BEHAVIORAL COMPLIANCE WITH WARNINGS: EFFECTS OF STRESS AND PLACEMENT

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ABSTRACT

Research on the effectiveness of warnings has tended to focus on internal design aspects including variables such as the inclusion of various pictorials, color, and signal words. Only a few studies have examined the influence of warning-related variables that are external to the design of the warning itself although there have been some exceptions such as research on the effects of social influence and cost of compliance. Another potentially important external factor with respect to warning effectiveness is stress. Stress has been shown to influence the quality of decision-making and judgment formation in other domains. The present research examined the effects of stress and warning placement on compliance behavior. Participants were assigned randomly to one of four conditions in a 2 (Stress: lower vs. higher) x 2 (Warning Placement: as a posted sign vs. within a set of task instructions) between-subjects design experiment. In the higher stress condition, participants were given a time limit to complete the task, and during the task the experimenter stood immediately adjacent to the participant, appearing to be measuring and timing the participant's performance. Thus in this condition there were both time-pressure and social-evaluation stress. In the lower stress condition, participants were given as much time as they needed to complete the task and the experimenter stood at a distance, out of the participant's field of view. Participants performed a chemistry task in which they weighed and measured various chemical substances that appeared potentially hazardous, but were actually safe. A warning directing participants to wear mask and gloves while performing the task was present in one of the two locations. Compliance with the warning (wearing of protective equipment) was significantly higher among participants under lower stress and who were exposed to the within-instructions warning. The findings add to knowledge about the effects of external warning factors by showing that stress, such as that evoked in the present experiment, affects the extent to which warnings are complied with. Implications of these results are discussed.

INTRODUCTION

In recent years, human factors researchers have examined many kinds of factors influencing the effectiveness of warnings. Much of this research has investigated the effects of factors that are internal to the design of the warnings themselves such as the presence of pictorials, color, and the use of signal words. Many of the internal warning factors have their effects on salience which in turn tends to influence the early information-processing stages, such as noticeability (Wogalter and Young, 1992).

Relatively few studies have examined the influence of extra-warning variables. These variables do not pertain to the design aspects of the warning itself, instead they relate to other situational (person-environment) factors that are external to the warning—but still affect compliance. Many of the external factors tend to effect later information-processing stages of warnings, such as motivation, attitudes, and behaviors. Examples include the effects of social influence and cost of compliance (Wogalter, Allison, and McKenna, 1989; Wogalter, Godfrey, Fontenelle, Desaulniers, Rothstein, and Laughery, 1987). These external factors can have as large or larger effects on compliance than the internal factors comprising the warnings themselves, and thus they should be considered in systems analyses involving warnings.

Another potentially important external-warning factor that heretofore has not been examined in warning research is stress. Stress has been shown to affect the quality of people's judgments and decision-making in other domains, and may also affect compliance with warnings. For example, manipulations of psychological stressors such as time pressure, potential for electric shock, and noise have shown increased errors on cognitive tasks and greater reliance on simplified, non-analytical information-processing strategies such as heuristics and stereotypical judgments (Zakay and Wooler, 1984; Baradell and Klein, 1993). Stress has been suggested to narrow attentional focus such that other available, and possibly important, information may not be noticed or used (Ben Zur and Breznitz, 1980; Zakay and Wooler, 1984). Moreover, individuals under stress sometimes do not consider a wide range of possible alternatives and consequences of proposed actions or inaction,

but instead make judgments based on incomplete information (Janis, Defares, and Grossman, 1979) which can sometimes lead to lower quality decisions. Having adequate resources (in terms of time, energy, and information) is critical for high quality analytical decision-making (Janis and Mann, 1977).

The stressor employed in the present research was a combination of two kinds of stress: time pressure and social evaluation. Previous research on time pressure has shown a performance decrement under a variety of conditions (e.g., Klein, Calderwood and MacGregor, 1989; Moray, Dessouky, Kijowski, and Adapathya, 1991; Leon and Revelle, 1985; Verplanken, 1993). Also, social evaluation by another person has been shown to induce stress and decrease performance in a variety of tasks such as motor (Innes and Gordon, 1985) and computer learning (Schneider and Shugar, 1990). The purpose of combining both time pressure and social evaluation was to create a situation that would induce an adequate level of stress to determine whether this potential factor does or does not affect compliance. The finding of an effect would then provide impetus for further study that delineates the important components of stress affecting compliance.

