

# WARNING CHANNEL: MODALITY AND MEDIA

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## ABSTRACT

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One of the most important areas regarding warnings is the channel through which a warning is sent. This chapter focuses on research on how a message may be transmitted to a receiver from a source. A message can be delivered through one or more media and received by one or more sensory modalities. In many contexts, multiple channels can be more effective in warnings transmissions than a single channel. Choice of the appropriate channels may make the difference in whether that warning message is delivered to the at-risk population or not.

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## INTRODUCTION

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Warnings may be transmitted to people through various media (e.g., warning labels, signs, television commercials) from a source. In doing so, the information transmitted may have an impact on one or more sensory modalities in the receiver. The channel refers to this intermediate area between the source and the receiver. At one end is the source (see also Cox & Wogalter, chap. 8, this volume), who decides what warning will be communicated and then how it will be communicated. These decisions result in the warning be transmitted through one or more media. The receiver is the other end of the channel. Carried along the path or in the channel is the information composing the warning message. The warning message may never make it to the receiver, or it may be distorted. Nevertheless, some form of the warning may get delivered to the

receiver, going to the receiver's sensory modalities where it is transduced to neural impulses.

If this sounds like a communications model, it is. Communications models have been around for more than 100 years. The implications and research of the basic and more advanced communication models are applicable here. The specific model adopted in this chapter is the communication-human information processing (C-HIP) model (Wogalter, chap. 5, this volume; Wogalter, DeJoy, & Laughery, 1999).

The channel can refer to the media or sensory modality involved. In the case of media, the frame of reference is frequently the source, which transmits the message. In the case of modality, the frame of reference is the receiver who is the beneficiary. In some circumstances, the information in the message may have some relationship with the media doing the transmitting. McLuhan and Fiore's (1967) classic "the medium is in the message" reflects the fact that the kind of information relayed is partly affected by the media involved. Television can give dynamic elements not conveyed by a static warning label. Likewise, the information in the message may have some relationship with the modality. Older adult receivers have age-related sensory declines, which can affect the quality of information transduced.

The most recent version of the C-HIP model (Wogalter, chap. 5, this volume; Wogalter & Laughery, 2005) includes explicit mention of an important function of the channel. This function is message delivery. It highlights the importance of getting the message to receivers at risk. The point of including delivery into the model is to call attention to a major bottleneck in the information transmission process. It is a failure in which the information transmitted by the source does not make

it to the receiver, or in other words, the flow to the relevant target audience is broken. Three examples of delivery failure are offered here. In the first example, consider the transfer of bulk silicon from one company to another at the shipping and receiving department at an industrial site. Although the receiving department might receive warnings in the form of material safety data sheets (MSDS), the workers down the line who use the silicon later in the manufacturing process may never see that printed information. In the second example, consider highly flammable foam insulation is sent to a construction site. Although warnings may be sent successfully from the manufacturer to the building contractor, these same warnings may not get to subcontractors who are using welding torches during building construction (see Williamson, chap. 56, this volume). The third example concerns product manuals. Although the initial owner may receive the manual for some product, that person may not open it, may misplace it, or may even discard it. Furthermore, even when some portions of the manual are read, frequently not all of the documentation is read (Mehlenbacher, Wogalter, & Laughery, 2002). In addition, manuals are not often transferred to subsequent owners of resold or donated equipment (Wogalter, Vigilante, & Baneth, 1998). Thus, despite some warnings having been developed by the source and having been placed in the stream of commerce, the warning may not make it to the receiver. In some respects, this phenomenon is similar to another well-known factor of warning effectiveness, that of location of the warning. A warning that is positioned where it cannot be seen has no direct effect on the receiver. The problem, of course, with inadequate delivery is that the intended warning does not get to the persons at risk—they are not given the opportunity to be informed of the hazard or how to avoid it.

Another similar point with respect to delivery is sensory deficiencies. Again, a source may have put out a warning, but unlike the other examples, this time the warning information arrives at the receiver. However, a person who is blind lacks the capability to receive the information directly if the warning is simply a printed label. Likewise a person who has permanent hearing loss is at a disadvantage for an oral warning given by another person or a recording. The person who is blind or deaf has characteristics that impair information flow to later stages of processing and, thus, would not receive the warning message through the impaired modality. One of the primary discussion points of this chapter are some possible ways to deliver warnings to individuals that may not otherwise get the information because of impaired senses and other constraints, such as task focus. Thus, the point of the concept of delivery is that in order for a warning message to be effective, it must be delivered one way or another to the at-risk individuals.

This chapter discusses issues associated with various aspects of the channel in conveying warning information. The primary focus is on the modalities in which the warning message may be received and the media by which the warning message may be sent. Other chapters in this volume examine factors and issues with respect to specific modalities.

The first part of this chapter focuses on modality effects. Warnings research comparing the effectiveness of visual and auditory warnings is reviewed. Spotlighted is the issue of multimodal reception using both of these senses or possibly

other sensory modalities. Later, this chapter focuses on the communications media as methods of conveying warnings including advertising, video and the World Wide Web. The last section gives implications of the research presented as well as areas for future investigation.

