Increasing the correct connection of car battery jumper cables with an enhanced tag warning

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Abstract
Every year people are injured while improperly 'jump starting' automobiles using battery booster cables. The most common scenario leading to injury occurs when people attach both negative leads to the battery terminals instead of properly grounding the negative lead of the 'dead' battery to that vehicle's engine block. The incorrect configuration can cause the 'dead' battery to explode, discharging strong sulfuric acid. Two experiments examined the effectiveness of a pictorial tag warning illustrating the hazards and the proper connection procedure. Experiment 1, using pictures of cars with open hoods, showed that participants were significantly more likely to draw the correct sequence of connections when the warning was present than when it was absent. Experiment 2, using actual booster cables to connect two realistic appearing, but fake, batteries in adjacently parked vehicles, showed that the presence of an enhanced warning on the cables significantly increased connection accuracy compared to an unenhanced warning or no warning. Together these studies show that well-designed warnings can correct inaccurate beliefs and facilitate safe behavior.

1. Introduction

Every year people are injured because they improperly attempt to 'jump' start an automobile using battery booster or 'jumper' cables (De Puy, 1990). These occurrences suggest that the correct procedure for jump starting a car with a dead battery is not common knowledge. Apparently the injured individuals and other people have the mistaken belief that each of the two cables should be connected to the corresponding poles of the two batteries (i.e., positive to positive and negative to negative). However, the final step of the correct procedure is to connect the negative cable clamp for the car with the dead-battery to the ground (any unpainted metal part of the engine) at a location away from the car battery. The purpose of this procedure is to avoid producing a spark that may cause the battery to explode, thereby discharging strong sulfuric acid, a scenario that is descriptive of many jump-start accidents.

One possible way to instill the correct, safe procedure and reduce the number of injuries that stem from incorrect jump starting of a dead battery is to display a well-designed instructional warning. A warning design that has recently shown promise is a tag warning (Kalsher, Pucci, Wogalter, and Racicot, 1994; Wogalter and Young, 1994). For example, one recent study by Kalsher et al. (1994) examined the use of a tag label to convey instructions and hazard completely comprised of verbal statements or an enhanced pictorial warning similar to the warning in Experiment 1 but was improved in appearance having multiple colors) or there was no warning attached to the cables. It was expected that in both experiments, a tag warning with features described earlier in the introduction of this article would enhance people's knowledge of the proper way to connect the batteries. More importantly, however, it was also expected that an effective tag warning would promote the correct behavior as measured by participants' drawings of the correct connections in Experiment 1 and performance with the actual battery booster cables in Experiment 2.

2. Experiment 1

In this experiment, participants were asked to diagram the correct procedure of connecting two car batteries using jumper cables while a warning tag was present or absent. Also participants completed a questionnaire that included items such as their knowledge of hazards and precautions of connecting car batteries.

2.1 Method

Sixty-five undergraduates at North Carolina State University took part in the study in order to fulfil an introductory psychology course requirement. Groups of two to seven students participated at a time. Forty-five were males (69.2%) and 20 (30.8%) were females. Mean age was 19.6 years. Participants were randomly assigned to conditions: 34 to the tag-present condition and 31 to the tag-absent condition.

A two-sided orange with black print tag warning was developed based on materials provided by the U.S. Battery Council and preliminary research conducted in the laboratory of the first author. On one side of the tag was a diagram illustrating how to properly connect two automobile batteries. The illustration consisted of two batteries (one labeled 'dead' and the other labeled 'live'). The negative and positive terminals were clearly visible and the proper jumper cable connections were shown. Each step in the connection process was numbered and directions at the bottom of the diagram stated that one should explicitly follow the steps in order. The other side of the tag warned of the hazards of improper connection (shock, explosion, corrosive material, and flammable) and the type of protective safety clothing advised (eye protection). This information was provided both pictorially and verbally. The physical dimensions of the tag were 9.53 cm x 8.26 cm (3.75 in. x 3.25 in.). Figure 1 shows a representation of both sides of the tag used in this experiment.

When participants arrived at the laboratory, they were randomly divided into two groups and directed into separate rooms where one of two experimenters administered the procedure of a particular group in a session. The two experimenters alternated the administration of which condition they directed. All participants were told that they were participating in a project to determine what people know about car batteries.

Initially, participants were asked to demonstrate, on paper, how to connect two batteries when jump starting a car. They were shown a page with detailed drawings of two automobiles with their hoods raised showing the engine compartments of each. One automobile was labeled as the 'dead battery car' and the other as the 'live battery car'. They were told to imagine that their car had a dead battery and a friend has come over with another car to help them get it started. They were to draw, using a set of red and black pens (provided to participants), how they would connect the jumper cables in order to jump start the car with the dead battery. Specifically, they were asked to mark the connection points on each car, draw lines from one car to the other to represent each cable, and to number each step in the order that it was completed.

In the warning tag present group, the tag was given to participants to examine before they began the diagram. In the warning tag absent group, no information regarding the connection not exposed to the tag warning (6.5%), $\chi^2(1, N=65) = 10.54$, $p<0.01$.

