Using a Hybrid Communication/Human Information Processing Model to Evaluate Beverage Alcohol Warning Effectiveness

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This article reviews the literature on beverage alcohol warnings using a hybrid communication/human-information processing model. The communications model has three components: source, channel and receiver. Within the receiver, an information processing model describes the various serial stages of processing: attention, comprehension/memory, beliefs/attitudes, behavioral intentions, and lastly, behavior. Each stage in the sequence is a potential bottleneck that could cause processing to stall, preventing any further flow of information downstream. Factors for each stage in the hybrid model are discussed. The model is useful in explaining why the currently mandated U.S. alcohol warning is less likely to be effective than it could be. It can also be used as a basis for recommending changes in the current warning's content and design and in making use of other warning methods.

Beverage alcohol offers both health benefits and risks. Recent medical reports indicate that moderate amounts of alcohol (e.g., one or two drinks per day) might offer some protection against various diseases (e.g., coronary diseases). However, alcohol can also be hazardous in several respects: (a) to the health of the drinker (e.g., in cases of abuse or in combination with interactive drugs), (b) to the health of others (e.g., a fetus or the victim of a drunk driver), or (c) to an individual with respect to the law (e.g., an

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under-age drinker or an individual driving with a blood alcohol content above the legal limit). Thus, alcohol poses risks under certain conditions and these potential hazards must be addressed by manufacturers and others responsible for public safety.

There is a fairly standard hierarchy in the safety literature on the preferred methods for dealing with product risks. Foremost, one should try to design out or remove the hazard from the product. It is preferable to eliminate hazards entirely without sacrificing product utility. One illustration of this method with respect to alcohol is low (or no) alcohol beer—if there is no alcohol in the product, it cannot cause harm. This strategy would not, for the most part, be acceptable because many consumers purchase beverage alcohol products for the sole reason that they contain alcohol. However, designing products without alcohol might be an effective strategy in instances where alcohol is not the primary consideration in the purchasing decision (e.g., with over-the-counter cold medications).

A second-level strategy (that is usually not as good as a design-related solution) is to guard against the hazard or to put a barrier around it so that consumers cannot encounter the hazard. One example of this with respect to alcohol would be laws preventing the sale of alcoholic beverages to minors (i.e., those below 21 years of age in the U.S.). However, such guarding strategies are not always effective—they were not very effective in times of prohibition, they are not applicable to individuals above the legal

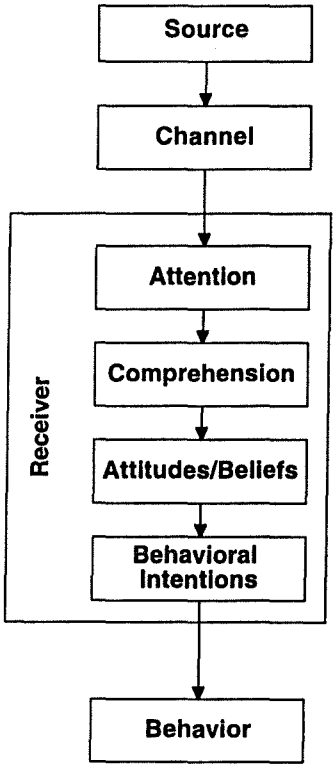

Figure 1. Communication/Human Information Processing Model

drinking age (except possibly in "dry" areas where alcohol is not sold to anyone), and they are sometimes circumvented by underage drinkers. A third level strategy that might be undertaken is to warn. Generally, warnings are not nearly as effective as the first two methods because they are not totally (100%) reliable. However, when the first two methods are impractical or impossible to implement, then warnings can be used as a potentially effective method of reducing exposure to injury or illness.

This review article discusses ways in which alcoholic beverage warnings can be improved. It does so within the context of a hybrid communication/information processing model (see Figure 1). This hybrid model combines three components from a basic communication model (source, channel and receiver) with a model of human information processing that represents the effect of the warning within the third stage of the communications model (the receiver). While the actual process is probably more complicated than implied in this model's linear sequence (see Wogalter, DeJoy & Laughery, in press), it is useful for conceptualizing the process by which warning information might influence intermediate stages prior to behavioral effects. According to the model, a warning message originates from some source, it proceeds across some channel and it reaches the domain of the receiver. If the receiver attends to the message and understands it, then the message can be factored into the user's behavioral decisions. Failure at any of the stages can result in a failure of the message to influence user behavior. The following sections review research and discuss factors associated with each stage of the model.

MESSAGE

Within the communication model, the message originates from the source, travels across the channel and hopefully reaches the receiver. Warning messages typically include a signal word, verbal statements (about the nature of the hazard, consequences of encountering the hazard, and instructions on how to avoid it), and/or pictorial symbols (see ANSI, 1991). Not all of these components are necessary in all cases, as some information may either be known independently or can be inferred from information provided in the warning (Wogalter et al., 1987).

