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## Risk beliefs for prohibition symbols before and after consequences

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### Abstract

The present research examined the connoted hazard level of symbols with two types of prohibition symbols shown with depicted image either before or after injury consequences. One common international symbol for prohibition is a circle with a slash which is intended to show that a depicted event should not be performed (e.g., putting hands near moving gears). Another prohibition symbol, a red circle without the slash is sometimes used to indicate prohibition but also as a restriction with respect to some activity. In the present research, eight base symbols were shown to 96 participants who evaluated them according to two hazard perception scales. The results showed the symbols depicting after consequences events produced significantly higher ratings than images of before consequences events. Symbols with circle-slash were rated somewhat higher than those with the circle only, but significantly different for only some of the base symbols. Having both the prohibition circle-slash and consequences tended to produce the highest ratings. Implications of these results are discussed.

*Keywords: warnings, pictorials, symbols, labels, risk perception*

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### 1. Introduction

One approach to conveying safety information is through the use of pictorial symbols [1,2,3].

Warnings that include symbols are more likely to capture people's attention [4] and can enhance the comprehension of hazard information including actions that should or should not be taken and the consequences of hazardous contact [5].

Some symbols use the "red slash line," alone or in combination with a red circle, to communicate a prohibitive message such as "Do not place your hands near machinery" [6]. Previous research has indicated that the use of the slash in the circle-slash combination can sometimes decrease the legibility

and comprehensibility of the symbol because it can obscure critical components [7, 8]. Thus, there is a need for further research to clarify which symbol design configuration is likely to enhance hazard knowledge.

To further complicate matters, safety symbols may also depict possible consequences of a dangerous action as an alternative means to induce caution in an individual. Some of these symbols depict a prohibited activity and are not combined with a circle alone or with a slash. These symbols generally (but not always) depict the resulting consequences in a direct manner (e.g., fingers being crushed by some gears). While a prohibition symbol may not be necessary, it is sometimes used together with

consequences symbols. Potentially, this could produce confusion if interpreted as a double-negative (positive) [8]. An alternative and very different effect is the combination of after consequence information and a prohibition symbol which together might enhance the perceived "strength" of the warning.

Given the number of potential designs that result from the combination of consequences symbols and different prohibitive indicators (e.g., circle with and without slash), it is important to determine how people interpret the meaning of each. However, examination of the warnings literature reveals that there is a surprising lack of research that systematically investigates this issue. To this end, the current research sought to evaluate the hazard perceptions of individuals exposed to two types of prohibition symbols shown with either before or after injury consequences. Participants rated the symbols on two hazard perception scales.

## 2. Method

### 2.1. Participants

Data was collected from 96 student participants who were taking introductory psychology courses for research credit. Participants ranged in age from 18 to 41 years with a mean age of 19.7 years ( $SD = 2.92$  years). The sample was composed of 60 males and 36 females. The ethnicity of the sample was: 71 Caucasian, 14 African-American, 5 Asian, and 6 multi-ethnic backgrounds. Ninety participants (94%) reported English as their primary language.

### 2.2. Stimulus materials and procedure

Stimuli were based on common symbols already in use. Most symbols were taken from computer clip art or scans of safety catalogs such as *Safety symbols and labels – New products for 2002* [9]. Some symbols were created by the first author using a computer graphics software application. Symbols used for analysis were black, while the surrounding circle and slash features were red. All symbols were presented to participants in a three-page booklet with 10 symbols per page printed on card stock. Participants were tested in groups of up to four in experimental sessions that lasted approximately 30 minutes.



Figure 1: Eight symbols base images and referents.

Each participant was shown a total of 30 randomly listed symbols of which 22 were fillers to help disguise the nature of the manipulation. For each symbol, participants were asked to rate the level of danger associated with that particular symbol and the level of carefulness needed. The eight base images illustrated in Figure 1 were selected for subsequent analysis because they had a complete set of four conditions: a) circle-alone image with pre-consequence illustration, b) circle-alone image with post-consequence illustration, c) circle-slash image with pre-consequence illustration, and d) circle-slash image with post-consequence illustration. At no time did participants encounter more than one illustration of the same base symbol in the set they viewed. Thus, the experimental design with respect to these 4 conditions was a completely between subjects model. The other experiment images not included in the analyses in this report lacked the pre/post consequences conditions. An example of the four conditions for one particular symbol is depicted in Figure 2.

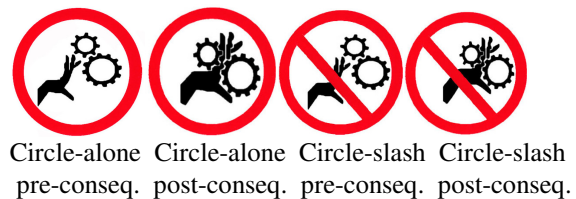


Figure 2: Example of two prohibition symbols (circle vs. circle-slash) and before and after consequence.

For each symbol, participants were asked to give a rating to the two following questions: "How much danger does this symbol convey?" and "How careful would you be if you saw this sign?" Response ratings for both questions used a 9-point Likert scale with anchors that ranged from (0) not at all

dangerous, (2) somewhat dangerous, (4) dangerous, (6) very dangerous, to (8) extremely dangerous. Once the procedure was completed, participants were thanked for their time, encouraged to ask any questions that they had, and were excused.

### 3. Results

Preliminary analyses suggested that both ratings of Dangerousness and Carefulness produced similar patterns of means as a function of conditions. A simple Pearson correlation between the paired ratings of all participants was  $r = .84$ ,  $N=1182$ ,  $p < .0001$ . To facilitate ease of exposition the two scores were collapsed by taking means of the paired ratings to form a combined dependent measure, hereinafter called "Hazardousness."

