RISK PERCEPTION AND PRECAUTIONARY INTENT FOR COMMON CONSUMER PRODUCTS

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ABSTRACT

This study examined whether accident scenario analysis reduces accident frequency misestimations and leads to heightened precautionary intent for products. Subjects generated or were provided with accident scenarios and then made estimates. Other subjects made estimates at either a quick or slower pace without analysis. These and an additional group of subjects then rated precautionary intent for the products. Subject gave ratings for confidence in their estimations and reported whether they had injury experience related to the products. No differences were found among group correlations with actual frequencies. The Hurried subjects reported lower precautionary intent ratings than other groups. Subjects with injury experience reported higher precautionary intent than subjects without such experience. No relationship was found between precautionary intent and frequency estimates. Personal knowledge of accidents rather than general knowledge of accidents or frequencies may be a better predictor of consumers' intended behavior.

INTRODUCTION

How individuals perceive risk, make judgments, and use available information is crucial for planning effective schemes to prevent accidents. If individuals misjudge the hazards or risks they may fail to behave with adequate precaution, to read or heed vital safety information, resulting in serious injury.

Availability Heuristic and Risk

People use heuristics, rules of thumb, to help make decisions and judgments (Tversky & Kahneman, 1973). One heuristic used in making frequency estimations is "availability". The premise of this heuristic is that individuals often determine the frequency or probability of an event by the ease of retrieval from memory or by the number of events remembered. Generally, availability helps us make accurate decisions, but can sometimes lead to errors because retrieval is affected by other factors, e.g., salience or vividness, media coverage, and the number of people affected.

The effects of availability on risk perception were observed by Lichtenstein, Slovic, Fischoff, Layman, and Combs (1978) when examining estimations for causes of deaths. Subjects overestimated infrequent causes of death and underestimated more frequent ones. Lichtenstein et al. argued that less frequent causes of death were more available because they gain a disproportionate amount of media attention compared to more frequent killers such as heart disease and cancer. Attention to infrequent catastrophic events (e.g., tornados, plane crashes) causes more salient or vivid images and better memories which are more easily retrieved. This can lead to the misjudgement that an event occurs more frequently than it objectively does.

Lichtenstein et al. attempted to remove this bias by informing subjects of judgement errors people make as a consequence of relying on availability. Despite this information, they found no evidence of debiasing. Subjects continued to misestimate the frequency of lethal events.

Another means of debiasing subjects was attempted in three experiments by Brems (1986, 1987). He examined whether accident frequency estimation could be influenced by exposure to and generation of accident scenarios.

In Brems (1986) first experiment, subjects performed these tasks: 1) ranked products according to estimated annual emergency room visits; 2) estimated the number of emergency room visits associated with each product; 3) generated accident scenarios for each product; 4) assigned percentages of accidents associated with each of the scenarios; 5) reported how they knew of each scenario; and 6) were given the opportunity to reorder their rankings.

Subjects produced reasonably accurate estimates ($r = .60$) relative to the data from the National Electronic Injury Surveillance System (NEISS). Recall of accident scenarios did not affect frequency estimations. Personally experienced scenarios were better predictors of estimation accuracy than scenarios generated from other sources such as warnings and the media.

Brems (1987) then addressed whether subjects automatically generate scenarios when they engage in estimation tasks. Subjects performed the following tasks: 1) gave a quick estimation of accident frequencies; 2) gave an unhurried estimation of the frequencies; 3) generated accident scenarios; 4) estimated the percentage of accidents associated with each scenario; 5) after being presented with a list of all possible scenarios were asked if they were unaware of the scenarios or had just failed to recall them; 6) estimated the percentage of accidents associated with each scenario from the list of all possible scenarios; and 7) again made estimates for each product.

The results were similar to those found by Lichtenstein et al. Infrequent events were overestimated and more frequent events were underestimated. Responses made quickly were just as accurate as those made less hurriedly. Response times for both tasks were short (2 vs. 4 sec) suggesting that subjects did not generate many scenarios before making estimations. Both types of estimates were as accurate as those made after 1/2 hour of recalling and rating scenarios. Thus, in this experiment scenario generation appeared to have no effect on the processes involved in making frequency estimations.

