BEHAVIORAL EFFECTIVENESS OF WARNINGS

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ABSTRACT

A paradigm was developed to examine the effectiveness of warnings in a laboratory task. A task was presented to subjects as one examining how people perform a basic chemistry demonstration. Experiment 1 examined the effects of two locations of the warning (before and after instructions) and two different signal word presentations (WARNING and Note). An additional condition with no warning or signal word served as a control. No effects were found on time or accuracy. However, compliance (use of mask and gloves) was affected by the inclusion of the warning as well as by its location. Greatest compliance occurred when the warning was placed prior to the instructions. Experiment 2 replicated the effect of location. The addition of a printed statement placed before the instructions (with warning at the end) to read through the instructions before beginning produced intermediate compliance that was not significantly different from the warning beginning and end conditions. Observation revealed that when the warning message was at the end of the instructions subjects complied only when they saw the warning message before starting the task. These results indicate that if warnings are placed in front of instructions the consumer is more likely to read and comply.

Introduction

An increasingly important issue to Human Factors specialists concerns the effectiveness of warning messages. Do warnings influence the behavior of the people to whom they are directed? Unfortuantely there is little empirical evidence to indicate the circumstances in which warnings are or are not effective in this regard. McCarthy, Finnegan, Krumm-Scott and McCarthy (1984) concluded from a review of the literature that warnings are not effective. While we would agree that there is little evidence to support the contention that warnings are effective, we disagree with the conclusion that the evidence shows they are not. No doubt there are situations where warnings have little or no effect; however, finding no effect of warnings in a particular situation does not permit the general conclustion that warnings are not effective. Indeed, whether or not warnings are effective is not the question. Rather, research in this area should focus on determining the factors that influence effectiveness.

It is widely agreed that if one is to address the issue of warning effectiveness the ultimate criterion is whether the warning has actually modified human behavior. There is only one published report known to the authors that presents evidence that behavior can be affected by a warning, in this case, safety posters in the workplace. Laner and Sell (1960) posted signs illustrating the hooking back of chain slings onto a crane hook as a safety precaution when they are not in use. Behavior of workers was measured before (as baseline) and after poster placement in 6 steelworks. A seventh steelworks acted as an additional control. They found that, in general, the posters increased the positive behavior depicted in the signs. They also found that this precautionary behavior was maintained for at least several weeks following sign placement. Further, the increase in safe behavior was greatest in those shops with low ceilings where the unsafe practice constituted the greatest hazard. Laner and Sell (1960) concluded that safety posters may be more effective if the warning messsage is directly relevant to the situation.

There are difficulties in carrying out research on effectiveness of warnings. Studies that directly observe behavior in the context of warnings have problems of detecting infrequent events as well as controlling numerous variables. The latter problem makes it particularly difficult to draw inferences about causal relationships. Laboratory studies may permit adequate control over extraneous variables, but often have the problem of generalizing the results to real-world settings. Such studies, particularly in dealing with warnings, may lack situational credibility. Creating situations that are within the boundaries of ethical considerations, while at the same time are believed to be hazardous by experimental subjects, is difficult.

The research reported in this paper consisted of a laboratory study (two related experiments) in which a paradigm was developed to examine the effects of two variables on the effectiveness of warnings. A critical point is that the laboratory task was one in which the warnings had face validity to the participants. The task was presented to the subjects as one examining how people perform a basic chemistry demonstration. The low- level hazards associated with the

demonstration task were believable and realistic. The task was constructed so that several aspects of behavior could be assessed as dependent measures. The two experiments focused on the influence of the signal word and the location of the warning on effectiveness.

EXPERIMENT 1

Method

Subjects and Design. Fifty-one students from Rice University participated for extra-credit in an introductory psychology course. One subject in the warning at the beginning condition withdrew from the experiment soon after receiving the demonstration instructions. An additional subject was substituted to make the cell sizes equal (n=10). The design of the first study investigated the effects of two locations of the warning statement (before and after instructions) and two different signal words (WARNING and Note). These two factors were crossed in a between-subjects design. An additional condition that was identical to the others but lacked the warning statements served as a control.

