Communicating Risk in a Global Economy: Emerging Issues Associated with the Globally Harmonized System (GHS) for Labeling Hazardous Chemicals

Michael J. Kalsher, Department of Cognitive Science, Rensselaer Polytechnic Institute

Claudia Mont'Alvao, Art & Design Department, PUC-Rio, Rio de Janeiro

Abstract

Sweeping globalization has produced unparalleled economic growth, including increased international trade of hazardous chemicals. Fundamental differences between nations trading these materials, including language, literacy rates, cultural values, and technical and governmental infrastructures has created the need for a common system of risk communication to reduce the occurrence of deaths and serious injuries that result from unintended chemical exposures. To accomplish this goal, the United Nations (UN) created the Globally Harmonized System for the Classification and Labeling of Chemicals (GHS) in 1992. Unfortunately, there was no requirement for testing of the GHS labeling components, including symbols intended to depict specific hazards, before their deployment. In Experiment 1, twenty GHS hazard pictographs were comprehension-tested in two non-student samples from the U.S. and Brazil, respectively. The results of testing showed that only a small number of the GHS hazard pictographs met currently accepted levels of comprehension. Experiment 2 investigated how people attribute blame when characteristics of product labeling are manipulated in terms of quality of the product's hazard warnings and whether entities in the distribution chain leading from the manufacturer to end users passed along critical product safety information to the next link in the distribution chain. The manufacturer received the most blame when the quality of the warning was high, but it failed to pass the information along to the next link in the distribution chain. End users received the most blame when the quality of the warning was high and the information distribution chain was complete. Risk communication needs in a global economy and the expanding role of products liability law will be discussed.

Introduction

Sweeping globalization has given rise to dramatic economic growth and opportunity as products and services are increasingly freely traded among many different countries throughout the world. On the other hand, the many positive contributions of globalization have been offset by problems arising from fundamental differences between nations involved in international trade including language, literacy rates, laws and cultural values, and technical and governmental infrastructures. This has been particularly true of international trade involving potentially hazardous chemicals. One particularly important difference between countries engaged in international trade is the availability (or lack thereof) of regulatory agencies focused on health and safety issues. Although the U.S. and other developed nations have sophisticated networks of regulatory agencies and accompanying system of laws in place to prevent its citizens from accidental exposure to hazardous chemicals, third world companies frequently do not (Laughery, 2006). Thus, there is an urgent need for a common system of risk communication that effectively conveys chemical hazards to a wide range of people from many different countries in order to reduce the occurrence of deaths and serious injuries worldwide that result from unintended chemical exposures.

Numerous attempts have been made to develop chemical classification and labeling systems to facilitate risk communication (OSHA, 2009). Unfortunately, not all of these have been effective and the existence of multiple systems has led to critical confusions due to differences in their recommendations and approaches to risk communication (Silk, 2003; Winder, Azzi & Wagner, 2005). A more recent effort to create a unified system of chemical risk communication intended for a global audience is the Globally Harmonized System for the Classification and Labeling of Chemicals (GHS). The primary goals of the GHS are to provide an internationally comprehensible system of hazard communication for chemical labeling, facilitate international trade of hazardous chemicals, and reduce the need for duplicate systems of chemical labeling (OECD, 2001; Pratt, 2002; Seguin, 2009).

Currently, the GHS requires labeling on chemical products to include specific information about the product (e.g., product name, its supplier, and its chemical composition) and its hazards (e.g., hazard and precautionary information). Information pertaining to the product's hazards must include signal words appropriate to the level of each hazard and specific pictograms designed to overcome language and cultural barriers and communicate risk to less well-educated users. Although the U.N.'s goals are laudable, there was a critical flaw inherent in the initial implementation of the GHS—it did not include a requirement for testing to determine whether people interpreted GHS labeling components, including the hazard pictographs, as intended. Instead, comprehension testing was left to the discretion of individual chemical manufacturers and governments.

