

MEMORY OF INSTRUCTION MANUAL WARNINGS: EFFECTS OF PICTORIAL ICONS AND CONSPICUOUS PRINT

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ABSTRACT

The present research sought to determine whether the salience of warning messages would improve the memory of warnings in proceduralized instructions. Subjects studied one of four instruction manuals for a gas-powered electric generator under the guise that they would later operate the generator. In the manual, the appearance of eight different warning messages were altered in two ways: 1) The verbal messages were printed in either conspicuous print (larger with color highlighting) or in plain print (same as the other text). 2) The verbal warning messages were either accompanied by meaningfully-related icons or the icons were absent. Three kinds of memory tests were given to subjects. The results showed that subjects who received the manual containing Conspicuous Print, Icons Present warnings recalled the verbal warning content and the semantic meaning of the icons significantly better than subjects who received one of the other three manuals. Implications for the design of instruction manual warnings are discussed.

INTRODUCTION

Most electrical and gas powered devices are accompanied by an owner's instruction manual. In addition to a description of the correct operation of the device, the manuals often contain warnings. The warnings are intended to provide information on the nature of the potential hazards and ways to avoid injury to person and machine. Users may not read the manual and the accompanying warnings, but there is evidence that people are likely to read warnings for hazardous products (e.g., Godfrey, Allender, Laughery, & Smith, 1983; Wogalter, Desaulniers, & Brelsford, 1986).

Reading the manual and warnings does not, in and of itself, ensure that the warnings will be remembered at a later time. Since consumers may not always have the manual available when they use a hazardous product, it would seem important that instruction manual warnings be constructed in a manner most conducive for enhancing memory of the warnings. For this reason, research on user memory and recall of consumer product warnings is important. However, research on variables that affect memory of warnings is scarce (Lehto & Miller, 1986). Either no effect or very small effects of warning manipulations on memory has been reported (Desaulniers, 1987; Rothstein, 1985; Strawbridge, 1986; Zlotnik, 1982).

Intuitive reasoning suggests that if a warning is not noticed or seen, it cannot be remembered. Improving the chance that warnings will be noticed (i.e., through increased visibility or salience) should lead to more effective encoding and thus produce better memory and recall of warnings. Simply put, one possible way of enhancing memory is to make the warning more conspicuous.

Virtually every set of published guidelines on warnings emphasizes the characteristic of attention-getting (Cunitz, 1981; Peters, 1984; Wogalter, Godfrey, Fontenelle, Desaulniers, Rothstein, & Laughery, 1987). Warnings should stand out from a noisy background. Although several recent studies have shown that warning salience facilitates behavioral compliance, we have been unable to find any published research on the effects of warning

conspicuity on memory. Zlotnik (1982), for example, embedded highlighted warnings which were blocked, cross-hatched, and multidimensionally printed (2-D vs. 3-D) in a set of procedural instructions. He was able to show that highlighting affected subjects' task behavior but the manipulation did not yield effects on memory. The present research reexamines the possibility that salient text facilitates memory. We expect readers will be more likely to notice and read conspicuously printed warnings, which in turn, should lead to better subsequent memory compared to the same warnings printed less conspicuously.

Another possible way of making warning messages more salient and more memorable is to include icons (symbols or pictograms). Dorris and Purswell (1978) conjectured that, in many situations, icons may be recognized more rapidly and may be more effective at conveying information about a potential hazard than a verbal message. However, Robinett and Hughes (1984) point out that, because of the complex nature of many hazards, icons cannot realistically exist by themselves as a method of communicating hazard information. In most situations, icons must be paired with written warning messages. So, in addition to the attention-getting characteristics of icons, the presence of icons might enhance memory in another way. By pairing icons and verbal warnings, they become associated in memory, and thus at reexposure, the icon might facilitate recall by cuing the warning message from memory.

The present research seeks to determine whether the salience of warning messages would improve the memory and recall of warnings in a set of operational instructions. Specifically, it is hypothesized that the inclusion of icons and the use of conspicuous print will enhance memory of warnings.

METHOD

Subjects

Sixty-four undergraduate students from the University of Richmond voluntarily participated in the experiment for credit in an introductory psychology course.

