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The Relative Contributions of Injury Severity and Likelihood Information on Hazard-Risk Judgments and Warning Compliance

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Research suggests that people base their judgments of product hazardousness on perceptions of the severity of potential injury. However, other research suggests that people base their risk perceptions on the likelihood of being injured. Four studies are presented that attempt to reconcile these findings. Studies 1 and 2 investigated whether the discrepancy could be attributed to the particular item lists used in the respective research. Study 1 showed that injury severity was the foremost predictor of perceived hazard in one list, but that injury likelihood was the best predictor in the other list. The two lists differed significantly on all the rating dimensions, suggesting that the items in the lists are at least partly responsible for the conflicting findings. Study 2, using a different set of items, confirmed that injury severity is the foremost predictor of hazard perceptions for consumer products. The last two studies examined the effects of injury likelihood and severity information in warnings on perceived product hazard and behavioral compliance. In Study 3, participants evaluated a set of product labels under the guise of a consumer marketing study in which the conveyed levels of injury severity and likelihood were incidentally manipulated. The results showed high severity warnings produced higher hazard ratings than low severity warnings. Injury likelihood produced no effect. Study 4 showed that a higher severity warning produced greater behavioral compliance than a low severity warning, but only for low injury likelihoods. Overall,

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this research: (a) provides an explanation for the conflicting results in hazard and risk perception research; and (b) demonstrates that injury severity is the primary determinant of lay persons' hazard perceptions for consumer products. The findings suggest that safety communications might have greater impact if they focused on injury severity, rather than (or to a lesser extent) the likelihood of getting hurt.

Keywords: Injury, accident, prevention, safety, probability, likelihood, risk, severity, consequences, hazard, danger, warnings

INTRODUCTION

It is clear that people do not act with the same degree of caution with all of the products that they encounter. Previous research suggests that people's cautionary behavior is influenced by the *perceived* hazard associated with a product (Godfrey, Allender, Laughery, & Smith, 1983; LaRue & Cohen, 1987; Wogalter, Brelsford, Desaulniers, & Laughery, 1991; Young, Martin, & Wogalter, 1989). Specifically, people are more likely to act cautiously (i.e., look for, read and/or comply with warnings) when perceived hazard level increases. Therefore, it is important to determine what information is used to form these judgments.

Research in the area of risk (e.g., Lowrance, 1980; Slovic, Fischhoff, & Lichtenstein, 1979, 1980a, b) asserts that risk perceptions are determined by a combination of two variables: (a) the likelihood of injury; and (b) the severity of potential consequences. Much of this literature suggests that the likelihood or probability component is the more important of the two. As such, researchers in the risk literature suggest that the optimal way to motivate people to act with caution is to provide them with "an appreciation of the probabilistic nature of the world and the ability to think intelligently about rare (but consequential) events" (Slovic et al., 1980b). This appreciation has been difficult to achieve in research and in practice because of biases in the manner in which people aggregate (Lichtenstein, Slovic, Fischhoff, Layman, & Combs, 1978) and use (Slovic et al., 1979) likelihood information. For example, Desaulniers (1991) demonstrated that people have difficulty in distinguishing between small probabilities (e.g., 1/100,000 vs. 1/10,000,000).

A different line of research, in the area of hazard perception, suggests that people do not use likelihood information when evaluating product hazardousness. Rather, this research suggests that people attend to information about the severity of potential injuries when forming perceptions of product hazardousness or risk (Wogalter et al., 1991; Wogalter, Brems, & Martin, 1993). It is suggested that people are more apt to consider severity information because it is a salient and useful source of information, and in most cases, sufficient to make hazard-risk judgments. Additionally, severity evokes greater use of heuristic processing because of its vivid mental imagery compared to pallid, normative likelihood information (Desaulniers, 1991; for reviews see Kahneman, Slovic, & Tversky, 1982; Nisbett & Ross, 1980).

In the risk literature, attention to severity information is seen as a bias in the formation of "objective" risk assessments. In the hazard perception literature, such "subjective" evaluations of product hazard levels are (actual and valid) indicators of lay people's hazard judgments. The purpose of the following four studies is to examine several possible components of hazard and risk judgments in an effort to reconcile previous research results. Studies 1 and 2 examine whether the stimuli used to elicit judgments of hazard and risk contribute to the discrepancy. The final two studies examine whether hazard judgments relate to the information that can be provided in safety communications. Specifically, Study 3 examines the influence of severity and likelihood information in warnings on perceived product hazard, whereas, Study 4 examines their effect on behavioral compliance.