One relevant warning with respect to alcohol is the following message that was mandated by the U.S. Congress to appear on containers sold in the U.S. since 1989 (Federal Register, 1989; see top warning in Table 1). The warning has a signal word ("GOVERNMENT WARNING"). It provides information about hazards (drinking during pregnancy and impairment when driving or operating machinery), consequences ("birth defects" and "health problems"), and instructions on how to avoid one of the hazards ("women should not drink"). The current labeling law explicitly prohibits the provision of additional health-related information on alcohol container labels. It is reasonable to assume that the rationale behind this fixed wording was to prevent the dilution of the warning message through either (a) inconsistent wording of the hazards on different labels or (b) presentation of many other, potentially extraneous hazards. Of course, it also prevents manufacturers from including better or more inclusive warning information on the label.

Table 1. Three Versions of a Beverage Alcohol Warning

(a) Current Warning (All Caps)
GOVERNMENT WARNING: (1) ACCORDING TO THE SURGEON GENERAL, WOMEN SHOULD NOT DRINK ALCOHOLIC BEVERAGES DURING PREGNANCY BECAUSE OF THE RISK OF BIRTH DEFECTS. (2) CONSUMPTION OF ALCOHOLIC BEVERAGES IMPAIRS YOUR ABILITY TO DRIVE A CAR OR OPERATE MACHINERY, AND MAY CAUSE HEALTH PROBLEMS.
(b) Current Warning (Mixed Case)
GOVERNMENT WARNING: (1) According to the Surgeon General, women should not drink alcoholic beverages during pregnancy because of the risk of birth defects. (2) Consumption of alcoholic beverages impairs your ability to drive a car or operate machinery, and may cause health problems.
(c) Formatted and Outlined Warning (Mixed Case)
GOVERNMENT WARNING
(1)According to the Surgeon General, women should not drink alcohol during pregnancy because of the risk of birth defects.
(2)Alcohol impairs your ability to drive a car or operate machinery,
(3)May cause brain and liver damage and other health problems.

Table 2. Various Potential Alcoholic Beverage Warnings (taken from Barlow & Wogalter, 1993 and used in Wogalter & Brelsford, 1994; Wogalter & Conzola, 1997)

WARNING: Drinking Alcohol During Pregnancy May Cause Fetal Alcohol Syndrome which means the Baby may have Deformities, Mental Retardation, Behavior Problems, or Abnormal Growth.
WARNING: Drinking Alcohol and Taking Sleeping Pills, Pain Killers or other Medicines and Drugs can be Deadly. Antibiotics, When Combined with Alcohol, may NOT Work. In the U.S., 25% of ALL Hospitalized Persons have Alcohol-Related Problems.
WARNING: Drinking Coffee, Taking a Cold Shower or Vigorous Activity does NOT Help to Sober Up. The Body Needs 2 Hours to Remove the Alcohol from 1 Beer, 1 Glass of Wine, or 1 Shot of Spirits.
WARNING: Drive Sober. In Many States, the MINIMUM Penalty for Driving Legally Drunk (.08 Blood Alcohol Count) is 6 Months Suspension of Driver's License, 15 Days in Jail, and a $1500 Fine. Insurance Costs Increase Dramatically.
WARNING: Drunk Driving is the Number-ONE Killer of Children and Young Adults. 55% of Traffic Deaths are Alcohol Related. There is an Alcohol-Related Death EVERY 22 Minutes. 90% of all Fatally Injured Drinking Drivers are Male.
WARNING: Drinking Alcohol Increases the Risk of Throat, Stomach, and Prostate Cancer and Diseases of the Liver and Heart, including Cirrhosis and High Blood Pressure. Alcohol is also linked with Dietary Deficiencies.
WARNING: Beverage Alcohol (also called Ethyl Alcohol or Ethanol) is a Drug which can be Addictive. Children of Alcoholics have 4 Times the Risk of Being Alcoholics. 4.5 million Young People are Addicted to Alcohol or are Problem Drinkers.
WARNING: Carbonated Alcohol is Absorbed Faster than Non carbonated Alcohol. Within 2 Minutes Alcohol is Absorbed by the Stomach and Carried by the Blood to the Brain. You can be Poisoned and Die If You Drink Alcohol Too Fast.
WARNING: Acts of Violence are MORE Likely after Drinking Alcohol, Including Sexual Abuse, Rape, Child Beatings, and Murders. If You are Under the Age of 21, It is Illegal to Buy Alcoholic Beverages.
WARNING: 40% of all Americans Will Be Involved in an Alcohol-Related Traffic Accident During Their Lifetime. Alcohol Impairs Your Ability to Drive a Car or Operate Machinery, and Will Make You Overconfident and Your Responses Slower.

Regulations and standards for most warnings (e.g., ANSI, 1991) do not specify content and/or format so rigidly, but rather they present a general framework to which manufacturers must adhere. This framework not only allows for variation in presentation, but also gives manufacturers the leeway to make improvements in content and design. Since most adults are aware of the information contained in the mandated alcohol warning (Graves, 1992; Greenfield, Graves, & Kaskutas, 1992), it would seem reasonable that either (a) the warning could be rewritten to present information that would be of greater utility or (b) a system of rotating warnings (e.g., cigarette warnings) could be employed. Table 2 shows a set of alcohol warnings with additional information that could be rotated.

