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What you don't know can hurt you: household products and events

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Abstract

Product safety is affected by product design and by the knowledge of the user, either through the user's own background or through instructions and warnings presented with the product. Given adequate knowledge, warnings can serve primarily to remind individuals of the hazards and precautions that can be taken. This study examined people in the USA (represented by two diverse samples) to evaluate their knowledge about the hazards associated with common household products and situations using both multiple choice and open-ended surveys. The results indicated that the respondents were aware of a substantial number of hazards, but their knowledge often did not extend to the specific circumstances that could produce personal injury and property damage. Further, comparisons of cued and non-cued responses suggested some hazards are not well recognized without the cue. The results indicate warnings are needed both as reminders and to provide safety information. © 2000 Elsevier Science Ltd. All rights reserved.

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1. Introduction

This paper is primarily concerned with safety in the home environment. Specifically, it will examine knowledge about hazards often encountered in the home. To the extent that lack of knowledge influences the safety of people it is important to know what they know and don't know about objects and events in their environments in order to provide adequate warnings. Many physical events are not well understood by the general public (cf. McCloskey et al., 1983). Some of these are relevant for understanding the seriousness of hazards and their consequences. Ergonomic development of products commonly used by consumers includes the necessity for users to be informed about hazards associated with those products. Understandably, the extent to which one perceives the risk in a hazard is based on understanding its consequences. Two factors important for safety are the physical characteristics of the products and the extent to which the limitations on use and the hazards associated with the products are recognized by the users. In industrial settings it may be possible to provide safety training regarding hazards of a specific apparatus when it is introduced. Thus, as new and different hazards occur, information about them can be introduced with them and transmitted rapidly, although this may not occur as quickly as it should in some instances. Unfortunately, for products used in the home, formal training in safe use is generally not possible.

Manufacturers may assume that the public at large is aware of the hazards, because those who develop and produce the products are experts who know the general physical principles and how they may produce those hazards. However, the small number of incidents reported may simply reflect the fact that many individuals have been fortunate and did not receive serious injuries when the hazard was experienced. Many reporting systems for injuries (e.g., the National Electronic Injury Surveillance System in the USA) do not include relatively minor events. Some products may become more widely available and potentially increase the number of

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accidents (Godfrey and Laughery, 1984). Further, because of prior use of earlier similar but less hazardous products, later more hazardous products may produce more injuries in the future. Experiences with hazardous materials that have not affected one adversely may reduce the perception of risk (Karnes et al., 1986). As suggested by the data of Wright et al. (1982), concern for reading instructions may be a result of how seriously one views the hazard. In some instances efforts at guarding may prove counterproductive, as in the case of motorized belt systems in automobiles. Because appreciable numbers of drivers do not understand the hazard involved if one fails to use the lap belt when the motorized shoulder belt is in place (Lehto and James, 1997; Leonard and Karnes, 1998), they may be unconcerned with the necessity for making the effort to protect themselves.

It was the specific concern of this research to evaluate people's knowledge about hazards posed by common household products and events rather than the information provided by warnings. If everyone understands a hazard, all that need be done is to provide a warning as a reminder. If the public is unaware of a hazard, additional effort by manufacturers in terms of design, guarding, or warning needs to be expended in order to counteract behavior that might result in injuries. Sometimes the best a manufacturer can do is to warn about a hazard. Incorporating awareness of hazards into the educational process may be possible, as has been done with safety training in the schools, but for hazards of newly developed products or new hazards incorporated in later versions of old products, a safety campaign may need to be mounted to inform those individuals whose school days are well behind them.

