

The Ordering of Safety Warnings in Product Manuals

William J. VIGILANTE Jr. and Michael S. WOGALTER

*Ergonomics Program, Department of Psychology
North Carolina State University,
Raleigh, NC 27695-7801, USA*

Abstract. There has only been limited research on how to order the multi-hazard warnings in product manuals. The present study examines this aspect using warning statements from manuals of three power tools having multiple hazards associated with their use, maintenance, and storage. This research also examines the relationship between the mean rank ordering and several user belief dimensions. One group of 25 participants rank ordered each set of warning statements based on how they believed the warnings should be listed in the manuals. Another group of 25 participants rated each warning statement on importance, injury severity, injury likelihood, and prior awareness. The results provided numerical orderings of the statements that could be useful in assembling warning lists in manuals. Three of the four belief dimensions had substantial negative correlations with mean rank; the fourth, awareness, showed a much weaker relationship. This research demonstrates that assessment of warning-statement orders might be useful in constructing operator manuals that better communicate product-related hazards.

1. Introduction

Manufacturers provide product manuals as means of enhancing utility and consumer satisfaction [1]. Operator manuals are attempts to educate consumers on the safe assembly, use, and maintenance of their product, as well as informing them of the hazards associated with its operation [2]. Furthermore research has noted that people generally want operator manuals to consult when they have questions or concerns [3]. However, operator manuals are frequently difficult to read and understand, often with important information not highlighted or salient which consequently escapes the users' attention.

Although many products available in today's market contain multiple hazards, past warnings research has mainly focused on individual hazards. Therefore there is a need to determine how to optimally communicate multiple hazards in operator manuals. In one study Young and Wogalter [4] found that highlighting hazard warnings with conspicuous print and icons, increased warning comprehension and memory.

Research has also been conducted to determine when consumers/users are likely to read operator manuals. Wright et al. [5] found that if a product is perceived as unfamiliar or complex to operate, the operator is more likely to read the accompanying manual. Lust et al. [6] also identified several variables that predict operator manual readership. They found that people were less likely to read the operator's manual if they believed they already knew how to use the product, if they felt pressured for time, or if they were more educated; whereas people were most likely to read them if they believed the manuals to be useful and helpful.

Research has also examined how the placement of different types of warnings in operator manuals can either deter or facilitate reading. Frantz [7] found that placing warnings within the general instructions of operator manuals increased the likelihood they will be read. Wogalter et al. [8] found that placing safety warnings before a set of task instructions produces greater compliance than warnings placed after the instructions. Showers et al. [9] used eight focus groups to explore consumers' behaviors and perceptions of product operator manuals. They found that obvious warnings presented first in a list appeared to offend consumers' intelligence acting as a "turn off" from reading the rest of the list. In such cases, important hazard information located farther down a list of text may not be read. However, another study by the same authors [10] examining the effect of the presentation of obvious warnings failed to show that obvious warning placed first in a list acted as a "turn-off" to reading the entire list. These inconsistent results suggest that the factors that produce the best method of conveying hazard warnings in operator manuals have not been determined.

Recent research with over-the-counter pharmaceuticals has shown that an empirically derived ordering of drug label components is determinable [11]. However, little work has been published on how to order safety warnings in an operator's manual. Should warnings of the greatest hazard be placed first? Many manufacturers put first in manuals the warnings required by the Underwriters Laboratory, an agency in the U.S. that approves electrical products based on industry standards. However, these warnings may be obvious or familiar to most people, and they may not be those that provide the most information.

Previous research indicates that product familiarity is negatively related to willingness to look for and read warnings [4, 12]. However, other research indicates that a product's perceived hazard to be a more important determinate of peoples willingness to read warnings [13, 14]. The greater the perceived hazard level the more likely the consumer will look for and read the warnings. Silver et al. [15] using pest control products found that willingness to read the warnings could be predicted by the following factors: perceived hazard, judged understandability and attractiveness of the warning, and intended carefulness in using the product.

The present study attempts to identify the kinds of warnings that people prefer to encounter first in product manuals. In addition, several factors that might be related to the preferred ordering were examined: the warning's importance, the severity and likelihood of injury implied by the warning, and prior awareness of the warning.