Systematic testing of labeling systems used on hazardous products is critical to determine whether they are achieving their goals of adequately alerting people who use or are exposed to these products. In the case of the GHS, comprehension testing is even more critical since its developers' goal is to implement the system worldwide. Fortunately, this critical omission has since been corrected and the most recent revision of the GHS has included a comprehension testing methodology (see the International Labor Organization's Annex 6, 2009). Despite this recent acknowledgement, however, there has been surprisingly little research examining the relative effectiveness of the GHS pictographs (Banda & Sichilongo, 2006). The research that has been done generally show that the GHS pictographs fail to correctly convey their intended meaning. In one recent study, Rother (2008) studied a sample of South African farm workers to determine their interpretations of pesticide labeling. Pictographs recommended by the United Nations Food and Agricultural Organization (FAO) are frequently used as part of the labeling on pesticide containers sold in developing countries to improve communication of health and safety risks. Although the pictographs are intended to overcome language and literacy problems, they are prone to misinterpretation and as a result fail to accomplish their intended purpose of reducing farm workers' and end-users' exposure to hazardous chemicals. This was confirmed in Rother's study as more than half of the participants' interpretations of the pictographs were incorrect. More importantly, their incorrect interpretations tended to reflect their social and cultural frames of reference. These results and the results of similar studies (e.g., Lin, 2009; Lie, Hoelscher, & Gruchmann, 2005) highlight the importance of systematic iterative design as part of the pictograph development process to ensure that the intended range of people understand their intended meanings, as compared to relying on training as the answer.

Clearly, more research is needed to evaluate the GHS system and its elements, including the hazard pictographs. One purpose of the current study was to evaluate comprehension of existing

GHS pictographs in culturally distinct populations. Thus, in Experiment 1, twenty GHS hazard pictographs were comprehension tested with two non-student populations from the U.S. and Brazil using the comprehension estimation procedure (Brugger, 1994; Zwaga, 1989).

A second purpose of this research was to investigate the processes by which people assign blame for injuries sustained during the use of or exposure to consumer products (e.g., Kalsher, Wogalter, & Williams, 1999; Laughery Lovvoll, & McQuilkin, 1996; Lovvoll Laughery, McQuilkin, and Wogalter, 1996; Walster, 1966; Wilson & Jonah, 1988). This interest stems from the explosion of products liability litigation that has occurred in developed nations, particularly the United States, over the past several decades. In light of the dramatic increase of global trade that has occurred, products liability issues, including lawsuits, are likely to spread into the international community.

Much of the products liability litigation in the U.S. has centered on a consideration of product manufacturers' efforts to effectively warn end users about the risks of their products. One goal of existing research on this topic has been to determine how people assign blame for injuries sustained through the use of or exposure to consumer products and how various entities associated with either the production or use of consumer products view responsibility for safety. Evidence drawn from the social cognition literature seems to indicate that negligence perceptions are highly sensitive to contextual information, and therefore, relatively unstable across people and settings (e.g., Karlovac & Darley, 1988; Walster, 1966). Because contextual information shapes perceptions and attributions, this suggests that decision makers in a legal context (e.g., jurors, judges) may attribute responsibility for accidents on the basis of the amount and type of information accessible to them. Support for this possibility comes from a number of studies recently reported in the human factors literature (e.g., Kalsher, Williams, & Murphy, 2001; Williams, Kalsher, Maru, & Wogalter, 2000; & Phoenix et al.,1997).

The power of the context in shaping culpability judgments can perhaps best be seen in instances in which jury awards for compensation and damages stemming from consumer product injuries contrast sharply with the public's lay theories concerning assignment of blame and appropriate compensation. Take for example, the infamous McDonalds hot coffee case in which an elderly woman suffered serious burns when she spilled coffee obtained from the drive-through window of a McDonalds restaurant onto her lap. The woman successfully sued