Warnings must adequately inform individuals who are not knowledgeable about the topic. Warnings generally include hazard information, information about possible consequences and safety instructions for avoiding those consequences. A problem with many warnings is that they are not well presented (e.g. in small print on the back of the container), and their constant presence can produce habituation even to the reminder function that they might serve. Thus, elimination or mitigation of the hazard by design or guarding is generally the best solution to the problem. Previous research has shown terms used in warnings on common consumer products are not understood by many individuals in the US population (e.g. Leonard et al., 1991; Leonard and Digby, 1992). This lack of understanding has resulted in inappropriate use of products with disastrous consequences in some cases. For example, if one is aware that flammable materials can cause explosions, the term flammable in a warning may influence how, or whether, one uses a product. Lacking this knowledge, misuse may occur, possibly producing injury. For example, Leonard et al. (1997) found considerable misunderstanding of common electrical terms and concepts which could lead to injuries and possibly even death.

Effective warnings include information about activities that might be associated with the hazards. Thus, it is important for the manufacturer to evaluate the possible uses and misuses of the product and determine which hazards need to be warned against. Those hazards would then be described and the appropriate countermeasures presented. Some hazards may be open and obvious to users, while others may be 'hidden' and require explanation and warning. Automobile accidents usually receive publicity if someone is killed or a number of people are injured, and an unusual incident such as a tree falling on a person may also be publicized. However, the ingestion of an overdose of iron tablets by a young child (possibly an unusual event) is unlikely to be reported in the news media, despite the fact the child may need treatment by professionals. A parent who is aware of the possibility of such an event and the danger it presents will be more likely to take appropriate precautions than one who isn't. The hidden or lesser known hazards are most important to warn against. The present research was done to examine people's cognizance about hazards in the home for which there was some question regarding the general public's knowledge, at least in the USA.

In contrast with previous studies that have examined understanding of warnings, this research focused on people's knowledge about certain hazards. Two types of questionnaires were used to examine the ability of relatively untrained people to recognize what possible ill effects might from various actions with several household products and some events that might occur in the home. One questionnaire was in a multiple choice (MC) format and administered in groups, while the other was an open-ended (OE) questionnaire that was administered individually. It was assumed that the cues provided in the MC condition would generate higher recognition of hazards than in the OE condition. A substantial difference between the two might indicate a difference in the extensiveness of the warning required.

2. Methods

A total of 62 students from two geographically widely separated colleges within the USA (Metropolitan State College of Denver in Colorado, MSCD and North Carolina State University, NCSU) completed a survey in the MC format. Of these 25 were men and 39 were women. The ages ranged from 18 to 55, but only 12 were 25 or older. Some respondents received course credit as incentive to participate. Two groups comprising a total of 115 individuals participated in the OE survey. One group completing the OE survey included

Table 1
Percentages of respondents selecting possible consequences

Object or event	Injury or illness possibility	Selecting item (%)
Hair spray	a. Cancer development	11
	b. Respiratory disease	48
	c. Explosive burning	89
	d. Asphyxiation	42
Removing old paint	a. Lead sickness	92
	b. Difficult to repaint	6
	c. Toxic fumes from solvent	84
How to remove paint around children	a. Heating	39
	b. Use of chemicals	27
	c. Chipping and scraping	45
Effect of age on toy purchase	a. Appreciation of toy by child	45
	b. Choking from small parts	97
	c. Sharp edges	90
Food supplements that may poison a child	a. Vitamin C	40
	b. Iron tablets	89
	c. Multi-vitamin/mineral tablets	45
	d. Vitamin B_1	50
Environmental signs of carbon monoxide	a. Flames glow more brightly	16
	b. Pets lethargic	63
	c. May feel drowsy	95
	d. See carbon monoxide vapor	6
Symptoms of carbon monoxide	a. Nausea	85
	b. Dizziness	97
	c. Headache	87
	d. Excitability	0
Indoor use of gas or kerosene heaters	a. Possibility of fire	94
	b. Buildup of carbon monoxide	68
	c. Catch hepatitis	2
	d. Respiratory problems from spill	34
What not to do with gas leak	a. Turn on water	5
	b. Lighting any flame	100
	c. Use any electrical equipment	85
	d. Opening doors	5
What to do if you suspect a gas leak	a. Leave immediately	77
	b. Call gas company and then leave	40
	c. Call gas company and stay	0
	d. Don't worry about it	0
Use of product that says do not use around an open flame	a. Hot but not flaming charcoal grill	73
	b. Gas furnace that is not running	23
	c. Lit cigarette	92
	d. Cigarette lighter with shield	77
	e. Glass-enclosed fireplace	69
What does message 'use in a well ventilated area' mean to you	a. Use only outdoors	26
	b. Use fan while using product	58
	c. Be sure door is open to area	79
	d. Window needs to be cracked open	56
	e. Not in small enclosed space like closet	84