2. Method

2.1. Participants

Fifty students from North Carolina State University (NCSU) participated for credit in their introductory psychology course. The first group of 25 participants (32% females) rank-ordered the three sets of warnings (rank-order group). The second group of 25 participants (28% females) rated the various warnings (ratings group) on several dimensions.

2.2. Materials

The warnings were taken from the operator manuals for three power tools: a chain saw, a circular saw, and a dry wall screw drill. These products were chosen because they have several potential hazards. Complete lists of warnings were derived for each power tool by combining the warnings contained in manuals from different manufacturers of the same power tool (i.e., the list of warnings for the dry wall screw drill were taken from the operator manuals developed by the manufacturers: Craftsman, Makita, and Milwaukee). This list of warnings were then given to five NCSU students, who were asked to assemble the warnings they believed should be combined into a single warning. For example, the warnings "Do not wear loose jewelry while operating tool" and "Do not wear loose clothing while operating tool," were combined into "Do not wear loose clothing or jewelry while operating this tool." Agreement of three persons was used to determine which warnings should be combined or eliminated. This procedure ensured that the warnings comprised a complete set of potential hazards and eliminated redundancy. The process produced 43 warnings for the chain saw, 44 for the circular saw, and 34 warnings for the dry wall screw drill. Each warning was printed on individual strips of paper with a letter/number designation in the lower right corner. The letter indicated the tool and the numbers were randomly assigned to warnings to track the statements in the scoring and analysis procedures. The strips were laminated with clear plastic for durability.

2.3. Procedure

Initially a demographics questionnaire (asking gender, age, educational level, and ethnicity/race) was completed by all participants.

2.3.1. Ordering

The rank-order participants were told that they would be ordering warnings from the operator manuals of "three useful yet potentially dangerous power tools." For each tool, participants ordered the warnings, by placing first, the most critical information followed by less critical information. Critical information was defined for participants as information needed for the tool's safe operation by themselves and others.

Participants were given a set of warnings for one tool and asked to order them. After they finished ordering the warnings for one tool, the experimenter recorded the order and gave them another set of warnings and this procedure was repeated until all three sets of warnings were sorted. Participants were allowed to take all the time they needed. Order of the three tool sets as well as the order of statements within sets was randomized for each participant.

2.3.2. Ratings

The participants in the ratings' group were told that they would be making judgments of warning statements from three operator manuals according to four questions. The dimensions addressed by these items were: the importance of the statement, injury severity and likelihood implied by the statement, and prior awareness of the information in the statement. The ratings were made on nine-point Likert-type scales ranging from 0 (*absence of quantity*) to 8 (*maximum quantity*):

- (1) How *important* is this warning for the safe operation of this tool (0 = not at all important, 2 = somewhat important, 4 = important, 6 = very important, 8 = extremely important)?
- (2) How *severely* do you believe the injury would be if the warning was not complied with (0 = not at all severe, 2 = somewhat severe, 4 = severe, 6 = very severe, 8 = extremely severe)?
- (3) How *likely* do you believe the injury would be if the warning was not complied with (0 = not at all likely, 2 = somewhat likely, 4 = likely, 6 = very likely, 8 = extremely likely)?
- (4) To what extent were you already *aware* of the information contained in this warning (0 = not at all aware, 2 = somewhat aware, 4 = aware, 6 = very aware, 8 = completely aware)?

All four scales were printed on one sheet of paper and placed in front of the participant while rating the warnings. Participants recorded their ratings in spaces on a response sheet associated with each tool.

3. Results

3.1. Mean rank order of statements

The rank orders for each warning statement were averaged. The mean rankings for the top five and bottom five warnings for each tool are given in Table 1.

3.2. Relationship of order and ratings

The mean rank order data were combined with mean ratings of the four dimensions to determine the relation between the statement scores for each tool separately. The intercorrelations are shown in Table 2. Note that the correlations in this table are Spearman Rho for the rank order scores (with the four dimensions), whereas Pearson correlations are used among the four dimensions.