The other factor manipulated in the present study was location or placement of the warning. Wogalter et al. (1987) demonstrated that a warning positioned at the beginning of the written instructions was more frequently complied with than a warning at the end of the instructions. Also, there is evidence that a conventional posted sign warning is perceived as less relevant—both to the individual and the task to be performed—than a warning included a part of a set of task instructions (Wogalter, Kalsher, Racicot, and Simpson, in press). In the present study, warning location was manipulated in a similar way to that of a study described in Wogalter, Kalsher, and Racicot, (1993). That study also showed that people comply significantly more often when a warning is included as part of the task instructions than when the warning is presented in a separate location as a much larger posted sign.

The main purpose for including the location factor in the present study was to determine whether it interacts with stress. For example, it is possible that under lower stress people would be more likely to notice a nearby posted sign, and as a consequence, compliance might be as high as for the within-instructions warning. Moreover, the combination of higher stress and the posted warning might produce lower compliance than would be predicted by individual effects of these variables alone.

METHOD

Subjects

Eighty North Carolina State University undergraduates participated for research credit in their introductory psychology courses. The participants ranged in age from 17 to 50 years (M = 21.4), included 50 males (63%) and 30 females (37%) who had, on average, 2.3 years in college.

Design

Participants were randomly assigned to each of the four between-subjects conditions as a function of Stress (lower vs. higher) and Warning Location (posted sign vs. within task instructions): (a) lower stress-posted sign, (b) lower stress-within instructions, (c) higher stress-posted sign, and (d) higher stress-within instructions. There were 20 participants in each group.

Materials

The chemistry laboratory materials were similar to those described in Wogalter et al. (1987, 1989, 1993). Actual chemistry laboratory equipment was used such as a triple-beam balance, beakers, flasks, and graduated cylinders. A supply of plastic gloves and face masks was also available on a laboratory table next to the equipment. A set of written instructions directed participants to weigh, measure, and mix several substances and solutions in a certain order. The substances and solutions were available in large glass containers and labeled by a letter (A, B, or C) to disguise their true nature. The chemicals were actually harmless: colored flour, colored water, cooking oil, salt, and powdered sugar.

In the posted-sign conditions, a warning placard measuring 21 x 21 cm (8.3 x 8.3 in) was mounted on the wall above the laboratory table containing the chemistry materials, at a location 46 cm (18 in) above the work surface and 91 cm (36 in) in front of the person performing the task. The warning consisted of black lettering on a white background that stated: "CAUTION: Skin and Lung Irritant. Improper mixing may result in a compound that can burn skin and lungs. Wear rubber gloves and mask." A signal icon (triangle-exclamation point) was located to the left of the signal word in the first line of the warning. The sign dimensions were similar to the posted sign used in Wogalter et al. (1993a) with the following print dimensions: heights of 3 cm (1.2 in) for the signal word and 1.5 cm (0.6 in) for the rest of the message. In the within-instructions condition, an identical but overall much smaller warning, 3.3 x 3.3 cm (1.3 x 1.3 in) was inserted within the written instructions containing the specific procedures participants were to follow in measuring and mixing the chemicals. In the within-instructions conditions, the warning was located after the general information about the study on top of the sheet and immediately before the specific steps of the chemistry task. In the posted-sign conditions, the warning was mounted directly in front of the participant on an otherwise bare partition wall. In the posted-sign conditions, there was no warning within the task instruction sheet; the area of the sheet occupied by the warning in the within-instruction condition was left blank in the posted-sign condition.

Participants were given a set of questionnaires requesting demographic information such as name, age, gender, year in school, and chemistry course experience. Post task questionnaires asked if they saw and read the warning and saw the masks and gloves on the laboratory table. They were also asked if they were bothered by the experimenter evaluating their task performance. In addition, several subjective stress-related measures were collected. Participants were asked the degree to which they: (a) were careful while handling the substances in this demonstration, (b) perceived the substances they were working with to be potentially harmful, and (c) found the demonstration to be stressful. They rated these items on 9-point scales with the following numerical and verbal anchors: (0) "not at all," (2) "somewhat," (4) "moderately," (6) "very," and (8)" extremely." Also included in the questionnaire set was the Cognitive Interference scale (Sarason, Sarason, and Pierce, 1990) which has separate measures of cognitive workload stress attributed to an internal focus of attention, termed Worry, and to outside interference, termed Distraction. Participants described their thoughts during the task by responding to 21 statements using a 5-point scale with the following numerical and verbal anchors: (1) "never," (2) "once," (3) "a few times," (4) "often," and (5) "very often". A third measure of the scale represents the degree to which the person believed their mind wandered during the task and involved a single rating between (0) "not at all" and (8) "very much." Several additional questionnaire measures were collected, but those results are not included in this article.

