

The Influence of Location and Pictorials on Behavioral Compliance to Warnings

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ABSTRACT

The efficacy of two warning-related factors to produce cautionary behavior in a chemistry laboratory task was examined. Experiment 1 compared the effects of a posted-sign warning and a within-instruction warning on behavioral compliance. The results showed that a warning embedded in a set of task instructions produced significantly greater compliance (the wearing of protective gear) than a similar, larger warning posted as a sign nearby. Experiment 2 reexamined the effect of location and also examined the influence of the presence versus absence of pictorials. The results of Experiment 2 confirmed the location effect of Experiment 1. No influence of pictorials was noted, although there was a nonsignificant increase in compliance when pictorials were added to the within-instruction warning. The results indicate that warning placement is important for eliciting behavioral compliance to safety messages. Explanations such as differences in field of view and perceived relevance are discussed.

INTRODUCTION

Warnings are an increasingly common component of workplace accident prevention programs. Their purpose is to prevent injury to people, equipment, and environment. Since the mid-1980s, behavioral compliance research has begun to identify variables that affect warning effectiveness. Some of these factors include: placement in a set of instructions (Strawbridge, 1986; Wogalter, Godfrey, Fontenelle, Desaulniers, Rothstein, and Laughery, 1987), social influence (Wogalter, Allison, and McKenna, 1989), severity of the consequences (Wogalter and Barlow, 1990), inclusion of pictorials (Jaynes and Boles, 1990), voice presentation (Wogalter and Young, 1991), and effort needed to comply (Wogalter et al., 1989).

Most research investigating behavioral compliance has been conducted in laboratory settings in which warnings are placed within a set of task instructions (e.g., Jaynes and Boles, 1990; Wogalter et al., 1987, 1989). In contrast, only a few studies have examined the effects of posted-sign warnings, and until recently, all of this research has been done in field settings (Laner and Sell, 1960; Saarela, 1989; Wogalter et al., 1987; Wogalter and Young, 1991). Recently, Wogalter, Rashid, Clarke and Kalsher (1991) evaluated a posted-sign warning in a controlled laboratory setting and they noted that the level of compliance was much lower than the levels reported in earlier research in which the warnings appeared in a set of task instructions (Jaynes and Boles, 1990; Wogalter et al., 1987, 1989). No research has directly compared the effects of a posted-sign warning and a within-instruction warning in a single experiment. One purpose of the present research was to determine the relative efficacy of these two types of warnings in producing behavioral compliance.

A second purpose was to examine whether adding pictorials to a warning influences compliance. Jaynes and Boles (1990) reported greater compliance when pictorials were added to a warning in a set of task instructions. However, Wogalter et al. (1991) reported no beneficial effect of pictorials when added to a posted sign. Therefore, Experiment 2 explores the possibility that the effects of pictorials differ when they are included within a set of printed instructions versus on a posted sign.

EXPERIMENT 1

This experiment examined the effectiveness of a warning placed in two locations (on a posted-sign versus within a set of task instructions). Compliance to the warning (the wearing of protective gear), as well as several other warning-related variables, was measured.

Method

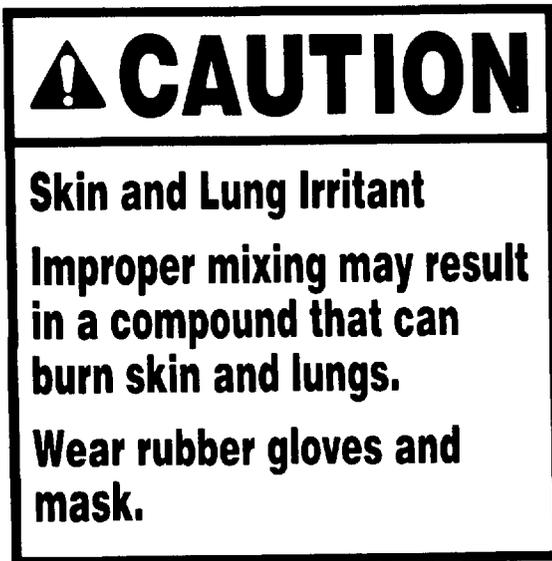
Design and participants. This experiment consisted of four between-subjects conditions: (1) no warning (control), (2) posted-sign warning, (3) warning inserted within a set of task instructions, and (4) both posted-sign and within-instruction warnings. Forty-eight Rensselaer Polytechnic Institute (RPI) undergraduate students participated and were assigned randomly to each of four conditions in equal proportions (12 per condition).

