CHAPTER TEN

Connecting jumper cables: the effectiveness of pictorial warnings

MICHAEL S. WOGALTER, MICHAEL J. KALSHER, BARBARA L. GLOVER and AMY B. MAGURNO

10.1 INTRODUCTION

Each year, people are injured improperly jump starting their vehicle. They connect booster cables by incorrectly attaching them to the four battery terminals (i.e., positive to positive and negative to negative). These occurrences suggest the correct procedure is not commonly known (De Puy, 1990). The correct connection involves making the last connection for the car with the dead battery to an earth away from the battery. This procedure avoids having a spark ignite hydrogen gas from the battery, possibly causing an explosion and release of sulphuric acid.

Previous research has shown that warnings can be effective in influencing behaviour. Factors such as the inclusion of colour (Kline *et al.*, 1993) and pictorials (Jaynes and Boles, 1990) have increased compliance behaviour compared to their absence. However, their positive effects are not unequivocal (Duffy *et al.*, 1993; Wogalter *et al.*, 1993). In addition, a tag-type warning has been shown to facilitate compliance (Wogalter and Young, 1994). In the present study, two experiments were conducted to investigate the effectiveness of coloured tag-type warnings pictorially illustrating proper battery cable connection.

10.2 EXPERIMENT 1

Participants diagrammed the procedure for jump starting two vehicles using booster cables while a warning tag was present or absent. Participants also completed a questionnaire about their car battery knowledge.

Visual information for everyday use: Design and research perspectives. H. J. G. Zwaga, T. Boersema, & H. C. M. Hoonhout (Eds.). London: Taylor & Francis.

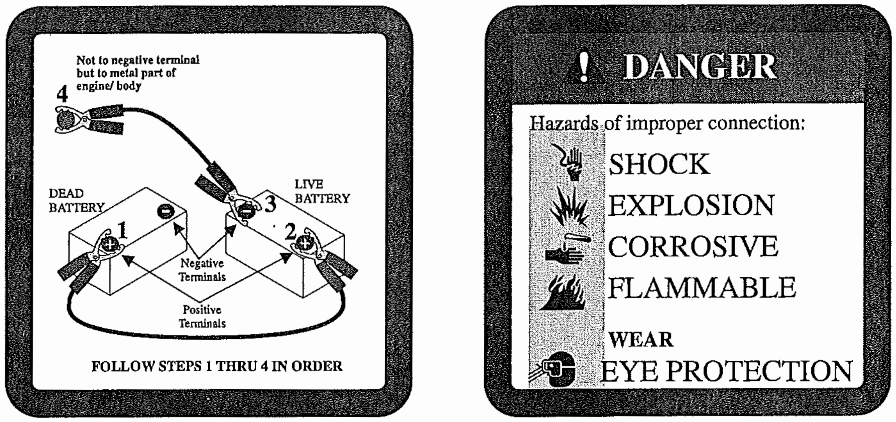

Figure 10.1 The two sides of the tag warning used in Experiments 1 and 2. (In Experiment 1, this warning was printed with black letters on an orange background. In Experiment 2, the enhanced tag warning was identical in content except the background was of a bright saturated red and yellow colour.)

10.2.1 Method

Sixty-five North Carolina State University undergraduates participated. A two-sided orange tag warning with black print was developed using information from the Battery Council International (Chicago). One side of the tag illustrated the proper connection procedure. The other side of the tag listed, pictorially and verbally, the hazards of improper connection. The physical dimensions of the tag were 9.5 × 8.3 cm. Figure 10.1 shows both sides of the tag.

Participants were shown a drawing which depicted an overhead view of two automobiles with the engine compartments exposed. One was labelled 'dead battery car' and the other 'live battery car'. They were asked to draw in, with red and black felt-tip pens, the cables and the connection points, and also to number the sequence. In the warning present condition, participants examined the tag before drawing connections. In the warning absent group, no tag was provided. When participants completed the diagram, they filled out a questionnaire assessing: knowledge about the hazards/dangers associated with car batteries, their experience and ownership of jumper cables, and their preference of several possible placements of the warning (on the jumper cables, on the battery, in the engine compartment, in the owner's manual, on the inside of the glove box door, and on the sun visor) on a Likert-type scale from 1 (definitely do not prefer) to 7 (very much prefer).