A 2 (Prohibition Symbol: Circle vs. Circle Slash) X 2 (Before vs. After Consequences) X 8 (Base Symbol) mixed-model analysis of variance (ANOVA) using the combined hazardousness score as the dependent variable showed significant main effects for Before and After Consequences,  $F(1, 92) = 7.34$ ,  $p < .01$ , and Base Symbol,  $F(7, 644) = 23.71$ ,  $p < .00001$ . The after-consequences images ( $M = 5.32$ ) were generally given higher ratings than the before-consequences images ( $M = 4.64$ ). The means for Base Symbols are shown in the right-most column of Tables 1 or 2. Tukey's Honestly Significant Difference test (at  $p = .05$ ) showed that Chemical, Explode, Gears and Impale which did not differ from each other but all were rated significantly higher than the other base symbols (except Impale which did not differ from Heat). Heat, Pinch and Dive did not differ among themselves but they were all significantly higher than Boot, which was the lowest.

There was no significant main effect of Prohibition Symbol (circle vs. circle-slash), nor did it yield a significant interaction with the Before versus After Consequences factor, both  $F_s < 1.0$ . However, a planned comparison between Before Consequences and After Consequences for symbols with the circle-slash was significant,  $F(1, 92) = 5.26$ ,  $p < .05$ , yet the same comparison for the circle only was not,  $F(1, 92) = 2.37$ ,  $p > .10$ .

The ANOVA also showed a significant interaction of Prohibition Symbol and Base Symbol,  $F(7, 644) = 2.30$ ,  $p < .05$ . These means are shown in Table 1. Simple effects analyses failed to note any significant

comparison between circle vs. circle-slash for any of the base symbols. This relatively small interaction was probably caused by the non significant reversal (of circle higher than circle slash) shown for Impale and Explode.

Table 1  
Mean Hazardousness (composite score) as a function of Prohibition Symbol: Circle vs. Circle Slash) and Base Symbol

<u>Base Symbol</u>	<u>Circle</u>	<u>Circle-Slash</u>	<u>Mean</u>
Chemical	5.72	5.59	5.66
Explode	5.92	5.32	5.62
Gears	5.39	5.50	5.44
Impale	5.60	5.17	5.39
Heat	4.60	5.04	4.82
Pinch	4.60	4.96	4.78
Dive	4.25	4.94	4.59
Boot	3.42	3.67	3.54
Mean	4.94	5.02	

Lastly, the ANOVA also showed a significant interaction of Before vs. After Consequences and Base Symbol,  $F(7, 644) = 4.75$ ,  $p < .00001$ . These means are shown in Table 2. Simple effects analysis comparing Before vs. After Consequences for each of the Base symbols showed significantly higher After Consequences means for the Impale, Gears and Pinch base symbols. The three factor interaction was not significant,  $F(7, 644) = 1.53$ ,  $p > .10$ .

Table 2  
Mean Hazardousness (composite score) as a function of Before and After Consequences and Base Symbol

<u>Base Symbol</u>	<u>Before</u>	<u>After</u>	<u>Mean</u>
Chemical	5.33	5.98	5.66
Explode	5.66	5.58	5.62
Gears	4.97	5.92	5.44
Impale	4.78	5.99	5.39
Heat	4.73	4.92	4.82
Pinch	3.85	5.71	4.78
Dive	4.48	4.71	4.59
Boot	3.34	3.74	3.54
Mean	4.64	5.32	

#### 4. Discussion

The data from this study extend previous ergonomics research efforts that have explored the uses of pictorial safety symbols in public environments. By investigating four design combinations that illustrate either before or after injury consequences for prohibition symbols that use the circle-alone and the circle-slash, a number of findings emerged. First, illustrations that depict the after injury consequences were rated as more hazardous than those that depicted the before injury condition. Second, differences in the perceived hazardousness of the base symbols illustrated that some images communicate different levels of hazards than others. Third, a planned comparison revealed a greater hazard level for the after consequence compared to before consequence for the circle slash but not for the circle-alone prohibition symbol. Fourth, an interaction indicated certain base symbols were dramatically increased in hazard in their after consequence form than their before consequences form.

The results offer a number of warning design implications for symbols that target international audiences. Although not statistically significant, the circle-slash prohibitive design appears to have been more effective than the circle-alone prohibitive symbol at influencing participants' perceived hazardousness. While it seems premature to dismiss the use of the circle-alone design, it should be noted that the addition of the after injury consequence details resulted in the highest mean ratings for hazardousness among the conditions studied here. These results suggest these two separable features can be combined to produce higher perceived hazard.

Future research efforts might investigate how symbol design can be further enhanced by exploring the perceived hazardousness of different types of circle-slash combinations. Previous research indicates that slashes that appear over and under the pictorial are preferred to symbols that depict partial slashes [8]. Other variables that might be investigated include the orientation of the pictorial and complexity of the message content. Precursor tests of message complexity might be elucidated by measures of concept concreteness and ease of visibility which can be used to predict the likelihood of developing a comprehensible symbol [10]. Furthermore, these findings illustrate the need for comprehension testing before symbols are deployed. Rapid prototyping might be used where symbols are evaluated iteratively (design, test,

redesign) until adequate message comprehension is achieved [11].

With the present set of symbols no discernable confusions were found for prohibition symbols combined with after consequence images. If the after consequence image in combination with the circle-slash were confused as a double negative, lower and more variable ratings would have been found.

In conclusion, this examination of the benefits of using before/after consequences in the design of safety symbols that use either the circle-alone or the circle-slash formats illustrates that seemingly small or trivial design details can impact perceived hazardousness of public warning symbols. It is hoped that the current data will be of use to researchers and practitioners in developing symbols designed to protect the public regardless of what language they know.

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