Apparatus and materials. Participants used a triple-beam balance, beakers, flasks, and graduated cylinders to weigh, measure, and mix several substances and solutions as directed by a set of chemistry laboratory task instructions. This procedure is described in more detail in Wogalter et al. (1987, 1989, 1991). The substances and solutions were disguised to appear potentially hazardous but were actually safe (e.g., flour, colored water). A large supply of plastic gloves and face masks were available next to the equipment.

The warning is shown in Figure 1. The posted warning sign was in black print on a 31 x 31 cm yellow background and was identical to the no-pictorial warning sign used by Wogalter et al. (1991). The within-instruction warning, when present, was located in the middle of the task instruction sheet and was approximately 4% the size (6 x 6 cm) of the posted sign. It was otherwise identical to the sign except it had a white rather than a yellow background. The posted warning, when present, was located so it could be seen from the doorway upon entering the laboratory room and was positioned facing the participants 1.0 m away.

Procedure. Participants were asked to read and sign a consent form which described the study as investigating the procedures and equipment involved in a chemistry laboratory task. They were told that a set of specific instructions would be available on a table in the next room. After showing

Figure 1. The Within-Instruction and Posted-Sign Warning in Experiment 1.



participants how to use a triple-beam balance, the experimenter told the participants to perform the chemistry task quickly and accurately, and then escorted them to the doorway of the adjoining room. The experimenter pointed to the laboratory table, and told the participant to enter and begin the task. Whether the participant wore the protective gear was recorded. If the participant had not completed the task within five minutes, they were told to stop. After the chemistry task, participants returned to the first room and completed a short questionnaire asking whether they saw the protective gear (mask and gloves), saw a warning of any type, and if so, what specifically did the warning say. Later, participants were debriefed and thanked for their time.

Results

Behavioral compliance. Preliminary analysis showed that if participants in the three warning-present conditions wore one piece of protective gear, they were very likely to wear the other piece, $\phi = .88$ ($N = 36$), $p < .0001$. Given this result, the first analysis of compliance used a score that counted participants as complying only if they wore *both* the mask and gloves. These compliance frequencies (and percentages) are shown in Table 1. The overall Chi-square test for these data was significant, $\chi^2(3, N = 48) = 24.67$, $p < .0001$. Greatest compliance occurred when the within-instruction warning was present. Comparisons among the individual conditions showed that all differences between

conditions were significant ($ps < .05$), except between the two within-instruction warning conditions.

Another measure of compliance was formed by summing the number of pieces of protective gear that each participant wore. This score ranged from 0 to 2. A 2 (Posted-Sign Warning: present vs. absent) X 2 (Within-Instruction Warning: present vs. absent) between-subjects analysis of variance (ANOVA) showed a significant main effect of Within-Instruction Warning, $F(1, 44) = 36.67$, $p < .0001$. The presence of the within-instruction warning ($M = 1.71$) produced significantly greater compliance than its absence ($M = 0.46$). There was no main effect of Posted-Sign Warning, but there was a significant interaction, $F(1, 44) = 4.08$, $p < .05$. Comparisons among the means using Fisher's Least Significant Difference test ($LSD = 0.58$ at $p = .05$) showed that the posted sign (only) condition produced significantly greater compliance compared to the no-warning control condition, but the posted sign produced no additional compliance when added to a within-instruction warning.