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## MODALITY

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### Visual and Auditory Channels

Warnings research has examined and compared visual and auditory warnings. A common question in this research is whether one modality is better than another with regard to a given warning message on memory performance or behavioral compliance.

Wogalter and Young (1991) used a chemistry laboratory to examine compliance to warnings using the following conditions: (a) a printed-only warning, (b) a voice-only warning, (c) both a voice and print warning, or (d) no warning. The warning was to wear gloves and a mask before performing the steps of measuring and mixing various disguised chemical substances and solutions. In two experiments, the results showed that the condition with both voice and print had the highest compliance (79% in Experiment 1 and 80% in Experiment 2).

Wogalter, Rashid, Clarke, and Kalsher (1991) also used the chemistry laboratory to compare a printed warning sign with and without pictorials. This was an instrumented sign with sensor electronics that would detect persons approaching the area and in some conditions would also elicit a flashing strobe light or a recorded voice warning. The environment was also manipulated by having clutter or no clutter (numerous equipment and materials in the surrounding area or not). The results showed that the largest positive effects on compliance was with the combined printed sign and voice warning. The presence of clutter also reduced compliance. Racicot and Wogalter (1992), in a similar kind of chemistry task, presented the following type of warning(s): (a) videotape of a warning sign stating to wear protection; (b) videotape of a warning sign followed by video footage of a person putting on the protective equipment; and (c) same as condition two plus a voice warning. The results showed that watching a person use the safety equipment significantly increased behavioral compliance compared to the static sign video, whereas the addition of the voice had little additional effect. The authors attribute the results to the strong effect of modeling and also note a ceiling effect from the modeling condition that limited further compliance.

Conzola and Wogalter (1999) gave participants directives to complete three tasks as part of a computer disk drive installation in one of five conditions: A 2 (print vs. voice) × 2 (warning vs. directive) plus a control with these factors absent. In the print directive condition, the message told participants to consult the accompanying manual before completing the task. In the print warning condition, a sheet of paper containing a printed warning was taped to the inside flap of the box, whereas the warning told the three warnings directly. In the voice conditions, a warning message or directive was activated when the participants opened the box. Compliance with the three directives was moderately high across all of the five conditions with

the four experimental conditions significantly greater than the control condition. The voice warning produced greater compliance than in the recall of instructions control and the two print conditions.

Wogalter and Young (1991) reported a study conducted in a field setting where individuals were observed as they entered an area of a shopping center in which there was a mop and bucket. In some of the conditions there was a sign saying, "Warning! Wet Floor. May be Slippery." In the voice condition there was a tape recording repeating the same message vocally. The four warning conditions were: (a) no warnings, (b) voice-only, (c) print-only, and (d) both voice and print combined. Compliance was measured by a person avoiding a defined area of floor tiles near the mop and bucket. Compliance was highest in the voice and print combined condition (76%). Second highest was the voice-only warning condition (64%).

In Barlow and Wogalter (1993), participants watched a simulated television program where several alcoholic beverage commercials were varied on modality. Length of presentation of the messages was held constant (i.e., voice and print were given for the same amount of time). Participants were in one of the following conditions: (a) voice warnings spoken at an average rate of 146 words per minute, (b) print warnings appearing as white text on the bottom of the screen and (c) combined voice and print warnings. *Participants remembered the warnings when presented in the print condition versus the voice-only condition. The individuals in the combined warning condition performed had superior recall to either of the other modalities used alone.* Shaver (2003) found similar results.

Wogalter, Howe, Sifuentes, and Luginbuhl (1999) used a different kind of stimuli, informed consent forms for research participation. The form gave information that the study had a risk of injury and that participants could optionally take part in a less risky task. The participants never actually performed either task but were instead given a test that measured comprehension of the form. In one condition, the consent form was given only in the print version, whereas in another the print version was given but the experimenter also played a reading of it on a tape player. The results showed that comprehension was significantly higher with voice accompaniment than without voice.

In a study of communication modality as a determinant of message persuasiveness and comprehensibility, Chaiken and Eagly (1976) told participants to assist the university psychology department in evaluating a law student's ability to argue legal cases. The procedure included reading background information about a case, then viewing or listening to a randomly selected law student's case discussion and answering a questionnaire regarding their agreement with the message, comprehension of the message, perception of the source, and other measures such as distraction and appropriateness of language. In the experimental conditions, participants were presented with easy versus difficult-to-understand persuasive messages by written, audiotaped, or videotaped media. Also manipulated was the confidence of the communicator in the audiotape and videotape messages using nonverbal cues. Comprehension was equal across all media, and there was no effect of the communicator's confidence. Furthermore, persuasion was greatest for difficult messages in the written condition. However, for easy messages,

persuasion was greatest when videotaped, moderate when audiotaped, and least when written.