4. Discussion

This study identified a preferred ordering of product manual warnings for each of three tools. Although these orders are not necessarily the best possible arrangement of the warnings, they are probably better than the apparently random orders currently found in most electrical tool manuals. The best possible arrangement may depend on other factors beyond the simple preference determination used here. Factors such as prior awareness of the information, the extent and probability of injury that might occur, specific product attributes, and semantic organization of the material (e.g., personal injury vs. product damage) as well as others might be important in the determination of the best ordering.

The present study also examined the relationship of four statement-related dimensions. Ratings on these dimensions were attained from a group of participants independent of those who ordered the statements. For all three tools the ratings of importance, injury severity and injury likelihood were shown to be substantially (negatively) correlated to the statement mean rank orders. These results indicate that the preferred order of the statements in the product manuals are predictable and consistent. The statements preferred at the beginning of the list should be ones that convey the most important information and concern information that may result in the most severe and probable injuries.

The fourth dimension, prior awareness of the information, was much more inconsistent than the other three dimensions. For the chain saw the relation with mean rank was strong. For the circular saw it was much weaker (although significant). For the dry wall screw drill the relation was of the same magnitude

Table 1. The 5 top ranked and 5 bottom ranked warnings for the three tools.

| <i>Chain saw (43 statements)</i> | |
|--|------------------|
| <i>Top Ranked</i> | <i>Mean Rank</i> |
| WARNING! KICKBACK may occur when the nose or tip of the guide bar touches an object, or when the wood closes in and pinches the saw chain in the cut. | 10.24 |
| To reduce the risk of serious or fatal injury to the operator or bystanders, never use the saw with one hand. You cannot control reactive forces and you may lose control of the saw, which can result in the skating or bouncing of the bar and chain along the limb or log. | 13.36 |
| Keep a good firm grip on the saw with both hands, the right hand on the rear handle, and the left hand on the front handle, when the engine is running. Use a firm grip with thumbs and fingers encircling the chain saw handles. A firm grip will help reduce kickback and maintain control of the saw. Don't let go. | 14.76 |
| Keep all parts of your body away from the saw chain when the engine is running. | 14.80 |
| Tip contact in some cases may cause a lightning fast reverse REACTION, kicking the guide bar up and back towards the operator. Pinching the saw chain along the top of the guide bar may push the guide bar rapidly back towards the operator. Either of these reactions may cause you to lose control of the saw which could result in serious personal injury. | 15.04 |
| <i>Bottom Ranked</i> | <i>Mean Rank</i> |
| Keep the handles dry, clean, and free of oil or fuel mixture. | 29.68 |
| Follow manufacturer's sharpening and maintenance instructions for the chain saw. | 32.12 |
| When transporting your chain saw, use the appropriate guide bar scabbard. | 32.32 |
| Spark arrester mufflers approved to SAR Standard J335b are standard on all chain saws to reduce the possibility of forest fires. | 34.24 |
| All chain saw service, other than the items listed in the operator's manual maintenance instructions, be performed by competent chain saw service personnel. Only use replacement bars and chains specified by the manufacturer or the equivalent. | 34.80 |
| <i>Circular saw manual (44 statements)</i> | |
| <i>Top Ranked Warnings</i> | <i>Mean Rank</i> |
| ALWAYS WEAR SAFETY GLASSES. Everyday eyeglasses have only impact-resistant lenses; they are NOT safety glasses. | 8.92 |
| DO NOT OPERATE THIS TOOL WHILE UNDER THE INFLUENCE OF DRUGS, ALCOHOL, OR ANY MEDICATION. | 10.48 |
| KEEP HANDS AWAY FROM CUTTING AREA. Keep hands away from blades. Do not reach underneath work while blade is rotating. Do not attempt to remove cut material when blade is moving. | 10.56 |
| NEVER touch the blade or other moving parts during use. | 12.16 |
| WARNING: GUARD AGAINST ELECTRICAL SHOCK BY PREVENTING BODY CONTACT WITH GROUNDED SURFACES, for example pipes, radiators, ranges, refrigerator enclosures. Also when using electric tools, basic safety precautions should always be followed to reduce the risk of fire, electric shock, and personal injury. | 13.12 |
| <i>Bottom Ranked</i> | <i>Mean Rank</i> |
| DON'T ABUSE CORD. Never carry tool by cord or yank it to disconnect from receptacle. Keep cord from heat, oil, and sharp edges. | 31.36 |
| OUTDOOR USE OF EXTENSION CORDS. When tool is used outdoors, use only extension cords intended for use outdoors and so marked. | 31.64 |
| INSPECT TOOL CORDS PERIODICALLY. If damaged have repaired by authorized service facility. Stay constantly aware of cord location and keep it well away from the rotating blade. | 32.64 |
| When servicing use only identical XXXXX replacement parts. | 35.24 |