65 students from NCSU. Of these 36 were men and 29 were women. The ages ranged from 18 to 35 years, but very few were older than 23 years. A second group with an additional 50 individuals, 27 women and 23 men, were sampled from the nearby community. Their ages ranged from 21 to 70 years with a median of 32.5 years. The community group were roughly comparable to the student population in intellectual capabilities as indicated by the fact that 25 of them indicated they had degrees and an additional 15 stated they had from one to three years of college training. They were recruited at a flea market and received small prizes for their participation. An attempt was made to avoid overweighting the samples with persons having technical jobs. Most were employed in business capacities.

The survey forms were similar in terms of the questions, but the MC forms included several possible responses for the items. Each item consisted of a short sentence describing the hazardous object or event with descriptions of a hazard or hazards associated with it as well as some hazards not related to it in most items. The respondents were instructed to check all items they thought were correct and were allowed to select as many of them as they wished. Abbreviated versions of the items and possible responses are included in Table 1. In the OE group the survey form did not include any possible responses, but participants were asked to give their ideas about the items. Each item consisted of a short question about an object or event that has hazards associated with it. In general, the items examined

dealt with problems of home activities that are relatively common. Each participant was presented with one of the safety surveys containing 23 items. The items shown in abbreviated form in Table 1 were interspersed with additional items regarding electrical hazards which have been reported elsewhere (Leonard et al., 1997).

3. Results and discussion

As shown in Table 1, the level of understanding varies among topics. To simplify matters we have presented the data in content categories related to the understanding involved. The topics will be considered in their order in the table. The presentation order in the original survey was somewhat different in order to obviate possible effects of juxtaposition of similar items. One concern about the procedure was that because of usual test procedures individuals might select only one of the possible hazards despite the instructions allowing them to select more than one. The response percentages displayed in Table 1 indicate this fear was unfounded. Only the items involving gas leaks and paint removal produced minimal responding, and for both of those items the respondents could have considered some of those responses to be mutually exclusive.

It appears that most of the respondents to the MC form were aware of the explosiveness of hair sprays in that 89% selected that hazard. However, the percentages associated with some of the other responses may suggest a bit of a positive response bias. For example, asphyxiation was listed by 42% of the respondents. Further, without the cue only 65% of the respondents provided a response of flammability. The difference between cued and non-cued percentages were found to be significant at $P < 0.001$ by the chi-squared test of independence. All differences between the OE and MC conditions described in these results as significant reached that probability level. The percentages of responses provided by the different subgroups on the OE questions are provided in Table 2. It should be noted that responses to the MC items were tied to the terms used in the survey form, while responses to the OE questions were stated in the words used by the respondents. Thus, as seen in Table 2 the respondents tended to use the word flammability. These data do not allow determination of whether or not use of the term explosiveness by the MC respondents was influenced by its presence on the form.