Questionnaire responses. Additional analyses examined the questionnaire responses. Table 1 shows the frequencies and percentages for the items asking participants whether they saw both pieces of protective gear and whether they saw a warning. Most participants saw the protective gear, and as a result, the Chi-square test showed no significant differences among conditions (in analyses counting both or either piece of gear). However, a significant effect was found for seeing the warning, $\chi^2(3, N = 48) = 28.70$, $p < .0001$. Paired comparisons indicated that all differences between conditions were significant, except between the two within-instruction warning conditions.

Analyses also examined whether memory of the warning differed between the conditions. On the questionnaire, participants were asked to give a specific description of the warning message. Responses were scored in two ways, by a lenient criterion and by a strict criterion. When scored according to the lenient criterion, a response was counted as correct if there was some mention about a hazard being present. Using the strict criterion, the components of the warning were broken down into 11 idea elements. The total number of elements included in each participant's response was divided by 11 to form proportion-correct scores. The memory scores are shown on the last two columns of Table 1. A 2 X 2 ANOVA on the lenient data showed a significant main effect of within-instruction warning, $F(1, 44) = 20.43$, $p < .0001$. Participants had greater lenient memory of the warning if the within-instruction warning was present ($M = .71$) than absent ($M = .17$). There were no other significant effects for the lenient

TABLE 1. Dependent Measures as a Function of Warning Condition in Experiment 1.

Condition	Compliance		Compliance Score (0-2)	See Protective Gear		See Warning		Memory	
	freq	%		freq	%	freq	%	Lenient	Strict
No warning (control)	0	0	.17	8	67	0	0	0	0
Posted-sign warning	4	33	.75	8	67	5	42	.33	.20
Within-instructions warning	11	92	1.83	12	100	11	92	.67	.32
Posted-sign and within-instructions warning	9	75	1.58	10	83	11	92	.75	.28

Note. $n = 12$ for all conditions ($N = 48$).

scores. The strict memory scores also showed a significant main effect of within-instruction warning, $F(1, 44) = 12.45$, $p < .001$. Participants had greater strict memory of the warning if the within-instruction warning was present ($M = .30$) than absent ($M = .10$). There was no main effect of posted sign, but there was a reliable interaction, $F(1, 44) = 4.69$, $p < .05$. Paired comparisons (Fisher's LSD = 0.16) showed that strict memory was significantly higher when the posted sign was present than when it was absent, but this was only true when the within-instruction warning was absent; there was no effect of the posted sign when the within-instruction warning was present.

Relation of compliance to the questionnaire responses. Lastly, the questionnaire responses were related to compliance using data from the three warning-present conditions ($N = 36$). There were substantial positive correlations between compliance and whether participants reported seeing the protective gear ($r = .70$), reported seeing the warning ($r = .90$), and remembering the warning ($r_s = .69$ and $.60$ for the lenient and strict criteria, respectively), all $p_s < .0001$. Additional correlations showed that participants who saw the warning also saw the protective gear ($r = .60$) and remembered the warning ($r_s = .68$ and $.58$ for lenient and strict memory, respectively), $p_s < .001$.

Discussion

Though all warning conditions produced greater compliance than the control condition, the within-instruction warning produced greater compliance than the posted-sign warning. This difference was found despite the fact that the within-instruction warning was much smaller and lacked the bright yellow background of the sign. These findings are consistent with the informal observation by Wogalter et al. (1991) of lower compliance to a posted-sign than to a within-instruction warning.

The questionnaire measures showed similar results. Participants were more likely to see the protective gear, see the warning, and remember it, if they were exposed to a

within-instruction warning. These measures were strongly related to compliance.

EXPERIMENT 2

This experiment reexamined the effect of location and also examined the influence of warning pictorials added to the warnings on behavioral compliance.

