Behavioral Compliance to In-Manual and On-Product Warnings

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Warnings have several purposes, including the communication of hazard information and promotion of safe behavior. The present study examined how compliance is affected by viewing duration of product manual warnings and the presence and content of on-product warnings for a computer memory installation task involving an electrostatic discharge hazard. Analyses showed that both the presence of an ANSI-style label and longer manual exposure increased behavioral compliance. The additive effect of exposure time and label presence and content suggest that both previous exposure to warning information and effective on-product warning design benefit compliance.

INTRODUCTION

Warnings are a form of safety communication, intended to inform persons about hazards and minimize undesirable consequences such as illness, injury, or property damage (e.g., Wogalter & Dingus, 1999; Wogalter & Laughery, 2006). Warnings have several established purposes (e.g., Wogalter & Laughery, 2006). First, warnings are a means for conveying important safety-related information to users, allowing them to make well-informed decisions regarding product usage. Second, warnings attempt to minimize injuries, illnesses, and property damage associated with product usage. Third, these authors suggest that warnings can act as reminders, cuing information that is stored in long-term memory and prompting awareness of a particular hazard. The third purpose has not received much experimental attention.

Well designed warnings enhance compliance during hazardous circumstances (Wogalter et al., 1987). A substantial amount of empirical research on warning effectiveness has aided the development of principles for warning design (see, e.g., Wogalter, Conzola, & Smith-Jackson, 2002). Generally, warnings should include information about potential hazards, their consequences, and instructions for avoiding the hazards (e.g., Wogalter & Laughery, 2006). Warnings should be placed physically and temporally close to the hazard (Frantz & Rhodes, 1993; Wogalter, Barlow, & Murphy, 1995). This addresses potential problems related to memory. If the warning is physically distant in location and time when needed, the safety-related information could be forgotten and absent from awareness.

Since consumers may not always have the manual available when encountering a hazard, warnings viewed at one point in time should be carried in memory over time to when relevant during product use. Warning presentation should facilitate both initial comprehension and later recall of a hazard and ways to avoid it. Limited research has not specifically evaluated the effectiveness of warnings as reminders. In one study, Young and Wogalter (1990) found that warning recall was better when icons (i.e., pictorials or safety symbols) were present at study and at test. In that study, icons were used to cue retrieval of previously studied information and conceptual information.

When warnings are intended to serve as reminders, their presence presumably generates awareness of a particular hazard by summoning information from long-term memory into working memory. Working memory refers to the processes used for temporarily storing and manipulating a limited amount of information during rehearsal, reasoning, and other mental procedures (Baddeley, 1986). Long-term memory refers to the more permanent storage system from which information can be retrieved and utilized within working memory. In other words, working memory allows individuals to consciously attend to and use a limited amount of information stored in long-term memory for making decisions and selecting appropriate actions.

One of the presumed purposes of reading a product manual is to learn about proper product use. Sometimes, a product manual may not be present and one must summon information learned previously, hopefully by reading the manual or parts of it. The present study examined the effects of manual exposure and the presence and content of on-product warning labels on behavioral compliance. Behavioral compliance is often considered one of the most important measures of warning effectiveness. The present task presented a risk/hazard to the equipment during a consumer task of installing additional memory to a desktop computer.

METHOD

Participants

A total of 207 undergraduate students from introductory psychology courses at North Carolina State University participated in the study. The first 20 were in a pilot study. The remaining 187 participants (M = 18.7 years, SD = 2.19; 52.2% female) were in the main experiment and were randomly assigned to one of the eight conditions.

When the participants signed up, the purpose of the research was described as "investigating the effects of branding on the selection and use of consumer products." The purpose of this ambiguous information at the outset was to avoid signaling to participants that the real purpose of the

study pertained to warnings. This was done so that participants would behave in the task in an ecologically-valid way (i.e., without cuing participants to pay particular attention to the warnings).