Materials and Apparatus. Much of the laboratory equipment (glassware, etc.) was borrowed from the Rice Chemistry and Chemical Engineering departments. The equipment included a 500 gram analog scale, two graduated cylinders (80 ml. and 250 ml.), one large beaker (300 ml.), three large lockable Mason-type canisters, one volumetric flask (250 ml.), one measuring teaspoon, a glass stirring stick, and measuring paper. There was an ample supply of paper towels, several pairs of plastic gloves, and molded-paper masks located on the laboratory work table. Other laboratory glassware was available to the subject on the table, even though their use was not explicitly specified by the instructions. These items included one flask (100 ml.), two beakers (50 ml.), and one measuring tablespoon. A Mettler analytical scale was used by the experimenters to measure pre- and post-weights of the substances in the containers.

The instructions called for the handling and mixing of several different substances. The instructions did not name the actual substances except to refer to them by the number or letter label attached to the containers. The actual substances used were: water, bleached white flour, corn oil, table sugar, and yellow corn flower. An attempt was made to disguise some of these substances: green food coloring was added to the water, and red coloring was added to the sugar. These substance were selected for two reasons. First, they would not be truly hazardous; no actual harm would come to the subjects in the experiment. Second, these substances had a somewhat varied consistency and coloring.

Task and Procedure. Subjects entered a small room containing a table with the laboratory equipment. Subjects were told they could use the materials to do the demonstration task. They were handed the instructions, told to read them and begin. All subjects were given the following set of written instructions:

Demonstration Instructions

Before you are two graduated cylinders, several beakers, canisters, volumetric flasks and a scale. With these materials you will be asked to measure and combine specified amounts of five substances. The chemical identity of the substances are not revealed in order to avoid any effects of prior knowledge. Instead, they are identified by numbers and letters on the labels. The method for measuring the five substances and the order in which they are to be combined is given below. This demonstration can be performed without any previous laboratory experience. However, these materials and substances are expensive. Please treat them with care.

The five substances before you are to be combined in the order specified below.
(1) Using the scale, place 100 grams of substance A on measuring paper and then add directly to the large composition beaker.
(2) Pour 150 ml. of liquid #1 from the flask into the large graduated cylinder. Then pour liquid into the composition beaker.
(3) Mix the composition thoroughly.
(4) Pour liquid #2 directly from the small graduated cylinder into the composition beaker.
(5) Measure 4 level teaspoonfuls of substance B. Add to the composition beaker.
(6) Carefully mix these substances to form an even solution.
(7) Finally, using measuring paper and the scale, add 20 grams of substance C to composition beaker. Mix to complete the composition.
Please call the experimenter when you have completed these instructions.

The warning contained in the warning and note instructions is shown below:

(1) Skin contact may result in discoloration or irritation.
(2) Inaccurate measurement or improper mixing order may result in (a) an unusable product, (b) a foul-smelling gas or (c) a noxious gas.
Avoid skin contact with all substances.
Perform accurate measurements.
Mix substances in proper order.
Wear rubber gloves and mask.

The warning and note conditions differed by the signal word as well as the way it was presented. The signal word was always placed immediately

prior to the warning statements. The warning was on the first or second page depending if it was at the beginning or end. The presentation format for the two signal words are shown below (as well as the first line of the warning statements).

WARNING

(1) Skin contact may result in discoloration or irritation.

or

Note: (1) Skin contact may result in discoloration or irritation.

Before and after each session, the experimenter measured weights of the containers specified directly and indirectly by the instructions using a highly accurate analytical Mettler balance. Subtracting the post-weights from the pre-weights provided an accuracy measure for the subjects performance on the task. Pre- and post-weights were gathered for the composition beaker, the canisters, the volumetric flasks, and the large and small graduated cylinders. In addition, while subjects performed the task the experimenter recorded elapsed times for several events. These included: time to put on the mask, time to put on the gloves, time to pick up the first laboratory object, and time to complete the task.

