (1989). Pest-control products: Reading warnings and purchasing intentions, in *Proceedings of the Human Factors Society 33rd Annual Meeting* (pp. 436-440). Santa Monica, CA: The Human Factors Society.

Mazis, M., Morris, L.A., and Gordon, E. (1978). Patient attitudes about two forms of printed oral contraceptive information. *Medical Care,* 16, 1045-1054.

McGuire, W.J. (1980). The communication-persuasion model and health-risk labeling. (pp. 99-122), in L.A. Morris, M.B Mazis and I. Barofsky (Eds.) *Product Labeling and Health Risks: Banbury Report 6,* Cold Spring Harbor Laboratory.

Morris, L.A., Mazis, M.B. and Gordon, E. (1977). A survey of the effects of oral contraceptive patient information. *The Journal of the American Medical Association,* 238, 2504-2508.

Otsubo, S.M. (1988). A behavioral study of warning labels for consumer products: Perceived danger and use of pictographs, in *Proceedings of the Human Factors Society 32nd Annual Meeting* (pp. 536-540). Santa Monica, CA: The Human Factors Society.

Purswell, J.L., Schlegel, R.E. and Kejriwal, S.K. (1986). A prediction model for consumer behavior regarding product safety, in *Proceedings of the Human Factors Society 30th Annual Meeting* (pp. 1202-1205). Santa Monica, CA: The Human Factors Society.

Ringseis, E.L. and Caird, J.K. (1995). The comprehensibility and legibility of twenty pharmaceutical warning pictograms, in *Proceedings of the Human Factors & Ergonomics Society 39th Annual Meeting* (pp. 974-978). Santa Monica, CA: The Human Factors & Ergonomics Society.

Sherer, M. and Rogers, R.W. (1984). The role of vivid information in fear appeals and attitude change. *Journal of Research in Personality*, 18, 321-334.

Silver, N.C. and Braun, C.C. (1993). Perceived readability of warning labels with varied font sizes and styles. *Safety Science*, 16, 615-626.

Smith, D.B.D. and Watzke, J.R. (1990). Perception of safety hazards across the adult life-span, in *Proceedings of the Human Factors Society 34th Annual Meeting* (pp. 141-145). Santa Monica, CA: The Human Factors Society.

Viscusi, W.K., Magat, W.A. and Huber, J. (1986). Informational regulation of consumer health risks: an empirical evaluation of hazard warnings. *Rand Journal of Economics*, 17, 351-365.

Wagenaar, W.A. (1992). Risk taking and accident causation, in Yates, J.F. (Ed.) *Risk-Taking Behavior.* (pp. 257-281). New York: John Wiley & Sons.

Westinghouse Electric Corporation (1985). *Product Safety Label Handbook.* 2nd Edition. Trafford, PA: Westinghouse Printing Division.

Wogalter, M.S. and Silver, N.S. (1990). Arousal strength of signal words. *Forensic Reports*, 3, 407-420.

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 Young, S.L. (1994). The effect of alternative product-label design on warning compliance. *Applied Ergonomics*, 25, 53-57.

Wogalter, M.S., Desaulniers, D.R., and Brelsford, J.W. (1986). Perceptions of consumer product hazards: Implications for the need to warn, in *Proceedings of the Human Factors Society 30th Annual Meeting* (pp. 1197-1201). Santa Monica, CA: Human Factors Society.

Wogalter, M.S., Desaulniers, D.R. and Brelsford, J.W. (1987). Consumer products: How are the hazards perceived? In *Proceedings of the Human Factors Society 31st Annual Meeting* (pp. 615-619). Santa Monica, CA: The Human Factors Society.

Wogalter, M.S., Sojourner, R.J. and Brelsford, J.W. (1997). Comprehension and retention of safety pictorials. *Ergonomics*, 40, 531-542.

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.

Wright, P., Creighton, P. and Threlfall, S.M. (1982). Some factors determining when instructions will be read. *Ergonomics*, 25, 225-237.

Young, S.L. (1991). Increasing the noticeability of warnings: effects of pictorial, color, signal icon and border, in *Proceedings of the Human Factors Society 35th Annual Meeting* (pp. 580-584). Santa Monica: Human Factors Society.

Young, S.L. (1996). Subject differences in the perception of risk, in *Proceedings of the Human Factors and Ergonomics Society 40th Annual Meeting* (pp. 503-507). Santa Monica, CA: The Human Factors and Ergonomics Society.

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.

Young, S.L., Brelsford, J.W., and Wogalter, M.S. (1990). Judgments of hazard, risk and danger: Do they differ? In *Proceedings of the Human Factors Society 34th Annual Meeting* (pp. 503-507). Santa Monica, CA: Human Factors Society.

Young, S.L., Martin, E.G. and Wogalter, M.S. (1989). Gender differences in consumer product hazard perceptions, in *Interface '89: The Sixth Symposium on Human Factors and Industrial Design in Consumer Products* (pp. 73-78). Santa Monica, CA: The Human Factors Society.