After the main experimental task was completed participants gave ratings of prior experience and hazardousness of the task. Mean reported experience with the task of installing RAM into a computer was slightly below "somewhat experienced" (M = 1.66, SD = 2.42) on a 9-point scale ranging from (0) "not at all experienced," (2) "somewhat experienced," (4) "experienced," (6) "very experienced," and (8) "extremely experienced." Mean perceived hazard of the memory installation task was between "somewhat hazardous" and "hazardous" (M = 2.79, SD = 2.35) on a 9-point scale ranging from (0) "not at all hazardous," (2) "somewhat hazardous," (4) "hazardous," (6) "very hazardous," and (8) "extremely hazardous."

Materials

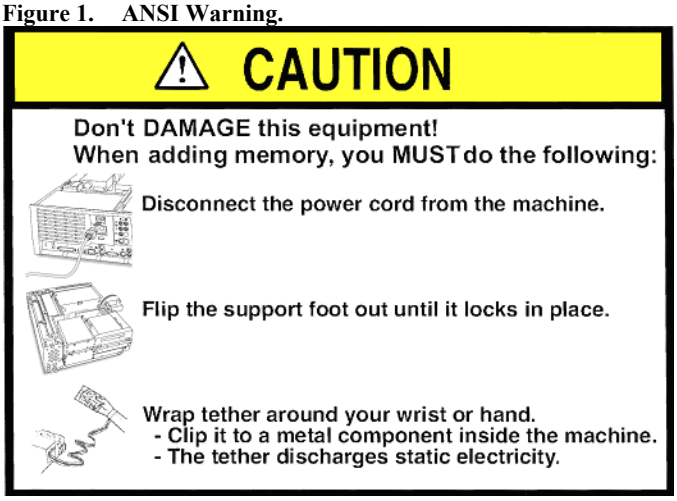
Participants were given selected pages from an Apple Macintosh 7500 product manual, specifically the pages regarding the installation of additional memory. The memory installation process as described in the manual states:

Please follow the steps below to avoid injury or damage to the equipment when adding a memory chip to your computer:

1. Disconnect the power cord from the back of the computer. To open the main cover, the cord must first be removed from the machine
2. Flip the support foot out until it locks in place. After opening the machine, the main cover must rest on the support foot.
3. Wrap the tether around your wrist or hand and clip it to a metal component. The tether is used to discharge static electricity.

Freeman (2003) created a warning label containing the above information based upon the ANSI Z535.4 (2002) design guidelines. The warning label displayed in Figure 1 was placed in the product manual given to all participants. It had a yellow signal word panel containing an alert triangle and the signal word, "CAUTION." In addition, a pictorial symbol appeared next to each of three instructions listed on the label.

Figure 1. ANSI Warning.



Note: Actual Size is 9.7 x 14.0 cm (3.8 x 5.5 inch)

There were four on-product warning label conditions: (1) ANSI-style, (2) blurred ANSI-style, (3) general warning, and (4) no label. For the first condition, the ANSI-type label described in Figure 1 was also placed on the product itself. The second condition included a version of the ANSI-style label was blurred using the blur tool in Adobe Photoshop. The blurred label included the same formatting as the ANSI-style label; however, the pictorials and text instructions were illegible. The third condition used a general warning label included the yellow signal word panel, but only nonspecific text, stating: "Incorrect installation can damage your computer." These labels were conspicuously placed on the product itself, in a location likely to be viewed during the memory installation task. The salience of the warnings and their location was confirmed during a pilot study. In the fourth condition, no label was present on the product.

Design

The experiment was a between-subjects factorial design: 2 manual (manual exposure time: 15 seconds vs. 300 seconds) x 4 [on-product warning: (a) ANSI style, (b) blurred ANSI style, (c) general, vs. (d) no warning.]

Procedure

The memory DIMM installation task was selected for two reasons. One was because previous research (Freeman, 2003) showed that the task was unfamiliar to participants. The other reason was that earlier research suggested that people were motivated to comply with the warning to avoid damaging the equipment, even though no personal risk existed.