Brems (1987) also examined whether organization of scenarios through the use of fault trees would improve estimations. Fault trees are often used to determine where and how system errors may occur. A fault tree organizes possible sources of trouble or alternative solutions into a hierarchical branching structure from general to specific causes. In Brems' third experiment, subjects performed these tasks: 1) gave a quick estimation of frequencies; 2) gave confidence ratings for these estimates; 3) gave an unhurried estimation of frequencies; 4) gave confidence ratings; 5) created fault trees for each product; 6) estimated injury frequencies using their fault trees; and 7) gave confidence ratings. The results again showed that subjects overestimated less frequent accidents and underestimated more frequent ones. Organization of the scenario information through fault trees did not appear to facilitate estimation performance as there were no differences between the earlier and later estimation conditions. Confidence ratings, however, were higher for the estimation task following the generation of the fault trees. The process of analysis apparently gave subjects a false sense of confidence that they had performed better than during earlier estimations.

Brems' (1986, 1987) results suggest that knowledge about accident frequencies is accessible without the use of scenarios. Three possible reasons can be offered. The first is simply that the information provided by scenarios is not sufficient or not used in the processing of risk. The second is that in semantic memory, risks may be tied directly with product knowledge and thus do not need to be analyzed or extracted separately via scenario analyses. The third possibility pertains to the methodology of these studies. Within-subjects designs were used in which the same subjects were asked to give frequency estimates two or more times. The failure to find a difference in estimations may be a result of the subjects' reluctance to stray too far from their original estimations, and thus obscurring any beneficial effects of these manipulations. A between-subjects design might show differences among the estimation conditions. The present research reexamines the questions raised by Brems using a between-subjects design.

Precautionary Intent

While accident frequency estimation has been used in a number of studies examining risk misperceptions, it may not be the best predictor of people's recognition of hazards. A more relevant and direct measure of risk perception is precautionary intent; that is, how much precaution an individual reports to be willing to take when using a product. Precautionary intent has been found to be strongly and positively related to perceptions of hazards (Wogalter, Desaulniers, & Brelsford, 1987). It is, after all, an individuals' behavior that is most important, not how well he or she can estimate frequencies. By recognizing and considering the ways in which one may be injured, individuals may report appropriately heightened precautionary intent when using a hazardous product. Therefore, generation and use of scenarios was examined not only to determine if they improve frequency estimation but also to determine if they have an effect on precautionary intent.

METHOD

Subjects

Preliminarily, 24 University of Richmond undergraduates participated to compile a list of all reasonable accident scenarios associated with the products. In the main experiment, 80 undergraduates, 40 males and 40 females, participated. Subjects were randomly assigned to one of five equal groups. Later, 31 additional students took part in a product perception rating task. All subjects participated for credit in introductory psychology classes.

Materials

Eighteen products (e.g. bicycles, bleach) were selected from the 1986 National Electronic Injury Surveillance System (NEISS) data base (U.S. Consumer Product Safety Commission, 1986). NEISS provides estimates of emergency room injuries associated with consumer products based on a sample of 64 statistically representative hospitals in the United States. Products used in the study, shown in Table 1, were selected on the basis of accident frequencies from NEISS which were classified into 3 categories: high, medium, and low.

Preliminary Scenario Collection. A preliminary study was conducted to collect a list of all reasonable accident scenarios for each product. Subjects were given unlimited time to generate as many scenarios as possible. Each subject generated scenarios for six of the 18 products so that a total of eight fault trees per product was collected. Responses were pooled to form the list of all reasonable scenarios. Responses that were redundant or did not fit into the context of physical injuries were eliminated.