Materials

Four instruction manuals concerning the operation and maintenance of a gas-powered electric generator were prepared. This product was chosen for three reasons: 1) For most persons, it is an unfamiliar piece of equipment. 2) This product poses some risk of injury. 3) And since the generator is designed for use in a power outage, it will have to be safely operated in conditions in which it is impractical or impossible to reference an instruction manual (e.g., in rain or absence of light).

The basic ten-page manual was an adaption of several manufacturers' manuals and had the appearance of an actual owner's manual. The text of the manuals were printed in 12-point Helvetica font (except for the section headings which were in bold). It contained sections on the generator's operation and maintenance as well as detailed drawings of the generator. Each manual contained eight warnings. The warnings were either in plain or conspicuous print. Warnings printed in plain print had the same appearance as the other textual print in the manual. Conspicuous print warnings were printed in an 18-point Times font and were covered with transparent orange fluorescent highlighting. The warnings were accompanied by meaningfully-related icons or the icons were absent. The icons were obtained from an icon evaluation report by

Collins, Lerner, and Pierman (1982). Nine icons were used, one for each of the eight warnings, except for one warning about a potential gas explosion which had two icons paired with it. Thus, there were four manuals constructed to have have warnings in: 1) Conspicuous Print, Icons Present, 2) Conspicuous Print, Icons Absent, 3) Plain Print, Icons Present, and 4) Plain Print, Icons Absent. Figure 1 shows an example warning and the ways it was manipulated in the manuals.

Three tests were used to assess subject's memory of the warnings: a content question test, an icon recognition test, and an icon definition test. The content question test consisted of ten short answer questions. One question was created for each of the eight warnings. Each dealt with some aspect of the semantic content of the warning message (e.g., "What is the potential result of running the generator with the choke OPEN?"). The other two questions in the test dealt with operational aspects of the generator and were not analyzed. The icon recognition test consisted of 36 randomly placed icons and a numbered response sheet. Nine of the icons were actually used in the manuals; these were the target icons. (Note that two icons were used for one of the eight verbal warning messages). The test set also included nine icons which were similar in name and content to the target icons but were graphically different. The other 18 icons were 'pure' distractors. These were

Figure 1. Example of a Warning as a function of Conspicuous Print and Icons

Plain Print, Icons Absent

Warning: To prevent electric shock from faulty appliances, the generator should be grounded. Connect a length of heavy wire between the ground terminal and the ground source.

Plain Print, Icons Present



Warning: To prevent electric shock from faulty appliances, the generator should be grounded. Connect a length of heavy wire between the ground terminal and the ground source.

Conspicuous Print, Icons Absent

Warning: To prevent electric shock from faulty appliances, the generator should be grounded. Connect a length of heavy wire between the ground terminal and the ground source.

Conspicuous Print, Icons Present



Warning: To prevent electric shock from faulty appliances, the generator should be grounded. Connect a length of heavy wire between the ground terminal and the ground source.

Note: Shading represents orange highlighting.

icons that were not used in the manual. Nine of these 'pure' distractors had the same basic meaning as the other nine 'pure' distractors but were graphically different. In the icon definition test, the nine icons used in the manuals were placed on a blank sheet. Space was provided next to each for the subjects' responses.

Procedure

Subjects were given an instruction manual on the operation and maintenance of a gas-powered electric generator. Subjects read the manual under the expectation that they would later use the product. This was an attempt to have a more ecologically valid procedure than one using intentional memory instructions. Subjects were told that they were to learn about the generator so that they could operate it from memory later in the session. The premise that subjects would have to operate the generator was enhanced by their participation in another experiment just prior to the present study in which subjects solved a series of computer tasks using instructions. The impression given to the subjects was that the first experiment was a test of their ability to operate a complicated appliance with the instructions present, and that the generator manual task was a test of their ability to operate an appliance with the instructions absent (i.e., from memory).

At the end of a four minute study period, all subjects were told that they were in the "control" group and would not be operating the generator. They were instead given the three tests of their memory of the warnings in the following order: 1) content questions, 2) icon recognition, and 3) icon definition. In the content question test, subjects answered questions regarding each warning in the manual. In the icon recognition test, the subject's task was to recognize the nine icons used in the manuals with icons from a total of 36 randomly ordered icons. For each icon, subjects placed a "Y" (Yes, the icon was in the manual) or an "N" (No, the icon was not in the manual) at the corresponding number on the icon recognition sheet. Subjects also indicated their confidence in their answers by placing a "1" (guessed the answer), "2" (fairly sure of the answer), or "3" (very sure of the answer). The icon definition test required subjects to describe the verbal meaning of the icons used in the manuals. The subjects were instructed to write their response with specific reference to the instruction manual, but to guess if necessary. All tests sheets were graded without knowledge of which condition the subject participated.