Overall, these experiments suggest that voice warnings are more effective than print warnings. They show that video (with sound) and voice-only warnings have a distinct advantage over print labels or sign. This advantage may be due, at least in part, to the dynamic, omnidirectional nature of the auditory warning as compared to a static print warning. However, some studies show otherwise. The Barlow and Wogalter (1993) and Shaver (2003) studies showed that people performed better on a memory task when in the print condition than in the voice-only condition. In both of these studies, people were focused on the television monitor and, thus, could read and reread the printed warning during the same time that the auditory warning would be voiced. In studies that found superiority for voice, people were in situations where visual focus was not directed necessarily to the warning sign. This highlights the advantage of the omnidirectionality of auditory warnings; they can be received while persons are oriented in different directions, unlike the visual warning in which the eyes must be directed to a particular location to receive the warning. Thus, it is apparent that compliance and memory for warnings can depend on the context of the presentation or the task involved but these studies showed fairly convincingly that voice and print warnings combined are the most effective. This effect demonstrates that redundancy can be more effective than single modalities in many contexts.

The aforementioned studies illustrate how, in some contexts, using two modalities to deliver a message can be more effective than a single modality. This combination can allow the message to reach a larger audience, for example, persons with sensory deficits in one modality and not the other, and persons who may be occupied in a task using one sense and not the other. For others, receiving the message in both modalities may produce the belief that the message is of some enhanced importance relative to that of receiving it in one modality and, therefore, they give greater impetus to remembering and complying with the warning.

## Other Senses

The previous studies indicate that using more than one modality to convey warning information is better than a single modality. If so, there might be some benefit of using other sensory modalities that can be used to deliver warnings including the tactile, olfactory, and gustatory modalities. The following sections review some of the ways that warnings have been used in these senses.

**Tactile Channel.** Tactile warnings are used relatively infrequently. Two examples in which the tactual sense signals hazardous conditions are (a) a tire that goes flat during driving provides tactual cues to the driver to pull over and check what is wrong, and (b) when a jet is being maneuvered improperly tactile vibrations are given through the pilot's control stick to signal the need to reorient the control.

There are a number of other ways in which the tactile channel may be used in warning communications. Braille warnings



FIGURE 9.1. Tactile warning product label. Copyright Dantech Ltd. at [www.tactilelabels.com.uk](http://www.tactilelabels.com.uk) Reprinted with permission.

could be added to hazardous products so that individuals with visual impairments can be informed of the potential dangers. In Europe, products with hazardous chemicals must include a raised warning label of either a raised triangle or three raised dots forming the points of an equilateral triangle to signal a hazard. The BS EN ISO 11683:1997 standard which sets forth warning design guidelines for blind and visually handicapped persons mandates that all chemicals sold to the public that are labeled “very toxic,” “toxic,” “corrosive,” “harmful,” “extremely flammable,” or “highly flammable,” require a tactile hazard warning (British Standards Institution, 1997). The example shown in Fig. 9.1 shows a flexible tactile warning label with adhesive that can be applied to hazardous products or their containers.

Other examples of tactual warnings are derived from the Americans with Disabilities Act (see also American National Standards Institute, 1998, standard on accessible and usable buildings and facilities—ANSI A117.1). One is having detectable raised quarter-sized domed tactile cues on walkways just before the edge of a roadway to signal danger. Figure 9.2 shows an example. Similar cues can be placed near the edge of a step or stairs so that individuals can be aware of an approaching drop and/or step. Figure 9.3 shows an example at an airport in Japan.

Peck and Bentzen (1987) reported a study examining different floor textures for rail station platforms for use near the edge to cue visually impaired individuals that they are near the edge. The study evaluated four different types of surfaces including a rough steel plate surface, a ribbed rubber mat, a linear corduroy surface, and a tennis court surface. The experimental task involved participants reporting whether they felt a surface or not. Of the four tactile warnings, the corduroy surface had the greatest detection rate and the ribbed rubber mat having the next highest detection. These examples suggest that textured surfaces can aid the visually impaired population.

Textured surfaces can also aid sighted individuals. One study (Hickey, 1997) reported how the use of rumble strips on the sides of Pennsylvania highways reduced the number of drift-off road accidents caused by drowsy, impaired, or distracted drivers. These rumble strips alert by producing a distinct sound as well as kinesthetic feedback to vehicle occupants. Hickey reported that after the installation of rumble strips on the Pennsylvania Turnpike, drift-off road accidents decreased by 70% per month.

Kalsher, Cote, Champagne, and Wogalter (1997) conducted a study on the effectiveness of tactile feedback on warning labels in which they examined the effectiveness of raised and

nonraised borders. The three experimental conditions included no warning, regular warning, and warning with raised border. Participants reported the warning with the raised border the most noticeable and the information contained in it was also the best recalled.

The effectiveness of tactile feedback was also investigated in a study on interactive warnings (Dingus, Wreggit, & Hathaway, 1993). In this study, participants had to interact with a bottle of bathroom tile descaler. The dependent measure in this study was compliance with wearing a pair of gloves and a mask. The warning interactivity levels employed were a conventional label, a billboard label over the nozzle that had to be removed before use, and a trigger block, which is a plastic piece that had to be pushed away from the nozzle before each use. Compliance increased in conditions where individuals had to interact with the warning in order to use the product (i.e., billboard label and trigger block). Duffy, Kalsher, and Wogalter (1995) also found positive effects of a physically interactive warning by participants who were assisting in the set up of electronic equipment. Wogalter, Barlow, and Murphy (1995), using a product installation task (a separate disk drive for a computer), found that an interactive warning was powerful enough to capture the attention of even highly familiar users.