STUDY 1

This study examined whether the discrepancy of findings in hazard and risk perception investigations is due to the lists of products and activities used in the respective research. More specifically, two lists, one from Wogalter et al. (1991) and another from Slovic et al. (1979), were employed as representative of the two lines of research. This study sought to determine the extent to which the judgments can be captured by different contributions of injury likelihood and severity. Another interest in this study was whether context influenced the evaluations of the list items. We examined whether the judgments of four items common to both lists differed as a function of the context (the list) in which they appeared.

Methods

Participants

Forty undergraduate students from the University of Houston participated for credit in an introductory psychology class.

Materials

Tables 1 and 2 show the two lists of items. Half of the participants were exposed to the 72 products from Wogalter et al. (1991) and the other half were shown the 30 products, technologies, and activities taken from Slovic et al. (1979). Below are the eight questions (and anchors) used to rate the items.

a) *Hazard-Risk*: "How *hazardous* is this product, technology or activity?" The anchors were: (0) not at all hazardous, (2) slightly hazardous, (4) hazardous, (6) very hazardous, and (8) extremely hazardous.
b) *Likelihood of Injury*: "How *likely* are you to receive *any* injury with this product, technology or activity, including all *minor* ones (requiring little or no first aid) and *major* ones (requiring emergency room treatment)?" The anchors were: (0) never, (2) unlikely, (4) likely, (6) very likely, and (8) extremely likely.
c) *Severity of Injury*: "How *severely* (i.e., degree, extent or magnitude) might you be injured by this product, technology or activity?" The anchors were: (0) not at all severe, (2) slightly severe, (4) severe, (6) very severe, and (8) extremely severe.
d) *Cautious Intent*: "How *cautious* would you be when using this product or technology or while doing this activity?" The anchors were: (0) not at all cautious, (2) slightly cautious, (4) cautious, (6) very cautious, and (8) extremely cautious.
e) *Likelihood of Reading Warnings*: "If you *saw* a warning on this product or during this activity, how *likely* would you be to read it?" The anchors were: (0) never, (2) unlikely, (4) likely, (6) very likely, and (8) extremely likely.
f) *Familiarity*: "How *familiar* are you with this product, technology or activity?" The anchors were: (0) not at all familiar, (2) slightly familiar, (4) familiar, (6) very familiar, and (8) extremely familiar.
g) *Control*: "If exposed to the risks, to what extent can you, by personal skill or diligence, avoid the hazards associated with this product, technology or activity? That is, how much control do you have over being injured by this product,

Table 1. The 72 Consumer Products Used in Study 1 (from Wogalter et al., 1991)

Electrical			
Battery alarm clock	Electric carving knife	Oscillating fan	Sun lamp
Curling iron	Electric food slicer	Photoflash unit	Toaster oven
Desk lamp	Electric hedge trimmer	Pocket calculator	Transistor radio
Digital watch	Flashlight	Quartz/space heater	Trash compactor
Drip coffee maker	Metal detector	Sewing machine	Typewriter
Electric blanket	Microwave oven	Steam iron	Vacuum cleaner
Chemical			
Alcoholic beverage	Cake mix	Kerosene	Roasted peanuts
Antacid	Cough medicine	Lacquer stripper	Roll-on deodorant
Apple sauce	Drain cleaner	Milk	Shampoo
Artificial sweetener	Dried cereal	Nonprescription diet aid	Skin moisturizer
Aspirin	Eggs	Oven cleaner	Soap
Baby powder	Household bleach	Pesticide	Suntan lotion
Non-Electrical			
Bicycle	Garden shears	Hunting knife	Rake
Binoculars	Garden sprinkler	Inflatable boat	Screwdriver
Chain saw	Gas outdoor grill	Ladder	Scuba gear
Clothesline	Golf club	Lawn mower	Semi-automatic rifle
Dart game	Hammer	Life vest	Wheel barrow
Football helmet	Hiking boot	Ping pong table	Wood splitter

