Evaluating Choking Child Pictorial Symbols

Michael J. Kalsher
Department of PP&CS
Rensselaer Polytechnic Institute
Troy, NY 12180

Kimberly A. Brantley
Michael S. Wogalter
Department of Psychology
North Carolina State University
Raleigh, NC 27695

Jennifer Snow-Wolff
The Creative Factor
El Cerrito, CA 94530

Abstract

Two experiments evaluated pictorial symbols intended to warn consumers of a child choking hazard. In Experiment 1, participants used the Zwaga (1989) comprehension estimation procedure to estimate the percentage of the U.S. population they felt would understand the intended meaning of 15 symbols designed to depict a choking hazard. For the symbol with the highest comprehension estimate, participants indicated that 74% of the population would correctly interpret the intended meaning: choking. All of the top-rated symbols contained similar combinations of features, including crossed hands, a protruding tongue, and a frontal face orientation. But interestingly, symbols with lower comprehension estimates also contained a different set of similar features. In Experiment 2, small groups of participants constructed multiple panel choking hazard symbols from the set of 15 symbols in the first experiment. As in the first experiment, there was a high degree of consistency among participants' responses. Unexpectedly, the first and last symbols selected for this three-panel sequence were among symbols that received the lowest comprehension estimates in the first experiment. These findings seem to confirm that symbol comprehensibility can be influenced by context. Implications of this study for future research are discussed.

Introduction

Well-designed pictorial symbols may enhance product warnings by communicating hazards to consumers with varied educational and cultural backgrounds. They offer many advantages over verbal messages, as they are compact, salient, and multidimensional (Dewar, 1994). Sojourner and Wogalter (1997) showed that pictorial symbols are especially valuable when combined with verbal warnings and instructions. While good pictorial symbols may contribute to the effectiveness of a warning, poorly designed symbols may result in dangerous comprehension errors. This concern is often associated with pictorial representations of abstract or complex referents. In order to produce effective pictorial symbols, they must be designed and tested iteratively until an acceptable level of comprehension is reached.

Comprehension is the most important measure of a symbol's effectiveness. A variety of comprehension test methods exist (ANSI, 1998; Brugger, 1994; Dewar, 1994; Silver, Wogalter, Brewster, Glover, Murray, Tillotson, & Temple, 1995; Wolff & Wogalter, 1998; Zwaga, 1989; Brantley & Wogalter, 1999). Typically, comprehension test procedures include multiple-choice or open-ended written techniques. However, there are costs and limitations associated with these procedures. For example, multiple-choice tests lack ecological validity and inappropriately inflate comprehension scores (Wolff & Wogalter, 1993) and open-ended tests are time consuming and difficult to score. Brantley and Wogalter (1999) found that the traditional open-ended technique combined with probing elicited more complete responses from participants. While this procedure may make scoring easier, open-ended testing is still a time consuming and costly process.

The American National Standard Institute (1998) Z-535 standard recommends both open-ended testing and comprehension estimation. The comprehension estimation procedure attempts to identify symbols that are likely to be rejected in more expensive, comprehensive open-ended testing. In comprehension estimation, participants estimate the percentage of the population that would understand a pictorial symbol (Brugger, 1994; Zwaga, 1989). In addition to reducing the cost of testing and retesting poor symbols, comprehension estimation is an effective method of selecting a symbol for further development and testing from a set of alternative symbols.

While most research on pictorial symbols addresses comprehension testing, there has been less research on effective pictorial symbol design. Usually, pictorial symbols are presented individually. However, complex information, such as the passage of time, non-visible processes, and abstract concepts may not be amenable to such simple representations. Individual symbols may not provide enough information to facilitate comprehension or fully communicate hazard and consequence information. Part of this can be aided by additional symbols providing context.

Communication of concepts may be improved by presenting them in a multiple panel pictorial format. When information is sequentially organized into panels, abstract concepts such as time may be more clearly represented. Additionally, the multiple panels provide an opportunity to include contextual information, as well as add hazard, consequence, and instructional information, part of which an individual symbol may lack.

