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SEVERITY MESSAGE FROM HAZARD ALERT SYMBOL ON CAUTION SIGNS

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Standards for the design of signal word panels specify different combinations of colors, signal words, and a hazard alert symbol. The warning sign standards of the American National Standards Institute specify a yellow signal word panel, with the word Caution and a hazard alert symbol, for signs marking people hazards. The same panel, without the symbol, is intended for property hazards. The purpose of this study was to determine if the presence or absence of the symbol effectively conveys the intended severity messages. A sample of 59 college students rated their impressions of a Caution sign with and without the symbol. Subjects rated the plain Caution sign as communicating significantly higher severity levels than property damage, indicating that a yellow Caution sign inaccurately communicates a hazard to property. Subjects rated the sign with the symbol as connoting significantly greater severity than the sign without the symbol.

INTRODUCTION

Methods for controlling hazards include engineering and behavioral methods. Engineering methods include eliminating hazards, minimizing the degree of hazard, and controlling the hazard with guards and other safety devices. Behavioral methods commonly used in the workplace include establishing standard operating procedures, training personnel, providing appropriate instructional material, providing personal protective equipment, and placing warning signs and safety information signs in appropriate locations. While less reliable than engineering methods, behavioral methods play a significant role in workplace and product safety. Each of these behavioral methods serves to enable personnel to behave safely if they decide to do so.

Decisions regarding safety-related behavior are influenced by many factors. A plausible theory is that people weigh costs and benefits in their decisions (Edworthy, 1998). The weighting is a subjective process partially determined by the individual's understanding of cost to comply and benefits from compliance.

Costs typically involve hazard-specific effort to comply with safe practices, while benefits involve avoidance of harm. By providing accurate information

about the hazard, warning signs can contribute to a more accurate perception of hazardousness among those who notice and pay attention to the sign. Perceived hazardousness plays a critical role in the cost-benefit balancing process leading to behavioral decisions (DeJoy, 1998).

Perceived hazardousness is affected by severity and likelihood. Severity appears to have a stronger influence on perceived hazardousness than likelihood for non-catastrophic hazards (DeJoy, 1998; Wogalter, Young, Brelsford, & Barlow, 1999). Therefore, the severity information in warning signs is an important characteristic for helping people formulate accurate hazard perceptions. Since sign manufacturers often follow national and international standards, the standards development committees should also seek to communicate accurate severity information through their standardized sign components.

Sign Design and Standardization

Sign standardization is an evolving process that seeks uniformity of overall sign design while preserving flexibility for hazard-specific messages and symbols. A fundamental element of safety signs is the signal word panel located at the top of the sign. The colors and words

in this panel are intended to convey information about the message of the sign, including severity of foreseeable harm associated with the hazard.

The standard of the American National Standards Institute (ANSI Z535 Committee on Safety Signs and Colors, 1998a and 2002) specifies which signal word panel format to use based on severity, likelihood, and imminence (Jensen, 2001). The three severity categories are: 1) property damage, 2) minor or moderate injury, and 3) death or serious injury. The standard for a hazard involving property damage severity specifies the signal word Caution stands alone in a yellow signal word panel. For a hazard involving minor or moderate injury, the standard specifies a "safety alert symbol" left of the word Caution in a yellow signal-word panel. For a hazard involving death or serious injury, the standard specifies the symbol left of either a Warning or Danger signal word on an orange or red background, respectively. The symbol, or icon, in the standard is an exclamation inside a triangle. Because this symbol is actually specified to mark a hazard to personnel, rather than a safe condition, we choose to call it a "hazard alert symbol." The term "hazard alert symbol" is also used by Miller and Lehto (2001) in reference to literature on the symbol.

A prior study examined responses of 135 individuals to signs with signal word panels with and without a hazard alert symbol (Wogalter, Jarrad, & Simpson, 1994). The symbol was used with two signal words, Danger and Lethal. Ratings of overall hazardousness were not significantly different for signs with and without the symbol. The investigators recommended further research to confirm the lack of effect on rating of hazardousness, and specifically to examine the symbol with signal words of lesser hazard level than Lethal and Danger.

A study was designed to extend the findings of Wogalter et al. (1994) by introducing two important differences. First, instead of using the overall hazardousness rating scale, the present study used a rating scale for severity derived from the severity levels used in ANSI sign standards. Second, instead of using the signal words Lethal and Danger, the present study used the signal word Caution. The reason for these differences was a desire to directly examine the specified uses for the symbol in the ANSI standard for facility safety signs (ANSI Z535 Committee on Safety Signs and Colors, 1998a and 2002).