McDonalds and received a large, but publicly undisclosed, award. Media reports of public reaction to this case clearly show that most people were dumbfounded by the decision, questioning the basis for concluding that McDonald's acted in a negligent manner. However, in light of findings drawn from the social cognition literature, the verdict becomes more understandable if we allow for the possibility that contextual information about the event (perhaps made available during the trial) helped to channel jurors' attributions away from the victim and toward McDonalds. A field investigation by Kalsher, Phoenix, Wogalter, and Braun (1998) supports this reasoning. These researchers examined how participants allocated blame in fictitious scenarios based loosely on the McDonalds hot coffee case. In the study, supplementary information intended to be either positive or detrimental to the company and its safety practices was either present or absent from the scenario. Results showed that participants attributed significantly less blame to the consumer when the scenario was accompanied by supplementary information that placed McDonalds' policies and practices in an unfavorable light, compared to when the same information was framed positively or when no supplementary information was provided.

Two principles, in particular, appear to guide the decisions that observers make about negligence. First, they attempt to reconstruct the foreseeability of harm as it appeared to the injured person prior to the accident. If the foreseeability of the risk is judged to be high, then the (injured) person is likely to be seen as negligent. Second, they assess the degree of care taken to prevent foreseeable risks and harms. Applied to the McDonald's hot coffee study just described, the supplemental information can be interpreted as having successfully manipulated observers' perceptions of foreseeability and precaution: the company knew about the risks of its product and either did or did not take action to minimize the risk of injury to its customers.

These results seem to suggest that the principles of foreseeability and precautionary action should be applied to the actions of <u>all</u> parties involved, and allocation of blame will depend on who is seen as most negligent in their actions leading up the injury. Interestingly, most of the studies in this area have examined the processes underlying attributions of blame in fictitious accident scenarios involving either just the injured person, or the injured person and the product manufacturer. However, in actual product liability cases, multiple parties are typically involved and each entity may be seen as negligent, or contributing, to the injury in some manner. The specific actions (or non-action) of the manufacturer, distributor, and consumer of a product, to name but a few, may each contribute to the occurrence of an accident and severity of the resultant injury. Hence, the process of assigning blame in actual product liability cases is complex, and therefore, the judgments should reflect the potential involvement of all relevant parties.

Thus, in Experiment 2, we examine how people allocate blame when multiple entities are involved. In line with findings from the social cognitive literature, we predict that allocation of responsibility will depend to a large extent on the context in which an accident occurs and the observers' interpretation of actions taken (or not taken) by the different parties involved. In particular, we seek to examine how the safety practices of each of those entities affects blame allocation. The principles of foreseeability and precautionary action should be applied to the actions of all parties involved, and allocation of blame should depend on who is seen as most negligent in their actions leading up the injury.

Experiment 1

Method

Participants. There were a total of 312 non-student participants; 155 were males and 157 were females. Of these, 225 (111 males and 114 females) comprised the U.S. sample and 87 (46 men and 41 women) comprised the Brazilian sample. The average age of participants was 40.6 (S.D.=14.7) and 41.3 (S.D.=17.7) in the U.S. and Brazilian samples, respectively.

Procedure. After providing informed consent, participants were asked to evaluate each of twenty GHS pictographs using the comprehension estimation procedure. For each pictograph, participants were provided with the context in which each of the pictograph would likely be seen (e.g., see Laughery, 2006) and then asked to estimate the percentage of people in their respective countries who would comprehend its intended meaning. Previous research has shown that comprehension results obtained using the comprehension estimation procedure are highly correlated with results obtained using open-ended testing (Bruger, 1994; Zwaga, 1989). The comprehension estimation procedure is beneficial because it is less expensive and time consuming than the open-ended procedure. The estimation procedure is particularly effective for screening and selecting pictographs for further development and testing from a set of alternatives (e.g., Kalsher et al., 2000).

Results

Table 1 provides a summary of the comprehension estimates for each of the twenty GHS pictographs evaluated. For each pictograph, the table reports the means and standard errors for the U.S. and Brazilian samples, respectively. The pictographs are arranged in order of level of comprehension estimate from highest to lowest (left to right and top to bottom). Pictographs receiving the highest comprehension estimates were generally ones intended to depict relatively tangible hazards, including flammability, acute toxicity, and marine pollutant/environmental hazards, respectively, although the ratings varied significantly between the U.S. and Brazilian samples. Pictographs receiving the lowest comprehension estimates were ones intended to depict relatively abstract hazards, including reproductive and carcinogenic hazards, oxidizing hazards, the pyrophoric liquid hazard, and flammable gases hazard.