Procedure

Participants were tested individually, and first entered a small room created by free-standing partitions within a larger room. This room contained only a triple-beam balance on top of a desk. The experimenter gave oral instructions describing the task as an engineering psychology study evaluating how people perform a chemistry demonstration procedure. Participants then completed a consent form. Use of a triple-beam balance was demonstrated for those who were not familiar with it. Participants were then asked to put on a white lab coat, and were taken to the chemistry task work area, which was a separate enclosed area partitioned within the larger room and which contained the chemistry materials and equipment on a lab table. Before the participant had entered this area, the experimenter had placed the written task instructions on the laboratory table along with and next to the chemistry equipment.

In the lower stress condition, the participants were told that they had as much time as they needed to perform the task. In addition, during the mixing procedures the experimenter moved back from the lab table to a doorway 3.7 m (12 feet) behind the participant and out of the participant's field of view. The experimenter observed task performance from that less intrusive location. In the higher stress condition, the participants were told that they had a time limit to complete the entire set of chemical mixing tasks. Also, during the mixing procedures the experimenter stood within 1.5 m (5 ft) holding a clipboard. The experimenter was within the participant's peripheral visual field and appeared to be collecting time measures of the participant's performance. The higher stress subjects were told they would have only five minutes to complete the task and that a rapid pace was necessary to finish the task. Both groups were told that accuracy was important and that evaluation of their performance would be based on their final chemical product and on time to complete the task. The experimenter recorded whether the participant complied with the warning (wore mask and gloves) before mixing the chemical materials.

Table 1

Compliance as a Function of Stress and Placement Conditions

	Placement		
	Within instructions	Posted sign	*mean*
Stress			
Low	.65	.25	.45
High	.35	.15	.25
mean	.50	.20	

Task performance by both groups was stopped after five minutes (regardless of whether they finished the task), and the participants were taken back to the first partitioned area and were given a set of questionnaires to complete. After the questionnaires were completed, participants were thoroughly debriefed and thanked for participating.

RESULTS

Compliance, defined as wearing both items of protective equipment as specified in the warning, was given a score of "1" and failure to comply was given a score of "0." A 2 (Stress: lower vs. higher) x 2 (Location: Warning within instructions vs. on sign) between-subjects analysis of variance (ANOVA) was used on these data. Table 1 shows the means. The ANOVA showed a significant main effect of Stress, $F(1, 76) = 3.95$, $p = .05$, and Location, $F(1, 76) = 8.88$, $p < .001$. Participants under lower stress ($M = .45$) complied significantly more often than participants under higher stress

(M = .25). Participants exposed to the within-instructions warning (M = .50) complied significantly more often than participants exposed to the sign warning (M = .20). No significant interaction effect between these two variables was shown ($p > .05$) indicating that these two factors combine with linear, additive effects. As can be seen in Table 1, compliance ranged from a low of .15 in the higher stress-sign condition to a high of .65 in the lower stress-within instruction condition.

Similar ANOVAs were performed using the data derived from the questionnaires. Analyses showed that the Stress and Location factors produced separate effects on several of these measures. Several significant main effects of the stress manipulation were seen. The higher stress condition produced higher ratings of stress, Ms = 2.03 vs. 1.28, $F(1, 76) = 5.00$, $p < .05$, less frequent reports of seeing the protective equipment, Ms = .70 vs. .975, $F(1, 76) = 12.43$, $p < .001$, more frequent reports of the presence of the experimenter bothering them, Ms = .63 vs. .35, $F(1, 76) = 6.37$, $p < .05$, and higher scores on the Worry subtest of the Cognitive Interference scale (Ms = 22.70 vs. 19.65, $F(1, 76) = 4.82$, $p < .05$) compared to the lower stress condition. Also, the Placement independent variable produced several significant main effects on the questionnaire measures. The within-instruction warning produced higher ratings of harmfulness of the materials, Ms = 2.20 vs. 1.38, $F(1, 76) = 4.39$, $p < .05$, more frequent reports of seeing the warning, Ms = .55 vs. .23, $F(1, 76) = 10.07$, $p < .01$, reading the warning, Ms = .65 vs. .23, $F(1, 76) = 17.54$, $p < .0001$, seeing the mask, Ms = .55 vs. .20, $F(1, 76) = 11.78$, $p < .001$, and seeing the gloves, Ms = .58 vs. .28, $F(1, 76) = 8.29$, $p < .01$, than the posted-sign warning. In only one instance did the Stress and Location variables interact: for the rating of feeling stress during the experiment, $F(1, 76) = 4.34$, $p < .05$. The Newman-Keuls Multiple Range test indicated that significantly less stress was felt in the lower stress-within instructions condition (M = 0.70) compared to the other three conditions (for the lower stress-posted sign: M = 1.85; for the higher stress-within instructions: M = 2.15; for the higher stress posted sign: M = 1.90). The latter three conditions did not differ significantly.