Purpose

The purpose of the study was to determine if college students would form impressions of the two signs consistent with the meanings specified in the ANSI Standard. One meaning found in the ANSI Standard is that a plain Caution sign indicates a property hazard. A second meaning is that a Caution sign with the symbol connotes a greater severity than the same sign without the symbol. Consequently, the study specifically sought answers to two questions:

1. Would students rate a Caution sign without the symbol as indicating a property damage severity level?
2. Would students rate the sign with the symbol as connoting higher severity than the sign without the symbol?

METHODS

Subject Population

The sample population consisted of 59 college students attending Montana Tech of the University of Montana. Of the students, 52.5 percent were male (31), and 47.5 percent were female (28). Tests were conducted in a classroom. None of the 59 reported having prior training on safety signs. Each subject signed an Informed Consent Form prior to participation, and each received a small stipend at the conclusion of testing.

Materials

Twelve signs were included in a masters thesis project by McCammack (2001). Two of the signs had a yellow background with the word Caution in black capital letters. One of these signs also had a hazard alert symbol. These signal word panels are shown in Figure 1. This paper is limited to results from these two yellow signs. The other ten signs consisted of five with different signal words on a gray background, and five with a nonsense word on different colored backgrounds.

All signs had a text panel containing repetitions of the letter x in what appeared to be a sentence format. This approach was copied from the study by Wogalter, Kalsher, Frederick, Magurno, and Brewster (1998). The reason for this was to make the sign appear similar to safety and health signs encountered in a workplace setting while not containing a word message that might influence ratings of signal-word panel properties.

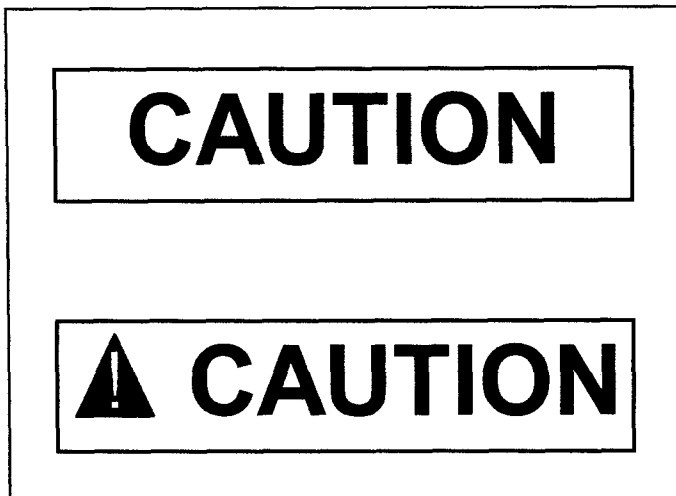


Figure 1. The signal-word panels compared. Both have the same yellow background color.

The question and rating scale for this part of the study was: "This style of sign seems appropriate for a hazard that will cause:

- Property damage
- Minor injury
- Moderate injury
- Serious injury
- Death"

Signs were developed using Maxisoft software and then printed on 8.5 by 11 inch photograph quality paper. The yellow color matched that of safety color samples obtained from Munsell Color Services for standard safety yellow (Munsell 5.0Y 8.0/12). This is the yellow specified in the ANSI standard on colors (ANSI Z535 Committee on Safety Signs and Colors, 1998b).

Procedure

The experiment used a randomized complete block design (also known as a repeated-measures design). Subjects were the blocking variable and the signs were the treatments. Subjects were tested in nine small groups. After explaining the study and obtaining informed consents, students were shown examples of what they would see and be asked to do. After the briefing, subjects were handed an answer booklet and the experiment commenced. The subjects first read a paragraph restating the instructions and answered three questions about their age, gender, and whether they had previous training in how to interpret workplace safety signs. When everyone was finished with this portion of the survey, 12 signs were shown at 45-second intervals in a predetermined random order. On a page in the answer booklet, subjects

were asked three questions, each followed by a rating scale. Students viewed a sign and then rated it on each scale.

Then subjects turned to another page in their answer book containing three other questions and rating scales. Each sign was displayed again and subjects rated it on the three rating scales.

Statistical Analyses

Response categories were assigned numerical values from zero for property damage to four for death. Statistical analyses were performed using Minitab software. A Wilcoxon signed-rank test (Hollander & Wolfe, 1973) was used to test the difference between ratings for the plain Caution sign and the expected ratings according to the ANSI Standard. The expected rating for a property damage hazard, using the rating scale, was zero.

A sign test for paired data was used for determining if the presence of the hazard alert symbol on a Caution sign had an effect on ratings. The data set had 59 pairs of ratings for the Caution signs depicted in Figure 1. The alternative hypothesis was the ratings for the sign with the symbol were greater than the sign without the symbol.

RESULTS

The plain Caution sign received higher ratings than property damage from 57 of 59 subjects. Using a two-sided test, the median rating (2), was significantly different ($p < 0.0001$) from a property damage rating (0). A one-sided test also indicated that the median rating was significantly greater than zero ($p < 0.0001$, Wilcoxon Statistic = 1653).