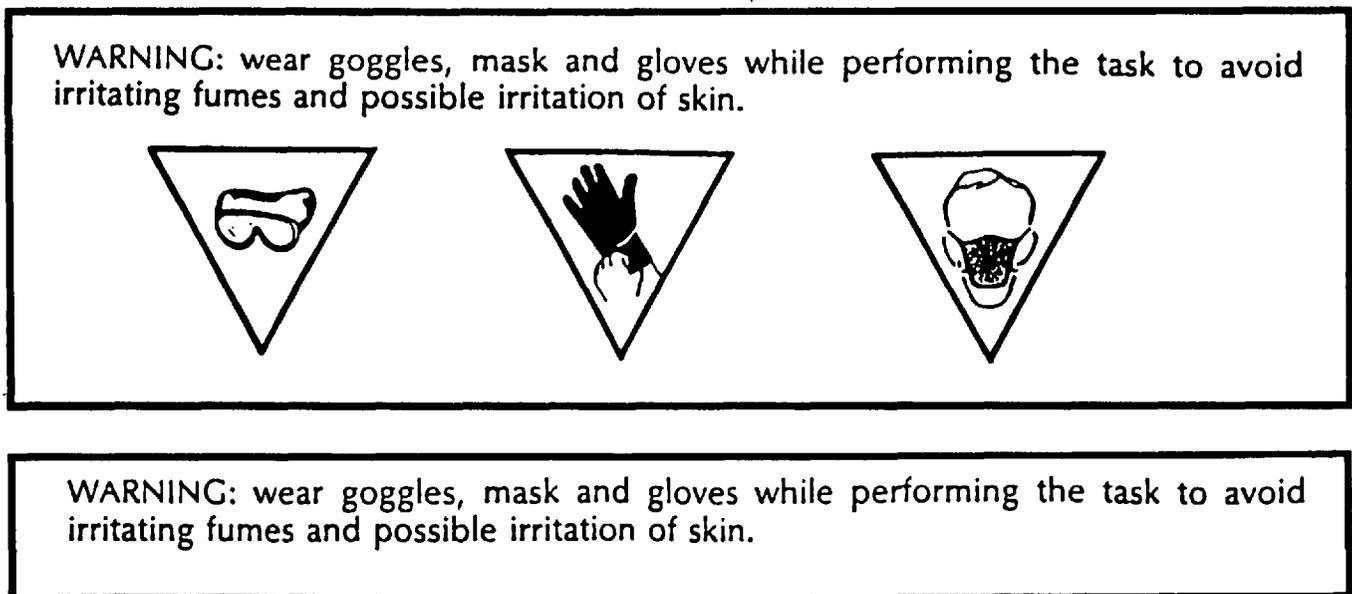
Method

Design and participants. This experiment consisted of five between-subjects conditions: (1) no warning (control), (2) posted sign, (3) posted sign with pictorials, (4) within-instruction warning, and (5) within-instruction warning with pictorials. Eighty RPI undergraduates were assigned randomly to conditions in equal proportions (16 per group).

Apparatus and materials. The apparatus and materials were similar to those used in Experiment 1 except several changes were made to replicate the conditions of an earlier study by Jaynes and Boles (1990) that examined the effects of pictorials in a set of written instructions. The identical within-instruction warnings, pictorials, and protective gear employed by Jaynes and Boles (1990) were used. Depictions of the warning with and without pictorials are shown in Figure 2.

The within-instruction warnings measured 0.80 x 14.9 cm (with pictorials) and 3.5 x 14.9 cm (without pictorials). The three pictorials were previously evaluated and shown to be adequately understood by lay persons (Collins, Lerner and Pierman, 1982). The posted-sign warning was identical to the within-instruction warning except its area was approximately 7.5 times larger, measuring 2.1 x 41.75 cm (without pictorials) and 9.5 x 41.75 cm (with pictorials). When present, the posted-sign warning was located 68 cm away from the rim of the laboratory table with the bottom edge 13 cm above the table directly in front of participants' standing position at the table. Both the within-instruction and posted-sign warnings were black print on a white background.