The previous studies illustrate some of the ways tactual cues have shown benefits for alerting and in cases with Braille communicating a specific warning message. The tactile symbol on European hazard labels is useful to visually impaired person, as well as serving as a redundant cue to nonimpaired.

Tactile cues are also used concurrently with sound. A pilot feeling the vibration of a control stick also hears sound cues. A flat tire gives off sound as well as vibrations. Sidewalks are being outfitted with detectable tactile domes on the curb pavement. Some of these are combined with traffic lights that have chirping sounds to guide persons who are blind safely across the street.

We believe that tactual cues could be used in more applications—together with auditory and visual warnings. Tactual cues cannot be used in every warnings application. But the use of the raised hazard triangle on hazardous chemical labels in Europe is a good example of how tactual warnings could be used in more applications than are currently in use.

**Olfactory.** In a general sense, the olfactory sense has been used as a warning across the ages. Spoiled, rotten food gives off a rancid odor that gives off cues so that even a very hungry person would not want to consume it. To help in detecting gas leaks, utility companies commonly add an odor to natural gas.

A study by Hatem and Lehto (1995) examined the effectiveness of an olfactory warning agent relative to a glue product. Participants were engaged in a craft task in which they had to use glue to complete the task. A strong odor cue (naphthalene and camphor) emanated from the glue in some conditions. Participants were exposed to one of the following four ( $2 \times 2$ ) warning conditions: (a) no warning, (b) an olfactory warning, (c) a textual warning label on the glue bottle or (d) a combination of the text and olfactory warnings. Participants rated the glue as less safe if the odor cues were present compared to absent.

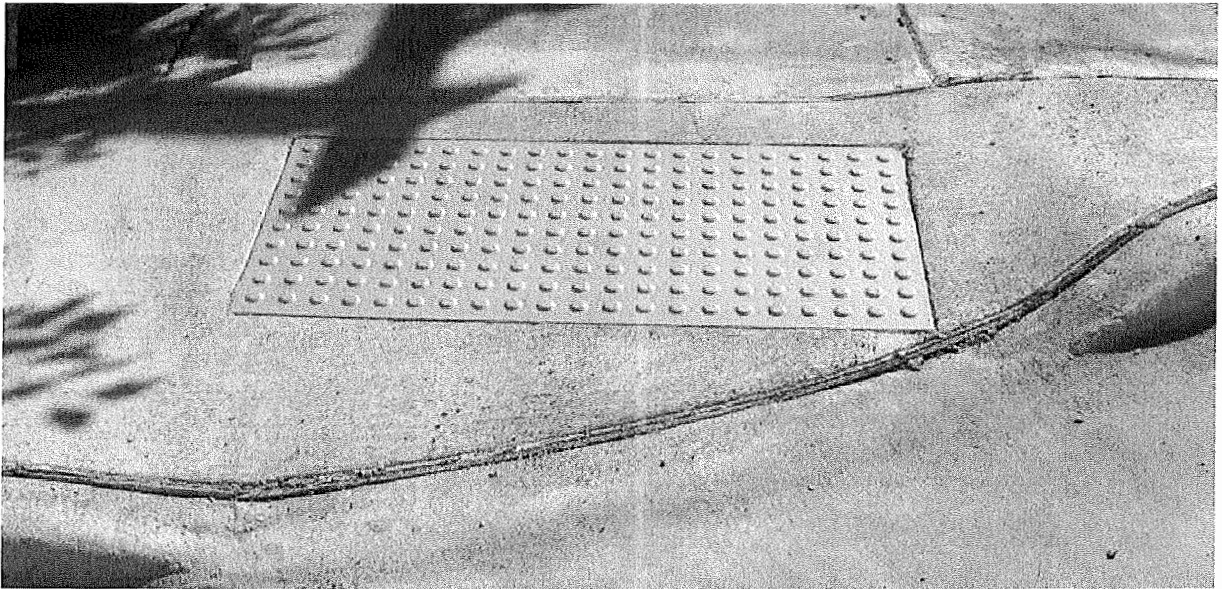


FIGURE 9.2. Truncated warning domes for handicap access ramps. Reprinted with permission from the Wisconsin Department of Transportation.



FIGURE 9.3. Detectable tactile warnings at the edge of descending stairs in a Japanese airport. Reprinted with permission from the Wisconsin Department of Transportation.

Danuser, Moser, Vitale-Sethre, Hirsig, and Krueger (2003) examined the influence of pleasant and unpleasant odors on task performance. In part, they examined whether the presentation of moderate novel stimuli might elicit an orienting response. Orienting response refers to a shift in attention away from a task in which they are engaged to the eliciting stimulus. Four odors were used, two pleasant—pentylacetate and methane—and two unpleasant—H<sub>2</sub>S and NH<sub>3</sub>. Participants performed a computer-based complex cognitive task, which involved a tracking task with a central memory task and a peripheral reaction task. The participants had to simultaneously follow a shape with a cursor, press a response key when three colors were presented one after the other, and press another key when a circle jittered in a peripheral area of the screen. When exposed to the two malodors, there was a decrease in task performance and an increase in reaction time.

