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The Matching Game: Educating Children about Household Hazards and Warning Symbols

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Abstract

Because young children lack reading skills, traditional text-based warnings can be rendered ineffective. Pictorials might be an alternative for text to conveying safety-related information. Surprisingly, very little research has been conducted to explore the comprehensibility of safety symbols by young children. In the current study, 15 young children, aged 3-6 years ($M = 4.7$ years, $SD = 1.2$) were asked to: (a) identify the hazards associated with five common household items, (b) interpret the meaning of five associated warning symbols, and then (c) play a matching game where household items were paired with appropriate warning symbols. Results indicated that successful hazard identification varied considerably between household items. All children were able to identify the fall or crush hazard associated with an open window but almost none of them identified the strangulation hazard associated with window-blind cords. When symbol comprehensibility was initially assessed, fewer than half exceeded 50% correct identification but training provided by the experimenter benefited the children in understanding their meaning. Performance on the matching game illustrated that children were able to successfully acquire the safety information after being provided with definitions of the symbols and were able to pair them with the appropriate household items.

Keywords: Children, warnings, risk communications

1. Introduction

The National Electronic Injury Surveillance System (NEISS) has indicated that approximately 1,051,354 young children aged 3-6 years were hospitalized for injuries received in the home during 2004 in the US [1]. Annually, US hospital emergency rooms treat an estimated 4.3 million children for product-related injuries [2]. Leading causes of injury-

related deaths in the home for this age group include drowning which might occur in bathtubs or swimming pools, exposure to poisons such as household cleaning solutions or medications, and burns associated with residential heat sources such as electrical outlets, ovens, and fireplaces [3]. Given the documented prevalence of injury to this segment of the population, US government and health service organizations are increasingly recommending that healthcare providers

such as pediatricians and family practitioners provide routine, age-appropriate counseling to their patients [4,5].

While the need for increased safety education for children is apparent, it is essential that the content of “age-appropriate counseling” be designed following a thorough analysis of the capabilities and limitations of this population. Specifically, young children possess a number of attributes such as their curious nature, physically small stature, limited coordination, and immature cognitive abilities that place them at heightened risk for injury-related death [3].

Examination of the warnings literature [6,7] reveals a distinct paucity of research on warnings that target young children. As very young children are not yet able to read, the effectiveness of traditional text-based warnings is very limited. Although some research describes the development of pictorial warnings for child-care products such as high chairs and car seats [8], these warnings are designed for use by adults overseeing the care of children, not the children themselves. However, evidence from the developmental psychology research literature indicates that preliterate young children over the age of 2.5 years can grasp the relationship between symbols and concepts [9]. One well-documented approach to conveying safety information to those who cannot read a particular language is to use safety symbols [10]. The current research is an attempt to fill a fairly large gap in the ergonomics literature on children’s safety and warnings by investigating the design of safety symbols for young children aged 3-6 years. Of particular interest in the current study is whether (or not) young children can (a) identify the hazards associated with five common household items, (b) interpret the meaning of five symbols associated with the household items, and then (c) match household items with the appropriate symbols. To address these questions in the current study, a procedure was designed to mimic a common matching game such that learning household safety information would be fun and engaging for the children.

2. Method

2.1 Participants

Fifteen young children, aged 3-6 years ($M = 4.7$ years, $SD = 1.2$) were recruited through a local daycare center in the Raleigh-Durham area of North Carolina.

The sample was relatively balanced for gender with 8 males and 7 females participating. The ethnicity of the sample was composed of 10 (67%) Caucasians, 2 (13%) African-Americans, and 3 (20%) Asians. All children spoke English as their primary language.



Figure 1: Example of a Household Item

2.2 Stimulus materials and procedure

Following informed consent and completion of demographic items, participants completed an individually-administered structured interview that lasted approximately 35 minutes. Interview procedures were conducted on site at the daycare center where participants were recruited. Interviews were guided by a structured script that was composed of three sections. In the first section, children were shown five color pictures of household products one at a time. The products were chosen because they represented household hazards that according to the US Consumer Product Safety Commission [1] are likely to cause injury to young children. Household objects included doors, stairs, televisions, irons, windows, fireplaces, electrical plugs, bathtubs, window blinds, and cleaning materials (i.e., Clorox Bleach). Each child saw only five items and presentation was randomized to control for order effects.

For each picture, participants were asked two questions: “What do you see in this picture?” and “How could this object hurt you?” Children who did not understand how objects could cause harm were informed about the hazard. For instance, a child who

stated that an oven as depicted in Figure 1 could not hurt him/her was given feedback that “you can burn yourself if you touch it.”