The sign with the symbol received significantly higher ratings ($p < 0.00001$) than the sign without the symbol. Response frequency distributions are listed in Table 1. For signs with the hazard alert symbol, the median rating was serious injury (3). For signs without the alert symbol, the median rating was moderate injury (2). Subject-specific rating differences are shown as a histogram in Figure 2. The right-sided density of the distribution indicates higher ratings for the sign with the symbol. Signs with the symbol received higher severity rating from 44.1% of subjects (3.4% two levels higher plus 40.7% one level higher). The signs received equal ratings from 52.5% of subjects. Only 3.4% of the subjects gave lower ratings to the sign with the symbol.

Table 1. Frequency Distributions of Ratings for Signs With and Without the Symbol

Rating Category	With Symbol		Without Symbol	
	N	%	N	%
Death 4	4	7	0	0
Serious Injury 3	31	53	20	34
Moderate Injury 2	16	27	25	42
Minor Injury 1	6	10	12	20
Property Damage 0	2	3	2	3

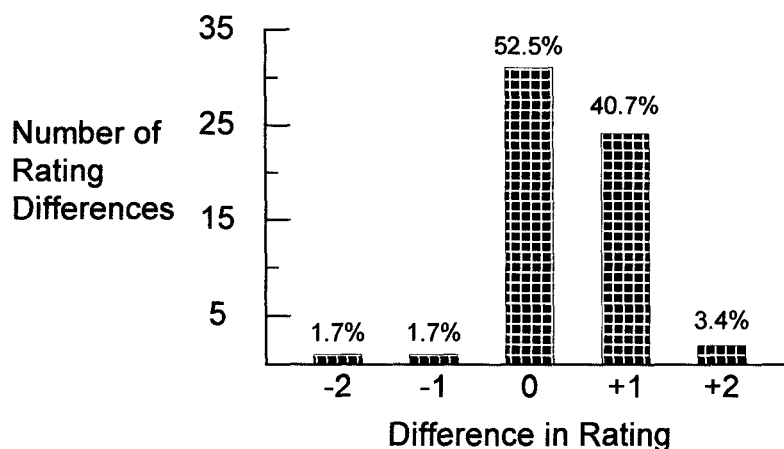


Figure 2. Frequency of 59 rating differences (with symbol minus without symbol)

DISCUSSION

Property Damage?

The first question this study sought to answer was: Would the students rate a Caution sign without the symbol as indicating a property damage severity? The answer is no. These results do not support the ANSI standard as to using a Caution sign without the hazard alert symbol to indicate property damage. Only 3 percent of subjects in this study judged the plain Caution sign as indicating a severity level as low as property damage. Nearly all ratings were distributed among the minor, moderate, and serious injury categories, with the median rating being moderate injury.

The rating scale may have influenced this result. The five rating categories used ranged from property damage to death. It may be that subjects were reluctant to use the

lowest response category for a Caution sign. If the response scale had included a lower severity category (e.g., no harm), subjects might have been more inclined to rate the Caution signs in the minor injury and property damage categories. The rating distribution shown in Table 1 indicates a tendency to use the middle severity categories for the Caution sign. Thus, had the rating scale included a no harm category, the response distribution might have shifted from a central tendency in the moderate injury category to a somewhat lower level, perhaps the minor injury category. It is very unlikely that such a change in the scale would have shifted the median rating into the property damage category.

Implications from this finding may be of use for a future revision of the ANSI safety sign standards. It appears that a yellow signal word panel with the word Caution conveys a message of a hazard greater than property damage. Perhaps an alternative signal word

panel design could be found for marking a hazard associated with property damage. Additionally, the Caution sign with the symbol had a median rating of serious injury. This also indicates a discrepancy with the ANSI Standard which specifies this panel for a minor or moderate injury.

With Symbol versus Without Symbol

The second question this study sought to answer was: Would subjects rate the sign with the symbol as connoting higher severity than the sign without the symbol? A prior study reported no significant effect on perceived hazardousness of such a symbol used with the signal words *Danger* and *Lethal* (Wogalter et al., 1994). This study found the hazard alert symbol used with the signal word *Caution* received significantly greater severity ratings than the same sign without the symbol. This finding is consistent with the ANSI Standard as to using the hazard alert symbol to increase the impression of hazard severity.

Recommended Research

It would be useful to compare findings from these college students with a sample of working adults. A prior study comparing sign ratings by college students with those of people from the community and industry found far more similarities than differences (Wogalter et al., 1998). However, there are still concerns, particularly in the legal community, about how representative college students are of the employed workforce. Therefore, a comparative study is recommended.

There appears to be a need for development and testing of alternative signal word panels to more accurately mark hazards involving property damage, minor injury, and moderate injury. Both *Caution* signs in this study invoked greater severity level ratings than specified in the ANSI Standard.

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