Table 1. Products within Frequency Category, and NEISS Accident Frequencies

Product Name	NEISS Frequency
Low Accident Frequency	
Vacuum cleaners	11,117
Fireworks	12,602
Bleach	15,109
Fans 17,454	
Gasoline	17,768
Televisions	25,435
Medium Accident Frequency	
Chainsaws	45,012
Hammers	48,479
Skateboards	81,066
Drinking glasses	81,606
All terrain vehicles (ATVs)	86,400
Ladders	90,019
High Accident Frequency	
Bathtubs and showers	101,866
Windows and window glass	128,777
Nails, screws, thumbtacks	214,656
Drugs and medication	216,246
Knives	333,478
Bicycles	546,420

Subsequent Product Perception Rating Study. Thirty-one additional subjects were asked a series of questions about the 18 products. Each subject received one of two product orders and a set of six questions randomized for each subject. Responses were on 9-point Likert scale with endpoints of 0 (lack of quantity) and 8 (maximum quantity). Though only some of the scale points had verbal anchors, subjects were told that they were free to use any integer between 0 and 8. Subjects rated all 18 products on a particular question before going on to the the next question. The questions and rating scale anchors were:

1) "How frequently do you use this product?" with anchors of never (0), infrequent (2), frequent (4), very frequent (6), and extremely frequent (8).
2) "How knowledgeable are you about the hazards related to this product?" with anchors of not at all knowledgeable (0), slightly knowledgeable (2), knowledgeable (4), very knowledgeable (6), and extremely knowledgeable (8).
3) "How severely might you be injured with this product?" with anchors of not at all (0), slight injury (2), severe injury (4), extremely severe injury (6), and death (8).
4) "How likely (probable) are you to read a warning for this product?" with anchors of not at all (0), not likely (2), likely (4), very likely (6), and extremely likely (8).
5) "How likely (probable) would it be that you would be severely injured (requiring emergency room care or resulting in permanent injury) by this product in the next year?" with

anchors of not at all (0), unlikely (2), somewhat unlikely (4), likely (6), and extremely unlikely (8).

6) "How likely (probable) would it be that you would receive any sort of minor injury by this product in the next year?" with anchors of not at all (0), unlikely (2), somewhat unlikely (4), likely (6), and extremely unlikely (8).

Procedure

Subjects were randomly assigned to one of five groups. Four of the groups differed with respect to the estimation procedure. All other tasks for these groups were identical. The procedures for the four groups are described below. The procedure for the fifth, *Precaution Only*, group is described later.

The *Hurried Estimation* subjects who were told to give a vocal estimate of the annual accident frequencies associated with each product within 2 sec after hearing the product name read aloud by the experimenter. The importance of giving immediate estimates was emphasized. Subjects in the *Unhurried Estimation* group were told to take as much time as they needed to make their estimates. Subjects in the *Scenario Generate* group first constructed fault trees that identified all reasonable accident scenarios for each product. Using the fault trees for reference, these subjects made accident estimates for each product. Subjects in the *Scenario Provided* group were given a set of fault trees with all reasonable accident scenarios which were compiled from the preliminary study. Using the fault trees for reference, these subjects made accident estimates for each product.

Before the estimation task, the experimenter described fault trees to the *Scenario Generate* and *Scenario Provided* subjects. As demonstration, a fault tree containing accident scenarios for swimming pools and accessories was provided. Subjects were told that "swimming pools and accessories" are associated with 88,000 emergency room injuries annually and were told to use this number as reference point in making their estimates.

Following the estimation task, subjects in the *Hurried, Unhurried, Scenario Generate* and *Scenario Provided* groups performed the following sequence of tasks:

Precautionary Intent. Subjects gave ratings of precautionary intent for each product using the following scale and anchors: no precaution at all (1); little precaution (3-4); moderate precaution (6-7); and extreme precaution (9).

Confidence. Subjects gave confidence ratings for their estimates using the following scale and anchors: no relationship between estimated and actual frequencies (1); moderate relationship between estimated and actual frequencies (5); and perfect relationship between estimated and actual frequencies (9).

Injury Experience. Subjects responded to whether they or someone they know had experienced an injury related to each product.

Subjects in the fifth, *Precaution Only* group, without having given accident frequency estimates, gave ratings of precautionary intent for each product and then reported if they or someone they know had experienced injury related to the products.