According to criteria outlined in the American National Standard Institute's Criteria for Safety Symbols (ANSI Z535.3, 2007), symbols and pictographs are considered acceptable if 85% of the study participants are able to understand its meaning with no more than 5% critical confusions. When compared against this standard, only three of the GHS hazard pictographs can be judged acceptable, and only for the U.S. sample: the flammability symbol (M=91.6, $S.E.$=0.91), the acute toxicity symbol (M=86.6, $S.E.$=1.35), and the marine pollutant symbol (M=85.0, $S.E.$=1.55). Even if the 85% criterion is relaxed, as has been recommended for studies employing the comprehension estimate procedure, only the environmental hazard symbol (for the U.S. sample) can be judged as acceptable (M=65.5, $S.E.$=2.04).

Insert Table 1 about here

A mixed-model analysis of variance (ANOVA) was performed on the data. The repeated-measures variable was Type of Symbol and the between-subjects variable was Nationality (U.S. vs. Brazilian samples). Mauchly's test of sphericity was significant, $X^2(189)=1142.17$, $p<.01$, and so the Greenhouse Geisser correction was applied. There was a significant Symbol x Nationality interaction, $F(12.93, 4008.31) = 19.43$, $p<.01$. Post-hoc tests were carried out to examine differences in comprehension estimates between the U.S. and Brazilian samples. Significant differences were found for pictographs depicting the following hazards: the flammability hazard ($t(98.64)=7.46$, $p<.05$), the acute toxicity hazard (skull-and-crossbones) ($t(104.46)=7.67$, $p<.05$), the corrosive hazard ($t(311.00)=5.56$, $p<.05$), the carcinogen hazard ($t(311.00)=1.99$, $p<.05$), the environmental hazard ($t(311.00)=4.66$, $p<.05$), the acute hazard ($t(207.69)=3.03$, $p<.05$), the explosives hazard ($t(189.62)=4.15$, $p<.05$), the acute toxicity ($t(311.00)=4.04$, $p<.05$), the organic peroxide hazard ($t(187.30)=3.66$, $p<.05$), the flammable solid hazard ($t(183.20)=2.14$, $p<.05$), the pyrophoric liquid hazard ($t(310.00)=2.40$, $p<.05$), the marine pollutant hazard ($t(117.03)=10.23$, $p<.05$), and the chronic hazard ($t(184.83)=3.06$, $p<.05$). Differences in the samples' comprehension estimates for the remaining seven symbols were not significant (ps>.05).

Discussion

The major finding of Experiment 1 was that a majority of GHS symbols were not well understood by the study participants. There were clear differences in comprehension estimates between the samples, but these should be interpreted carefully, and in light of a consideration of their similarities and differences. A comparison of the U.S. and Brazilian samples indicated a number of similarities. For example, the mean age in both samples was approximately 40 years of age and both samples contained roughly equal proportions of males and females. However, the two samples differed in ways that may help to explain, at least in part, the observed differences in their comprehension estimates. Specifically, participants in the U.S. sample rated their familiarity with the GHS system significantly higher than their Brazilian counterparts. And as a group, participants in the U.S. sample had attained a significantly higher level of education than their Brazilian counterparts.

These results indicate an urgent need to address deficiencies in the current GHS symbols. In the present study, only four symbols met the ANSI Z535.3 criteria, or relaxed criteria, for correct comprehension (i.e., flammable hazard symbol, acute toxicity hazard, marine pollutant hazard, and environmental hazard) and only one of these, the flammable hazard symbol, met the 85% comprehension criteria in both the U.S. and Brazilian samples. One school of thought has advocated for more and better training to achieve the goal of a shared understanding of the GHS symbols. However, it isn't clear what form the training would take or where the resources would come from to pay for it. Another, better, possibility is to develop and iteratively test new symbols that more clearly convey the intended meanings.