With regard to the message, we must ask "What is the purpose of this alcohol warning?" If it is to serve as a reminder of information that is already known (i.e., a cue during product use), then the current warning may be adequate. If, however, the purpose of the warning is to provide users with a greater appreciation of the risks associated with alcohol consumption (including risks that may not be fully known or understood), then the current warning is not adequate to fill the gaps in their knowledge base. In designing the message, the user's informational needs must be the primary consideration.

SOURCE

The source of a message is important because it is the provider of the information and characteristics of the source that can influence how the message is transmitted and/or received. Potential sources of warning information can include manufacturers, the federal government, nonprofit public service organizations, and industry trade organizations. The perceived credibility of the source may influence the impact of the message. The federally mandated alcohol warning label gives two sources: Government and Surgeon General. Surprisingly, the effect of message source has received relatively little attention in the warnings' research literature. Thus, the influence of source on the credibility of alcohol warnings must be inferred from theory and/or generalized from the broader domains of communications and social persuasion research. These sources suggest that factors such as the perceived expertise of the source, their popularity and trustworthiness (among others) influence the effectiveness of a communication on its recipients (Cox, in press).

Only recently (Wogalter, Kalsher, & Rashid, in press) has some empirical study been initiated on the effects of the warning's source. In this research, one of the three product warnings investigated was the government's mandated alcoholic beverage warning. The presence vs. absence of the signal word was manipulated as were the terms used to describe the source of the message. In one experiment, it was shown that adding GOVERNMENT to the signal word WARNING produced higher credibility and a greater reported willingness to comply than the signal word (WARNING) alone. The further addition of the terms U.S. and FEDERAL, separately or together (e.g., U.S. FEDERAL GOVERNMENT WARNING), produced even higher ratings of credibility and willingness to comply. A second experiment examined the influence of (a) specific government related sources (e.g., SURGEON GENERAL'S WARNING), (b)

Table 3. Mean Ratings of Credibility and Compliance Likelihood as a Function of Prefix (Wogalter et al., in press)

Prefix	*Credibility*	*Compliance Likelihood*
Experiment 1		
[blank]:	2.67	3.11
WARNING:	3.64	3.89
GOVERNMENT WARNING:	4.30	4.15
U.S. GOVERNMENT WARNING:	4.79	4.51
FEDERAL GOVERNMENT WARNING:	5.13	4.62
U.S. FEDERAL GOVERNMENT WARNING:	5.33	4.69
Experiment 2		
__[blank]__:	2.81	3.53
WARNING:	3.51	4.23
U.S. SURGEON GENERAL'S WARNING:	5.25	5.33
U.S. CONSUMER PROD SAFETY COMMISSION WARNING:	4.49	4.88
U.S. FOOD AND DRUG ADMINISTRATION WARNING:	5.25	5.40
AMERICAN MEDICAL ASSOCIATION WARNING:	5.53	5.51
AMERICAN PEDIATRIC ASSOCIATION WARNING:	5.02	5.16
HEALTH WARNING:	4.32	4.81
SAFETY AND HEALTH WARNING:	4.54	4.95
U.S. PUBLIC HEALTH WARNING:	4.75	5.07
MEDICAL HEALTH WARNING:	4.74	5.05
IMPORTANT HEALTH WARNING:	4.72	4.95

specific scientific professional group related sources (e.g., AMERICAN MEDICAL ASSOCIATION WARNING), and (c) general statements in which no explicit source was given (e.g., IMPORTANT HEALTH WARNING). The results showed that exemplars from the two types of specific sources made the warnings more credible and increased the ratings of compliance likelihood compared to a signal word (WARNING) by itself. The general statements produced ratings that were intermediate between the signal word alone and the specific government/scientific sources. These results suggest that having a source in the warning can influence its credibility. However, research on the effect of source is still in its infancy. We do not know, for example, what the effect of product manufacturer or person-specific sources has on credibility and behavioral intentions.

CHANNEL

The channel concerns the way the message is transmitted from the source to potential receivers. Usually when we think of warnings, we think of printed visual material such as the federally mandated warning label. But hazard information can be conveyed through other sensory modalities and other media. Besides visually, warnings can be transmitted in any of several other sensory modalities: auditory, olfactory, and so forth. For example, a warning could be transmitted by radio or by a friend or acquaintance. Also, the odor of alcohol on a person's breath could be a warning that they are not competent to drive a car. With some media, two (or more) sensory modalities

might be involved. A video warning, for example, could relay both auditory (nonverbal alarms, speech) and visual (alphanumeric text, pictorials) information. Each of the senses and the channels by which the warnings arrive have their own characteristics which should be considered when designing a warning system. Each channel type has certain advantages and disadvantages depending on the message, the environment, the tasks involved, and the target population. We will focus only on situations where warnings are conducted through visual and auditory modalities.