To ensure a consistent experience across participants, a script was used for the various instructions given by the experimenter. The participants were given a selected portion of an owner's manual for a computer, which included warnings and instructions related to the installation of DIMM memory. Instead of using a no manual exposure condition, a very brief manual-exposure condition (15 seconds) was used

to ensure consistency in procedures across the manual exposure conditions. Freeman (2003) found that 5 minutes (300 seconds) of exposure was an adequate amount of time for persons to read and comprehend and remember identical manual information. After manual exposure (for either 15 seconds or 5 minutes), the manual was taken away and the individual completed a 10-minute distracter task unrelated to the completion of the experimental task. The purpose of the distracter task was to decrease rehearsal of the information related to the task and assimilation of the information into long-term memory (e.g., Baddeley, 1986).

After the distracter task, participants were led into an adjacent room where the computer was located. Participants were then asked to complete the installation task without access to the product manual. The outer cover of the computer was partially removed from the computer because the cover itself was difficult to remove. The end of the power cord was plugged into a surge protector that was visible to participants; however, the surge protector power cord was hidden behind a nearby table out of the participant's view and not plugged into an outlet for safety reasons.

While the content of warning information placed upon the product varied, the location of the warning remained constant. The ANSI-style, blurred ANSI, and general warning labels were adhered to the computer's power supply. This was a conspicuous location as it was located where individuals were to install the memory DIMM. All of the participants in the earlier pilot study reported noticing the warning in this location in the conditions during which one was present.

The memory DIMM and wrist tether were located next to each other to the right of the computer; the wrist tether was clearly visible to participants as they retrieved the memory to complete the installation task once the computer was open. The wrist tether is a device that is used to prevent product damage resulting from electrostatic discharge. One end of the tether is intended to be placed around one's wrist or palm and includes a plastic loop; the other end of the tether should be adhered to a metal part while handling and installing the memory.

During the installation attempt, the experimenter was located approximately 1.5 m (5 feet) to the right of the participant in a position that allowed viewing their actions. The experimenter asked the participant to install the memory DIMM and to notify him when the participant thought the memory installation was completed or when the participant was unable to continue any further. The experimenter recorded whether each step in the process was successfully completed. In addition, the experimenter demonstrated the proper method for unplugging the power cord if either a participant made five unsuccessful attempts to rotate the internal component tray or indicated that they could progress no further in the task prior to unplugging the cord.

RESULTS

Behavioral compliance scores were established by observing whether particular steps (i.e., unplugging the power plug, use of the support foot, and use of tether) were properly performed during the memory installation task. Properly performing a particular step was coded as "1"; failure to perform a particular step was coded as "0." Percentages for behavioral compliance are provided below in Table 1.

Total Compliance Score

An average 'Total Compliance' score was computed for each condition by adding the three above-mentioned steps properly completed by each participant and converting to proportions complied. An ANOVA using exposure time to the manual (15 or 300 seconds) and warning-type (no, general, blurred, ANSI) yielded significant main effects for exposure time to the manual, $F(1, 187) = 74.7$, $p < .001$, and presence and warning type, $F(3, 187) = 11.7$, $p < .001$. The interaction between manual exposure and presence and type of on-product warning was not significant, $F(3, 187) = 0.65$, $p = .59$.

The pattern of means was as follows. Total compliance was significantly higher for the 300 second manual exposure condition ($M = 1.76$) than the 15 second manual condition ($M = 0.68$). For the on-product warning means, post hoc comparisons using Tukey's Honestly Significant Difference (HSD) test showed that the ANSI warning label ($M = 1.84$) produced higher compliance than the no ($M = 1.04$), general ($M = 0.80$), and blurred ($M = 1.20$) warning conditions, $p < .001$. The difference between the blurred ($M = 1.20$) and general ($M = 0.80$) warning conditions just missed being significant at the conventional probability level of .053. The total compliance means are provided in Table 2.