Table 2. The 30-item List (from Slovic et al., 1979) Used in Study 1

Items			
Alcoholic beverage	General (private) aviation	Motorcycles	Skiing
Bicycle	H.S. and college football	Mountain climbing	Smoking
Commercial aviation	Handguns	Nuclear power	Spray can
Contraceptives	Home appliances	Pesticide	Surgery
Electric power	Hunting	Police work	Swimming
Fire fighting	Large construction	Prescription antibiotics	Vaccinations
Food coloring	Lawn mower	Railroads	X-rays
Food preservatives	Motor vehicles		

technology or activity?" The anchors were: (0) no control at all, (2) some control, (4) control, (6) much control, and (8) total control.

h) *Catastrophe*: "Are the risks associated with this product, technology, or activity the kind that injure or kill people one at a time or are they risks that injure or kill large numbers of people at a time?" The anchors were: (0) injures/kill one at a time, (2) injures/kill a few at a time, (4) injures/kill several at a time, (6) injures/kill many at a time, and (8) injures/kill large numbers at a time.

Five of the questions (questions a, b, d, e, and f) are taken from (and are unique to) Wogalter et al. (1991), whereas, the last two are unique to Slovic et al. (1979). The third question, (c), was common to both studies. The questions were slightly reworded to accommodate products, technologies *and* activities, thus allowing the same questions to be used regardless of the item list given to participants. In the test booklets, each question was printed on a separate page and the pages were randomly ordered. The orders of the products and items were randomized.

Procedure

Participants received one of the two lists and were allotted two minutes to examine its contents and acquaint themselves with the range of items shown. Participants were then given question booklets and told to rate all products or items on the first question before moving on to the next question page, and so on. They were also told not to preview forthcoming questions or to review earlier answers.

Results

Rating Question Differences between Lists

Analyses initially compared the two lists with respect to the mean ratings on the eight questions. These means are shown in the first two columns of Table 3. The lists differed significantly on all dimensions ($p < .05$). The 30 Slovic et al. (1979) items were perceived as more hazardous and less familiar than the 72 Wogalter et al. (1991) products. Participants reported that they would be more likely injured by the 30 items and that those injuries would be more severe and more catastrophic than the 72 products. In addition, they reported greater cautious intent and higher likelihood of reading warnings for the 30 items than the 72 products, while at the same time believing they have less control over being injured with the 30 items.

Regression Analyses

Using hazard-risk ratings as the criterion variable, forward stepwise regression analysis was performed using the ratings of the 72 products. Scores in the analysis were item means collapsed across participants within each scale. The greatest overall predictor of hazard-risk dimension was severity ($r = .973$), which accounted for 94.7% of the variance. Catastrophe contributed a small but significant ($p < .05$) amount of additional variance, increasing the total variance explained to 95.3%. A similar stepwise regression analysis on the 30 items showed that injury likelihood was the single best predictor of hazard-risk, accounting for 86.6% of the variance. Familiarity was the only other variable that made a significant contribution in addition to injury likelihood, augmenting the amount of explained variance to 88.9%.

Analysis of Common Products

Four products were common to both lists: bicycle, lawn mower, pesticide, and alcoholic beverage. The means for these shared items are shown in Table 4. To identify any contextual effects on the ratings, means for these items were compared between lists. Substantial (and statistically significant)

Table 3. Mean Ratings of the 72 Products and 30 Items from Study 1 and the 85 Products from Study 2

	List		
Questions	**72 Products (Study 1)**	**30 Items (Study 1)**	**85 Products (Study 2)**
Hazardous	2.66	3.74	2.89
Likelihood	2.41	3.42	2.51
Severity	3.08	5.03	3.39
Cautious intent	2.94	4.81	2.87
Likelihood of reading warnings	3.80	5.11	3.72
Familiarity	5.18	3.89	4.57
Control	5.59	4.13	5.44
Castastrophe	1.26	2.38	0.95

Note. All rating dimensions were significantly different ($p < 0.05$) between the 72-product and 30-item lists (first and second columns).

differences were observed between the means of the two lists for two of the four products. In the context of the Slovic et al. (1979) items (as compared to the Wogalter et al. (1991) products), injuries associated with the lawn mower and pesticide were considered less hazardous, less likely, and less severe. In addition, participants reported that they would be less likely to read warnings or behave cautiously when these items appeared in the Slovic et al. (1979) list. The differences between lists for the other two products were less straightforward. Alcoholic beverage differed on some of the rating questions (e.g., likelihood, familiarity, and catastrophe), whereas, bicycle differed on none.

