# RELATIVE IMPORTANCE OF DIFFERENT VERBAL COMPONENTS IN CONVEYING HAZARD-LEVEL INFORMATION IN WARNINGS

Stephen L. Young
*Liberty Mutual Research Center for Safety & Health*
*Hopkinton, MA 01748*

Michael S. Wogalter
*Department of Psychology*
*North Carolina State University*
*Raleigh, NC 27695*

Participants rated 18 different warning-type statements describing various hazardous scenarios. The components of the statements were manipulated according to five variables: duration of exposure to the hazard, quantity of exposure to the hazard, likelihood of injury, severity of injury, and duration of injury. The relative importance of these variables in influencing hazard ratings was evaluated. The component describing injury severity was by far the best single predictor of hazard ratings (accounting for almost 78% of the hazard variance). Injury duration contributed an additional 15% of the variance. These results suggest that people consider the dimensions of injury severity and duration when evaluating the degree of hazard conveyed by warning text. Using these dimensions, warning text could be calibrated to the level of actual hazard to convey a better sense of hazardousness.

## INTRODUCTION

Well-designed warnings convey information that gives people an appreciation of the nature *and* the level of danger associated with the hazard. It has been suggested that such an appreciation can be provided by explicitly worded warnings so that users will be both better informed and more motivated to comply (e.g., Laughery et al., 1991). Explicit warnings supposedly act to influence user behavior through an increase in the perceived severity associated with the hazard. While severity of injury has been shown to influence people's perception of the risk associated with a hazardous situation (e.g., Wogalter, Desaulniers & Brelsford, 1987; Young, Wogalter & Brelsford, 1990, 1992), there are, in reality, several different informational components that could influence how hazardous or dangerous a situation is perceived to be. These include:

(a) the nature of the hazard itself (e.g., asbestos, methane gas, etc.)
(b) the nature of the consequences (e.g., impaired vision, coughing, headache, etc.
(c) duration of exposure to the hazard (e.g., brief vs. prolonged exposure to ...)
(d) the quantity or amount of the hazard to which one is exposed (e.g., exposure to "small/large quantities of ...")
(e) the likelihood of injury (e.g., "may/will result in...")
(f) the severity of potential injury (e.g., mild/severe...)
(g) the duration of potential injury (e.g., temporary/permanent...)

In a one-sentence description of a hazardous scenario, these components might be combined into statements in the following manner:

> (Brief/prolonged/*no mention*) exposure to (small/large/*no mention*) quantities of (hazard) (may/will) result in (mild/severe/*no mention*) (temporary/permanent/*no mention*) (consequences).

Corresponding warning statements that might follow this form include (with "X" representing a hazard and "Y" representing a consequence):

(a) "Brief exposure to small quantities of X may result in mild, temporary Y."
(b) "Exposure to quantities of X may result in Y."
(c) "Prolonged exposure to large quantities of X will result in severe, permanent Y."

Several hypotheses could be formulated regarding the effect of these components on perceived hazard. Given the same consequence, an injury caused by brief exposure to a hazard might be considered more dangerous than the same consequence caused by prolonged exposure. However, it is also possible that prolonged exposure to a hazard might be considered

worse than brief exposure to the same hazard. A similar set of opposing expectations could be made for hazard perceptions stemming from exposure quantity. Additionally, injuries that *will* occur should be considered more hazardous than injuries that *may* occur. Severe consequences should be considered worse than mild consequences. Finally, prolonged or permanent injury should be considered worse than a temporary condition.

The question of interest in the present research is "What is the relative importance of these different informational components on the perception of hazard for the described scenario?" This question is relevant because (1) there is a paucity of research on the composition of warning text, (2) warnings should include relevant material for the user's informational needs and to help form appropriate hazard perceptions, and (3) warnings should be as brief as possible. Determining the relative importance of different textual components could allow a warning designer to determine what types of information should be included (or emphasized) and excluded (or de-emphasized) in order to produce the most effective warning while maintaining brevity.