In the second section, a total of six warning symbols were evaluated because generic symbols such as those that depict a burn hazard could appear on multiple household items such as ovens, irons, or a fireplace. Hazard symbols were chosen from commercially available ANSI-type symbols might be found to appear on the household products. For each symbol, participants were asked “What do you think this means?” If the child’s interpretation of the symbol was judged to be incorrect, he/she was told the correct meaning. For example, a child who could not identify a “hot and burning” symbol as depicted in Figure 2 was told that “this safety picture means that you could burn yourself.”



Figure 2: Example of Warning Symbol

Lastly, the children were told to play a matching game where they had to pair objects that they had seen previously with safety pictures [warning symbols] that illustrated how the object might hurt them. Initially, children were provided with the following example:

Here is an oven. How might the oven hurt you? Yes, an oven can burn you if you touch it with your hand. Here is a safety picture that you might find on the oven. So, you should match this safety picture with the oven.

Following the example, the children played the matching game with the five objects and safety symbols that they had previously encountered. Participants were directed to consider only one household object at a time. One household object was placed on the table alongside the hazard symbols to avoid distraction. Once the matching game procedure was completed, the children were thanked, encouraged to ask any questions that they had, and were excused.

3. Results

3.1 Inter-rater reliability

The open-ended responses to the (a) identification of hazards associated with household products, and (c) item-symbol matching sections of the procedure were recorded and subsequently scored as “2” completely correct, “1” partially correct, or “0” incorrect. As the symbols presented for interpretation were ANSI-type, the lenient scoring criteria recommended by this organization were used to score the current symbol comprehension data [11]. Correct symbol interpretations were scored as “1” and incorrect responses were scored as “0.” The percentage agreement between coders was calculated to determine the inter-rater reliability of the scoring procedure for all portions of the data. The percentage agreement between coders was 89.3 percent indicating the coding scheme used to score the responses was sufficiently defined to allow reasonably consistent scoring.

3.2 Identifying household hazards

In only two instances in all of the responses across children did the participants fail to correctly identify the pictures of a household item. In both instances, a television was incorrectly identified as a computer and the child was informed of the error before being asked to identify the hazard associated with the product.

Examination of the participants’ responses indicated that successful hazard identification varied considerably between household items. Mean scores ranged from “2” for windows to “.44” for window blinds. Table 1 represents the mean hazard identification score for each household item. These data can be interpreted as indicating that virtually all children were able to identify the fall or crush hazard associated with an open window. By contrast,

children's ability to identify the strangulation hazard associated with window-blind cords was much lower.

Table 1.
Mean Hazard Identification (and standard deviations) as a Function of Household Item

Household item	Mean (SD)
Fireplace	1.33 (1.0)
Window	2.00 (0.0)
Electrical Plug	0.67 (1.0)
Bathtub	1.33 (1.0)
Clorox	0.50 (.84)
Door	1.63 (.74)
Window Blinds	0.44 (.88)
Iron	1.56 (.88)
Television	0.67 (.87)
Stairs	1.56 (.53)

3.3. Symbol interpretation

When asked to give the meaning of symbols, participants provided an open-ended response. Table 2 illustrates the mean interpretation scores for each symbol. From these data it is apparent that more than half of the symbols failed to exceed correct interpretation rates of 50% when children initially tried to discern their meanings. Collectively, these data illustrate the relative inability of young children to identify the meaning of safety symbols. After the symbol interpretation task, the experimenter provided some training by explaining the correct meaning of each symbol in an effort to illustrate the nature of potential household hazards.

Table 2.
Mean Interpretation Scores for each Symbol

Symbol	Mean (SD)
Burn	0.60 (.51)
Crush	0.14 (.36)
Electrical Shock	0.50 (.55)
Fall	0.22 (.44)
Poison	0.50 (.55)
Slip	0.80 (.41)

3.4 Providing training via the Matching Game procedure

Results revealed that the children could effectively

pair household items with warning symbols. Because the symbol illustrating the strangulation hazard associated with window blinds was considered too graphic for inclusion in the study, only nine item-symbol pairings were evaluated. Table 3 illustrates the mean matching performance for each item symbol pairing. Given the relatively high accuracy scores obtained for each of the household item-symbol pairings, it appears that young children can benefit from safety training that uses warning symbols and matching procedures.