Discussion

This study demonstrated that severity of injury was the primary predictor of hazard-risk judgments for the Wogalter et al. (1991) products and that likelihood of injury was the foremost predictor of hazard-risk for the Slovic et al. (1979) items. The study also demonstrated that there were significant differences between the two lists on all dimensions rated. These results strongly point to list content as being responsible for the disparate findings in the hazard and risk perception literature. Given that list content can substantially influence the pattern of results, one question that arises is whether any generalization can be made beyond these particular lists. Specifically, would a different list of items produce an entirely different result? One might expect that the 72-product list to be more representative of consumer products than the 30-item list, since more than half (57%) of the Slovic et al. (1979) items are not consumer products.

Table 4. Means of the Common Products between Wogalter et al. (1991) and Slovic et al. (1979) Lists

	Alcoholic Beverage		Bicycle		Lawn Mower		Pesticide	
Questions	**Wogalter**	**Slovic**	**Wogalter**	**Slovic**	**Wogalter**	**Slovic**	**Wogalter**	**Slovic**
Hazardous	5.70	4.80	2.70	2.05	4.55	1.80[1]	5.95	3.65[1]
Likelihood	5.00	3.50[1]	3.70	3.25	3.60	2.20[1]	3.42	3.15
Severity	6.35	5.65	4.40	3.90	5.00	3.60[1]	5.74	4.30[1]
Cautious intent	5.65	5.00	3.35	3.60	4.25	2.85[1]	5.32	3.80*
Likelihood of reading warnings	4.10	3.90	3.15	2.35	5.30	3.80[1]	6.58	5.25[1]
Familiarity	6.40	5.10[1]	7.35	7.15	5.90	6.00	4.42	3.60
Control	5.10	6.15	5.10	5.60	5.00	6.25[1]	4.47	3.15[1]
Catastrophe	5.40	3.35[1]	0.80	0.35	0.95	0.15	4.79	2.90[1]

Note. [1]Indicates a significant difference between lists on this question ($p < 0.05$).

STUDY 2

Study 2 employed a different list of consumer products to determine whether the findings of earlier hazard perception research can be generalized to other product lists. The ratings are compared to the results from Study 1.

Method

Participants

Thirty-five Rice University undergraduates participated.

Materials and Procedure

Table 5 shows a list of 85 product names that were chosen at random from a list of over 950 products monitored by the National Electronic Injury Surveillance System (NEISS; US Consumer Product Safety Commission, 1989). The list was assembled into four random orders, each comprising two pages. The products were rated on the same eight questions employed in Study 1. The rated questions and other procedures were identical to those of Study 1.

Results

The mean ratings of the eight questions for the 85 products (shown in Table 5) were very similar to the pattern of means observed for the 72 products (refer to Table 3). Comparisons between the means of this study's 85-product list and the two lists in Study 1 showed that the 85-product list was statistically different from the 30-item list on eight rated dimensions, but differed from the 72-product list only on the familiarity question. Participants reported being less familiar with the products on the 85-product list than the 72-product list. Thus, it appears that the 85 products in this study are statistically more similar to the 72 products used by Wogalter et al. (1991) than the 30 items used by Slovic et al. (1979).

Using the ratings of the 85 products, a forward stepwise regression analysis with hazard-risk as the criterion variable was performed using product mean scores (collapsed across participants). The single best predictor of hazard was severity ($r = .958$), accounting for 91.8% of the variance. The dimension of control contributed a rather small (0.8%) but significant ($p < .05$) amount of additional variance. No other variable contributed further to the prediction.

Table 5. The 85 Products from the NEISS List

Abrasive cleaners	Dune buggies	Kerosene/oil heaters	Saber saws
Aerosol containers	Electric toy cars	Laundry baskets	Saunas
Artificial Christmas tree	Food grinders	Laundry soaps/detergents	Scissors
Baby bathinett	Food processors	Lawn mowers	Seeds
Beds	Food warmers	Lighter fluid	Sheets or pillowcases
Bench/table saw	Footlockers	Liniments	Slow cookers
Benches	Four-wheel ATV's	Log splitters	Snow blowers
Bicycles	Furniture polishes	Luggage	Solid room deodorizer
Blankets	Garage doors	Manual lawn trimmers	Swimming pool equipment
Bleachers	Gas water heater	Orthopedic beds	Tables
Bubble baths	Gasoline cans	Padlocks	Toboggans
Built in swimming pools	Glass bottles/jars	Pens and pencils	Toy cosmetics
Burglar alarms	Glass test tubes	Pins and needles	Toy sports equipment
Can openers	Hair clippers	Pogo sticks	Toy weapons
Chemistry set	Hair coloring	Power pruning equipment	Treehouse/playhouse
Children's play tents	Hair dryers	Power sanders	Upholstered chairs
Clothes dryer	Hay processing equipment	Pressure cookers	Whirlpool/hot tubs
Clotheslines	Hot water	Pull down/folding stairs	Windows
Darts	Household cleaners	Ribs	Windshield wiper fluid
Diapers	Ice crushers	Rope or string	Wire
Drinking straws	Inflatable toys	Rug shampooer	Workshop staples
		Rust preventatives	