The current uses and the findings from the two experiments just discussed suggest the use of malodors may be beneficial in some situations as warnings. Instead of a sweet lemon smell in household chemicals, an odor that would repel small children could be used instead. Obviously, the odor should not be so noxious that it would annoy adult users. If there were products available with such odors, caregivers of very small children might be more apt to purchase them to reduce accidental poisonings.

One of the problems with using olfaction as a cue to signal danger is that this sense adapts or habituates over time. Although a person may note an odor initially, after some time passes, that person may no longer detect the still-present odor. Another problem is that some people cannot detect odors (anosmia) either because of a genetic/physiological deficiency or because of congestion caused by a cold, flu, or allergy. When possible, the warning should be present in at least one other modality.

**Gustatory.** Like olfaction, the gustatory (taste) sense providing a cue for danger has a long history. Something that does tastes bad is not consumed. It might be poisonous. Even lower animals use taste as a cue. Rats are known to be “bait shy.” They taste very little of a novel substance, and if they get sick soon after that, the rats will avoid consuming anything that tastes like it again (Kalat & Rozin, 1973). The use of taste for warning is probably a “built in” mechanism in higher order animals.

Research specifically examining the gustatory sense as a warning tool has been rather limited. There is some indirect related literature, however. For example, Lawless and Stevens (1988) sought to identify specific areas in the mouth that were most responsive to chemical irritants: capsaicin and piperine, both irritants derived from black and red pepper. Capsaicin was found to produce a greater response than the piperine. These findings suggest certain foul tastes may be more useful than others in signaling poison.

One example of a gustatory warning is Bitrex™. Bitrex™ is a bitter substance (denatonium benzoate), which can be used in hazardous products in minute quantities to render the product unpalatable. The taste is very bitter, and the expectation is that children would tend to spit it out before they consume much of it (Jacob, 2003), making it effective in warding off children from consuming much of the hazardous product.

## Implications

The previously mentioned studies highlighted a number of general findings with respect to sensory channels and warnings. First, in many contexts, using more than one sensory channel may be more effective than using a single modality when transmitting a warning. There are several potential reasons. One is that the redundancy of the message makes at least one of the modalities available to catch and maintain an individual's attention. A second reason is that two or more channels are able to reinforce the warning message. A third reason is that it could compensate for sensory deficiencies in one of the two main senses. Because there are numerous persons in the general population who are hearing or visually impaired, a warning given only through the visual *or* auditory modality will compromise the safety of persons having one or the other of these impairments. Thus, by presenting the warning in more than one modality, persons in these categories would have the chance of receiving the warning. Thus, to reach a larger target audience at risk, the use of more than one sensory modality should be considered. The warning designer's toolbox should not only include visual and auditory warnings but also tactile, olfactory, or gustatory warnings, as they may prove effective in some circumstances.

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## MEDIA

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The previous section focused on the effectiveness and ineffectiveness of various warnings with respect to various sensory channels. The following section examines various communication media channels that could be used to deliver warnings. Communications media can be described as channels through which warnings or product information are delivered. Some examples of common communications media are pamphlets, product labels, signs, and advertisements, which can be in print, radio, or on television. We have already offered some examples of the effects of media in the context of describing the effects of multiple modalities. The information arriving to the modalities came from some form of media. In this section, we will mainly limit our discussion to research using common media as channels for warning communications.

### Media Campaigns

For many decades, risk and hazard information has been disseminated to the public using mass-market media campaigns. The purpose of *mass media* warning campaigns is to expose hazard information to larger target populations (as opposed to individuals). The campaigns have used television, radio, print media, and mail. The warnings may appear in news broadcasts, magazine-type news shows, and advertisements. More recently, they may involve electronic mail and the Internet. A benefit of transmitting information through the mass media is that it can potentially reach large numbers of people. The messages can also be repeated a number of times, possibly through several channels, to increase the likelihood the messages will be received at least once and possibly many times and encoded into long-term

memory for recall at a later time. Drawbacks include not reaching all of the relevant target audience at risk, for example, if they are not watching the broadcast when the warning is presented or if they do not receive the magazine that contains the warning.

The literature on the efficacy of mass media campaigns differentiates between behavioral change and behavioral intentions, with the majority of the research focusing on the latter (Silver & Braun, 1999). For example, participants reported significantly more intent to engage in physical activity after mass media campaigns conducted by the National Heart Foundation of Australia (Owen, Bauman, Booth, Oldenburg, & Magnus, 1995). Similarly, in a survey of two east Caribbean countries following a mass media condom use campaign, Middlestadt et al. (1995) found that intentions to use condoms was greater in participants that were exposed to the campaign, in comparison to those who were not.