STORE AND MAINTAIN TOOLS WITH CARE. When not in use tools should be stored in a dry, high place out of reach of children. Keep tools sharp at all times, and clean for best and safest performance. Follow instructions for lubricating and changing accessories. 35.28

Dry wall screw drill (34 statements)

| <i>Top Ranked</i> | <i>Mean Rank</i> |
|--|------------------|
| DRUGS, ALCOHOL, MEDICATION, STAY ALERT. Do not operate tool while under the influence of drugs, alcohol, or any medication. Watch what you are doing and use common sense. Do not operate tool when tired, and do not rush. | 7.72 |
| KEEP HANDS AWAY FROM ALL CUTTING EDGES AND MOVING PARTS. | 7.90 |
| ALWAYS WEAR SAFETY GLASSES WITH SIDE SHIELDS. Everyday eyeglasses have only impact resistant lenses; they are NOT safety glasses. | 8.92 |
| NEVER USE IN AN EXPLOSIVE ATMOSPHERE. Normal sparking of the motor could ignite flammable liquids, gases, or fumes. | 10.24 |
| VOLTAGE WARNING: Before connecting the tool to a power source (receptacle, outlet, etc.) be sure the voltage supplied is the same as that specified on the nameplate of the tool. A power source with voltage greater than that specified for the tool can result in SERIOUS INJURY to the user - as well as damage to the tool. If in doubt, DO NOT PLUG IN THE TOOL. Using a power source with voltage less than the nameplate rating is harmful to motor. | 10.40 |

| <i>Bottom Ranked</i> | <i>Mean Rank</i> |
|--|------------------|
| MAINTAIN TOOLS WITH CARE. Keep tools sharp at all times, and clean for best and safest performance. Follow instructions for lubricating and changing accessories. | 24.32 |
| OUTDOOR USE OF EXTENSION CORDS. When tool is used outdoors, use only extension cords intended for use outdoors and so marked. | 24.80 |
| MAINTAIN CORDS WITH CARE. Inspect tool cords periodically and if damaged, have repaired by authorized service facility. Never carry tool by cord or yank it to disconnect from receptacle. Keep cord from heat, oil and sharp edges. | 26.80 |
| REPLACEMENT PARTS. When servicing, use only identical replacement parts. | 28.20 |
| STORE IDLE TOOLS. When not in use tools should be stored in a dry, and high or locked-up place out of the reach of children. | 29.44 |

Table 2. Intercorrelations between the statement mean rank and belief dimension ratings.

| | <i>Rank Order</i> | <i>Importance</i> | <i>Severity</i> | <i>Likelihood</i> |
|---|-------------------|-------------------|-----------------|-------------------|
| <i>Chain saw (43 statements)</i> | | | | |
| Importance | -.65** | | | |
| Severity | -.77** | .76** | | |
| Likelihood | -.77** | .71** | .63** | |
| Awareness | -.60** | .47** | .59** | .50** |
| <i>Circular saw (44 statements)</i> | | | | |
| Importance | -.65** | | | |
| Severity | -.74** | .86** | | |
| Likelihood | -.62** | .15 | .06 | |
| Awareness | -.30* | .32* | .37* | .08 |
| <i>Dry wall screw drill (34 statements)</i> | | | | |
| Importance | -.48** | | | |
| Severity | -.66** | .70** | | |
| Likelihood | -.67** | .67** | .86** | |
| Awareness | -.30 | .07 | .46** | .53** |

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

as the circular saw, but because the number of statements was lower, it was not significant. The interesting aspect is that the concept of awareness is connotatively similar, although not identical, to the concept of obviousness. Both concern people's prior knowledge of the information. Showers et al. [9] and Lust et al [10]. also found inconsistent results for obviousness in their studies. Moreover, another knowledge-related concept, familiarity, has also shown inconsistent results in the warning literature [12 -14]. It appears then that there is a complex relationship between people's knowledge and how they deal with products and warning statements. Whether there are relevant moderating or latent variables has yet to be determined.