In general, long complex messages are best conveyed by the visual (printed language) channel. Such messages are not conveyed well by the auditory (speech/voice) channel since they can exceed attentional/working memory capacity under certain conditions (Penny, 1975, 1989). However, short, easy-to-understand messages can be effectively conveyed by voice. Moreover, because auditory warnings are omnidirectional (i.e., the information can arrive at the senses without the person having to look in a particular direction), voice presentation may more easily capture attention than the same message in print form (unless the latter is made particularly salient). Generally, having information presented in more than one sensory modality is better than unimodal presentation (Barlow & Wogalter, 1993), and likewise, there tends to be better information transfer/conveyance when there is more than one media (e.g., labels and broadcast video will make a population more aware of the message than either one alone).

THE RECEIVER

The next several sections focus on the mental processes that occur within the receiver. This third stage of the basic communications model contains the model of information processing that will guide our discussion of the processes that occur within the receiver. The model is linear and serial, with the information contained within the warning message passing through a series of stages. If successful processing occurs at each stage, enhanced safety behavior could result.

Receiver: Attention

The first stage at the receiver concerns attention—whether or not a target individual notices or attends to the warning message. Because warnings are but one of many possible messages competing for one's attention, an effective warning must stand out from its background (i.e., be salient, prominent, conspicuous) and capture the attention of users. Salience is a particularly important consideration when people are not actively seeking warning information. However, even if a warning attracts attention to its presence, there is no guarantee that the user will examine it further. If no further examination takes place (and if the warning has not been accessed previously), then very little useful information will be conveyed. Thus, once a warning is noticed, attention must be maintained. Fortunately, many of the same design features that capture attention also appear to facilitate attention maintenance (Barlow & Wogalter, 1991b; Wogalter, Forbes, & Barlow, 1993). For example, large print in mixed-case type not only attracts attention, but also makes it less effortful to read (see middle warning in Table 1).

The law mandating the warning label on alcoholic beverage containers in the U.S. recognized the need to capture and hold attention. Certain minimum type sizes (heights) are mandated (though other important characteristics of type were not specified). Also, it was mandated that the label be "prominent and conspicuous," although this requirement was not explicitly defined. As a result, many real-world alcoholic beverage warnings are not noticeable.

If one wished to improve the noticeability of printed warnings on alcoholic beverages, what attention-getting characteristics should be considered? Laughery and Wogalter (1997) describe several factors that could be used to increase the salience of warnings and to make it more likely that attention will be attracted.

Salience Features

Contrast

The print should have high contrast (light-dark difference) with the background. Dark print on light background or vice versa maximizes contrast (Barlow & Wogalter, 1993). Certain color combinations (e.g., black and yellow, as opposed to dark blue and purple) can also enhance contrast.

Size

Within reasonable limits, a larger warning is generally better (Barlow & Wogalter, 1993). Both the absolute and relative size of the warning should be considered. Information on how to prevent injury should be allocated relatively more weight (in terms of size) than other, less important information. The government warning label law specifies type height and nothing else, which does little to prevent the use of non-readable text. For example, a condensed version of a font could be used to meet the height requirement, while the text would be relatively difficult to read. Basic human factors design handbooks (e.g., Sanders & McCormick, 1994) describe several type styles (e.g., NAMEL) that were developed and/or sponsored by government agencies to be highly legible.

Format

Printed material that presents the main points in an outline/list/bulleted format is usually better and is usually preferred to a paragraph of continuous prose (Desaulniers, 1987). A label that is appealing in layout or format will likely attract and hold attention, thus making it more likely that information will be extracted easily (Hartley, 1994). Formatting can be based on many factors including the amount of "white space," information groupings, line spacing, etc. Brevity is desirable (Wogalter et al., 1987). If the label contains large amounts of text, individuals may decide that reading requires too much effort and attention may be lost (Morris & Kanouse, 1980).

Location

Because English-language users tend to scan from left to right and from top to bottom, important information should be located near the top or to the left if possible (Hartley, 1994). Warnings should not be "buried" within less important text (Strawbridge, 1986). Preferably, warnings should be on the front of the container and in the orientation that the person is most likely to hold it (Laughery, Young, Vaubel, & Brelsford, 1993; Young, 1991).

Signal words

Signal words can be used in labels to attract attention. The most commonly used signal words are CAUTION, WARNING and DANGER, which are intended to denote increasing levels of hazard, respectively. Laughery et al. (1993) demonstrated that the salience of the GOVERNMENT WARNING signal word on existing alcohol labels significantly influenced the warning's noticeability.

Pictorials or safety symbols

Pictured concepts can make warnings more noticeable (Schmidt & Kysor, 1987; Young & Wogalter, 1990). Laughery et al. (1993), using both reaction time and eye movement methodologies, found that pictorials enhance the speed with which the person focuses on the warning.