To answer the research question of interest, participants read statements like the examples above and, for each, provided ratings of the hazardousness of the described scenario. Five of the 7 components above (c, d, e, f, and g) were varied systematically, whereas (a) the nature of the hazard and (b) the nature of the consequences were not examined. In this study, unfamiliar or fictitious hazards and consequences served as "placeholders" for the manipulation of other statement components.

## METHOD

### *Participants*

Fifty-one people from the eastern Massachusetts community participated in this study. They were recruited by newspaper advertisement and were paid for their participation.

### *Materials*

Fifty-one separate booklets were prepared—one for each participant. Each booklet consisted of 18 pages, with one statement per page. On each page was a statement with a number (1 through 18) and a blank space for the hazard rating. The hazard rating was a response to the question "How hazardous is this scenario?" A 100-point Likert-type scale was provided, with 1 representing "Not at all hazardous" and 100 representing "Extremely hazardous."

The 18 statements were combinations of five variables: exposure duration, exposure quantity, injury likelihood, injury severity, and injury duration (see Table 1). Each variable had three levels except likelihood. The three levels included a "low" and "high" condition, as well as a condition where that component of the statement was omitted. Likelihood had only a "low" and "high" condition. These variables were combined according to a fractional factorial design that allowed the evaluation of unconfounded main effects. The benefit of this design is that it allows one to test a large number of variables with a few number of trials (for detailed discussion on fractional designs, see Box & Draper, 1987; Montgomery, 1991). A complete factorial design would have required evaluation of 162 statements, while the fractional design required only 18.

The hazard and consequences were not formally manipulated in the experiment. Rather, 18 hazards and 18 consequences were randomly assigned (each independently) within each booklet. The hazards (e.g., methyl pentene, treazol, sortalic trexate) and consequences (e.g., hypoxia, macroglossia, lysis) were purposefully made to be unfamiliar to the participants (they were rare or fictitious names) to force them to consider the other statement information when making their hazard ratings. The 18 statements were randomly ordered for each participant. Example statements include:

(a) Exposure to large quantities of sodium balcofenic may result in severe macroglossia.

(b) Prolonged exposure to quantities of thalaninic saline will result in mild, temporary lysis.

(c) Brief exposure to small quantities of propylene may result in prolonged apraxia

Note that in the first example (a), exposure duration and injury duration are not stated. In the second example (b), quantity of hazard exposure is not stated. Finally, in the third example (c), injury severity is not stated.

*Procedure*

Participants received a booklet with the 18 statements. Subjects were instructed to read each statement and provide a rating according to the hazard rating scale. Subjects were instructed to rate the statements in the order they appeared and they were told not to preview later pages in the booklet or to change ratings to earlier statements.

## RESULTS

The ratings for each participant were converted to z-scores so that each participants' unique interpretation of the rating scale could be controlled and compared. A fractional factorial ANOVA was conducted; the summary table is shown in Table 2. These five main effects accounted for 97.3% of the variance of the hazard ratings. Of the five effects in the model, injury severity and injury duration contributed significant variance to the prediction of hazard ratings ($ps < .01$). Injury severity was by far the largest single predictor, accounting for 77.8% of the variance of the hazard ratings. Injury duration contributed an additional 15% of the variance. The means demonstrated that prolonged and severe injuries were judged more hazardous than temporary or mild ones (see Figure 1). When the injury severity and duration components were not stated, hazard ratings were intermediate between the stated extremes. Tukey HSD post hoc tests demonstrated that all three conditions for both injury duration and injury severity significantly differed from one another ($ps < .05$). Exposure duration just missed meeting conventional