DISCUSSION

The present experiment represents the first study that systematically manipulates stress to determine its effect on behavior compliance with warnings. The results showed that stress, as defined in this study as increased time pressure and social evaluation anxiety, produced significantly lower compliance than the lower stress condition in which there was less apparent time pressure and social evaluation. Of the 28 participants who complied with the warning, 21 reported noticing the warning first. Of those who noticed the warning and complied, more were in the lower stress conditions (n = 13) than in the higher stress conditions (n = 8). Only 2 of 21 compliers were in the higher stress, posted-sign condition.

That participants in the higher-stress conditions did indeed feel some stress was confirmed not only by the compliance effects but also from the questionnaire results showing higher ratings of stressfulness, being bothered to a greater extent by the experimenter's presence, and higher scores on the Worry subtest of the Cognitive Interference Scale. The Worry subtest is indicative of self-focus or preoccupation with one's performance, as with test anxiety. This internal focus, as expected, seemed to interfere with cognitive processing. In addition, under higher stress the reports of seeing the protective equipment were less frequent—an effect that would be expected if the stress was narrowing attentional focus.

Warning placement was also found to produce a main effect on behavioral compliance. More participants complied with the within-instruction warning than the posted-sign warning, even though the sign was over 40 times larger in terms of area than the warning in the instructions. Although the posted sign was somewhat more distant from the participant than the within-instruction warning, under the conditions in this experiment the larger posted sign was not so distant as to produce a smaller visual angle on the retina than the within-instructions warning (for the position in which they stood and handled the instruction sheet at the chemistry work area). This location effect confirms the findings of several studies including Wogalter et al. (1993a) which showed that placing the warning in a location where participants are known to look (in this case the chemistry task instruction) produces higher compliance than placing it in locations that participants are less likely to look (in this case, a sign). It had been expected that under lower stress the difference in compliance between the two locations would decrease or disappear because under lower stress participants would have more time to look around. However, this effect was not found. Other recent research (Wogalter et al., 1993a; Wogalter, Kalsher, Racicot and Simpson, 1993b, in press) has noted that the effectiveness of a sign can be influenced by the extent to which participants believe the warning is specifically directed to them. The posted sign is somewhat ambiguous in terms of to whom it is directed and whether it is appropriate to the task that the participant is assigned to do. The same warning in the instructions is much less ambiguous as to whom it is directed and whether its directives are required in the set of tasks they are to perform.

The stress and the location factors produced additive linear effects, as there was no significant interaction of the two factors. Of the two independent variables manipulated in this experiment, warning placement had the larger effect on compliance.

Efforts were made to create an environment where exposure to a hazard seemed possible and the setting seemed moderately realistic. These efforts included the requirement that participants sign a consent form, that they wear a lab coat, that they make use of actual chemistry laboratory

equipment and disguised chemicals, the provision of protective equipment, and the presentation of a warning. Despite these factors, compliance tended to be lower than in some previously published reports using similar methods. During debriefing, informal data was collected from persons who did not comply with the warning. Some of them mentioned that they did not believe the materials to be particularly harmful or that the consequences and likelihood of failing to comply were too low, although several of these same noncompliers did express some lack of certainty about what they were handling, mentioning that they had insufficient information on which to base their judgments. Interestingly, many of the compliers expressed the same uncertainty, giving this as a reason for why they complied. Some of the noncompliers also commented that they knew they could not be placed into a highly dangerous situation. A few with chemistry laboratory experience mentioned that they were surprised that they were not asked to wear goggles, but many of these individuals donned the requested protective equipment anyway. Lastly, some of the noncompliers noted that they did not expect to get any of the chemicals on themselves so they felt that they did not need to wear protective gear. Together, these factors might have led to the lower overall compliance rate seen in this experiment.

Generally, when attempts are undertaken to increase the levels of warning compliance, the methodologies employed are usually based on enhancing the internal design characteristics of warnings. This study calls attention to the fact that variables external to the warnings can have a significant effect on compliance with warnings. Thus, in designing systems that contain warnings, it becomes important that consideration be given to likely levels of stress experienced by people in that situation. In some cases, the work situation itself might produce stress (such as severe time pressures and social evaluations from supervisors and co-workers). However, it also needs to be recognized that people's stress levels are affected by other aspects of their lives which vary from person to person and day to day.

Finally, it should be noted that in the current experiment, the stress factor was comprised of two factors: time pressure and social evaluation. Thus, it is not possible to determine the individual effects of each of these stressors or which had the greater influence on compliance (or on the other measures). Additional research is needed to disentangle the effects of these and other stressors on warning compliance.

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