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COMPARISON OF STUDENT VERSUS EMPLOYEE TEST POPULATIONS FOR WARNING SIGN RESEARCH BASED ON SEVERITY RATINGS FOR SIGNAL WORDS

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Most studies of warning signs involve undergraduate students as subjects. This paper reports a direct comparison of findings from an undergraduate population and an employed population. The 48 employed subjects from this study were compared with 59 undergraduate subjects from a companion study. Subjects from both populations were shown the same signs and asked to rate the severity level connoted by each sign. The signs differed only in signal word. Results for each population indicated that signal word had a highly significant effect on severity ratings. When the two populations were compared for ratings of each signal word, the only significant difference was for Caution. Median ratings of each population were the same: Deadly (4), Danger (3), Warning (2), Caution (1), and Notice (0).

INTRODUCTION

Experimental studies of warning signs are popular on campuses for introducing students to research. Among the reasons for this popularity is affordability – most of the effort is uncompensated student labor. Other reasons are that such studies illustrate:

- Use of rating scales to provide the data for a dependent/criterion variable,
- Construction of experimental treatments, and
- Application of statistical analyses.

The results of these studies constitute a fairly large body of literature. Miller and Lehto (2001) found 270 publications concerning students used as subjects in studies involving warnings and instructions.

The warning sign literature provides a scientific foundation for some practical applications. One is the standardization of safety signs (e.g., ANSI Z535 Committee on Safety Signs and Colors, 2002). A second is the use of signage in support of injury and illness prevention efforts. A third is use in litigation involving an issue of warning adequacy. The empirical foundation for nearly all these applications is a body of literature developed from studies in which undergraduate students served as subjects. This raises a concern about the representativeness of findings based on undergraduate students.

For occupational safety and health, the target population is the broad population of employed people. In

contrast, the population chosen for most signage studies is a convenience sample of undergraduates at a particular educational institution. This approach to sampling does not conform with the well-established principle that experimental populations should be selected in a manner that ensures representativeness of the target population.

Two previous studies compared ratings of signal words obtained from student and employee populations. One obtained ratings of various signs from 56 college students and 75 industrial workers (Wogalter, Kalsher, Frederick, Magurno, and Brewster, 1998). Using ratings of overall hazard level, the two groups provided very similar ratings for signal words. The other study compared a student population to service station attendants for warnings regarding over-inflating tires (deTurck and Goldhaber, 1989). Using expressions of behavioral intent, the two groups had different responses to signal words. This finding, however, is inconclusive due to a confounding effect from gender differences in the two populations.

This paper reports the results of a signage study comparing a convenience sample of undergraduate students with a convenience sample of employed people. Results of the first study involving 59 undergraduate subjects are reported in a companion paper in these conference proceedings (Jensen and McCammack, 2004). In that paper, the authors recommended a follow-up study of employed people for comparison. The goal of this follow-up study

was to obtain comparable data from an employed population in order to examine differences and similarities in ratings for various characteristics of safety-related signs.

METHODS

Subjects consisted of 48 people engaged in full-time employment. The comparison subjects consisted of 59 undergraduates attending Montana Tech of The University of Montana (Jensen and McCammack, 2004). Both samples were located in southwestern Montana. Each received ten dollars for participating. Their gender distributions were:

- Undergraduates – 52.5 percent male (N=31) and 47.5 percent female (N=28).
- Employees – 77.1 percent male (N=37) and 22.9 percent females (N=11).

Age distribution data of the two populations are provided in Table 1. The undergraduate subjects had a mean age of 25, while the employed subjects had a mean age of 46.

Table 1. Age distribution data

Statistic	Undergraduate Subjects	Employed Subjects
Mean	25	46
Std. Dev.	9	12
Median	22	47
Minimum	18	19
Maximum	55	74

Five employers agreed to facilitate the study and permit their employees to participate in the study. Table 2 indicates the nature of the workplace, male and female subjects, and total subjects.

Table 2. Workplaces of employed subjects

Workplace	Males	Females	Total
Residential Construction	3	1	4
Job Corps Training Center†	5	5	10
National Guard	13	2	15
County Government	1	3	4
Metal Foundry	15	0	15
Total	37	11	48

† Five male instructors and five female office staff

Twelve workplace safety signs were constructed. Five of the signs had a gray signal-word panel with a white

signal word as shown in the Appendix. The signal words were Deadly, Danger, Warning, Caution, and Notice. All letters were capitalized to conform to the ANSI standard. The signs differed only in signal word. Signs were developed using Maxisoft software and then printed on 8.5 by 11 inch photograph-quality paper.

The message panels of all the signs consisted of black lettering on a white background to comply with the ANSI standard. Borrowing a method from Wogalter et al. (1998), X's were used in the message panel to make the signs look like those encountered in workplace setting while not containing a word message that might detract from the focus of the study.