Each subject in each group was given one of 16 random product orders. Responses were recorded and sessions were tape recorded.

RESULTS

Estimation Latency

The mean estimation response times for the Hurried and Unhurried groups were 1.96 and 3.76 seconds, respectively. This significant difference, $t(30) = 3.92$, $p < .005$, confirms that the instructions affected subjects' response strategies. These latencies are similar to those found by Brems (1986, 1987).

Estimation Accuracy

Several kinds of analyses examined whether estimation accuracy differed among groups. One way to assess accuracy is to examine how well subjects' estimations correspond with NEISS frequencies. The first analysis examined the magnitude of the correlations between estimates and NEISS frequencies. Greater positive correlations should be shown for more accurately ordered estimates. The estimates were collapsed across subjects in each group to form a mean estimation score for each product. The correlations were: Hurried, $r = .54$, $N = 18$, $p < .03$; Unhurried, $r = .54$, $N = 18$, $p < .03$; Scenario Generate, $r = .65$, $N = 18$, $p < .004$; and Scenario Provided, $r = .62$, $N = 18$, $p < .007$. Because variance is larger for products with high accident frequencies relative to low accident frequencies, the estimates and NEISS frequencies were transformed to logarithms. The correlations for the transformed data were: .64, .53, .68 and .66 for the Hurried, Unhurried, Scenario Generate, and Scenario Provided groups, respectively (p's < .05).

The correlations were then converted to Z scores using Fisher's Z prime transformation to determine whether the correlations differed. None were found using the raw or log transformed means, p's > .05.

Under- and Overestimation

Further analysis examined whether subjects tended to overestimate low frequency products and underestimate high frequency products. Three product frequency categories were formed using the NEISS frequencies (high, medium, and low with six products in each category). Then a set of difference scores was calculated between every estimation produced by subjects and the corresponding NEISS frequency. Means of the differences were then obtained for each of the product frequency categories (high, medium, low) resulting in three scores for each subject. Scores closer to zero indicate greater accuracy. Larger numbers in either the positive or negative direction indicate overestimations and underestimations, respectively. These scores were then entered into a 4 (group) X 3 (product frequency category) mixed-model ANOVA. The ANOVA failed to show a significant effect of group, $F(3, 60) = 1.29$, $p > .05$. The ANOVA did show a significant main effect of product frequency category, $F(2, 120) = 421.7$, $p < .0001$. As can be seen on the top row of Table 2, low frequency products were overestimated and medium and high frequency products were underestimated. Tukey's Honestly Significant Difference (HSD) test showed significant differences among all three product frequency categories. The interaction of group and product category was not significant $F(3,60) < 1.0$.

This analysis was repeated using log difference scores. The ANOVA again yielded a main effect of product category, $F(2, 120) = 171.45$, $p < .0001$. These means on the bottom row of Table 2 show that with logs low frequency products show a slight underestimation. As the accident frequency increases so does the amount of misestimation. The ANOVA again failed to show an effect of group $F(3, 60) < 1.0$, or an interaction, $F(6, 120) = 1.67$, $p > .05$.

Precautionary Intent

A 5 X 3 ANOVA was used to analyze the precautionary intent data. There was a significant main effect of group, $F(4,75) = 2.94$, $p < .03$,

Table 2. *Mean Raw and Log Differences of Estimates (from NEISS) for Product Frequency Categories.*

	Product Frequency Category		
	Low	Medium	High
differences	21,770.8	-23,579.2	-170,065.8
log differences	-.035	--.521	-.705

and product category, F (2, 150) = 107.2, $p < .0001$. The means can be seen in Table 3. Tukey's (HSD) test showed that the Hurried group reported significantly less precautionary intent than the other groups. Tukey's (HSD) also showed that significantly greater precautionary intent was reported for products in the medium and high accident frequency categories than for products in the low frequency category. Significantly higher precautionary intent was reported for products in the medium frequency category than in the high frequency category. No significant interaction was shown, F (8, 150) = 1.44, $p > .05$.