Silver and Braun (1999) contended that the literature on the efficacy of mass media warnings in modifying behavior is mixed, demonstrating some negative findings and, at best, limited effectiveness. For instance, Maccoby, Farquhar, Wood, and Alexander (1977) examined an education program regarding coronary heart disease in two different California communities over a 9-month period. In two experimental communities, the researchers used television, radio, newspaper, cookbooks, and health information. Face-to-face contacts were also added in the second experimental condition. Participants in the experimental communities showed significant increases in knowledge and decreases in plasma cholesterol levels in comparison to the control communities in which no intervention occurred. Warner (1977) also demonstrated that events such as a Surgeon General's warning reduced the per capita consumptions of cigarettes 4 to 5% in the 1960s. Furthermore, Warner concluded that the celebrity-endorsed commercials and advertisements on the hazards of smoking reduced per capita consumption of cigarettes by 20 to 30%. Additionally, Lewitt, Coate, and Grossman (1981) reported that adolescent smoking decreased following an anti-smoking campaign broadcast by radio and television. Stravinos (1987) concluded that presenting hazard information to smokers was more effective in modifying behavior than raising the price of cigarettes in Greece. There are numerous other studies that have shown positive effects of mass media warnings for a variety of hazards.

In contrast, the U.S. National Highway Traffic Safety Administration, using observations and telephone interviews, reported that radio and television public service announcements did not significantly affect seatbelt use (Fleischer, 1971). Robertson (1976) gave a similar conclusion in a literature review. A study in the public education system was unsuccessful in reducing severe burn injuries (McLoughlin, Vince, Lee, & Crawford, 1982). Flay, Hansen, and Johnson (1987) also reported negative findings following a joint school-based education program and television campaign to change students' intentions and behaviors regarding smoking. Similarly, Barber and Grichting (1990) concluded that Australia's mass media campaign targeting drug abuse was unsuccessful in modifying behavior. Bauman, LaPrelle, Brown, Koch and Padgett (1991), comparing six experimental communities with four control communities, found that smoking behaviors actually increased following three different radio campaigns.

Why have many mass media campaigns been ineffective? Several reasons have been cited. The messages are usually very brief and the information contained in them is abstract (Adler & Pittle, 1984) and inaccurate and/or exaggerated (Moynihan et al., 2000; Warneck, 1998). There are several additional reasons for the failures.

First, the mass media message must actually get to the individual and this requires adequate coverage. Some individuals might not see the television commercials. Even if they do see the commercial, the message may not contain material perceived as relevant to the targeted individual. The content may also be incomplete. Taylor (1991) noted the message often lacks adequate directives to guide future behavior. The message may also lack adequate information on the hazard itself and the consequences of not complying with the directives. These missing content components have been shown to be important for maximizing the warning's effectiveness. Warning research has revealed numerous factors that influence warning effectiveness. These include the use of explicit consequence statements, salience/prominence features, and so on. Yet, these aspects have frequently not been incorporated into mass media warnings (Silver & Braun, 1999). Research in the domain of warnings indicates that the message should convey the appropriate level of severity of the hazard involved. However, media campaigns often inadequately convey the negatives associated with the hazard. Apparently this has happened because some early research suggested that people might be "turned off" by campaigns that evoke fear, and thus, they are not receptive to the message. The suggestion is that it might be better to use moderate-or low-fear messages. For example, a meta-analysis reported by Boster and Mongeau (1984) showed low-to moderately low-correlations (from .10 to .36) between fear manipulations, perceived fear, attitudes, and behavior—suggesting that there is no close tie between these variables. With findings like these, most campaigns have not used warnings that convey appropriate severity levels. Instead they have used wilted, watered-down warnings that do not convey the appropriate level of hazard.

Another reason for mass media warning failures is simply that some campaigns have targeted for change highly intransigent behaviors. To expect a few commercials and print ads to change a heroin user's drug-taking behavior is nothing more than wishful. Recycling, using less electricity, and avoiding work zones on roads are the types of behaviors more changeable by mass media warnings.

A review by Dejong (2002) discussed the importance of learning from media campaign successes and failures related to excessive consumption of alcohol by college students. Dejong classified alcohol abuse media campaigns into three categories—advocacy, information, and social norms marketing—and suggested that research has shown that the mass media is an effective channel for communicating risk information and changing behavior if implemented and sustained in accordance with "sound principles." The principles offered were to:

1. Start with a strategic plan.
2. Define objectives.
3. Choose a target audience.

4. Create stages for behavioral change.
5. Develop the promised benefit.
6. Avoid fear tactics.
7. Choose an appropriate source.
8. Use a mix of media channels.
9. Make the most of media exposure.
10. Conduct research.
11. Evaluate process and outcomes (pp. 185-189).

McLoughlin et al. (1982) recommended combining legislation, education, and product modification. In addition to (and missing from) these guidelines is to make use of findings from existing empirical warning research regarding content and enhancement features. Thus, it is easy to see why many mass media campaigns have failed.