Subjects were briefed on the experimental purpose and procedures. They signed an informed consent form before continuing. They were then provided with an answer booklet and the experiment commenced. Students first read a paragraph restating the instructions and answered three questions about age, gender, and if they had been trained in how to interpret workplace safety signs. Signs were then shown in a predetermined random order and displayed until all subjects had completed their ratings. Subjects viewed a sign and then rated it on three scales presented on a page. This procedure was repeated for all signs. Then each sign was displayed again and subjects rated it on three other rating scales on a page. Thus, each sign was rated on six scales. Ratings reported here are for the same severity scale used by Jensen and McCammack (2004). It was an ordered rating scale derived from the ANSI standard with five response categories: death, serious injury, moderate injury, minor injury, and property damage.

Responses were assigned numerical values for data analysis. A zero was used for the property damage category, with other category values increasing by one as severity increased. Minitab software was used to test the null hypotheses of no effect of signal word using the Friedman Test, and no difference between the word-specific ratings of the two test populations using the Mann-Whitney test.

RESULTS

Results from the employed population indicated that signal word had a highly significant effect ($p < 0.001$) on severity ratings using a Friedman's Rank Sum two-way analysis. Table 3 lists the sum of ranks, true median (most frequent rating), and estimated median for each signal word. The estimated median rating is a statistic computed as the grand median plus or minus the effect size. To help interpret the

sum of ranks, the maximum would be 240 and the minimum 48. For example, if all 48 subjects had rated Deadly as being the most severe of the five signal words, the sum of ranks would have been 240.

Table 3. Ratings data for five signal words

Signal Word	Sum of Ranks	True Median	Estimated Median
Deadly	224.5	4	3.2
Danger	172.5	3	2.2
Warning	143.0	2	1.4
Caution	106.5	1	1.0
Notice	74.0	0	0.2

Figure 1 is a bar graph showing the estimated median rating for each signal word. Figure 1 also shows, as small squares, the corresponding results from the student subjects.

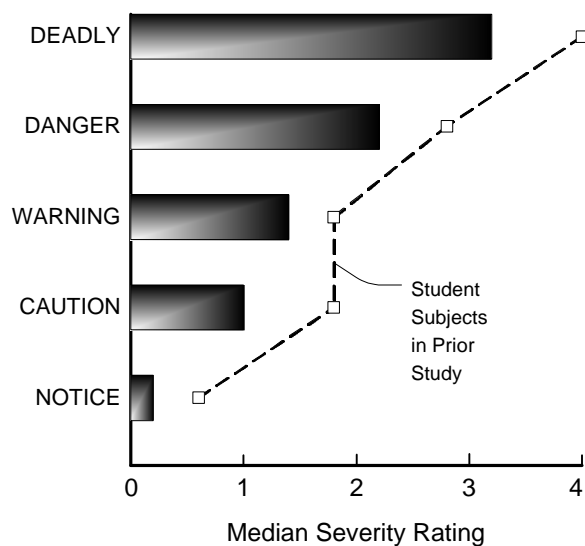


Figure 1. Estimated median severity ratings for the two study populations

Ratings of signal words by the employed populations had the same medians as the student population (see Table 3). The Mann-Whitney test for equality of rating by the two populations indicated a significant difference for Caution, and no significant difference for the other signal words ($\alpha=0.05$). The probability values for the null hypothesis of no difference were: Deadly (0.067), Danger (0.415), Warning (0.527), Caution (0.037), and Notice (0.336).

DISCUSSION

The finding that Deadly received the highest severity rating was consistent with prior studies (Leonard, Hill, and Karnes, 1989; Wogalter et al., 1998; Jensen and McCammack, 2004). Danger received the second highest rating. Warning and Caution received the third and fourth highest ratings. Notice was clearly rated lowest.

The findings of these companion studies and those reported by Wogalter et al. (1998) are remarkably consistent. The studies used the same sign formats, but different rating scales. Another difference was the statistic used for comparing group ratings. Wogalter et al. reported mean ratings while this paper reports median and estimated median. The reason for using medians was that the severity rating scale uses categories not proven to be equal intervals apart, as required for taking a mean. The similarity of findings suggests a level of robustness in the research methods even when applied to different populations and using different rating scales.

The most effective comparison of the student and employee ratings is the graphical one in Figure 1. The plotted values of estimated medians reveal the consistent pattern of student ratings being slightly to the right of those of the employed subjects. Ratings by employees showed a rather consistent declining pattern from Deadly to Danger to Warning to Caution to Notice. Ratings by students followed the same declining pattern except that their ratings for Caution and Warning did not differ.

A complication for studies comparing students to employed people is the possible effect of training on signage. In these studies, the student ratings were only from individuals who indicated they had no prior training on safety signs. The employee population consisted of 20 who reported having had prior training, such as the requirement to use personal protective equipment in areas where a sign so designates. We believe that a representative sample of employed people should include those who have had some prior training; otherwise, it would not be representative.

In conclusion, the two subject populations rated the five signal words similarly. Median ratings for each signal word were the same for each test population: Deadly (4), Danger (3), Warning (2), Caution (1), and Notice (0). This finding, and those of Wogalter et al. (1998), support the conclusion that signage studies of signal words using students provide results suitable for extrapolation to employed people.

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APPENDIX Signs presented to subjects