The objective of the current set of experiments was to establish a pictorial warning for the choking hazard associated with marshmallows. Previous research by Kalsher, Wogalter, and Williams (1999) indicated that people do not perceive eating marshmallows to be hazardous, despite the fact that many children either die through suffocation, or are permanently injured after choking on them, or related types of food. In Experiment 1, participants used the comprehension estimation procedure to determine the probability that each of 15 pictorial symbols would accurately depict the choking hazard. In Experiment 2, small groups of participants constructed multiple panel choking hazard symbols from the set of 15 symbols in the first experiment.

Experiment 1

Method

Participants. One hundred forty-nine Rensselaer Polytechnic Institute undergraduates volunteered to participate in the study.

Materials. Each participant received a sheet of paper containing the 15 pictorial symbols presented in Figure 1. These symbols were designed specifically to depict a child choking. The initial impetus for the project began with civil litigation involving cases in which children died or were critically injured after choking on food or some other object (e.g., a toy). Over time, the original set of pictorials was altered to incorporate features suggested by the participants in preliminary iterative testing. All symbols included a face and hands. However, they varied according to other features such as orientation (frontal vs. profile), the number of hands (one or both), hand position (hand near or clutching the throat versus raised and apart to depict surprise or alarm), the presence (or absence) of a protruding tongue, the presence (or absence) of a cross-sectional view of the windpipe, and the shape and expression of the eyes—open wide in surprise, or crossed out (X X) to depict unconsciousness or death.

Procedure. Participants were each given a sheet of paper containing a random ordering of the 15 symbols and the following instructions that were based on a previous study adapted from Zwaga (1989):

"The pictorials on the page before you were developed to accompany consumer products that present choking hazards to children (e.g., certain types of foods or small toys). The international symbol for choking is located in the upper right-hand corner of the page. Next to each of the pictorials, please write the percentage of the U.S. population that you feel would understand the intended meaning of each symbol."

Participants were asked to write their responses directly on the sheet of symbols.

Results

The mean percentage estimation and standard deviations (SD) are shown in Figure 1. The symbols are shown in descending order down the page. Symbol 1, a frontal view of a wide-eyed child with a protruding tongue and both hands clutching the throat, received the highest comprehension estimate. Symbol 15, a frontal view of a wide-eyed child with hands held up and apart (presumably to depict surprise or alarm) received the lowest comprehension estimate. Participants' responses were quite consistent across the symbols evaluated. For instance, the top-rated symbols contained similar combinations of features, such as crossed hands, protruding tongue, and a frontal face orientation. Also, most of the symbols with *lower* comprehension estimates also consistently included similar features, such as either one hand placed on the child's throat or hands held apart, profile face orientation, and esophageal occlusion (e.g., marshmallow). Standard deviations among all the symbols were high, but constrained within a relatively narrow range (21% to 29%).

Experiment 2

Experiment 1 revealed a clear difference in comprehension among the 15 pictorials tested. Experiment 2 was designed to investigate whether comprehensibility of the pictorials predicted how participants would construct multiple panel warnings designed to depict a choking episode.

Method

Participants. Fifty-two undergraduates from Rensselaer Polytechnic Institute served as participants. There were 41 males and 11 females (M = 18.2 years old). They formed 10 groups, with four to six participants in each group. None of the participants in Experiment 2 had taken part in first experiment.