A comment should be made regarding some of the peculiarities of the testing procedure. The three tests were given in a fixed order (i.e., not counterbalanced). The reason for this was, in part, because we were most interested in recall of semantic content as a function of format. To avoid possible carry-over effects, the content question test was always given first. The other two tests were constructed and given in an order that had the least potential for carry-over. All subjects were required to take the two icon tests regardless of whether or not they were exposed to a manual containing icons.

RESULTS

The data were initially analyzed using a set of planned comparisons between the Conspicuous Print, Icons Present

condition and the other three conditions. 2 X 2 between-subjects analyses of variance (ANOVAs) were used in addition to the planned comparisons because we were also interested in whether each of the modes of salience would, by itself, facilitate memory and whether together their influence changes.

Content Questions

The answers for the warning content questions were graded twice according to strict and liberal grading criteria. The strict grading criterion required that subjects include certain "key words" or specific details of the manual's warnings in their answer. The liberal grading criterion required that subjects convey the general meaning of the warning message. Correct answers for both criteria were scored as "1" and incorrect answers were scored as "0".

Table 1 shows the mean proportion correct scores for the warning message content questions using the strict and liberal criteria. The strict criteria scores are lower than the liberal criteria scores, but the pattern is similar for both measures. It is apparent from the table that the Conspicuous Print, Icons Present condition produced greater performance than the other three instruction manual conditions.

TABLE 1. Mean Proportion Correct as a Function of Warning Format for Verbal Content Questions

	Conspic Print Icons Pres	Conspic Print Icons Abs	Plain Print Icons Pres	Plain Print Icons Abs
STRICT	.47	.27	.32	.26
LIBERAL	.75	.56	.58	.53

Planned comparisons using the strict grading scores showed that subjects who read the manual with the Conspicuous Print, Icons Present warnings performed significantly better than subjects who read Conspicuous Print, Icons Absent, $t(30) = 3.34, p < .01$, and Plain Print, Icons Absent warning manuals, $t(30) = 3.38, p < .01$, and were marginally better than subjects who read the Plain Print, Icons Present warning manual, $t(30) = 1.95, p = .06$. For the liberal graded scores, the Conspicuous Print, Icons Present warning manual condition was significantly higher than the Conspicuous Print, Icons Absent, $t(30) = 3.03, p < .01$, the Plain Print, Icons Present, $t(30) = 2.26, p < .04$, and the Plain Print, Icons Absent conditions, $t(30) = 4.12, p < .001$.

An overall ANOVA on the strict data yielded a significant main effect of the icons, $F(1, 60) = 7.53, MSe = .038, p < .01$. Performance was higher when icons were present (.40) than when they were not present (.26). Neither the effect of conspicuous print alone nor the interaction was significant, $F(1, 60) = 2.67, p > .05$, and $F(1, 60) = 2.07, p > .05$, respectively.

The ANOVA on the liberal data yielded a significant main effect of the icons, $F(1, 60) = 6.28, MSe = .038, p < .01$.

.02. Performance was higher when icons were present (.66) than when they were not present (.54). There was also a significant main effect of conspicuous print, $F(1, 60) = 4.07, p < .05$. Recall of the verbal content of the warning message was significantly greater with conspicuous print (.65) than with plain print (.55). The interaction was not significant, $F(1, 60) = 1.92, p > .05$.

Icon Recognition Test

Subjects' responses from the icon recognition test were examined a number of ways. Responses to the target icons (ones that appeared in the manual) were scored as hits (1's for "yes" responses) or misses (0's for "no" responses) to produce proportion hit scores. In addition, targets responses were converted to a confidence ratings which ranged from 1 to 6 ("N3" was assigned a "1", "N2" assigned a "2", and so on, to "Y3" assigned a "6"). A number of other recognition measures were also examined. The recognition test contained target-related distractors (similar in meaning to the target icons) and target-unrelated distractors. Scores on these sets of icons were examined separately and in combination. Moreover, a series of discrimination measures were derived for the purpose of eliminating response criteria effects from the target and distractor measures. The discrimination measures were target-distractor difference scores.