Table 1. Percentage Behavioral Compliance as a Function of Manual-Exposure Time and Presence and Content of On-Product Warning.

Manual Exposure	On-Product Label	Task Compliance (%) Unplugged	Support Foot	Tether
15 seconds				
	None	22.2	22.2	5.6
	General	23.1	15.4	0.0
	Blurred	18.5	29.6	7.4
	ANSI	64.7	47.1	17.6
	mean	*32.1*	*28.6*	*7.7*
300 seconds				
	None	63.0	66.7	29.6
	General	34.8	69.6	17.4
	Blurred	77.8	81.5	25.9
	ANSI	95.7	91.3	52.2
	mean	*67.8*	*77.3*	*31.3*
Overall				
	None	42.6	44.4	17.6
	General	28.9	42.5	8.7
	Blurred	48.1	55.6	16.7
	ANSI	80.2	69.2	34.9
	mean	*50.0*	*52.9*	*19.5*

Note: "Overall" within the manual column is a combination of the participants from the "15 and 300 seconds conditions.

Table 2. Total Compliance (0-3) as a Function of Manual Exposure Duration and Presence and Content of On-Product Warning.

On-Product Label	Product Manual Exposure Duration 15 sec	300 sec	mean
None	0.50	1.59	1.05
General	0.39	1.22	0.80
Blurred	0.56	1.85	1.20
ANSI	1.29	2.39	1.84
mean	0.68	1.76	

Nonparametric Analyses

Behavioral Compliance. Statistical analyses using Kruskal-Wallis tests revealed significant differences between the conditions for all three behavior compliance measures: unplugging power cord ($\chi^2(7, N = 187) = 56.4$, $p < .001$), flipping out the support foot ($\chi^2(7, N = 187) = 54.5$, $p < .001$), and wearing the wrist tether ($\chi^2(7, N = 188) = 28.9$, $p < .001$).

Post hoc paired comparisons were made using Mann-Whitney U test to analyze the following specific effect: (1) the presence of the ANSI warning regardless of manual condition to examine the effect of the label alone, (2) short vs. long exposure to the manual in the no warning condition to examine effect of manual alone, (3) the presence of the ANSI warning and longer exposure to the manual to examine the effect of the manual and label together, (4) the effects of general warning label versus an explicit one (i.e., ANSI), (5) the effects of a general warning label versus the no warning regardless of manual condition, (6) blurred warning versus general warning, and (7) the presence of an ANSI warning versus a general warning in the longer exposure condition. See Table 1 for mean percentages in these conditions.