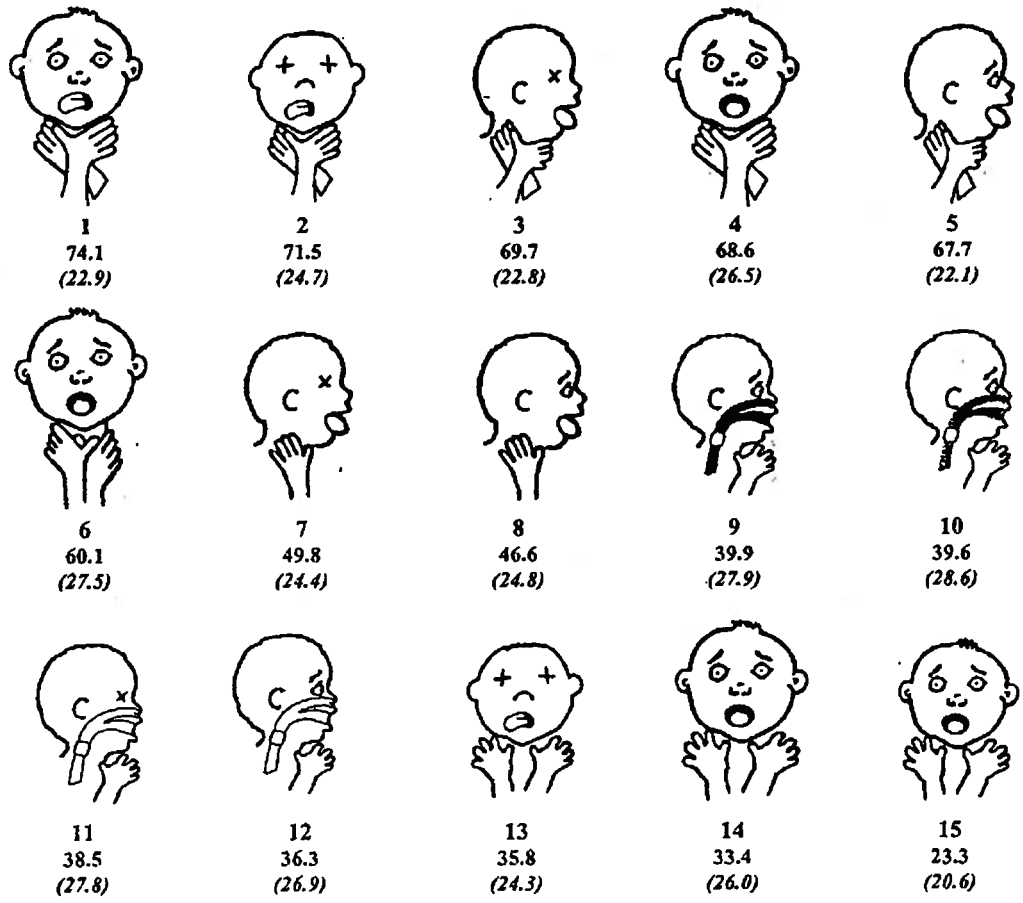

Figure 1. The 15 Choking Symbols Tested in Experiment 1. The Symbol Number, Mean Comprehension Estimate, and Standard Deviations, Are Presented Below Each Symbol.

Materials. The 15 choking symbols described in Experiment 1 were mounted on separate 3 x 3 inch (7.6 x 7.6 cm) pieces of card stock. Each group of participants received a set of the symbol cards and a response sheet containing written instructions. The order of the cards within each set was randomized.

Procedure. Half of the groups were told that the symbols were designed to depict a person choking on food; the other groups were told that the symbols were designed to depict a person choking on marshmallows. They were instructed to arrange three of the pictorials into a sequence, or multiple panel pictorial, that best illustrates a complete choking episode. Additionally, they indicated which individual symbol best depicts a choking hazard. Finally, they indicated why they selected the three symbols for the sequence. Groups were asked to reach consensus for all responses. Participants' explanations and response frequency were analyzed.

Results

As in the first experiment, there was a high degree of consistency among participants' responses. Symbols 4 and 1 (refer to Figure 1) were most frequently selected as the best depictions of a choking hazard (four and three votes, respectively). This supports findings from the first experiment, in which symbol 1 received the highest comprehension estimate. Additionally, symbol 4 was repre-

[illegible] commented that the second symbol indicates distress and it shows crossed hands, which participants identified as the universal sign for choking. A pair [illegible]

[illegible] cedure and to complete a specific cost-benefit analysis of various comprehension test methods.

... 10 multiple panel symbols developed by the groups and symbol 1 was represented in four of them.