Planned comparisons were made between the Conspicuous Print, Icon Present condition and the Plain Print, Icon Present condition. We expected that between the two conditions containing icons, the conspicuous print version would yield greater recognition performance than the plain print manual. This was not found. None of the measures showed a significant effect of conspicuous print on icon recognition (all p 's $> .05$). As expected, for all recognition measures, subjects who read manuals with icons present had significantly better recognition performance than subjects who saw no icons in the manual (all p 's $< .05$). There were no other effects yielded by any of the ANOVAs on these data (p 's $> .05$).

Icon Definition Test

The icon definition test was graded using both strict and liberal criteria. Under the strict grading criterion, subjects had to describe not only the inherent meaning of the icon, but also needed to be specific to the associated warning in the manual. Under the liberal grading criterion, subjects needed to convey only the general meaning of the icon. Correct answers were scored as "1" and incorrect answers were scored as "0".

Table 2 shows the mean proportion correct under the strict and liberal grading criteria. The table shows that greatest performance was produced by manuals containing Conspicuous Print, Icons Present warnings compared to the other three manuals. Planned comparisons using the strict scores showed that icon definitions were significantly more accurate for subjects reading the Conspicuous Print, Icons Present manual than the Conspicuous Print, Icons Absent, $t(30) = 3.09, p < .01$, the Plain Print, Icons Present, $t(30) = 2.47, p < .02$, and the Plain Print, Icons Absent manuals, $t(30) = 5.52, p < .001$. For the liberal graded data, the definitions produced by subjects reading the Conspicuous Print, Icons Present manuals were

significantly better than for subjects who read the Conspicuous Print, Icons Absent, $t(30) = 3.25, p < .01$, and the Plain Print, Icons Absent manuals, $t(30) = 2.30, p < .03$, but only marginally better than those who read the Plain Print, Icons Present manual, $t(30) = 1.87, p < .08$.

TABLE 2. Mean Proportion Correct as a Function of Warning Format for Icon Definitions

	Conspic Print Icons Pres	Conspic Print Icons Abs	Plain Print Icons Pres	Plain Print Icons Abs
STRICT	.48	.21	.26	.10
LIBERAL	.93	.81	.86	.85

Overall analyses using a 2 X 2 ANOVA on the strict data yielded a significant main effect of the icons, $F(1, 60) = 15.10, MSe = .049, p < .001$. Performance was higher when icons were present (.37) than when they were absent (.15). There was also a significant main effect of conspicuous print, $F(1, 60) = 9.16, p < .004$. Recall of the verbal content of the warning message was significantly greater with conspicuous print (.34) than with plain print (.18). The interaction was not significant, $F(1, 60) = 1.01, p > .05$.

The ANOVA on the liberal data yielded a significant main effect of the icons, $F(1, 60) = 7.01, MSe = .011, p < .02$. Performance was higher when icons were present (.40) than when they were absent (.26). Conspicuous print did not yield a main effect, $F(1, 60) < 1.0$, but it did enter into an interaction with icons, $F(1, 60) = 4.49, p < .05$. Performance was facilitated by the presence of icons when the warnings were printed conspicuously. The presence vs. absence of icons did not affect performance for warnings in plain print.

DISCUSSION

The present results show that increased salience of warnings enhances memory of their content. Presumably the reason for the facilitation is that salient warnings lead readers to notice and attend to the warnings. For both verbal warning messages and icon definitions, the presence of both icons and conspicuous print was found to produce memory performance that was higher than either method of salience alone or when both were absent.

In all three memory tests, the presence of icons improved performance over conditions with icons absent. Not only was facilitation seen for memory of the icons themselves but also for the icons' associated warning messages.

The effect of conspicuous print was smaller. The presence of conspicuous print showed a beneficial effect using the liberal graded warning content and strict graded icon definition measures. Conspicuous print also interacted with icons using the liberal icon definition measure. However, there was no effect of conspicuous print shown

by the strict graded content measure, nor was there an additional benefit of conspicuous print for warnings containing icons using the recognition or liberal graded icon definition measures.

The icon recognition test produced results that were not particularly interesting. As expected, subjects who were exposed to icons had greater recognition performance than subjects who did not have icons in the manual. However, the possibility that the presence of conspicuous print with icons might facilitate icon recognition over the version with plain print and icons was not confirmed.