**Table 1**. The five variables, statement components and examples

| Variable | Levels | Example |
|---|---|---|
| Exposure duration | Brief<br>*not stated*<br>Prolonged | *Brief* exposure to ...<br>Exposure to ...<br>Prolonged exposure to... |
| Quantity of hazard exposure | Small<br>*not stated*<br>Large | *small* quantities of (hazard)<br>quantities of (hazard)<br>*large* quantities of (hazard) |
| Likelihood of suffering consequences | May<br>Will | *may* cause...<br>*will* cause... |
| Severity of potential injury | Mild<br>*not stated*<br>Severe | *mild*...<br>[blank]<br>*severe*... |
| Injury duration | Temporary<br>*not stated*<br>Prolonged | *temporary* (consequence).<br>...(consequence)<br>*prolonged* (consequence) |

**Table 2**. ANOVA summary table for the fractional factorial design

| Source | df | SS | F-ratio | p-value |
|---|---|---|---|---|
| Exposure duration to the hazard | 2 | 0.185 | 4.24 | .0556 |
| Quantity of exposure to the hazard | 2 | 0.023 | 0.53 | .6060 |
| Likelihood of suffering consequences | 1 | 0.077 | 3.52 | .0988 |
| Severity of potential injury | 2 | 4.923 | 113.08 | .0000 |
| Injury duration | 2 | 0.951 | 21.85 | .0006 |

levels for statistical significance. Brief exposure to the hazard (m = .13) was considered more dangerous than when exposure duration was either not stated (m = -.02) or when the duration was prolonged (m = -.115). The other two variables, likelihood of injury and exposure quantity, showed no statistically significant effects (*p*s > .05).

## DISCUSSION

The results demonstrate that, when people evaluate the level of hazard for a particular scenario, injury severity is an extremely important factor in their judgments. This finding concurs with other results suggesting that severity of the consequences is the primary predictor of hazard ratings for consumer products (e.g., Wogalter, Desaulniers & Brelsford, 1987; Young, Brelsford & Wogalter, 1990, 1992). Participants' hazard judgments were also influenced by the length or permanence of injury described in the scenarios. These two findings appear to lend support to the notion that explicitness in the description of consequence information can influence people's perception of the hazard level associated with products.

One interesting aspect of the manipulations is that they involved simply changing the verbal quantifiers or modifiers ("mild," "severe," or nothing) to describe unfamiliar hazards and consequences. While explicitness is often associated with "wordiness," an adequate level of explicitness might be achieved (with regard to affecting perceived hazard) by simply stating that the consequences are severe. Additionally, a modifier regarding the duration of injury might also be used to influence perceived hazard when appropriate.

The present study used hazards and consequences that were not readily known to subjects. Consequently, it is possible that the modifiers may have had an undue influence on the ratings because they could not be tempered by subjects' knowledge. It is not known if such modifiers interact with known hazard knowledge or what the nature of that interaction might be. There is an additional problem in terms of "mapping" the modifiers to the hazard description in the warning. Since dangers can vary along a continuum, the range of useful and appropriate modifiers needs to be determined, especially in cases where the hazards and consequences are known.

Two of the other variables, exposure duration (*p* = .056) and injury likelihood (p = .098) were close to attaining statistical significance. It is possible that a larger sample of subjects might demonstrate that these variables contribute significant variance to the prediction of hazard ratings, but their effects would likely be much smaller than the two significant effects shown here. Quantity of exposure was the only variable that clearly did not affect subjects' ratings of the hazards.

With the likelihood variable, it was hypothesized that a low probability of injury would be considered