The relationship between precautionary intent and the NEISS frequencies was also examined. The precautionary intent ratings were collapsed across subjects in each group to form a score for each product. The correlations were: .12, .17, .18, .19, and .08 for the Hurried, Unhurried, Scenario Generate, Scenario Provided, and Precaution Only groups, respectively. None of the correlations was significant (all p's > .05). However, when the precautionary intent means are correlated with product estimations (from the four groups that provided them), all were positively related and significant: .59, .70, .53, and .55 for the Hurried, Unhurried, Scenario Generate, and Scenario Provided groups, respectively (all p's < .05).

Table 3. *Mean Precautionary Intent as a function of Group and Product Frequency Category*

	Accident Frequency Category			
	Low	Medium	High	mean
Hurried	3.83	5.37	5.05	4.75
Unhurried	4.40	6.19	5.48	5.35
Generate	5.02	6.18	5.88	5.69
Provided	5.03	6.07	5.88	5.66
Precaution	4.89	6.05	5.55	5.49
mean	4.63	5.97	5.57	

Confidence

Mean reported confidence for product frequency estimation was obtained for the Hurried, Unhurried, Scenario Generate and Scenario Provided groups. The group means were 4.31, 4.81, 3.94, and 4.44, respectively. An ANOVA showed no significant differences among the groups, F (3, 60) = 1.41, $p > .05$.

Injury Experience

Analyses examined whether subjects who have injury experience with a product tend to elevate their estimates. Subjects were divided into two groups with respect to injury experience or no injury experience for each product. Significant differences were only found for gasoline and all terrain vehicles (p's < .05), but there was a general trend for subjects who reported injury experience to give higher estimates for 10 additional products. A sign test was conducted to examine this trend (.67 vs. .33) but failed to find a significant effect, $t(17) = 2.05$, $p > .10$. Similar analyses were performed to examine whether injury experience heightens ratings of precautionary intent. Significant differences were found for the five products: Gasoline (7.00 vs. 6.07), Drinking Glasses (3.74 vs. 2.58), Ladders (6.59 vs. 5.71), Windows & Window Glass (5.10 vs. 3.91), and Nails, Screws & Thumbtacks (4.98 vs. 4.11). A trend in the same direction was seen for 10 additional products. A sign test showed a significant effect, $t(17) = 3.69$, $p < .01$ indicating that, in general, subjects with greater injury experience reported greater precautionary intent (.83 vs. .17).

Table 4. *Correlations of NEISS, Precautionary Intent, and Accident Estimations with the data collected in the product perception study.*

	NEISS	Estimates	Precaution
Frequency of Use	.09	-.04	-.57*
Knowledge of Hazards	.45	.38	.39
Severity of Injury	.19	.66**	.97**
Read Warning	-.12	.46	.77**
Likelihood of Major Injury	.61**	.71**	.50*
Likelihood of Minor Injury	.58*	.53*	.31

* $p < .05$
** $p < .01$

Product Perception Study

Analyses were also performed on the product perception study data. Ratings were collapsed across all subjects for each question and then entered into correlational analyses usings product means as the random variable (n = 18). Table 4 shows that he NEISS accident frequencies were positively related to likelihood of receving a major and minor injury but not related to the other ratings. Accident estimates showed a similar pattern except that the estimates were also positively related with perceptions of severe injury. Precautionary intent showed a different relationships than the NEISS frequencies and accident estimates. Precautionary intent for the products was positively related with perceptions of severe injury, likelihood of reading a warning and receiving a major injury and negatively related with frequency of use.

DISCUSSION

Although the accident frequency estimations were positively correlated with the NEISS frequencies, there was no significant correlation difference among the Hurried, Unhurried, Scenario Generate and Scenario Provided groups. The short times involved in making the hurried (2 sec) and unhurried (4 sec) suggest that not many scenarios were generated, but nevertheless, subjects in these conditions were just as accurate as subjects who explicitly considered scenarios. This result replicates Brems' (1986, 1987) results in which hurried estimates were found to be as accurate as unhurried estimates and estimates made after fault tree analyses. These results suggest that Brems' findings were not a result of the repeated measures design he used.