Conclusions and Recommendations: Attention

We believe that rather than specifying arbitrarily-selected letter characteristics, a better basis for determining whether the warning's features enhance salience is through use of an explicitly stated performance standard. Such a requirement or standard could state simply that 95% of the target population should be able to notice and read it given normal conditions of use (regardless of the colors, background, contrast, and other label characteristics that are combined to form the warning). Normal conditions of use might be specified to reflect the dim lighting conditions at most bars and restaurants, etc. Such specifications would allow the manufacturer to enhance the salience of warning information within the context of their particular label design scheme. However, it might also require that the manufacturer test their labels to determine whether the warning has adequate salience and legibility. One potential alternative to individual testing might be the promulgation of a standard salient warning—one that is tested and then offered to be affixed to any label so long as it is not altered in any way.

Obviously the size of a warning's type is affected by the label's surface area. The alcohol beverage labeling act specifies different minimum sizes for the warning depending on the container's size. Because the warning might be printed in very small type, it is possible that the warning information will not be as salient as it could be. Alternative labeling designs have been offered to reduce the problems associated with small print (e.g., Barlow & Wogalter, 1991a; Wogalter & Young, 1994). Expanded

surface area and/or other conspicuity-enhancing techniques (e.g., larger print, color, signal words, and pictorials) can be employed to increase attentional capture.

Receiver: Comprehension

A person may notice a warning and examine it but, if he or she does not understand the material presented in it, processing will be stalled. In the comprehension stage, the information passing through the attention stage acts as a cue, activating memory structures and producing elaboration. Information that is, for the most part, already well known is relatively easy to assimilate into memory. Information that is not known can be accommodated into memory (with sufficient time and effort) where new structure and connections are created. It is critical that the warning message be understood by individuals in the population to whom it is directed.

A common and unfortunate misconception held by warning designers is that the information they include in warnings will be understood by others (with less expertise than them) to the same degree that they understand it (Laughery, 1993). Knowledge in some particular area or domain is often so ingrained that experts may assume that others possess similar levels of knowledge. As a result, the label may not convey the necessary information in a clear and understandable manner. Although some receivers are extensively trained and educated (e.g., physicians), many, if not most, warnings are designed for the lay public—as would be the case for most alcoholic beverage warnings. Of particular concern with respect to the comprehension stage are individuals who have lower (or different) reading skills and less knowledge about the particular subject's hazards. In order to better reach these groups, warnings should be designed so they can be understood by the lowest practical level possible.

In extreme cases, poor comprehension can lead to "critical confusions," resulting in people understanding the opposite of what they should, and possibly prompting people to perform the wrong actions. Consider the statement "low birth weight" found on the label of some cigarette warnings. This statement is intended to convey the notion that smoking is harmful to the baby. This interpretation may seem, on the surface, to be fairly reasonable. Apparently, however, some people have failed to interpret the statement as a hazard, but rather as a rationale for continuing to smoke (such as making labor easier because of the baby's small size). Others have interpreted this statement as a way to keep their *own* weight down. Had this warning been tested with a representative sample of the target population (i.e., women of child bearing age), these misinterpretations might have been noted, and the wording changed to avoid ambiguity.

Assessing Comprehension

Research on the factors that make the language of warnings comprehensible is surprisingly limited. While many studies *measure* warning comprehension, they typically do not *manipulate* factors that influence comprehension. The same is often true for the later stages of processing as well. The following sections discuss research on comprehension of various warning components.

Signal Words

There is a considerable amount of research on people's understanding of signal words. Signal words can increase understanding by conveying the extent or degree of danger involved. Wogalter and Silver (1990, 1995) have examined comprehension of these terms using subjective ratings, objective frequencies of occurrence in the language, and readability indices. Two novel approaches have used measures of variability (e.g., standard deviations) and missing (blank) evaluations as indications of understandability. The assumption here is that either variability or blank responses indicate that a signal word is not universally understood. Based on the tabled data in Wogalter and Silver (1995), terms can be selected with respect to understandability and connoted hazard level.

Verbal Warning Messages

Although there is not much research specifically on label language, the literature in other domains (e.g., basic grammar, technical writing) identifies factors that can facilitate word comprehension. Some of these characteristics include the use of short, high frequency words in the form of brief statements. Readability indices (Klare, 1974-75) based on these criteria (e.g., the Flesch and Dale-Chall formulae) can automatically measure, by computer, the grade level or percentage of the population that will likely understand the text. However, numerous research studies (e.g., Davison & Green, 1987; Klare, 1984; Powell, 1981) have shown that these criteria, when used without any corroborating evidence of understandability in the target population, can provide misleading measurements of comprehension. As a result, they should be used only as rough guides in the preliminary stages of label design.

Some authors have done away with simple readability formulae (e.g., word frequency, letters-per-word, words-per-sentence), and have concentrated on other ways to evaluate information so as to increase comprehension. For example, Siegel, Lambert and Burkett (1974) focused on mental workload and suggested, among other things, that the number of letters in a word was not as important as the number of morphemes—the smallest unit of speech sound that has meaning. Duffy and Kabance (1982) suggested that comprehension could be increased according to the "transformer concept"—having an individual or group of people ("transformers") evaluate the comprehensibility of information on behalf of the target audience. While intuitively appealing, the transformer concept suffers from the potential flaw of assumed knowledge—having the potential to make inferences about what the target population does or does not know.