The possibility of lead poisoning from paints was recognized by 92% of the MC group, although again the percentage of those making the response was significantly less (70%) when no cue was provided. However, fact that 45% would adopt the technique of chipping and scraping off the old paint as the solution to its removal suggests that they may not recognize that young children might ingest the resulting chips. It is also possible that some respondents thought that they were required to make some response to each item and considered this to be the best alternative. This possibility is considered because relatively fewer multiple responses were made to this item than to most of the others. Because there was almost universal recognition (97%) that small children can choke on small toys, one can assume the respondents recognized that young children often put things in their mouths. However, the connection between ingestion of paint chips and lead sickness may not have been made. The problem of recognizing that an object may have the characteristic that is hazardous is also seen in the responses to the items regarding food supplements and use of products around an open flame. Clearly, a very high percentage (90%) of individuals can recognize iron tablets pose a danger of overdose among young children, but the possibility that a multiple vitamin and mineral tablet might contain iron is not considered by many people. Only about half as many (45%) respondents selected that particular response. The effect of cues on responses is perhaps most evident in responses to this item. Only 26% of the respondents in the OE condition spontaneously mentioned iron tablets as dangerous.

While awareness of symptoms of carbon monoxide (CO) was high among those in the MC condition with 95% selecting drowsiness as a symptom, only 12% in the OE condition responded in terms of physical symptoms. Only 68% recognized that using a gas or kerosene heater indoors could produce CO buildup. Again there was a substantial difference as a function of cue availability with only one-third of the respondents in the OE condition mentioning the CO hazard in conjunction with using a grill indoors. In a similar fashion there was universal awareness that one should not light a flame if a gas leak exists, and 85% responded that one should not use electrical appliances. Again significantly fewer respondents in the OE condition (only 21%) who mentioned using electrical equipment. Moreover, in the MC condition 40% chose the option of calling the gas company and then leaving the house. In the OE condition a similar percentage (47%) indicated that they would call an authority. A logical inference is that many people do not recognize the possibility of spark production by the telephone.

Many products warn against their use around an open flame. However, the concept of an open flame is apparently quite varied in the thinking of these respondents, as shown by the percentages of individuals not responding to many of the options in the MC question. The small percentage that recognized pilot lights on furnaces suggests warnings about open flames may not

be adequate without some description of what is meant. While this specific problem is being partially ameliorated by the replacement of pilot lights by igniters in newer furnaces, many older pilot lit furnaces will continue to be used for years to come. More troublesome is the possibility that in moderately cool weather a furnace may be cycling on aperiodically with extended off periods, thus providing a source of ignition for any explosive gasses. In such circumstances one may be unaware of the furnace's operation. The fact that only 69% indicated that they would consider a glass enclosed fireplace to be an open flame suggests that some people consider only the fire moving out rather than the vapors moving into the flames. Therefore, it appears warnings concerning the use of highly flammable and explosive materials will not be adequate if they include only a statement to avoid open flames.

From both a safety standpoint and from the standpoint of efficiency of use the presentation of warnings or instructions in vague terms has plagued the consumer. In an effort to evaluate whether or not people in general are likely to interpret vague instructions in the same way the respondents were asked to indicate what, 'Use in a well ventilated area', meant to them. As seen in Table 1 the responses were very variable. Somewhat surprisingly only 84% checked the choice of not using the substance in a closet. Although instructions regarding cubic feet per minute of airflow would likely be no more instructive to the average user than 'well ventilated', it should be possible to provide some sort of benchmarks for size of the area and possible ventilating techniques that would be less vague.

4. Conclusions

If a hazard is well understood by the general public, its consequences also might be expected to be understood. In such cases instructions are not necessary, but the results obtained in this study indicate warnings may be necessary to remind users of the hazards. The importance of warnings as reminders, even if not necessary as information providers, is clear from the differences between the MC and OE conditions. The cues provided by the alternative responses given in the MC condition produced substantially more appropriate responses