The task took an average of ten minutes to complete. After subjects completed the task they were debriefed and questioned concerning their hypotheses and beliefs about the purpose of the experiment.

Results

Accuracy measurements were not influenced by warning location or signal word (all p's > .10). Similarly, none of the time measurements showed signficant effects (all p's > .10). The use of protective equipment (gloves and mask), however, was clearly influenced by the location and presence of the warning. Table 1 shows the percentage of subjects who complied with the warning to use protective equipment for the different conditions. A one-way between subjects ANOVA indicated a significant effect of conditions, $F(4,45)=4.45$, $p < .01$. Planned comparisons showed that the location (beginning vs. end) effect was statistically significant as was presence (warning vs. no warning). A significantly higher percentage of subjects used the mask or gloves when the hazard statment was present as compared to the no warning control group, $t(45)= 3.49$, $p <.001$. In addition, placement of the hazard message before the task instructions led to significantly higher percentage of subjects using the protective equipment, $t(45)= 2.13$, $p < .05$. There was no effect of the signal word manipulation, $t(45) < 1.0$.

Observation of the subjects in those conditions where the warning message was at the end of the instructions suggested that if they turned the page before starting the task and read the warning, they tended to comply with it. If they did not turn the page they did not comply. Notes were taken by the experimenters on 18 of the 20 subjects in the "end" conditions. These observations indicated 10 of 18 in the end conditions did not turn the page. Of these 10 subjects, 9 did not put on the mask and gloves, while the 7 of the 8 subjects who turned the page complied by using the protective equipment.

EXPERIMENT 2

Subjects in Experiment 1 who did not turn the page may have been unaware that the instructions continued onto a second page. Alternatively, subjects may have simply decided after reading the instructions not to read further but rather to begin carrying out the task immediately. The second study was an attempt to examine the possibility that subjects were not aware of the second page and thus did not have the opportunity to comply with the warning. This experiment was also an attempt to replicate the basic findings of Experiment 1. In Experiment 2, two subject groups received the warning after the instructions. One group received a statement printed on the top of the first instruction sheet which told subjects to read through the entire set of instructions before beginning. The other group did not receive this printed statement. Experiment 1 suggested that if subjects turned the page before beginning the task, they generally complied with the warning. It was proposed that the presence of the "read through" statement would increase the number of subjects who turned the page and attended to the warning, and thus would increase the number who complied. If the presence of the statement increases compliance and compliance depends on turning to the second page of the instructions, then this would indicate that failure to comply was primarily caused by a failure to see the warning.

Method

Subjects and Design. Forty-six subjects from Rice University participated for extra credit in a course. Two groups of subjects received the warning after the instructions but differed as to whether they received (n=15) or did not receive (n=16) written instructions to read through the entire set of instructions before starting the task. A third group received the warning before the instructions (n=15).

Apparatus and Materials. The apparatus and materials were identical to those used in the first experiment with a few exceptions. First, there were only three sets of demonstration and warnings instructions. The materials for the warning at the beginning and warning at the end conditions were identical to those used in Experiment 1. An

additional condition had the same instructions and warning as the warning at the end condition except that it had on the top of the first page the statement:

Please read through the entire instructions before beginning.

Procedure. The procedures and instructions were identical to those used in Experiment 1 with a few exceptions. No pre- and post- weights of the materials were obtained, because none of the accuracy measures in the first experiment approached significance. Although none of the time measures in Experiment 1 were signficant, they were relatively easy to record, so they were again recorded in this experiment. In addition, the experimenters took note of whether or not subjects turned the page before starting the task. Experiment 2 drops the signal word manipulation and adds a condition, warning at the end with "read through" instructions.