Discussion

The results using the 85-product list were strikingly similar to the results of the 72-product list in Studies 1 and 2. In fact, the overall mean responses to the eight questions were nearly identical between the two product lists. Many of the Slovic et al. (1979) items are different from the kinds of items that people encounter on a daily basis. This fact may be responsible for the disparate contribution of severity and likelihood information in the formation of hazard-risk perceptions.

Also replicated was the strong relationship between hazard-risk perception and injury severity. A tentative explanation can be offered on why severity is important for the consumer product lists and likelihood is important for the mixed-item list. Injury likelihood is very low for the kinds of products evaluated in the Wogalter et al. (1991) list, making the use of such probabalistic information difficult. In this case, people's use of severity information, which is more salient and available, may be entirely rational. However, when injury severity reaches some upper level (i.e., with consequences of very serious injury or death), which is probably the case for many of the items on the Slovic et al. (1979) list, the only remaining uncertainty about the outcome is the probability of its occurrence. For example, people's notions about plane crashes or nuclear accidents are generally associated with disaster—there is no question about the severity of the consequences (i.e., death). Therefore, only the probability of the event serves to differentiate the items, and so, in these cases, likelihood would be expected to play a larger role.

Another possible explanation might be considered. People may assume that the products they can buy in a grocery, hardware, and drug stores have been adequately tested and certified as safe (whether this is true or not). Further, they may believe that reasonable people using the products in a reasonable manner will not be injured. These notions can be contrasted with natural disasters that are not controllable by the consumer, or contact sports in which persons who participate are expected to know the consequences.

Studies 1 and 2 provide a basis for resolving the discrepant findings of the hazard (Wogalter et al., 1991) and risk (Slovic et al., 1979) perception studies. These results suggest that injury likelihood may be an important variable in the formation of hazard-risk perceptions when the evaluated items are extremely dangerous, very likely to result in very severe injury or death, unfamiliar, not controllable, and/or catastrophic. However, these characteristics are not typical of most consumer products to which people are exposed, and thus, injury likelihood may not play a substantial role in people's everyday hazard-risk evaluations.

STUDY 3

The methodology employed in the first two studies has evaluated the relative contribution of likelihood and severity information by asking people to judge the perceived hazard-risk for generic product names. To date, no study has addressed the extent to which likelihood and severity information influences people's judgments in a controlled experiment. In our everyday lives, we often see and hear a variety of communications that attempt to warn us about hazards. Given the results of the first two studies, it might be expected that people's hazard-risk judgments for consumer products would be sensitive to and affected by severity information to a greater extent than likelihood information.

The final two studies examined the effect of verbal statements conveying different levels injury severity (low vs. high) and likelihood (low vs. high) in warnings. The effect of this information is measured with respect to hazard perceptions for commercially available consumer products (Study 3) and to behavioral compliance in a chemical-mixing task (Study 4). Both studies were experiments designed to assess the influence of severity and likelihood information through incidental exposure (i.e., participants were not explicitly directed to the warnings). The present study was designed and conducted to have the appearance of "marketing research" that was concerned with factors affecting people's purchase decisions for certain consumer products. Participants answered a variety of questions for a set of products. Only one question, which assessed product hazardousness, was of interest.

Method

Participants

Forty-six students from Rensselaer Polytechnic Institute (RPI) participated for credit in the introductory psychology course. Prior to this experiment, a different set of 30 students from the same population participated in a preliminary word rating study.