The icon definition test addressed the extent to which the icons cue memory of the verbal warning message. The strict criterion scores suggest that subjects were better able to recall the meaning of icons when they had previously viewed the icons paired with conspicuously printed warnings than subjects who had seen the icons paired with plain print warnings. This facilitated ability of the icon to cue hazard information when originally paired with salient text would be important in situations where the icon is seen very briefly or alone. Here the icon must cue the user to the kind of hazard present without reference to the written warning message. Our results suggest that an initial simultaneous presentation of the icon and saliently printed warning text enhances the icon's ability to cue recall of the warning message.

The present research has implications for writers of instruction manuals. Manuals should be designed in a way that readers will notice and attend to the warnings. The present results suggest that the way the warnings are presented in a manual affects memory of the warning's message. Memory of warning information is important because users of hazardous equipment may not have the manual present/available at the time of product use. Our results suggest that the inclusion of both icons and conspicuously printed warnings promote better memory of warnings. The implication for instruction manual design is clear: Warnings should be made salient.

Finally, a comment should be made regarding the generality of the present results. We examined the effect of warning salience using a manual for only one product. Future research should examine whether the effects shown here also hold for other products and manuals. For example, the effects of warning salience might be dependent on such factors as the type of product and consumer familiarity.

REFERENCES

- Collins, B. L., Lerner, N. D., & Pierman, B. C. (1982). *Symbols for industrial safety*. (Tech. Report NBSIR 82-2485). Washington, DC: U.S. Department of Commerce.
- Cunitz, R. J. (1981). Psychologically effective warnings. *Hazard Prevention*, 17, 5-7.
- Desaulniers, D. R. (1987). Layout, organization, and the effectiveness of consumer product warnings. In *Proceedings of the Human Factors Society 31st Annual Meeting* (pp. 56-60). Santa Monica, CA: The Human Factors Society.
- Dorris, A. L., & Purswell, J. L. (1978). Human factors in the design of effective product warnings. In *Proceedings of the Human Factors Society 22nd Annual Meeting* (pp. 343-346). Santa Monica, CA: The Human Factors Society.
- Godfrey, S. S., Allender, L., Laughery, K. R., & Smith, V. L. (1983). Warning messages: will the consumer bother to look? In *Proceedings of the Human Factors Society 27th Annual Meeting* (pp. 950-954). Santa Monica, CA: The Human Factors Society.
- Lehto, M. R. & Miller, J. M. (1986). *Warnings: Volume 1: Fundamentals, design, and evaluation methodologies*. Ann Arbor, MI: Fuller Technical Publications.
- McCarthy, R. L., Robinson, J. N., Finnegan, J. P., & Taylor, R. K. (1982). Warnings on consumer products: Objective criteria for their use. In *Proceedings of the Human Factors Society 26th Annual Meeting* (pp. 98-99). Santa Monica, CA: The Human Factors Society.
- Peters, G. A. (1984). A challenge to the safety profession. *Professional Safety*, 29, 46-50.
- Robinet F., & Hughes, A. (1984). Visual alerts to machinery hazards: A design case study. In Easterby, R., & Zwaga, H. (Eds.), *Information Design: The Design and Evaluation of Signs and Printed Material* (pp. 405-417). Chichester: John Wiley and Sons.
- Rothstein, P. R. (1985). Designing warnings to be read and remembered. In *Proceedings of the Human Factors Society 29th Annual Meeting*, (pp. 684-688).
- Strawbridge, J. A. (1986). The influence of position, highlighting, and imbedding on warning effectiveness. In *Proceedings of the Human Factors Society 30th Annual Meeting*, (pp. 716-720). Santa Monica, CA: The Human Factors Society.
- Wogalter, M. S., Desaulniers, D. R., & Brelsford, J. W. (1986). Perceptions of consumer products: Hazardousness and warning expectations. In *Proceedings of the Human Factors Society 30th Annual Meeting* (pp. 1197-1201). Santa Monica, CA: The Human Factors Society.
- Wogalter, M. S., Godfrey, S. S., Fontenelle, G. A., Desaulniers, D. R., Rothstein, P. R., & Laughery, K. R. (1987). Effectiveness of Warnings. *Human Factors*, 29, 599-612.
- Zlomik, M. A. (1982). The effects of warning message highlighting on novel assembly task performance. In *Proceedings of the Human Factors Society 26th Annual Meeting* (pp. 93-97). Santa Monica, CA: The Human Factors Society.