Figure 2. The Pictorial and Nonpictorial Warning used in the Within-Instruction and Posted-Sign Warnings of Experiment 2.



Procedure. The procedure was similar to Experiment 1 except minor changes were made to replicate the method of Jaynes and Boles (1990). One notable change was that compliance to the warning included the wearing of goggles, in addition to the mask and gloves.

Results

The same compliance measures and questionnaire response that were analyzed in Experiment 1 were examined in this experiment. Three pieces of protective gear were present and required by the warning (instead of two in the first experiment). As a result, participants had to wear all three pieces of protective gear to be counted as having complied. The compliance score now ranged from 0 to 3, and the measures of seeing the protective gear and strict memory took the goggles into account.

Behavioral compliance. Compliance frequencies and percentages are shown in Table 2. The overall Chi-square test was significant, $\chi^2(4, N = 80) = 30.76, p < .0001$. As can be seen in the table, the within-instruction warning conditions produced the highest levels of compliance. Paired comparisons among conditions showed that all differences were significant ($ps < .05$) except between the control and the two posted-sign conditions, and between the two within-instruction conditions. If participants wore one piece of protective gear, they also tended to wear the other two pieces (rs ranged from .83 to 1.0, $ps < .0001$).

The other measure of compliance was the sum of the number of pieces of protective gear that each participant wore. In this experiment, the compliance score ranged from 0 to 3. Means for this measure are shown in Table 2. A 2 (Warning Location: posted-sign vs. within-instruction) X 2 (Pictorials: presence vs. absence) between-subjects ANOVA showed a significant main effect of Warning Location, $F(1, 60) = 30.73, p < .0001$. Within-instruction warnings ($M = 2.41$) produced significantly greater compliance than posted-sign warnings ($M = 0.75$). No other effects were noted in the analysis. Additional analyses compared the experimental (warning-present) conditions to the no-warning control condition. Results showed that the no-warning control produced significantly lower compliance than the two within-instruction warning conditions, but there was no difference between the control and the two posted-sign conditions.

Questionnaire responses. Table 2 shows the frequencies and percentages of the responses to the questionnaire items asking participants whether they saw the protective gear and a warning. For seeing the protective

gear, the Chi-square test showed a significant effect of condition, $\chi^2(4, N = 80) = 21.92, p < .001$. More participants saw the protective gear in the two within-instruction conditions than the two posted-sign and no-warning conditions. The only exception was that the within-instruction warning without pictorials did not statistically differ from the posted-sign warning without pictorials. The two within-instruction conditions did not differ, and there was also no difference between the two posted-sign conditions.

The see-warning item showed a significant effect of condition, $\chi^2(4, N = 80) = 30.47, p < .0001$. Table 2 shows that participants most often noticed the warning in the within-instruction conditions. Paired comparisons indicated that all conditions were different from each other except between the two within-instruction warning conditions and between the two-posted sign conditions.

As in Experiment 1, memory of the warning was scored using a lenient and a strict criterion. In this experiment, however, to form the strict score the components of the warning were broken into eight idea units. Means of these two measures are shown in the last two columns of Table 2. A 2 X 2 ANOVA on the lenient data showed no significant effects. However, as expected, additional comparisons showed that all four warning-present conditions had significantly higher lenient memory scores than the no-warning control condition. A 2 X 2 ANOVA on the strict memory data showed a significant main effect of Warning Location, $F(1, 60) = 13.29, p < .001$. Participants in the within-instruction warning conditions ($M = .43$) had greater strict memory of the warning than participants in the posted-sign conditions ($M = .20$). There was no significant effect of Pictorials or interaction. All four warning-present conditions showed significantly greater strict memory scores than the no-warning control condition.