## Advertising

Warnings in television, print, and radio have traditionally been the predominant channels for advertising consumer products and services. Such media have the distinction of being readily seen and heard, even though they are typically short in duration or appear in fine print (Mazis & Morris, 1999). However, many companies hesitate to use them, unless required to do so. Most believe it diminishes the quality of the sales pitch and consequently sales. By mentioning the associated dangers in the advertisement, it would increase the likelihood that consumers would evaluate the associated benefits and risks, rather than just the benefits and, consequently, decrease the likelihood of purchase or use. For example, Loken and Howard-Pitney (1988) reported that a specific rather than a general print warning in a cigarette advertisement diminished the advertisement's credibility, attractiveness, and persuasiveness. The challenge for the advertiser is how to give the risk information without detracting from appropriate purchase and safe use of the product. Nevertheless, few advertisements include risk information and warnings. There are a few exceptions. The U.S. Food and Drug Administration (FDA) requires a "fair balance" of benefit and risk information in broadcast and print advertisements for prescription medications. In marketing of noninsured equity funds, a risk disclosure is also given. The challenge of communicating risk information to the public becomes even greater because the recipient has no control of the message (Bettman, 1979), and the information presented in advertisements may be recognized but may not be recalled at the time of purchase or use. Video warnings may be more effective if they include examples of responsible behavior and/or warning compliance (Wright, 1979).

There are several studies that have implications for the design of warning disclosures in television advertisements. For example, Morris, Mazis, and Brinberg (1989) found that the recall of product benefits decreased when either two or four warning messages were included in a televised prescription drug advertisement. They concluded that warning messages must be long enough to be recognized but not so long as to burden the short-term memory store and reduce the recall of the product benefits. Houston and Rothschild (1980) discussed the impor-

tance of information specificity in television advertisement. In a laboratory study, participants failed to recall general disclosures (e.g., "use only as directed") when presented through the visual channel, but not the auditory channel. Similar results have been replicated in studies involving drug ads (Morris et al., 1989) and alcoholic beverages (Smith, 1990). It should also be noted that comprehension of warning messages in televised advertisements is also affected by factors such as conspicuity (Best, 1989; Hoy & Stankey, 1993; Smith, 1990) and size and the number of words in print (Murray, Manrai, & Manrai, 1993). In other words, shorter messages in large print are comprehended more readily than longer messages in small print.

Print advertisements containing risk and safety information are typically presented in magazines and newspapers and, in some cases, roadside billboards (e.g., prescription drugs ads). Mazis and Morris (1999) suggested that people process the information in these warnings in a *top-down* manner, or in other words, they may notice the warning, but they do not give it the necessary attention for encoding and subsequent recall.

With respect to design issues, Barlow and Wogalter (1993) and Foxman, Muehling, and Moore (1988) found that conspicuity affected the effectiveness of warnings in printed advertisements. As expected, conspicuous warnings are more likely to be read because there is visual separation or contrast between the important risk information and the surrounding background. However, Popper and Murray (1989) found that conspicuity did not affect warning effectiveness in a study using chewing tobacco ads. Furthermore, research on the shape of a warning in print advertisements has yielded mixed results. For example, Bhalla and Lastovicka (1984) reported that changing the shape from a familiar triangle to an irregular shape caused a small change in participants' recall of the warning, whereas Barlow and Wogalter (1993) found no effect of shape. Clark and Brock (1994) reported that moving the warning to a central location minimally affected consumer attitudes regarding the product brand. Small or fine print risk disclosures in product advertising have also been investigated. Such warnings have been shown to be ineffective because people frequently do not read them (see Baum, Schaeffer, Wideman, Reddy, & Yellin, 1983; Foxman et al., 1988).

No studies in the human factors and marketing literature specifically address how best to design warnings to convey risk information through radio or streaming audio. Potentially applicable research is primarily limited to studies previously discussed on media campaigns and modality effects. There is also a growing body of research on speech warnings, which may have applicability to warnings conveyed through radio. This research is discussed elsewhere in this Handbook (see Edworthy & Hellier, chap. 15, this volume).

## Other Electronic Media

Other media may also be used for warnings. This section describes some of these.

**Visual and Audio Media.** Videotape and DVD recordings are sometimes used for safety demonstrations and training. These



and other media (e.g., audiotape and CDs) may also be used in addition to owner's manuals with products. Video may benefit warning effectiveness through the use of vivid attention-getting demonstrations and presentations of use, and modeling by others of appropriate behaviors and various risk avoidance strategies. Likewise, audiotaped messages share similar advantages although lacking the visual component. As we have already shown, research indicates that, in general, combining visual and auditory warnings is better than warnings conveyed in a single modality.

**World Wide Web.** Advances in technology and increased bandwidth afford the opportunity for manufacturers and retailers in an e-commerce setting, as well as corporate trainers, to present risk and hazard information via the streaming video. Some of the recent literature in this area is reviewed in the following. See also Wogalter and Mayhorn (chap. 63, this volume) for more information on future trends of communicating warnings, involving technology.