Results

Table 2 shows the percentage of subjects who complied with warning instructions to put on the mask and gloves before beginning the task. A one-way between-subjects ANOVA indicated a significant effect of conditions, $F(2,43)=3.42$, $p < .05$. Planned comparisons replicated the location effect found in Experiment 1. Subjects who received the warning at the beginning of the instructions were more likely to comply than subjects who received the warning at the end without read through instructions, $t(29)= 2.70$, $p < .05$. Compliance for subjects who received the warning at the end with "read through" instructions was intermediate between the other two conditions, but did not differ significantly from either the warning at the beginning, $t(28)= 1.29$, $p > .20$ or the warning at the end groups, $t(29)=1.27$, $p > .20$.

In the condition with the warning message at the end (without the "read through" instructions), 8 of 16 subjects turned to the second page before beginning. Every subject who turned the page complied with one exception. This subject reported reading the warning but chose not to comply. The remaining subjects did not turn the page and did not comply. These results were similar to those found in Experiment 1 for the warning at the end condition. In the warning at the end condition with "read through" instructions, 3 of 15 subjects did not turn the page and did not comply. Of the other subjects who turned the page, 10 complied with the warning. The remaining 2 subjects who turned the page did not comply, reporting that they did not read the warning. In general, if subjects turned the page they put on the mask and gloves ($r = .82$, $n=31$).

The "read through" instructions produced an increase in the number of people who turned the page (80% as compared with 50%), however, this difference was only marginally significant, $t(29)= 1.78$, $p < .08$. The "read through" statement also tended to increase compliance (66.7% compared to 43.8% without the statement), though again this difference was not significant. However, it is important to note that the "read through" condition was not statistically different in percentage of compliance from the warning at the beginning condition. This result suggests a lack of power due to small sample size, or a weak manipulation. Though the "read through" condition was not statistically conclusive, the trend in the data shows that more people turned the page and complied with the printed statement than without the statement.

In general, these results indicate that the failure to attend to the warning before beginning the task was responsible for the differences in compliance. Experiment 2 firmly replicated the location effects of Experiment 1. No effect was found for the time measures (all p's $>.10$).

Discussion

The results of these two studies are encouraging. They indicate it is possible to study warning effectiveness with a laboratory paradigm, and they provide a demonstration that there are circumstances in which a warning can be effective in influencing the behavior of people. Specifically, these experiments indicate that the location of the warning with respect to other instructions affect compliance with the warning. In short, warnings must be seen and read in order to be effective. One cannot simply assume that because a warning is on a label or included in a set of instructions it will be encountered. Factors such as its location on the label are crucial to its effectiveness. Warnings labels frequently follow instructions on many products or are located opposite the instructions on a side panel. They may even be "buried" inside owners' manuals. Even when consumers are specifically told to read all instructions before using a product, it is highly probable that a significant percentage will simply read the information necessary to perform the task and ignore any additional information which might warn against possible hazards or provide instructions as how to avoid these hazards.

If the warning is placed in front of instructions the consumer is more likely to read and comply. The effectivenesss of a warning seems to depend on the ability of the warning to attract the consumers attention before contact with a hazard. The consumer can not comply unless he reads the warning and is made aware of the hazards and the means by which to protect himself against them.

The question of general effectiveness can not be definitively answered until the conditions which increase or decrease warning message

effectiveness are clearly delineated. One such condition appears to be the placement or location of the warning message.

The paradigm developed for this study or others like it can be useful for establishing conditions under which behavior may be influenced by warnings. Clearly there is a need to develop an empirical basis on which human factors specialists can base warning design decisions and evaluations.

REFERENCES

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Table 1

Percentage of behavioral compliance (use of mask and gloves) to warning message as a function of conditions (Experiment I).

Warning at Beginning	Note at Beginning	Warning at End	Note at End	Control (no warning)
90	70	50	50	10

Table 2

Percentage of behavioral compliance (use of mask and gloves) to warning message as a function of conditions (Experiment 2).

Warning at Beginning	Warnining at End with "read through" instructions	Warning at End
86.7	66.7	43.75