Additional research should be conducted using other warnings-related dimensions to determine if they relate to the statement orders. It may be useful to compare the ratings and rankings of the statements by product experts and lay persons to determine if they differ. Other products should be examined to determine generalizability. Further research is also needed to determine whether empirically-determined ordering of statements do in fact facilitate usability. This can be investigated with free recall and recognition tests [10] using reaction time and accuracy measures and actual product-use tasks.

This application of compiling warning statements should be useful to manufacturers as they develop manuals for the safety and welfare of the product users. Well designed operator manuals could reduce potential legal liability of not adequately informing consumers of the hazards associated with their product [2]. Ordering the warnings properly may be one of the ways to offer this protection.

References

- [1] K. G. Celuch et al., Product Owner Manuals: An Exploratory study of Nonreaders Versus Readers. *Journal of Applied Social Psychology* **22** (1992) 492-507.
- [2] L. S. Shower et al., Consumers' Use of Product Owner Manuals. *Advancing the Consumer Interest* **4**(1) (1992) 22-28.
- [3] M. S. Wogalter and R. C. Baneth, Availability of Owner's Manuals for 'Second-Hand' Consumer Products. In *Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting* (1994) 447-450. Santa Monica, CA: Human Factors and Ergonomic Society.
- [4] S. L. Young and M. S. Wogalter, Comprehension and Memory of Instruction Manual Warnings: Conspicuous Print and Pictorial Icons. *Human Factors* **32** (6) (1990) 637-649.
- [5] P. Wright et al., Some Factors Determining When Instructions will be Read. *Ergonomics* **25** (1982) 225-227.
- [6] J. A. Lust et al., The Use of Product Owner Manuals: A Comparison of Older Versus Younger Consumers. *Journal of Business and Psychology* **6** (1992) 443-463.
- [7] J. P. Frantz, Effect of Location and Procedural Explicitness on User Processing of and Compliance with Product Warnings. *Human Factors* **36**(3) (1994) 532-546.
- [8] M. S. Wogalter et al., Effectiveness of Warnings. *Human Factors* **29** (1987) 599-612.
- [9] L. Showers et al., Product manuals: A Consumer Perspective. *Advancing the Consumer Interest* **5**(2) (1995) 12-16.
- [10] J. A. Lust et al., An Investigation of the Effects of Placement of Obvious Warnings and Safety Warning Format in Product Owner Manuals. In *Proceedings of the Marketing and Public Policy Conference*. (1995) Atlanta, GA: Georgia State University.
- [11] W. J. Vigilante Jr. and M. S. Wogalter, *The Ordering of Over-the-Counter Pharmaceutical Label Components*. Unpublished Manuscript (1996) Raleigh, NC: North Carolina State University.
- [12] S. S. Godfrey and K. R. Laughery, The Biasing Effects of Products Familiarity on Consumers' Awareness of Hazards. In *Proceedings of the Human Factors Society 28th Annual Meeting*. (1984) 483-486. Santa Monica, CA: Human Factors and Ergonomics Society.
- [13] S. S. Godfrey et al., Warning Messages: Will the Consumer Bother to Look? In *Proceedings of the Human Factors Society 27th Annual Meeting* (1983) 950-954. Santa Monica, CA: Human Factors and Ergonomics Society.
- [14] M. S. Wogalter et al., Perceptions of Consumer Products: Hazardousness and Warning Expectations. In *Proceedings of the Human Factors Society 30th Annual Meeting* (1986) 1197-1201. Santa Monica, CA: Human Factors and Ergonomics Society.
- [15] N. C. Silver et al., Warnings and Purchase Intentions for Pest-Control Products. *Forensic Report* **4** (1991) 17-33.