Experiment 2

Method

Participants. Participants were 480 undergraduate volunteers (mean age = 19.5 years; SD = 1.73). Of these, 365 were males (mean age = 19.53; SD = 1.50) and 104 were females (mean age = 19.2; SD = 2.38). Eleven participants did not report their age or sex.

Materials. A fictitious accident scenario was developed in which a construction worker is severely injured when he falls through an acrylic panel used for roofing in a greenhouse. The independent variables of interest—quality of warning (existing, enhanced) and efforts taken (or not taken) by each of the several entities to distribute the manufacturer's safety materials (i.e., installation manual) to the end user (passed the information along vs. did not pass the information along)—were manipulated in a set of "Relevant Facts" that followed the accident scenario. A separate page contained a version of the product warning that was purportedly attached to the acrylic panels.

The content and format of the "existing"—or inferior—warning was based on the warnings that accompany a particular brand of commercially available acrylic panels. The content and format of the second, "enhanced", warning was created specifically for this study and was consistent with ANSI-Z535 (1998) guidelines. In addition to content and format, the enhanced warning differed from the existing warning in several other ways. It was in color and was presented via a three-panel sequence: the first panel depicts the person stepping onto the roofing panel, the second, falling through the panels, and finally, the person lying (injured) on the floor of the greenhouse. The warning text that accompanied the panels clearly states the hazard, the likely consequences and their severity, and what a person needs to do to avoid injury.

Procedure. After completing a consent form, participants were asked to read one of several variants of the fictitious accident scenario described previously. After the participants had read the scenario and viewed one of the two warnings, they were asked to assign blame for the worker's injuries (in percentage terms) to each of four entities (i.e., manufacturer, distributor, the owner of the construction company, the injured person) summing to 100%.

Participants were then asked to fill out a survey that included items asking them about the product, potential risks of working with the product, and items intended as manipulation checks for the independent variables (e.g., the quality of the product warning, the safety practices of the manufacturer, distributor, and construction company owner). Upon completing the survey, participants were debriefed and thanked for their participation.

Design. It is important to note that the independent variables—quality of warning and efforts taken (or not taken) by each of the relevant entities to distribute the manufacturer's safety materials to the end user —were not fully crossed. Rather, we used "breakdown" in the information distribution chain to establish four realistic conditions, as follows: (1) the manufacturer fails to disseminate their safety materials; (2) the distributor receives, but fails to disseminate the manufacturer's safety materials; (3) the owner receives, but fails to disseminate these materials; and (4) no breakdown in dissemination occurs – the manufacturer's safety materials are properly disseminated by all parties. Within each of these four conditions, the manufacturer used either the existing or enhanced warning label.

Our primary interest was in how blame is assigned in each of these conditions. When the manufacturer provides a better warning and each "link" in the information distribution chain does their job, we expected the injured person to receive the most blame. When there is a breakdown in the information distribution chain, we predicted that most blame would be assigned to the party that fails to distribute the safety information to the next link in the chain. We also hypothesized that the quality of the manufacturer's warning label would moderate the effects of failure to disseminate safety materials, such that more blame would be assigned to the culpable party when the manufacturer provides a better warning. The dependent measure was the percentages of blame allocated to each of several entities (and summing to 100%).

Results

Mean blame allocated to the four parties under different warning conditions are presented in Table 2 for each of the four information breakdown conditions.

Insert Table 2 about here

Manufacturer Fails to Disseminate Safety Materials. For this condition, the hypothesized Source (Manufacturer vs. All Others) X Warning interaction contrast was not significant, $F(1, 116) = 1.12$, $p > .20$. Instead, a main effect was found for source of blame: significantly more blame was placed on the manufacturer than the other three sources combined, $F(1,116) = 102.6$, $p < .001$, partial $eta^2 = .47$. Thus, when the manufacturer fails to distribute safety material, it receives significantly more blame than the other parties and providing a better (the enhanced) warning does not mitigate this effect.