Stimuli and Materials

Ten brand-name consumer products were chosen to represent a range of potentially hazardous household items. The generic names of the items were: contact lens cleaner, bathroom cleaner, extra-strength aspirin, laundry detergent, paint thinner, fixative spray, pesticide fogger, drain opener, hair mousse, and fabric protector. Labels from the products' front panels were scanned, stored, manipulated using a computer, and reproduced using a 300 dot-per-inch laser printer. Warnings on the front labels of the products were manipulated to differ with respect to conveyed injury likelihood (low vs. high) and severity of injury (low vs. high). These two independent variables were orthogonally crossed to form four warning labels for each product: 1) low likelihood—low severity; 2) low likelihood—high severity; 3) high likelihood—low severity; and 4) high likelihood—high severity. This manipulation was accomplished by changing the wording in the warnings' verbal statements.

Likelihood and severity terms were selected based on a preliminary word rating study. Thirty RPI undergraduates rated a set of terms representing a range of likelihood and severity. Eleven likelihood terms (can, likely, may, might, occasionally, possibility, probable, seldom, a slight chance of, unlikely, and will) were rated on a 9-point Likert-type scale according to the question: "What is the *likelihood* of injury implied by this term?" The anchors were: (0) never, (2) unlikely, (4) likely, (6) very likely, and (8) extremely likely. Ten severity terms (extensive, intense, irreversible, major, mild, minimal, minor, severe, slight, and superficial) were rated according to the question: "What is the *severity* of injury implied by this term?" The anchors were: (0) not severe, (2) slightly severe, (4) severe, (6) very severe, and (8) extremely severe.

For low and high likelihood, the terms "can" and "will" were used, respectively. The ratings showed that these two terms were significantly different in their conveyed likelihood (for "can" M = 3.40, SD = 1.5, and for "will" M = 7.73, SD = 0.52, t (29) = 17.3, $p < .0001$). For low and high severity, "mild" and "intense" were used, respectively. They differed significantly in their conveyed severity (for "can" M = 1.43, SD = 0.77, and for "will" M = 6.53, SD = 1.07, t (29) = 21.1, $p < .0001$). For example, the warning statements for the four conditions involving the hair mousse product were: "*Can* cause *mild* eye irritation" (low likelihood, low severity), "*Can* cause *intense* eye irritation" (low likelihood, high severity), "*Will* cause *mild* eye irritation" (high likelihood, low severity), and "*Will* cause *intense* eye irritation" (high likelihood, high severity). A fifth condition with no warning on the product labels served as a control.

Some of the original product label warnings described more than one hazard (e.g., telling about both hazardous consumption and skin contact). For purposes of control, all warnings in this study described only a single hazard, usually the first hazard mentioned on the front or back panel. The specific kind of injury described in the warning statements was allowed to vary but were matched for appropriateness to specific products. For example, the bathroom cleaner warned of consumption danger and the fogger warned of respiratory problems.

The warnings were placed in the same location as the original label warning. They were preceded by the signal word CAUTION, and were printed in font sizes and styles that best matched the fonts on the original label. Five booklets were formed having labels for all 10 products with each booklet containing two product labels representing each of the five conditions. Manipulated labels for each product were balanced across booklets. The label order in each booklet was randomized for each participant.

Fourteen questions were asked of each product; these included person- and product-related characteristics such as familiarity with the product, cost, and label attractiveness. The specific question of interest asked "How hazardous is it to use this product?" Participants responded using a 9-point rating scale having the anchors: (0) not at all hazardous, (2) slightly hazardous, (4) hazardous, (6) very hazardous, and (8) extremely hazardous. The other 13 questions were included to disguise the purpose of the study and were not analyzed.

Procedure

Participants were initially told that the purpose of the study was to examine factors that affect people's decisions to purchase certain consumer products that they might see on a store shelf. Participants were given the questionnaire, response sheets, and one of the five product-label booklets. Participants were told: (a) to move briskly through the questions; (b) to give their first impressions; and (c) to complete all questions for each product before moving to the next product. Approximately equal numbers of participants were given each of the five booklets (9 or 10 students per booklet). After completing the questionnaire, the students were debriefed on the study's true purpose.

Results

For each participant, the hazard ratings for the 10 products were collapsed to form five mean scores with each mean composed of two ratings of same-condition product labels. The first analysis examined whether hazard perceptions differed due to the simple presence of a warning on the label. A contrast comparing the warning-present (a composite of the four warning conditions) and the no-warning control condition was significant, t (45) = 2.04, $p < .05$, showing that products with warnings (M = 2.28) were perceived to be significantly more hazardous than products without warnings (M = 1.79).