10.2.2 Results

Diagram accuracy was scored with two criteria, strict and lenient. With strict scoring (correct connections, colour and order), participants exposed to the tag warning diagrammed the battery connections more accurately (26.5 per cent) than did participants who were not exposed to the warning (0 per cent) ($\chi^2_{(1, N=65)} = 9.52$, $p < 0.01$). With lenient scoring (correct connections and correct order), participants exposed to the tag warning were more accurate (41.2 per cent) than participants not exposed to the warning (6.5 per cent) ($\chi^2_{(1, N=65)} = 10.54$, $p < 0.01$).

With strict scoring (at least four hazards mentioned), participants exposed to the warning had greater hazard recall (32.4 per cent) than those not exposed to the warning (3.2 per cent) ($\chi^2_{(1, N=65)} = 9.14$, $p < 0.01$). With lenient scoring (at least three hazards mentioned), there was no significant difference between conditions.

With strict scoring (at least four precautions mentioned), participants had greater precaution recall (14.7 per cent) than those not exposed to the warning (0.0 per cent) ($\chi^2_{(1, N=65)} = 4.94$, $p < 0.05$). With lenient scoring (at least three precautions), participants exposed to the warning had greater precaution recall (79.4 per cent) than those not exposed to the warning (41.9 per cent) ($\chi^2_{(1, N=65)} = 9.62$, $p < 0.01$).

The preferred location for the battery booster warnings/instructions was analysed with a 2 (tag versus no tag condition) × 6 (location) mixed-model analysis of variance (with the last factor repeated). The analysis showed only a main effect of location ($F_{(5, 315)} = 40.52$, $p < 0.0001$). Comparisons using the Newman–Keuls test showed that placement on the cables ($M = 5.92$) and on the battery ($M = 5.65$) did not differ and both were significantly preferred over all other locations ($p < 0.05$). The owner's manual ($M = 4.51$) was no different than the engine compartment ($M = 4.01$), but both were significantly preferred over the glove box ($M = 3.19$) or the sun visor ($M = 2.99$), which did not differ.

No other questionnaire item differed by warning presence/absence condition. A total of 68 per cent correctly identified the presence of acid in batteries and 91 per cent associated red and black markings with positive/hot and negative/earth, respectively.

10.3 EXPERIMENT 2

In Experiment 2 the presence versus absence of a warning was also examined, but here a behavioural compliance measure in an incidental exposure paradigm was used. In addition, the effectiveness of a manufacturer's current tag warning was compared with an enhanced (multicolour) tag warning.

10.3.1 Method

Twenty-four undergraduates from Rensselaer Polytechnic Institute participated. Participants were told that they would be tested on their knowledge of basic automobile maintenance facts and procedures. All procedures were carried out in an automotive shop, on two adjacently parked cars. The batteries in both vehicles were removed and replaced with realistic-appearing non-functional battery shells to eliminate any potential for injury. Several 'filler' tasks (determining tyre air pressure and engine oil, brake fluid and radiator coolant levels) were included to disguise the study's true purpose.

INSTRUCTIONS: Consult your car owner's manual and booster cable package for complete details

1. Make sure the two cars are not touching and the ignition switches are turned off.
2. Connect one clamp to 'dead' battery terminal wired to starter or solenoid. (Positive (+) Post.)
3. Connect the other end of the cable with same color coded clamp to the Positive (+) post of the good battery.
4. Connect other clamp to Negative (–) post of 'good' battery.
5. Connect remaining clamp to engine block of stalled car as far away from the battery as possible.
6. Start car and immediately remove clamps, reversing procedure by removing clamp at engine block first.

CAUTION: Lead acid batteries generate explosive gases. Keep sparks, flames and lighted cigarettes away from battery. We recommend that extreme care be used when connecting battery jumper cables. Refer to the owner's manual for the nominal voltage and grounding specification. Use of a booster battery of a higher nominal voltage, or which is positively grounded may result in serious personal injury or property damage.

Figure 10.2 The original manufacturer's tag warning. The other side was printed in Spanish.

All necessary tools to perform these tasks (e.g. tyre gauge, hygrometer and towels) were provided nearby. In the main task of interest, the participant was to jump start the car with the dead battery using the booster cables provided. There were three booster cable sets, differing according to the warning conditions. Each participant received one of these sets. Booster cables in the control condition had no instructions or warnings. In the unenhanced tag condition, the cables were equipped with an original manufacturer's tag label, measuring 10.8 × 5.7 cm, with printed verbal instructions and warnings on one side in English and on the reverse side in Spanish. Figure 10.2 shows this label.