Table 2
Number of respondents specifying possible consequences

Object or event	Consequence	Number listing				Percent listing
		Student		Non-student		
		F	M	F	M	
Hair spray	Flammability	14	22	16	16	65
	Eye irritation	6	6	5	3	19
Removing old paint	Lead sickness	15	21	20	17	70
Effect of age on toy purchase	Choking on parts	25	26	18	11	76
	Other safety factor	4	5	3	3	14
	Age appropriateness	2	6	4	5	16
Food supplements that may poison child	Iron tablets	7	7	9	4	26
	Vitamin	1	2	5	2	10
	Vitamin C	5	4	1	3	12
	Other	14	13	5	6	36
Detection of carbon monoxide	Use detector	15	21	15	17	65
	Odor	5	5	4	3	16
	Physical symptoms	5	5	2	1	12
Symptoms of carbon monoxide	Nausea	10	11	8	6	33
	Lightheaded, dizzy	11	15	9	7	40
	Headache	3	3	5	4	14
Indoor use of grill	Fire	21	31	21	20	89
	Smoke	19	26	10	10	62
	Carbon monoxide	1	12	11	11	33
What not to do with gas leak	Lighting any flame	14	28	17	13	69
	Use electrical equip.	5	6	5	6	21
	Use telephone	0	0	0	3	3
What to do if suspect a gas leak	Leave immediately	12	14	12	10	46
	Call authority	16	14	13	6	47

than were obtained without the cues. Of course, it is possible that the warnings may simply not be noticed. Prior research on label preferences in the senior author's laboratory indicated this is often the case. The present studies were designed only to determine understanding of the problem. Other research is necessary to evaluate how warnings in some of these cases can be accomplished effectively. Presumably, if warnings are simply reminders the amount of information presented could be limited, but in the cases where understanding is generally poor, more information about avoiding the consequences would be included.

The results indicate that the US public, at least as represented in these samples, is aware of many hazards, but that awareness does not necessarily translate into understanding the sorts of actions necessary to avoid the hazards. This is particularly true when more than one sort of knowledge is required to obviate a hazard. The knowledge that an electric spark can set off a gas explosion may be negated if one is unaware that a telephone connection is electrical. The responses to questions dealing with CO are very revealing in terms of how lack of specific knowledge can place one at risk. Although there were other questions in the survey about CO, only 68% of the respondents in the MC condition recognized it as a potential threat from indoor combustion, and only 30% noted it when no cue was provided.

Generalization of these results is difficult to evaluate. Because college students and others who were primarily college educated were used, we can assume our sample to be better educated and perhaps more able to recognize problems and combine separate components than the population at large. The relatively skewed distribution of ages, however, suggests that the life experiences may be less extensive. Owing to the relatively small number of older respondents, no statistical analysis of differences was attempted, but examination of the raw data suggested that differences between older and younger subjects were minimal. There were also few, if any, differences between the samples from North Carolina and from Colorado. It might be expected that some knowledge, for example, about chemicals would be better understood by well educated individuals, and other knowledge might be likely to be accrued with age. Determination of this will take more extensive research. In any case, it is a fact that younger people and poorly educated people do use the products and engage in the activities considered in this survey and may be placed in situations where gas leaks and CO buildup can occur. Thus, it is important to provide them with appropriate information. Sometimes the best a manufacturer can do is to warn about a hazard. In some cases the information may be adequately presented by on product instructions, but in others an educational effort may be needed, such as has been done with other safety training in the schools.

Although the percentages obtained in this survey are sample values, the upper end of a 99.9% confidence interval for an appropriate response made 70% of the time would be approximately 90%. Thus, in a country of 250 million people, such as the USA, it is likely that at least 25 million people would be at risk. If a similar percentage of the European population follows the pattern, the individuals at risk would be more than doubled. Obviously, these problems are matters of concern. Manufacturers of products involving new hazards or new forms of older hazards should be encouraged to inform their clientele because of safety factors. It would also be important from a business standpoint to avoid the publicity that might discourage sale of products that would be safe if used appropriately. Safety campaigns may need to be mounted to aid in dealing with hazards of newly developed products. Further research is needed to determine what sorts of information and educational procedures will be most effective in bringing the hazard to the attention of the public and in providing adequate understanding of the characteristics of the hazard.

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