The second analysis examined differences among the warning-present conditions. A 2 (severity: low vs. high) $\times$ 2 (likelihood: low vs. high) repeated-measures ANOVA showed a significant main effect of severity: F (1,45) = 6.33, $p < .02$. Products with warnings conveying higher injury severity were judged to be more hazardous (M = 2.50) than products with warnings conveying lower injury severity (M = 2.05). Neither the main effect of injury likelihood nor the interaction of likelihood and severity was significant ($p > .05$).

Discussion

The presence of warnings on the front label increased participants' perceptions of product hazard. Products lacking warnings were perceived to be less hazardous than the same products with warnings—a result that confirms other research (Wogalter, Jarrard, & Simpson, 1994). Moreover, the content of the warning message affected hazard perception. Product labels with warnings conveying greater injury severity were perceived to be more hazardous than warnings conveying lower injury severity. While the severity manipulation influenced perceived hazard level, these perceptions were not influenced by manipulations of injury likelihood. This null result is in accord with the findings from the first two studies.

All of the studies reported thus far have examined the influence of severity and likelihood using ratings. The assumption has been that perception of hazard translates into cautionary behavior. Indeed, ratings of cautious intent was strongly related to perceived hazard-risk in the first two studies. However, these studies measured only intentions and not actual cautionary behavior. Study 4 examines the effect of injury likelihood and severity information (as conveyed in a warning) on compliance behavior.

STUDY 4

The purpose of this study was to determine the effect of injury likelihood and severity information on compliance behavior. In a chemistry laboratory, participants were given a set of instructions to mix various chemicals and solutions. The instructions included either no warning (a control condition) or one of four likelihood/severity warnings manipulated as in Study 3. Compliance was measured according to whether participants performed the safety-related behavior directed by the warning (i.e., wearing gloves).

Method

Participants

Seventy-nine RPI undergraduates participated for credit in the introductory psychology courses. They were randomly assigned to conditions and were run one at a time. Each condition contained 16 participants except for the control condition, which had 15.

Materials and Procedure

The basic procedure is a chemistry laboratory demonstration task (see Wogalter et al., 1987; Wogalter, Allison, & McKenna, 1989). Generally, the procedure involves having an individual participant measure and mix various "chemicals" according to a set of pre-printed instructions. These "chemicals" are actually safe substances and solutions (flour, sugar, water, etc.) that are disguised with food coloring to convey the appearance that potentially dangerous materials are being used and that there is some risk involved. In addition to the mixing instructions, participants are also instructed (on the sheet with the mixing instructions) to wear gloves while performing the task. A large number of disposable plastic gloves were located on the table containing the chemistry materials.

Participants received one of five printed instructions that contained a short introductory paragraph providing a general description of the laboratory task and the specific chemical mixing directions. When a warning was present, it was printed in the instructions in a space following the general description (before the specific mixing directions). In the no warning control instructions, this space was left blank. The four warning statements comprising the conditions were: (a) low likelihood-low severity: "Contact with skin *can* cause *mild* skin irritation. Wear gloves;" (b) low likelihood-high severity: "Contact with skin *can* cause *intense* skin irritation. Wear gloves;" (c) high likelihood-low severity: "Contact with skin *will* cause *mild* skin irritation. Wear gloves;" and (d) high likelihood-high severity: "Contact with skin *will* cause *intense* skin irritation. Wear gloves."

All of these instructions were preceded by the signal word WARNING. Whether the participant donned the gloves before starting to mix the substances was recorded.

Results

Compliance rates for the five conditions were: 43.8% for low likelihood-low severity; 81.3% for low likelihood-high severity; 68.8% for high likelihood-low severity; 68.8% for high likelihood-high severity; and 13% for the no warning control. These data were analyzed using Chi Square tests. The overall analysis was significant, $X^2(4, n = 79) = 18.28, p < .01$. A contrast comparing compliance in the no warning condition with the combined grouping of all warning-present conditions was significant, $X^2(1, n = 79) = 13.47, p < .001$. There was greater compliance when a warning was present (42 of 64 participants or 66%) than when it was absent (2 of 15 participants). The only significant comparison among the four warning conditions occurred between the low likelihood-high severity warning and the low likelihood-low severity warning conditions, $X^2(1, N = 32) = 4.80, p < .05$. With lower injury likelihood, there was greater compliance with the higher severity warning (13 of 16) than with the lower severity warning (7 of 16).