It is interesting to note that the first and last symbols selected for the multi-panel sequence were among symbols that received the *lowest* comprehension estimates in the first experiment (39.9% and 36.0%, respectively). This finding suggests that participants felt these pictorials were useful despite the fact these pictorials received low comprehensibility estimates in the first experiment.

Nine of the 10 groups reported that they constructed their multiple panel pictorials according to an order of events over time associated with choking. For example, the first symbol shows a marshmallow lodged in the victim's throat. Seven of the groups selected this referent for the first symbol in their sequences. Participants commented that the second symbol indicates distress and it shows crossed hands, which participants identified as the universal sign for choking. Again, these features were present in the second symbol selected by seven of the groups. Finally, participants suggested that features in the last symbol, such as limp or uncrossed hands and the crossed representation of eyes, convey loss of consciousness or death. Six of the groups placed a symbol with these features last in their sequences.

General Discussion

The results of this study suggest that comprehension estimation is a useful method of comparing the comprehensibility of variations of one referent. First, it provides information about which symbol features are associated with higher perceived comprehensibility. Such information is valuable in making design decisions and it demonstrates the relationship between symbol design and comprehension testing. Additionally, comprehension estimation provides a cost-effective basis for selecting a symbol, from a set of alternatives, for further development and testing. While comprehension estimation also serves to reject symbols that are *not* likely to pass in further testing, it is important to note that symbols that receive low comprehension estimates may be enhanced when included in a multiple panel pictorial. In the present study, symbols that were likely to be poorly understood alone conveyed important contextual information when presented in a sequence. This may actually be more cost-effective than redesigning and retesting a symbol.

This study also suggests that a logical multiple panel pictorial includes both hazard and consequence information, and conveys the progression of events over time. Multiple panel pictorials have the capacity to contain more contextual details and potentially more risk information than individual symbols. These qualities may reduce comprehension errors and increase confidence in using pictorial warnings on consumer products. However, the additional details may be associated with an information processing burden. Further studies are necessary to compare individual symbols and multiple panel pictorials, as well as establish guidelines for the design of multiple panel pictorials.

The use of the comprehension estimation procedure and "user" involvement in the development of a multiple panel pictorial served to identify consumers' mental model of a hazardous event and the pictorial features that are salient to this event. This approach early in symbol development may ultimately reduce cost and time associated with iterative design and testing. More research is necessary to validate the comprehension estimation procedure and to complete a specific cost-benefit analysis of various comprehension test methods.

References

American National Standard Institute. (1998). *ANSI 535.3-1998: Criteria for safety symbols.* Washington, DC: National Electrical Manufacturers Association.

Brantley, K.A. & Wogalter, M.S. (1999). Oral and written symbol comprehension testing: The benefit of cognitive interview probing. *Proceedings of the Human Factors and Ergonomics Society, 43,* 1060-1064.

Brugger, C. (1994). Public information symbols: A comparison of ISO testing procedures. *Proceedings of Public Graphics.* Lunteren: 26.1-26.11.

Dewar, R. (1994). Design and evaluation of graphic symbols. *Proceedings of Public Graphics.* Lunteren: 24.1-24.18.

Kalsher, M.J., Wogalter, M.S., & Williams, K.J. (1999). Allocation of responsibility for injuries from a "hidden" hazard. *Proceedings of the Human Factors and Ergonomics Society,* 43, 598-602.

Silver, N.C., Wogalter, M.S., Brewster, B.M., Glover, B.L., Murray, L.A., Tillotson, C.A., & Temple, T.L. (1995). Comprehension and perceived quality of warning pictorials. *Proceedings of the Human Factors and Ergonomics Society. 39,* 1057-1061.

Sojourner, R. & Wogalter, M.S. (1997). The influence of pictorials on evaluations of prescription medication instructions. *Drug Information Journal, 31,* 963-972.

Wolff, J. S. & Wogalter, M.S. (1998). Comprehension of pictorial symbols: Effects of context and test method. *Human Factors, 40,* 173-186.

Zwaga, H.J. (1989). Comprehensibility estimates of public information symbols: Their validity and use. *Proceedings of the Human Factors and Ergonomics Society, 33,* 979-982.