Pictorials or Safety Symbols

While there is not much research on the specific factors influencing understandability of warning language/wording, there is a larger warnings literature on pictorials. Pictorials are a potentially useful way to aid hazard comprehension. Well-designed pictorials have the potential to communicate large amounts of information at a glance (Dewar, 1994; Sojourner & Wogalter, 1997; Wogalter, Sojourner & Brelsford, 1997). Pictorials can convey information to individuals who would otherwise have difficulty

Figure 2. Example Beverage Alcohol Warning Pictorials

in reading warning text: those with low literacy levels, a lack of familiarity with the language, or vision problems that makes reading very small print difficult. Numerous pictorials have been developed relating to alcohol hazards. The example pictorials shown in Figure 2 represent hazards discussed in the currently mandated alcohol warning.

While some pictorials convey information very well, other symbols do not. ANSI (1991) and ISO (1984) suggest specific methods of testing to assure certain levels of pictorial comprehension are reached (85% and 67%, respectively). Nevertheless, most pictorials in common use today probably have not been tested, and some probably convey little information (Magurno, Wogalter, Kohake, & Wolff, 1994; Wolff & Wogalter, 1993, in press). Particularly egregious errors are called critical confusions. Wogalter (1994) cites an example of a critical confusion involving a pictorial designed for an acne medication. The medication could cause birth defects in the babies of women who use it during pregnancy. The pictorial showed a side-view outline shape of a pregnant woman within a circle-slash negation sign (like the top two pictorials in Figure 2, but without the drink in hand). The intended meaning of the pictorial is that women should not take the drug if they are pregnant or if they may get pregnant. However, some women incorrectly interpreted the pictorial to mean that the drug might help in preventing pregnancy! ANSI (1991) allows no more than 5% critical confusions in comprehension tests for a pictorial to be considered acceptable.

Conclusions and Recommendations: Comprehension

Several options are available to increase knowledge and comprehension of alcohol warnings. First and foremost is the recommendation that warnings be tested for comprehension using a representative sample of the target population as test participants. Making assumptions about what potential targets know and/or need to know is a risky endeavor, particularly when hazards are involved. While certain tools can be used to assist in the production of candidate warnings (e.g., readability software programs), testing is the only way to be assured that a warning will likely be understood with minimal critical confusions. One set of methods for testing pictorials is outlined in the revised ANSI Z535.3 (in press) standard. These procedures could also be adapted to test the wording of messages.

Another set of testing methods are usability-type evaluations (e.g., Wright, 1980). When failures of comprehension are revealed by initial testing, the warning materials should be reworked and re-tested. This process continues iteratively until the warning is adequately comprehended (Hartley, 1991). Specific attention should be devoted to technical terms and ambiguous or "fuzzy" words. Technical terms (e.g., combustible, biohazard, carcinogen) can be difficult to interpret in the general population (see Leonard, Creel, & Karnes, 1990, 1991a, 1991b). In addition, some words, which are not complex in a technical sense, can be difficult to define because of their "fuzziness" (see Kreifeldt & Rao, 1986). Phrases like "squeeze *gently*" or "push *firmly*" are members of "fuzzy sets" because they convey a range of perceived magnitudes. In general, ambiguity is a quality that warnings should not possess.

Other recommendations to improve comprehension pertain to design and format issues. For example, a label that has section headings and that is logically organized (e.g., arranged by content matter, or ordered temporally or procedurally) and physically formatted (e.g., small chunks of text in a bulleted list format with sections separated by white space) is likely to promote better comprehension than a single large chunk of disorganized prose. The structure of the material can provide organization that facilitates comprehension. Guidelines (Hartley, 1994) on these characteristics can be found in the technical writing literature and are likely to benefit the construction of preliminary label prototypes that can be subsequently tested. The current alcohol warning appears to suffer from some level of disorganization. The first statement deals concisely with the hazard of drinking during pregnancy. However, the second statement discusses impairment, with "health problems" tacked onto the end. A more appropriate method of presenting and formatting the information in this warning can be see in the bottom of Table 1.

Receiver: Attitudes and Beliefs

Attitudes and beliefs are, in a sense, the truth as we see it. They are interpretations of the world around us, and they are based on previous experience, familiarity, knowledge, etc. Once a warning message passes through the initial stages of processing, it is then subjected to evaluation with respect to the individual's attitudes and beliefs. If the warning is believable and if the person believes that the information is necessary or relevant, then the warning has the ability to influence the individual's perception of the risk associated with a product. These aspects of attitudes and beliefs will be discussed in the following sections.

Believability of Warning Messages

People (access and) interpret the information they receive from warnings in light of what they already believe to be true (DeJoy, 1991). Because beliefs tend to be strongly-held and resistant to change, warning information which contradicts previously-held beliefs is likely to be discounted or ignored (Beltramini, 1988). Information can be contradictory on a content level (e.g., smokers do not believe information about the hazards of smoking; Loken & Howard-Pitney, 1988), on an irrational level (people do not evacuate their homes during tornadoes because they simply do not want to believe that they could lose everything; Perry, 1983), on a control level (e.g., people do not wear seat belts because of their belief that they have control over potential accidents; Robertson, O'Neill, & Wixom, 1972), or on an experiential level (people may not heed a warning because of their belief that it is a false alarm; Loomis & Porter, 1982; Mallett, Vaught & Brnich, 1993).