Distributor Fails to Disseminate Safety Materials. The hypothesized Source (Distributor vs. All Others) X Warning interaction was significant, $F(1,113) = 10.40$, $p < .002$, partial $eta^2 = .08$. The distributor receives significantly greater blame than the other three parties when it fails to pass on the safety information and the manufacturer provides a better warning label. When the warning used by the manufacture was poor (existing warning), blame is distributed evenly between the manufacturer, distributor, and worker. Post-hoc examination of the simple main effects provides additional insights into blame allocation decisions in this condition. When the manufacturer uses a better warning, blame is significantly higher for the distributor and worker than the manufacturer and owner (Bonferoni-adjusted *p*s < .01). Additionally, the manufacturer receives significantly less blame than the owner ($p < .01$). Thus, when the manufacturer acts safely by providing a better warning and passing its safety materials onto the distributor, but the distributor fails to pass this information on, the manufacturer receives significantly *less* blame than all other parties. However, when the manufacturer uses a poor warning, the owner received significantly lower blame than all other parties, who do not differ from one another (Bonferonni-adjusted *p*s< .01).

Owner Fails to Disseminate Safety Materials. The hypothesized Source X Warning interaction was significant, $F(1,114)=5.19$, $p < .05$, partial $eta^2 = .04$. The owner receives greater blame than the other three parties combined, and this effect is stronger when the manufacturer provides the enhanced warning. However, an examination of the means in Table 2 suggests a different contrast may be more appropriate here: owner and worker vs. manufacturer and distributor X warning type. This contrast was significant, $F(1,114)=79.0$, $p < .001$, and stronger than the hypothesized contrast, partial $eta^2 = .41$. In essence, the owner and worker split the blame when the manufacturer and distributor pass along the safety information and an enhanced warning is in place. Once again, the simple main effects provide additional insight into the importance of an enhanced warning. Providing a better warning and disseminating its safety materials essentially inoculates the manufacturer against blame when the owner failed to pass on the safety information to the injured person. By contrast, when it provides a poor warning, the manufacturer receives the *most* blame, and significantly more than the worker and distributor (ps $< .01$).

All Parties Successfully Disseminate the Safety Materials. Strong support was found for the hypothesized Source (Worker vs. All Others) X Warning interaction contrast when all parties disseminate the information, $F(1,116) = 111.0$, $p < .001$, partial $eta^2 = .49$. When the manufacturer provides an enhanced warning and each "link" of the information distribution chain does their job, 80% of the blame falls on the worker. However, when a poor warning is in place, despite the fact that all "links" distribute the safety materials, blame attributed to the worker falls to 36% and blame attributed to the manufacturer increases by a factor of nine (from 4.2% to 38.8%).

General Discussion

The results of these two experiments highlight two different, but related issues. The results of Experiment 1 underscore the urgent need to address deficiencies in the GHS system, in particular, the set of hazard symbols it advocates to communicate serious health and safety hazards to a global audience. In Experiment 1, only four symbols met the ANSI Z535.3 criteria, or relaxed criteria, for correct comprehension (i.e., flammable hazard symbol, acute toxicity hazard, marine pollutant hazard, and environmental hazard) and only one of these, the flammable hazard symbol, met the 85% comprehension criteria in both the U.S. and Brazilian samples. One school of thought has advocated for more and better training to achieve the goal of a shared understanding of the GHS symbols. However, it isn't clear what form the training would take or where the resources would come from to pay for it. A more realistic approach is to develop and systematically test new symbols that will more clearly convey their intended meanings. Much more work will be needed to develop acceptable alternative pictographs that have high levels of shared meaning among the diverse global audience for which they are intended.