The accuracy of the hazards that participants listed were also scored according to strict and lenient criteria. When scored according to a strict criterion, participants had to list at least four hazards. In contrast, when scored according to the lenient criterion, participants had to list at least three. With strict scoring, participants exposed to the warning were more accurate (32.4%) than participants who were not exposed to the warning (3.2%), $\chi^2(1, N=65) = 9.14$, $p<0.01$. With lenient scoring, there was no significant difference between persons exposed to the warning (88.2%) and those who were not (74.2%), $\chi^2(1, N=65) = 2.12$, $p>0.05$.

The precautions were scored similarly as the hazards. When scored according to a strict criterion, participants had to list at least four precautions. In contrast, when scored according to a lenient criterion, participants had to list at least three. With strict scoring, participants who were exposed to the warning were more accurate in their list of precautions (14.7%) than participants who were not exposed to the warning (0.0%), $\chi^2(1, N=65) = 4.94$, $p<0.05$. With lenient scoring, participants who were exposed to the warning were more accurate (79.4%) than participants who were not exposed to the warning (41.9%), $\chi^2(1, N=65) = 9.62$, $p<0.01$.

Participants were asked where they preferred to find instructions on how to connect the cables. A 2 (tag vs. no tag condition) x 6 (location) mixed-model analysis of variance (with the last factor repeated) showed only a main effect of location, $F(5,315) = 40.52$, $p<0.0001$. Comparisons among these means using the Newman-Keuls multiple-range test showed that placement of the warning directly on the cables ($M = 5.92$) was the most preferred location and it received significantly higher ratings than all other locations except placement on the battery ($M = 5.65$). Placement on the battery was also significantly higher than the other locations (p's<0.05). Locating the instructions in the owners manual ($M = 4.51$) was no different than the engine compartment ($M = 4.01$), but both were significantly higher than placement in the glove box ($M = 3.19$) or on the sun visor ($M = 2.99$). The latter two locations did not differ significantly.

None of the other items on the questionnaire differed as a function of experimental conditions. Sixty-eight percent correctly identified that there was acid in batteries, and 91% correctly answered the question on cable color by describing the association of red and black markings with positive/hot and negative/ground, respectively.

On average, participants reported to have personally attached jumper cables to vehicles 11.2 times ($SD = 19.9$) and to have watched another person perform the task 11.94 times ($SD = 19.05$). All but one participant (98%) were licensed drivers ($M = 3.75$ years) and drive an average of 185 km with a standard deviation of 207.6 km (115 miles, $SD = 129$ miles) per week. Sixty-nine percent reported that they own jumper cables, and of these individuals, 95.6% keep them in their car.

2.3 Discussion

The results show that participants with the warning were better able to diagram the proper battery connections than participants without the warning. Participants having the warning also knew more hazards associated with improper connections and the precautions they should take while performing the task than participants who did not have a warning available. Clearly, then, this experiment shows that the information provided in the tag was beneficial in performing the requested tasks. However, the question remains as to whether a tag-type warning is beneficial in a more realistic task. This was the purpose of Experiment 2.

3. Experiment 2

This study was intended as a realistic test of the benefit of tag warnings. Like the previous study, the presence versus absence of a warning was compared. In addition, the

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 2 The original manufacturer's completely verbal tag warning label.

of the cables. The dimensions of the enhanced tag were 8.26 cm x 8.26 cm (3.25 in. x 3.25 in.).

3.2 Results

Four of the eight (50%) 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 (0% for the original manufacturer's tag and the no-warning control) correctly connected the batteries of the two cars with the jumper cables. The chi-square test among these conditions was significant, $\chi^2(2, N=24) = 9.60$, $p<0.01$. The identical pattern of results was found for seeing and recalling the contents of the warning as assessed by the post-task questionnaire.

3.3 Discussion

This experiment showed that the enhanced warning condition promoted more accurate connections with booster cables than either an unenhanced warning or no warning. Also participants exposed to the enhanced warning were more likely to recall seeing the warning. These results suggest that a better designed warning can improve the likelihood of safe behavior when jump starting a 'dead' battery with booster cables. Indeed, the original manufacturer's (unenhanced) version was no better in these respects than no warning at all.

4. General discussion

The results of these two experiments make 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 multi-fold, but may in part be due to the fact that people have probably viewed other individuals successfully jump-starting cars by connecting the corresponding poles of both cars, the most common error that can lead to battery explosion accidents. Indeed, this possibility is supported by data from the first experiment indicating that participants had on average viewed other people jump start cars 11 times. Most of the time, connecting batteries using this method does not lead to explosion injuries, but rather to successful jump starting of one's automobile. Thus, this potentially dangerous pattern of behaviors is reinforced and people eventually infer that this is the proper way to connect the cables. Another factor that is likely to promote improper connection is that people may not know what an electrical ground is or where inside the engine compartment a usable ground connection might be. And even if they do know what a ground is, the painted surfaces, increased use of plastic and rubber

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