The World Wide Web (WWW) provides a dynamic and engaging environment for consumers in a medium that allows a transfer of large amounts of information. E-commerce Web sites provide retailers and manufacturers a high degree of customization in communicating risk associated with products using high-quality graphics, video, and sound. A major concern is that those who purchase goods using this channel are not afforded the opportunity to try out the product in a store or benefit from face-to-face communications as in the purchase of prescription pharmaceutical products from a pharmacy. Therefore, Web site design becomes increasingly important in communicating risk and benefit information.

Current FDA regulations require that direct-to-consumer (DTC) advertising of prescription drugs in the broadcast and print media conform to certain guidelines of equal balance (see Ostrove, chap. 40, this volume). In other words, there must be a similar number of points raised about risks as benefits. There are two studies that have examined the presentation of benefit and risk information on pharmaceutical manufacturers' Web sites. Using software to record mouse clicks and times to complete the tasks presented, Vigilante and Wogalter (2001) examined the effects of integrating and separating risks and benefits on experimentally manipulated Web sites for fictitious drugs. They found that participants found and remembered risk information when it was placed on a page linked to the home page and were less likely to find risk information in deeper levels of the Web sites.

Hicks, Vigilante, and Wogalter (2001), using 20 randomly selected actual prescription drug websites, evaluated:

1. Clicks from the home page to the benefit information.
2. Clicks to risks from the home page.
3. Clicks from benefits to risks.
4. Clicks from risks to benefits.
5. The need to scroll to view benefits.
6. The need to scroll to view risks.
7. Whether the risks and benefits were on the same page.

8. If PDF was required to view the risks. Their results indicated that information associated with the risk of using the products would be more difficult to find than the benefits, that is, they required scrolling and more clicks.

These two studies illustrate that risk information on existing and fictitious pharmaceutical Web sites can be more difficult to find than the benefits information. The main difficulty is in users trying to locate risk information that is embedded deep within the Web site. Given FDA regulations requiring a balanced representation of both risks and benefits, these Web sites should be designed to make the risk information as easy to find as the benefits.

In a different computer-based task, Santos and Resnick (2002) compared participants' perception, risk comprehension, and behavioral compliance with warnings regarding the age-appropriateness of a children's toy when purchasing it online as compared to the traditional method of purchasing. In this experiment, the authors simulated an actual buying experience in which the participant was able to look at the product to be purchased versus the online condition where the individual was only able to review the product via the Web site. More than 90% of participants in both the virtual and physical channels conditions acknowledged that the toy was appropriate for children over 3 years of age when purchasing the products, that is, there was no significant difference between the two conditions. It is interesting to note that more participants reported seeing the warning when purchasing the product online as compared to those in the traditional buying condition. Santos and Resnick concluded that people were more likely to attend to printed information (i.e., the product warning and description) while shopping online. Future research should determine the reasons for the difference. For example, is it due to excellent placement of the risk information on the Web site and poor placement on the actual toy or some other reason?

Because of the rapid growth of DTC advertising of drugs (Kopp & Bang, 2000) and the increased purchasing of consumer goods online, there is a need for further research on the advantages and disadvantages regarding the communication of safety measures. Additional research on how consumers obtain, process, and act on risk information presented by computer-based systems is needed.

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## CONCLUSIONS

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With any type of warning, it is essential that the information reach persons at risk. Warnings that do not arrive can result in persons being in danger. Thus, knowledge about characteristics and efficacy of the warning channel can benefit warning communications.

When presenting a short message, the auditory channel appears to be more effective than the visual channel (Penney, 1989). Conversely, when presenting a long and complex warning, the visual modality appears to be better (Wickens & Hollands, 2000). Numerous studies have shown that warning presentation in more than one modality benefits attention capture, comprehension, and compliance.

When designing a warning and/or choosing a particular warning, it is necessary for one to thoroughly assess the context in which the warning may be presented. Different contexts will need different types of warnings. For example, in a situation where one is monitoring a congested visual display, introducing a visual warning could be ineffective and could possibly upset potentially important monitoring performance. A warning in another modality may be more appropriate. Likewise, in a construction or factory environment, concurrent noise or hearing protection devices, may mask an auditory warning, thereby reducing the warning's effectiveness. Here an appropriate consideration is to reduce the noise or use a warning channel that is not interfered with by the noise.

Using a multimodal approach gives greater assurance that the warning will get delivered to the appropriate targets. The research discussed in this chapter illustrates that a multimodal approach can be desirable in many contexts (Wickens & Hollands, 2000). In addition to employing visual and auditory warnings,

the use of nontraditional channels such as tactual, olfactory, and gustatory modalities should be considered, if feasible (Collins, Danner, & Tibbott, 1981). Multimodal delivery will benefit the sensory impaired (e.g., blind, deaf) and reinforce the message to fully able individuals—thereby increasing the probability that the message reaches a larger audience. Although developing warnings that benefit users with different sensory capabilities can pose challenges, the importance of reaching the vulnerable is clear.

More research is needed for deciding which modalities and media are most effective in different contexts. With technology growing at an unprecedented rate, there is an even greater need for research on the use of multiple modalities and communication media, particularly in computer-based systems. One of the most important goals in warnings is that the message reaches the target audience. Future research in this area will likely find better ways to ensure successful warning delivery.

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