Relation of compliance to the questionnaire responses. Compliance in the four warning-present conditions ($N = 64$) was examined in relation to the questionnaire responses. Analyses indicated substantial positive correlations between compliance and whether participants reported seeing all three pieces of protective gear ($r = .74$), seeing the warning ($r = .80$), and remembering the warning ($rs = .59$ and $.79$ for lenient and strict memory, respectively), all $ps < .0001$. Additional correlations showed that participants who saw the warning also saw the protective gear ($r = .66$) and remembered the warning ($rs = .58$ and $.81$ for lenient and strict memory, respectively), all $ps < .0001$.

TABLE 2. Dependent Measures as a Function of Warning Condition in Experiment 2.

Condition	Compliance		Compliance Score (0-3)	See Protective Gear		See Warning		Memory	
	freq	%		freq	%	freq	%	Lenient	Strict
No warning (control)	1	6	.19	2	12	1	6	0	0
Posted-sign warning	3	19	.75	6	38	7	44	.31	.20
Posted-sign and pictorial warning	3	19	.75	5	31	7	44	.31	.20
Within-instructions warning	11	69	2.38	10	62	14	88	.56	.48
Within-instructions and pictorial warning	13	81%	2.44	14	88	14	88	.38	.38

Note. $n = 16$ for all conditions ($N = 80$).

Discussion

This experiment confirmed Experiment 1's finding that a posted sign produces a lower rate of behavioral compliance compared to the same warning appearing in a set of task instructions. The responses to the questionnaire items corroborated this conclusion. More participants in the within-instruction warning conditions saw the protective gear, saw the warning, and remembered the warning in the within-instruction warning conditions than in the posted-sign warning conditions. The posted-sign produced relatively small effects. Some of the analyses indicated that the posted signs were not significantly better than no warning.

The study failed to find a significant benefit of pictorials, although there was a positive trend of greater compliance when pictorials were present in the within-instruction warning. However, this trend was nonexistent for the questionnaire measures, and for all measures comparing the two posted-sign warning conditions.

GENERAL DISCUSSION

This research showed that a warning appearing in a set of task instructions is more effective in producing behavioral compliance than a warning on a nearby posted sign. Two explanations can be offered. First, although the sign was near the participant, it was outside of their primary field of vision. Participants were probably focusing on the chemistry materials and task directions, and not on the surrounding environment. Therefore, it is possible that the posted-sign warning was less accessible to participants because it was not contained within their main attentional focus. Second, it is possible that all participants saw the warning when it was present, but those in the within-instruction conditions might have believed that the warning was more relevant to them and to the task at hand than participants in the posted-sign conditions. In other words, participants in the within-instruction conditions might have perceived the warning to be an important component of the task because it was included in the directions relative to participants in the posted-sign conditions whose warning was separated from the task instructions.

Interestingly, no effect of pictorials was seen in Experiment 2. Though it does not confirm Jaynes and Boles' (1990) finding, it does support a failure to find pictorial effects in other behavioral compliance research (Wogalter et al., 1991). Nevertheless, there was a slight trend of higher compliance when the pictorials were included in the task instructions in this study and in Wogalter et al. (1991). A pictorial effect might have been found had a larger sample of participants been included. Nevertheless, the failure to find an effect of pictorials should not be taken as evidence that pictorials are not a potentially important component of warnings. For example, pictorials have an important function for populations unable to read verbal commands (e.g., the illiterate, children).

An implication of this research is that printed instructions and work sheets given to employees should include warnings relevant to the task and environment in which the work is performed. Within-instruction warnings might be particularly useful for less experienced employees—whose attention is likely to be focused on the instructions and tasks, and not on other aspects of the surroundings. Signs, however, could act as occasional reminders for experienced workers who no longer need written task instructions. Additionally, there may be no other available way to inform visitors of work-area hazards other than through signage.

Future research in this area should continue to investigate ways to improve signage to facilitate capturing workers' attention and to increase the perceived relevance of the information to workers and their tasks. Moreover, greater emphasis should be given to target-audience variables, such as familiarity and experience, that may have important implications on whether warnings will have their intended effect.

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