Warning messages can be discounted if they conflict with people's beliefs. For example, Hilton (1993) cited Graves' (1992) data showing that, after introduction of the currently mandated alcohol warning label, people's perception of the hazards of driving after consuming two drinks was still low but that the risks of driving after 5 drinks were perceived as high. Trying to convince people that there is a risk of driving when one consumes small amounts of alcohol can be difficult. Hankin et al. (1993) showed that the currently mandated alcohol warning was associated with a slight but significant reduction in drinking by pregnant women who were previously light drinkers/abstainers (those consuming less than 0.5 ounces of absolute alcohol per day at conception). However, pregnant females labeled as risk drinkers (greater than 0.5 ounces per day at conception) showed no reduction in consumption of alcohol during pregnancy. It is possible that alternative warnings (see Table 2) might make the consequences more salient and therefore cause people to alter their perceptions of the risks associated with driving after drinking (e.g., high penalties for exceeding the blood-alcohol limit) and drinking during pregnancy (e.g., presentation of explicit information about potential birth defects).

Belief Regarding the Ability to Control Hazards

Even if the warning is believed, compliance may not occur because the user may believe in his or her ability to control the hazards without doing *exactly* what the warning says. This belief can have a strong effect on the extent to which people will seek out warning information and/or comply with warnings. A belief in the ability to control hazards appears to stem, at least partly, from a perception of whether the hazard is accepted voluntarily (internal locus of control) or whether it is imposed on the individual from without (external locus of control) (see Laux & Brelsford, 1989). People who believe that they encounter most hazards voluntarily, and who have high internal locus-of-control are people who are more likely to take precautions (e.g., look for and comply with warnings). Those with external locus-of-control would be less likely to seek out relevant safety information. In some cases, one's belief in the ability to control hazards is exaggerated (e.g., with young males).

Perception of Risk

If a warning message is believed and it is not discounted (because of perceived ability to control the hazard), then warnings can influence the perception of hazardousness or risk for a product. For example, consumption of two drinks prior to driving is not considered a large risk by most people in the population. However, certain conditions (e.g., if one has not eaten recently, if one has a low body weight, if one is taking certain medications, etc.) increase one's susceptibility to the effects of alcohol. A warning presenting this type of information could influence the perception of risk associated with a product such as alcohol. It is assumed that such changes would result in an increase in the propensity for cautionary behavior on the part of the target. People's perceptions of product risks is a strong determinant of intended behavior (see Wogalter, Desaulniers, & Brelsford, 1987). Thus, warnings have the potential to influence behavior through their effect on perceived risk.

Conclusions and Recommendations: Attitudes and Beliefs

If the content of warnings is discrepant with a person's beliefs and attitudes toward a product, then it is likely that discounting of the safety information will occur. In order to prevent discounting, warnings might need to be made more explicit with regard to the consequences. While this might make warnings longer than is practically possible, an alternative to one long warning is message rotation (see Table 2). This method allows more detailed information to be provided and it presents a more complete view of alcohol hazards and consequences. Such warnings could influence risk perceptions and, therefore, predispose individuals to (at least intend to) comply with the warning messages.

Receiver: Behavioral Intentions

When a warning is noticed, read, and understood, it has the potential to modify a person's beliefs and attitudes regarding the product and its hazards. This presumably affects an individual's predisposition to behave in a certain manner (i.e., behavioral intentions). For example, people are more likely to (at least intend to) behave safely with a product that they perceive as being more hazardous (Wogalter, Desaulniers, & Brelsford, 1987). A person's intention to behave with caution may derive from the person's desire to maintain safety (internally generated), or from the information on the product label (externally generated). In particular, information on the potential severity of injury can motivate people because they do not want to get hurt. A label that says "You may become overconfident in your ability to drive a car or operate equipment safely. You may kill yourself or someone else" is more likely to motivate compliance than a simple and vague statement like "Don't Drink and Drive." The former is also more explicit than the latter. Explicit statements clearly report the costs of non-compliance. Explicit statements (e.g., "brain and liver damage") are likely to be more motivating than broad, general statements (e.g., "health problems") (see Laughery, Vaubel, Young, Brelsford, & Rowe, 1993).