Discussion

Participants in the chemistry laboratory task more often engaged in precautionary behavior (wearing gloves) when a warning was present than when it was absent. This result supports other behavioral compliance work using the chemistry task paradigm (e.g., Wogalter et al., 1987, 1989). The results also showed greater compliance when the warning conveyed information regarding a more severe injury than a less severe injury. However, this difference was shown only for warnings describing an injury of lower likelihood; no difference was apparent for warnings expressing higher likelihood. The failure to find a severity difference for high injury likelihood is not clear. One possibility is that participants in the high likelihood conditions did not believe that harm would *definitely* occur if they mishandled the substances (perhaps from similar previous chemistry lab experience), and thus the warning message was possibly less believable to them. Another potential reason is that this experiment involved an industrial task that is not similar to tasks normally associated with the use of common consumer products. In this situation, injury likelihood may have had some effects that are not present when consumer products are involved. Further investigation would have to be undertaken to test the validity of these explanations and/or whether likelihood information interacts with other factors (e.g., personal experience, situational characteristics).

GENERAL DISCUSSION

Some risk perception research suggests that hazard-risk evaluations are determined by the objective likelihood or probability of encountering potential hazards (Slovic et al., 1979). However, other research suggests that objective likelihood plays little or no role in determining hazard-risk judgments. Rather, hazard-risk is primarily determined by a subjective assessment of the severity of injury (Wogalter et al., 1991). The present studies demonstrate that, with consumer products, hazard-risk judgments are determined by how severely one might be injured. Likelihood was shown to play a part in Study 2 using an item list taken from research in the risk perception literature. However, this list was composed of items that were, for the most part, non-consumer products. Moreover, while likelihood appeared to mediate the behavioral findings from Study 4, severity was still a strong predictor of compliance behavior.

Two of the studies showed that the presence of a warning increases perceptions of product hazard-risk (Study 3) and compliance behavior (Study 4) compared to its absence. The implication of these findings is that failure to include a warning for a potential hazard might lead users to underestimate the level of danger involved. A particularly serious error would occur if people made the assumption that the absence of a warning indicates that the product (or situation) is safe. This belief might then cause the user to act with less caution than is needed, possibly leading to an injury. If a warning is not located on or near the product, people may not see the warning and assume that there is little or no hazard involved (Wogalter et al., 1991).

The present studies used very different procedures (rating generic names of products, rating labels, and performing a chemistry task) but they, nevertheless, showed reasonably consistent findings. They support Wogalter et al. (1991, 1993) findings showing that severity is a more important cue than likelihood in people's judgments of consumer product hazards. It also supports Wogalter et al.'s (1993) suggestion that injury probabilities and frequencies may not be involved in people's everyday safety-related decisions.

Why would injury likelihood play such a minor role in perceptions of product hazards in some cases and not in others? One possibility concerns the different kinds of tasks involved in the respective lines of research. In studies of perception of risk, Slovic et al. (1979, 1980a, 1980b) asked participants to estimate mortality rates or make comparative judgments of accident frequencies. This kind of judgment demands consideration of likelihoods. However, even these numeric estimates are affected by severity judgments. For example, Slovic et al. (1979, 1980a, 1980b) found that mortality rates for agents capable of producing severe consequences were consistently overestimated, indicating that there is a contribution of severity even for judgments strictly concerned with the frequency of events. A similar result was noted by Wogalter et al. (1993).

A second possible reason is that the frequency of consumer product injuries is extremely low. While people have some capability of making distinctions between products based upon the frequency of injury (Wogalter et al., 1993), judging differences between relatively unlikely accident events is probably not a well-practiced skill. Accidents are so infrequent that people may consider the likelihood of injury to be too small to be of concern. Therefore, since the probabilities are so small, they may not be able to do so effectively (see Desaulniers, 1991). Thus, the most persuasive and vivid cue for judgments of hazard appears to be beliefs regarding injury severity.

If it is true that people access information about potential injury severity when forming perceptions of product hazardousness, then at least one implication for warning design may be drawn—emphasis should be placed on communicating how severely a person can get hurt, rather than (or to a lesser extent) the likelihood of getting hurt. Warnings should give people an appreciation of the nature and magnitude of potential injuries. Products capable of inflicting substantial damage should contain information describing how badly a person might get hurt. Such descriptions would provide the user with an accurate picture of the extent of possible loss, and hopefully provide them the kind of information they can use to make rational safety-related decisions.

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