Table 3.
Mean Item-Symbol Pairing Performance

Item	Symbol	Mean (SD)
Fireplace	Burn	2.00 (0.0)
Window	Crush	2.00 (0.0)
Electrical Plug	Shock	2.00 (0.0)
Bathtub	Fall	2.00 (0.0)
Clorox	Poison	1.83 (.41)
Door	Crush	1.44 (.88)
Iron	Burn	1.44 (.88)
Television	Fall	1.78 (.67)
Stairs	Slip	1.56 (.73)

4. Discussion

The data from this study extend previous ergonomic research efforts that have explored the uses of pictorial safety symbols. By investigating the abilities of young children aged 3-6 years, a number of findings emerged. First, children's performance when asked to identify product-specific household hazards was highly variable such that virtually all of the children could identify some hazards but others were rarely, if ever identified. Second, fewer than half of the warning symbols were correctly interpreted more than 50% of the time when the children initially encountered them. Given this initial low level of symbol interpretation, the experimenter intervened and provided training by explaining the correct meaning of each symbol. Lastly, children were successful at matching hazardous items with warning symbols after a single limited explanation from the experimenter. The engaging atmosphere of the matching game procedure might be adopted by other researchers to further explore how young children can be educated about household hazards.

While these results are suggestive of the potential benefits of using warning symbols to enhance the safety education of young children, a number of procedural limitations are present and should be addressed. This study used a small sample; thus, the present findings must be interpreted with caution. Replication and larger sample sizes should enhance the reliability of these findings. Also, conducting the research in the naturalistic setting of the daycare center might be interpreted by some as detracting from experimental control however, it should be noted that data collection might have been more difficult without the reassurance of the children's teachers who assisted in establishing rapport between the experimenter and the participants. Furthermore, the difficulties associated with recruitment and testing of such a population need to be addressed. Specifically, the design of procedures and educational content is constrained by the cognitive abilities of the participants. For instance, young children often have difficulty maintaining focused attention and are particularly susceptible to distraction by extraneous factors [12]. The extent of these age-related trends could not be investigated in the current study given the small sample size, yet future efforts might experimentally determine whether the youngest age groups (3 year olds) had different responses from the older groups (6 year olds). A related question is "How old does a child have to be to take advantage of the match game procedure?" This answer to this question would be better addressed by studies with larger sample sizes.

Regardless of age, the current findings indicate the necessity of making training materials engaging in terms of content, relatively brief in terms of time to complete an activity, and that children be able to interact with the content materials in a playful manner. Other important issues are: (a) whether it is good to become playfully familiar with hazards and (b) whether there is some dilution of safety content when it is transmitted via a game.

In conclusion, this initial examination of young children's abilities to grasp safety concepts conveyed by warning pictorials should illustrate the need for further research in the area. It is hoped that the current data will be of use to researchers and practitioners alike in developing educational programs designed to protect the well-being of young children.

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References

- [1] Consumer Product Safety Commission (2006). *National Electronic Injury Surveillance System (NEISS)*. Available at <http://www.cpsc.gov/library/neiss.html>.
- [2] Consumer Product Safety Review (1998). *Preventing children's injuries*. Washington, DC: US Government Printing Office.
- [3] National Center for Injury Prevention and Control (2001). *Injury fact book 2001-2002*. Washington, DC: US Government Printing Office.
- [4] Public Health Service (1990). *Healthy people 2000: National health promotion and disease prevention objectives*. DHHS publication No. 91-50213. Washington, DC: US Department of Health and Human Services.
- [5] Quinlan, K. P., Sacks, J. J., & Kresnow, M. J. (1998). Exposure to and compliance with pediatric injury prevention counseling—United States, 1994. *Pediatrics*, 102(5), 55-58.
- [6] Wogalter, M. S. (2006) *Handbook of warnings*. Mahwah, NJ: Erlbaum Associates.
- [7] Wogalter, M. S., Dejoy, D. M., & Laughery, K. R. (1999). *Warnings and risk communication*. London: Taylor and Francis.
- [8] Trommelen, M., & Akerboom, S. P. (1999). Explicit warnings for child-care products. In H. J. G. Zwaga, T. Boersema, & Hoonhout, H. C. M. (Eds.), *Visual information for everyday use: Design and research perspectives*. London: Taylor and Francis.
- [9] Deloache, J. S., Uttal, D. H., & Pierroutsakos, S. L. (1998). The development of early symbolization: educational implications. *Learning and Instruction*, 8 (4), 325-339.
- [10] Mayhorn, C. B., Wogalter, M. S., & Bell, J.L. (2004). Are we ready?: Misunderstanding homeland security safety symbols. *Ergonomics in Design*, 12 (4), 6-14.
- [11] National Electrical Manufacturers Association. (2002). *Criteria for safety symbols* (American National Standards Institute Z535.3-Revised). Rosslyn, VA: Author.
- [12] Bjorklund, D. F. (1995). *Children's thinking (2nd Edition)*. New York, NY: Brooks/Cole.