The enhanced warning resembled that used in Experiment 1, except that bright saturated yellow and red colours were added to the print and background, and that the tag was laminated. The enhanced tag dimensions were 9.5 × 8.3 cm. Both tag warnings were attached approximately 10 cm from the clamps at one end of the cables.

The sequence of steps performed by each participant was recorded. After this task, participants completed a questionnaire to assess whether they had seen and could recall the contents of the warning.

10.3.2 Results

Four of the eight participants in the enhanced tag condition accurately connected the booster cables to the two cars. However, none of the participants in the two other conditions correctly made the battery connections. The effect was significant ($\chi^2_{(2, N=24)} = 9.60$, $p < 0.01$). The pattern for seeing and recalling the warning content, as assessed by the questionnaire, mirrored the compliance results.

10.4 DISCUSSION

The results of these two experiments illustrate several points. The first is that people do not know the correct, safe way to connect car battery booster cables. The reason for this is probably that people have viewed other individuals successfully, but incorrectly, jump start cars by connecting the corresponding poles of both batteries – an error that could lead to an explosion. Indeed, participants in Experiment 1 indicated that they had viewed other people jump start cars an average of 11 times. Most of the time, this method will successfully start a vehicle without an explosion, which reinforces the potentially dangerous behaviour. Another factor is that many people probably do not know what an electrical earth is or where inside the engine compartment a usable earth connection might be made. Also, painted surfaces, increased use of plastic and rubber components in newer automobiles, as well as build-up of grease and dirt on metal parts makes locating a proper earth connection difficult.

The second point is that the mere presence of a warning does not guarantee proper safe behaviour. The original manufacturer's warning produced no proper connections. The enhanced warning was evidently better in overcoming the participants' mistaken belief on how car batteries should be connected.

The third point is that, while we were able to facilitate proper connection with the enhanced tag warnings, the percentages of correct connection were not as high as desired. Performance might be increased by enhancing the warning even further and perhaps by placing several (redundant) warnings at relevant locations (e.g. both on the battery and on the cables).

Perhaps the best way to accomplish the goal of safer jump starting is to redesign some of the involved components. For example, the cables themselves could be explicitly labelled on one end 'to be used for the *live* car battery' and the other end 'to be used for the *dead* car battery'. In addition, one of the clamps of the dead battery cable could be designed to appear different from the other clamps to make users aware that it should not be connected to the negative terminal of the dead battery. Similarly, an interactive warning design (e.g. Duffy *et al.*, 1993) that requires users to manipulate the warning physically might be useful in alerting users to read the label information. Finally, a particular place in the engine compartment could be designated (and well labelled) as the 'earth' for use in jump starts.

Careful consideration of vehicle components and cable design, in conjunction with the use of a well-designed set of warnings, could increase the frequency of correct battery connections and decrease injuries.

REFERENCES

De Puy, D. (1990) Be aware of costly mistakes. *Modern Tire Dealer* 12.

Duffy, R. R., Kalsher, M. J. and Wogalter, M. S. (1993) The effectiveness of an interactive warning in a realistic product-use situation. In: *Proceedings of the Human Factors and Ergonomics Society 37th Annual Meeting*, pp. 935–939. Santa Monica, CA: Human Factors and Ergonomics Society.

JAYNES, L. S. and BOLES, D. B. (1990) The effects of symbols on warning compliance. In: *Proceedings of the Human Factors Society 34th Annual Meeting*, pp. 984–987. Santa Monica, CA: Human Factors Society.

KLINE, P. B., BRAUN, C. C., PETERSON, N. and SILVER, N. C. (1993) The impact of colour on warnings research. In: *Proceedings of the Human Factors and Ergonomics Society 37th Annual Meeting*, pp. 940–943. Santa Monica, CA: Human Factors and Ergonomics Society.

WOGALTER, M. S. and YOUNG, S. L. (1994) Enhancing warning compliance through alternative product label designs. *Applied Ergonomics* **24**, 53–57.

WOGALTER, M. S., KALSHER, M. J. and RACICOT, B. M. (1993) Behavioral compliance with warnings: effects of voice, context, and location. *Safety Science* **16**, 637–654.