Low accident frequency products were overestimated and both medium and high accident frequency products were underestimated. Analysis of these data transformed to logarithms showed that low frequency products were also slightly underestimated. But no significant differences were found among the estimation groups. This replicates earlier research (Brems, 1987, and Lichtenstein et al., 1978) in which attempts to debias subjects were not successful. Scenario analysis should have increased the availability of accident information and reduced miscalculation involved with the availability heuristic, however, no effect on estimations was found compared to little or no scenario analysis.

Precautionary intent, which logically should be a better indicator of perceived risk, was also examined. Only the Hurried subjects, who spent the least time making estimates, gave lower precautionary ratings than subjects in other groups. That the Hurried had lower precautionary intent suggests that some quick processing did occur in the Unhurried condition that an organized and complex analyses does not improve upon. The two additional seconds on average that the Unhurried subjects spent compared to the Hurried subjects apparently helped while time beyond this had no effect. Thus, some processing time may be needed, but apparently not to evaluate scenarios. This concurs with the results of the estimation tasks in which the Scenario Generate and Provided groups did not perform better than the other groups.

Precautionary intent was also examined as a function of accident frequency category. Higher precautionary intent was reported for products in the medium frequency category than products in the high frequency category. A reason for this is suggested by the frequency of use data from the product perception study. Products in the high frequency category are used significantly less (M = 2.56) than products in the medium frequency category (M = 5.31), $p < .05$. In addition, precautionary intent showed a negative correlation with frequency of use. Clearly, frequency of use is related to familiarity; that is, the more frequently we use a product the more familiar it becomes. Godfrey, Allender, Laughery, and Smith (1983), Godfrey and Laughery (1984), and Wogalter, Desaulniers, and Brelsford (1986) reported lowered perceptions of hazard with more familiar products. High accident frequency may not be reflective of degree of hazard since more frequent accidents may result simply because the products are used more often. Precautionary intent was most strongly correlated with perceptions of severe injury ($r = .97$) suggesting that the magnitude of potential injury is considered to a greater extent than accident frequencies or likelihoods (Wogalter, Desaulniers & Brelsford, 1987). Indeed, precautionary intent and the NEISS frequencies were not related. Therefore, accident frequency are apparently not the primary source of information that people use when determining how careful to be.

Although accident estimates were significantly related to the NEISS frequencies (demonstrating that subjects had at least a rough idea of accident frequencies), the product perception study data suggests that the estimations were influenced, in part, by perceptions of severe injury. In conjunction with the finding that precautionary intent and NEISS frequencies do not relate suggests that knowledge of accident frequencies would have little impact on behavior. Furthermore, the finding that Scenario Generate and Provided subjects did not give higher ratings of precautionary intent suggests that incorporating accident scenarios or frequencies into warnings and educational programs may not enhance warning compliance and precautionary behavior. However, people do apparently consider the severity of injury that may result, so perhaps informing people of the potential consequences would be a useful way to augment precautionary behavior.

Brems found that subjects had greater confidence in their estimations after generating fault trees than after making hurried or unhurried estimates. In the present study subjects made estimates only once and no group differences were found. Brems' findings may have been an artifact of the within-subjects design. It is reasonable to expect that subjects would have greater confidence after a lengthy analysis than after an earlier brief analysis. Thus Brems' result might have been due to demand characteristics.

For two products, subjects with injury experience or knowledge of injury made significantly greater accident frequency estimates than subjects without such experience. The same, but nonsignificant, trend was found for 10 additional products. However, precautionary intent was affected by injury experience. Subjects who reported that they or someone they knew had a product associated injury, reported greater precautionary intent for 15 of the 18 products. A sign test showed that persons with injury experience had greater precautionary intent than persons without such experience.

Unfortunately being provided with theoretical or possible accident scenarios is not enough to correct risk perception errors or to enhance precautionary intent. Some kinds of information may be helpful, however. Perhaps vivid case studies that dramatize the severity of injuries that may result and accident accounts that personalize hazards would be more beneficial. Obviously, injury experience, perhaps the most influential factor, is not a viable solution to preventing serious product related injuries.

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