The results of Experiment 2 break new ground by examining a previously ignored factor that may influence how people allocate blame for injuries sustained through the use of consumer products. In this study, we showed that injuries sustained during the use of consumer products are complex events and that there are frequently more actors deserving of blame than merely the product manufacturer and the injured party. The results highlight the fact that manufacturers cannot avoid blame simply by developing effective warnings and other instructional materials. Indeed, our results indicate that efforts of the manufacturer, and other relevant entities, to ensure that these materials reach the end users are equally important. Participants were provided with information about the actions (or non actions) of each "link" in the chain of entities responsible for getting safety information to end users. And when a particular "link" was depicted as having failed in their duty, they were blamed accordingly. If products liability law begins to extend its reach to an international audience, these research findings will become increasingly important to help understand how triers-of-fact (e.g., judges, jurors) make judgments in this complex arena. However, human factors researchers and practitioners are especially well equipped to meet this challenge.

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Table 1. GHS symbol comprehension estimation results. Results are ordered from highest to lowest comprehension scores (from left to right and from top to bottom).

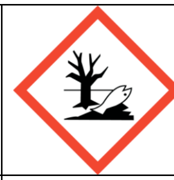
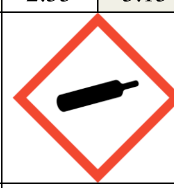
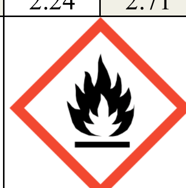
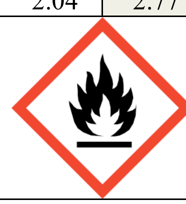
Symbol											
Intended Meaning		Flammables		Acute Toxicity		Marine Pollutant		Environmental Hazard		Corrosive	
		U.S	Brazil	U.S	Brazil	U.S	Brazil	U.S	Brazil	U.S	Brazil
Comprehension Scores	Mean	91.6	65.5	86.6	53.0	85.0	43.7	65.4	46.7	56.7	34.3
	St. Error	0.91	3.40	1.35	4.19	1.55	3.75	2.04	3.68	2.11	3.53
Symbol											
Intended Meaning		Explosives		Acute toxicity		Flammable Liquids		Organic Peroxide		Explosive Divisions	
		U.S	Brazil	U.S	Brazil	U.S	Brazil	U.S	Brazil	U.S	Brazil
Comprehension Scores	Mean	55.5	58.6	51.7	34.7	44.9	42.6	41.4	27.2	35.7	21.5
	St. Error	2.05	3.36	2.27	3.35	2.31	3.66	2.33	3.13	2.06	2.74
Symbol											
Intended Meaning		Flammable Solids		Acute Hazard		Chronic Hazard		Compressed Gas		Carcinogens	
		U.S	Brazil	U.S	Brazil	U.S	Brazil	U.S	Brazil	U.S	Brazil
Comprehension Scores	Mean	35.1	27.4	29.8	19.1	27.9	17.4	25.0	21.5	24.3	31.0
	St. Error	2.13	2.92	2.24	2.71	2.04	2.77	1.69	2.62	1.75	3.02
Symbol											
Intended Meaning		Oxidizing Chemical		Flammable Gases		Pyrophoric Liquid		Oxidizing Liquid/Solid		Reproductive Hazard	
		U.S	Brazil	U.S	Brazil	U.S	Brazil	U.S	Brazil	U.S	Brazil
Comprehension Scores	Mean	23.6	19.8	22.5	28.6	19.3	27.1	18.9	22.4	9.66	14.5
	St. Error	1.54	2.56	1.76	3.46	1.67	3.02	1.58	2.85	1.21	2.76

Table 2. Mean Blame Allocated to Each Source as a Function of Information Distribution Condition and Type of Product Warning.

Information Distribution Condition	Warning Type	% Blame Allocated to:			
		Manufacturer	Distributor	Owner	Worker
Manufacturer Negligent	Enhanced	50.1	12.5	17.4	20.1
	Poor	45.3	14.5	16.7	23.4
Distributor Negligent	Enhanced	4.6	45.5	12.3	37.6
	Poor	27.1	30.1	11.8	30.9
Owner Negligent	Enhanced	6.7	1.9	43.0	47.9
	Poor	37.1	6.4	32.9	23.4
Complete Distribution	Enhanced	4.2	2.8	13.3	79.6
	Poor	38.8	7.0	17.8	36.5