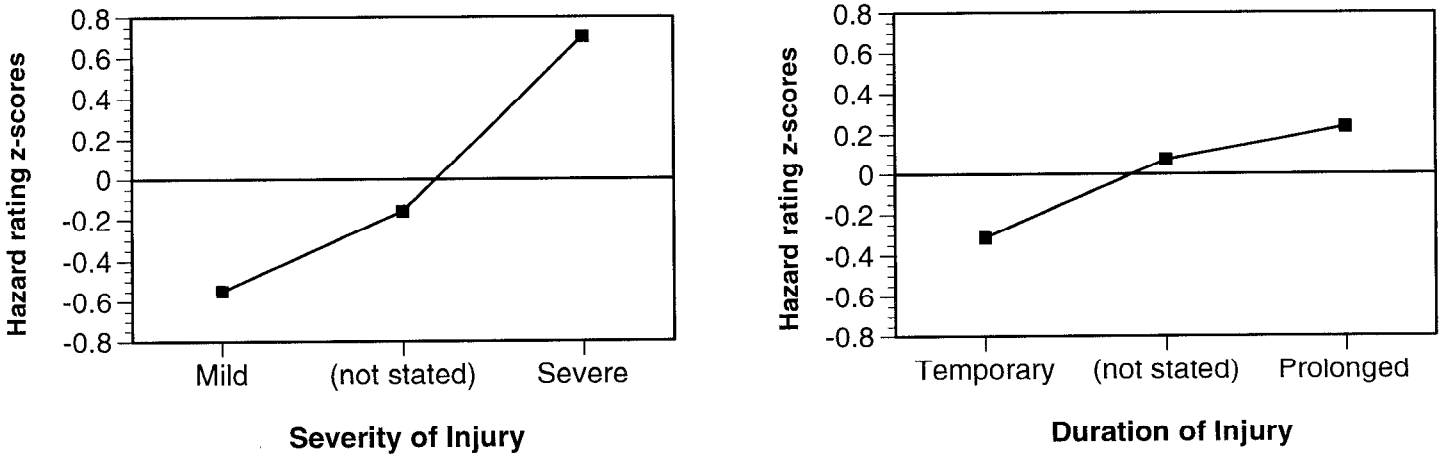


**Figure 1**. Graph of mean z-score ratings for injury severity and duration

less hazardous than one with a high probability. The data did not support this hypothesis (although the data were in the expected direction). However, with exposure duration and quantity, one could generate bi-directional hypotheses (or opposing *a priori* expectations). Specifically, either brief or prolonged exposure might be considered more hazardous depending on circumstances that are not yet know. Similarly, exposure to small or large quantities of a hazard might be considered more hazardous under different conditions. Thus, these variables may have produced inconsistent findings that may have been context-dependent.

One interesting aspect of the methodology employed in the present study is that it examined the statement variables using a fractional factorial design. This design allows one to examine unconfounded main effects, but does not allow interpretation of possible interactions between variables. Future research should examine whether the variables investigated here interact in some meaningful way, both with each other and with other hazard-related variables.

In all, this study demonstrates that the way in which a dangerous situation is described can influence people's hazard perceptions. This information could be used to influence the way people interpret text descriptions of hazards described in warnings. If a warning describes a very dangerous hazard, then it would be appropriate to word the message so as to provide users with the proper perception of hazard. This could be achieved by calibrating the language in the warning and the perceptions that it generates to match the actual level of hazard involved. According to the present data, information about the potential severity and duration of injury can substantially affect peoples' perceptions in a meaningful way.

## REFERENCES

Box, G. E. P. & Draper, N. R. (1987). *Empirical model-building and response surfaces*. New York: Wiley.

Laughery, K. R., Rowe-Hallbert, A. L., Young, S. L., Vaubel, K. P. & Laux, L. F. (1991). Effects of explicitness in conveying severity information in product warnings. In *Proceedings of the Human Factors Society 35th Annual Meeting* (pp. 481-485). Santa Monica, CA. Human Factors Society.

Montgomery, D. C. (1991) *Design and analysis of experiments* (3rd ed.). New York: Wiley.

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

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

Young, S. L. & Wogalter, M. S. & Brelsford, J. W. (1992). Relative contribution of likelihood and severity of injury to risk perceptions. In *Proceedings of the Human Factors Society 36th Annual Meeting*. (pp. 1014-1018). Santa Monica, CA: Human Factors Society.