1. *Presence of ANSI warning versus no on-product warning.* Compliance for unplugging the power cord ($U(N = 85) = 577.5$, $p < .01$) and flipping out the support foot ($U(N = 85) = 687.5$, $p < .05$) were significantly higher in the ANSI warning than in the no warning condition. The difference for wearing the wrist tether ($U(N = 85) = 742.5$, $p = .08$) was not significant at conventional levels of significance.
2. *Long vs. short manual exposure in the no on-product warning condition.* Compliance for unplugging the power cord ($U(N = 45) = 144.0$, $p < .01$), flipping out the support foot ($U(N = 45) = 135.0$, $p < .01$), and wearing the wrist tether ($U(N = 45) = 184.5$, $p = .05$) were significantly higher in the 300 second than in the 15 second exposure to the manual in the no on-product warning conditions.
3. *Presence of on-product ANSI warning and longer manual exposure versus the shorter, no on-product warning conditions.* Compliance levels for unplugging the power cord ($U(N = 41) = 55.0$, $p < .001$), flipping out the support foot ($U(N = 41) = 64.0$, $p < .001$), and wearing the wrist tether ($U(N = 41) = 110.5$, $p < .01$) were significantly higher with longer exposure to the manual and ANSI on product label compared with the shorter manual exposure and no on-product warning.
4. *Presence of on-product ANSI warning versus on-product general warning.* Compliance for unplugging the power cord ($U(N = 89) = 451.5$, $p < .001$), flipping out the support foot ($U(N = 89) = 669.5$, $p < .01$), and wearing the wrist tether ($U(N = 89) = 692.5$, $p < .01$) was higher in the ANSI warning than the general warning conditions.
5. *Presence of the on-product general warning versus the absence of an on-product warning condition.* Compliance for unplugging the power cord ($U(N = 94) = 451.5$, $p = .071$), flipping out the support foot ($U(N = 94) = 64.0$, $p = .434$), and wearing the wrist tether ($U(N = 94) = 972.0$, $p = .099$) was not significantly different between the ANSI and the general warning conditions.
6. *Presence of blurred warning versus general warning.* Compliance for unplugging the power cord ($U(N = 103) = 1064.5$, $p < .05$) was significantly higher in the blurred warning condition than in the general warning condition, regardless of manual exposure. Flipping out the support foot ($U(N = 103) = 1128.0$, $p = .137$) and wearing the wrist tether ($U(N = 103) = 1210.5$, $p = .197$) were not statistically significant.
7. *Presence of the ANSI-warning versus General warning in the 300 second manual exposure condition.* For individuals in the longer manual exposure condition, compliance for unplugging the power cord ($U(N = 46) = 103.5$, $p < .001$) and wearing the wrist tether ($U(N = 46) = 172.5$, $p < .02$) were significantly higher in the ANSI-style warning condition than in the general on-product warning condition. Flipping out the support foot ($U(N = 46) = 207.0$, $p = .07$)) was not statistically significant at conventional levels.

DISCUSSION

The present study examined the effects of manual exposure and presence and content of an on-product warning on behavioral compliance. This is one of relatively few warning compliance studies examining manual and on-product label type in a single study.

The presence of the ANSI-type label resulted in higher compliance for properly unplugging the power cord and flipping out the support foot versus than the no warning condition. The results also showed that the general warning condition describing a nonspecific hazard had a relatively low compliance rate and not significantly different from no warning. Telling people explicitly what to do is beneficial for warning effectiveness.

Like Freeman (2003), behavioral compliance scores were notably higher for the longer manual exposure condition than for the lower manual exposure condition. This supports the notion that adequate time is needed to encode information into long-term memory. Further, this reinforces the importance of making safety-related information easy to access and locate, both within product manuals and through

other media such as websites to maximize the likelihood of a user finding, reading, and utilizing the information. However, it is important to note that even an ANSI warning needs adequate time for review.

Also, as predicted, longer exposure to the product manual combined with the presence of the ANSI-style label resulted in the highest levels of compliance for each of the precursor tasks. In addition, the presence of the ANSI on-product warning resulted in the highest levels of compliance within the shorter manual exposure condition. These additive effects support the importance of on-product warnings as a primary method for exposing users to safety-related information and the suggestion that on-product warnings can be useful even for known hazards (Wogalter & Laughery, 2006).

Thus, on-product warnings can increase compliance even when users have been previously exposed to the warning information. This was evidenced by the significantly higher compliance for unplugging the power cord and the wearing of the wrist tether by participants who were given extra time to encode the product manual warning information into long-term memory. The largest effect was produced by participants exposed to the ANSI on-product warning (as compared to the general or no warning) during the installation task. Also, participants in the longer-exposure condition who were exposed to the blurred ANSI warning condition more often complied than the participants in the general warning condition for each task, suggesting a reminder effect. Participants in the blurred ANSI warning were generally more likely to successfully comply than the general warning for each task.

Using identical (or similarly formatted) information within the product manual may increase the effectiveness of a secondary exposure to a warning and the likelihood of compliance, even when only some of the warning's content is presented on the product itself. This may have important implications for the way product warnings and warning information are designed, given that it is common to find lists of safety-related instructions in manuals, but less information on the product itself. Labels may cue information in long-term memory, even though that information is not presented on the label itself, and thus be useful for increasing the likelihood of safe use.

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