Users must, in some way, make decisions about how they will behave with regard to a product. Based on their judgment of the hazardous nature of the product (which is

based on a number of factors, including warning information), users may be predisposed to act with caution. However, intentions to behave do not always correspond to actual behavior for several reasons. First, the user could be predisposed to act with caution, but could see the costs of compliance as too high to actually behave in that manner. There are two aspects of cost that could mediate behavioral intentions: cost of compliance (time, effort and/or monetary expenditures in the avoidance of hazards) and cost of non-compliance (potential injury, illness or property damage). When people perceive the cost of compliance to be greater than the cost of non-compliance, they are less likely to take proper actions. The requirement to expend even a minimal amount of extra time or effort can dramatically reduce compliance rates, regardless of people's prior *intention* to behave safely (Wogalter, Allison, & McKenna, 1989; Wogalter et al., 1987). One way of reducing the cost of compliance is to make the directed behavior easier to perform (Wogalter et al., 1987, 1989). An example of this in the alcohol domain would be the provision of free taxi cab rides home for intoxicated individuals. In addition, information about the cost of non-compliance could be made more salient so that it could be factored into the decision-making process more readily. Explicit consequence statements (e.g., the extent of potential injury or criminal penalties) provides such information, and they can lead to appropriate intentions because they express outcomes that people usually wish to avoid.

Second, the user could see others disregarding the warning with impunity and therefore decide to act in a similar, less cautious manner. If people see others comply they are more likely to comply, and if they see others fail to comply they are less likely to comply themselves (Wogalter et al., 1989, 1993). Third, the user could simply be too rushed or tired to expend the effort needed to comply with warnings. These are important considerations that can affect eventual behavior independent of behavioral intentions. People who are fatigued or time-stressed are less likely to comply with a warning (Magurno & Wogalter, 1994; Wogalter, Magurno, Rashid, & Klein, in press).

Conclusions and Recommendations: Behavioral Intentions

Consumers may form intentions to act in a particular manner based on internal or external cues. These intentions are not, however, sufficient to cause behavior. Such intentions can be thwarted by various external factors that can be dealt with, to greater-or-lesser degrees, by product design and by warning information. Emphasis should be placed on the external information that can be used to influence intentions and external factors (cost, social influence and time stress) should be considered as potential factors that could mediate behavior.

SUMMARY AND CONCLUSIONS

We have reviewed several factors that could influence the effectiveness of an alcohol beverage warning in the context of a hybrid communication/information processing model. Some of the principles and recommendations discussed herein have not been formally tested with alcohol warning materials. Rather, they have been derived from basic warning theory and from research in non-alcohol-related domains. Although we feel rather confident that such factors are applicable to alcohol warnings, it should be

noted that alcohol (and the hazards associated with it) differs from other products in several important respects. The first difference has already been discussed—alcohol is not always harmful, but it is so only in certain circumstances. Total abstinence in adults is rarely required; therefore information about alcohol hazards is not directed to all consumers at all times. This situation is in stark contrast to other types of hazards (e.g., asbestos, electrical shock), which are to be avoided at all times and in all circumstances. Second, for some individuals, alcohol can be physiologically addicting. One might expect that a warning alone would have little effect on these individuals. Third, for many adults, consumption of alcohol is a familiar and generally benign experience (except for possibly occasional abuses) which is frequently associated with pleasant social activity. Fourth, alcohol is a legal mind-altering drug that can impair processing of warning information at all stages of the model. These four reasons together reveal that alcohol is somewhat unique as a product and it can pose special problems for the warning designer.

In this review we focused mainly on the factors that could improve the existing U.S. mandated alcohol beverage warning. The message itself could be improved by reformatting and organizing the content and making changes to the text itself (to include information about additional hazards and their consequences). Within the warning itself, information about the source could be used to enhance the credibility and authority of the message (potentially influencing attitudes and beliefs). With regard to the channel of presentation, information about alcohol hazards could be presented via different media (e.g., television, radio, signs) than on-container warnings. We suggest that all of these channels should be coordinated as part of a *system* of conveying hazard information about alcohol consumption. This would increase the chance that consumers would notice these messages and would provide more avenues for the transmission of information. Manipulating the message, source and channel will affect the kind and nature of information that reaches the receiver.

Once the information reaches the domain of the receiver, attention must be paid to it. Attention to the warning could be aided by color, formatting into list/bullet style, pictorials, and other salience-enhancing methods. The warning, as it exists currently, lacks almost any form of design enhancement that might be used to attract attention. If attention could be attracted and maintained, then the warning message itself would be processed. Much of the information contained in the current warning is either generally known in the population (drinking and driving, and drinking during pregnancy) or it is vague ("health problems"). Knowledge could be improved if the warning were more explicit, which might require rotation of several messages. The highly general information does not provide sufficient detail to allow users to form proper attitudes and beliefs regarding the true nature of the risks associated with alcohol or to prevent possible discounting of the message. The more complete and explicit information provided by a rotating warning system would allow consumers to more fully appreciate the hazards and their consequences.

Is it fair to expect a label on containers to do much in the way of decreasing the personal, societal, and medical problems associated with alcohol? Probably not. Much of the alcohol-related information to which consumers are exposed in the marketplace is positive in nature (e.g., commercials depicting people having a good time while drinking). Any single warning label on containers would have a difficult time countering

these positive, pervasive, and persuasive communications. The goal is to reduce unnecessary and undesirable risks based on lack of information. The warning label is part of a larger system of potential communications. Not only are there many improvements that can be made to the label itself (including both content and salience enhancements), but also there are different channels of communication that should be considered as part of the process. These improvements should increase the chance that safety-related information regarding alcohol consumption will be effective.

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