THE ROLE OF PEDAL CONFIGURATION IN UNINTENDED-ACCELERATION AND PEDAL-ERROR ACCIDENTS

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This study examined the hypothesis that unintended-acceleration (UA) incidents, as well as other accidents caused by a foot pedal error or misapplication (PE), are related to the design of the pedal cluster. Using the North Carolina Accident Report Database, we evaluated the narrative descriptions of over 200,000 accidents to determine which accidents involved either a UA or PE. Three measures of the pedal cluster--the distance of the right edge of the brake pedal from the steering wheel centerline, the horizontal separation between the accelerator and brake pedal, and the vertical separation (the plane perpendicular to the brake-pedal face) between the accelerator and brake pedal--were evaluated to determine if the pedal cluster could be linked to a pedal-related accident. We found no differences in the pedal measurements of vehicles involved in accidents when compared with their non-accident peers. Therefore, there is no support for the notion that pedal-cluster design is a factor in pedal-error accidents.

INTRODUCTION

Over the past few decades, more than 10,000 automobile crashes have occurred in which the driver claimed that, after start-up and a shift from Park to a drive gear, the vehicle accelerated unexpectedly at full throttle and the brakes were ineffective. These types of accidents, which have occurred in nearly every make of vehicle, have become known as unintended-acceleration (UA) incidents and continue to be reported in accidents across the country. Typically, the driver insists that his/her right foot was pressing hard on the brake pedal, that the pedal went to the floor, and that the brakes would not stop the car (Pollard & Sussman, 1989; Reinhart, 1994; Schmidt, 1989, 1993). These episodes have lasted from a few seconds to as long as 45 seconds in rare instances. After the episode, analyses of the vehicle’s various mechanical and electrical systems reveal nothing that would explain the event. A related accident type appears to occur in a similar way, but after the start of the driving cycle (Schmidt et al, 1997, 1998); these are termed pedal-error (PE) accidents.

These phenomena have naturally generated considerable interest. Governmental agencies, independent research organizations, and many of the world’s automakers have devoted considerable effort to finding some
electrical/mechanical defect that would explain these events, all without success. On the other hand, several human factors have been associated with these events—e.g., an increase in driver age, less driver experience with the accident vehicle, and shorter driver height.

Given the strong suspicion that UA and PE incidents are caused by human error, many have suggested that aspects of the vehicle’s pedals may be responsible. For example, if the lateral placement of the pedal cluster is shifted leftward, when the driver makes a foot movement to what he/she believes is the brake pedal, the accelerator pedal could be contacted instead. In addition, if the horizontal or vertical distance between the accelerator and brake is small, then both pedals might be pressed at the same time. This study investigates the hypothesized relationship between various aspects of the pedal cluster configuration and pedal-error accidents.

METHODS

We first identified various UA and PE accidents from the North Carolina Accident Report Database. Unlike many other state accident databases, this database includes a verbatim written statement from the investigating officer providing a description of the accident in addition to vehicle characteristics and driver information. We used this information to find exemplars of the vehicles involved in pedal error accidents and compared them to peer vehicles, matched in terms of various vehicle features (i.e., size, cost, but from a different manufacturer), that were not involved in such accidents. We measured various aspects of the pedal cluster for each. If the configuration of the pedals is a factor in these accidents, then the accident vehicles should exhibit differences in pedal measurements relative to the non-accident vehicles.

Vehicle Selection

The North Carolina accident database contains over 4 million accident reports from the years 1979 to 1998, of which 3 million contain verbatim statements of the investigating officer. One can search these statements for critical keywords that would be related to various kinds of accidents. By reading the accident descriptions, we determined if the accident was caused by a pedal error of some kind.

During a UA episode, the driver typically believes that his/her right foot was on the brake, denies that it was on the accelerator, and believes that the vehicle malfunctioned in some way. To find such accidents within the database we searched using keywords such as [brake] failure, [throttle] stuck, malfunction, shift, gear, park, run-away, and out of control. For PE accidents, the driver is aware of the error, and reports it to the investigating officer. These accidents occur not only at start-up, but also in a wide variety of other situations such as turning and braking. These accidents were located by searching keywords such as slip, miss, and instead (e.g., accelerator instead of brake).

We searched years 1979 to 1998, using 19 keywords, which resulted in a collection of 236,231 accident narratives. These narratives were read in order to locate those that were clearly related to pedal errors, and then were classified as either UA or PE events. For each accident located, the accident report provided the year, make, and model of the involved vehicle.

An exemplar of each accident vehicle—either the same vehicle or a so-called “corporate twin” (identical in every respect except for trim and badging)—was located for measurement. We then defined peer vehicles that were matched on various criteria—such as wheelbase, weight, age, classification (e.g., sporty), and driver age, but different manufacturer—via each of the involved vehicles. We used Consumer Reports and the National Vehicle Population Profile (NVPP, The Polk Company) for these data. These peer vehicles had not been involved in either UA or PE accidents in the North Carolina database. Once these vehicles were located, we took various measures of their pedal configurations.
Thus, we had a sample of accident-involved vehicles, matched with their uninvolved peers, allowing a direct comparison of pedal configurations for these groups of vehicles.

The UA- and PE-involved vehicles ranged from model year 1978 through 1996, and were involved in accidents from 1981 through 1997. This resulted in a group of 20 UA- and 18 PE-involved vehicles, each of which was matched with an uninvolved peer vehicle.

Pedal Measurements

Using specially constructed equipment, we were able to measure three separate dependent variables. First, the steering wheel center was located laterally along with the lateral location of the right edge of the brake pedal and the left edge of the accelerator (at their centers vertically). This was used to define: (1) the separation between the right edge of the brake pedal and the steering wheel centerline, with a positive value being to the right of the steering wheel centerline; (2) the separation between the right edge of the brake pedal and the left edge of the accelerator (sometimes called “gap”); and (3) the vertical separation between the two pedals measured along a line perpendicular to the brake pedal surface at rest. These measures were taken from the vertical midpoints of the pedal edges.

Analyses

For each of the dependent variables, we used a 2(Involved vs. Peer) x 2(UA vs. PE) ANOVA, with repeated measures on the first factor, using a model in which the involved and peer vehicles were nested under accident type (UA, PE).

RESULTS

The mean measures of pedal configuration are summarized in Table 1. These are reported for both the involved and peer vehicles, and for both types of incident (UA and PE).

Brake to Steering-Wheel Centerline

The right edge of the brake pedal to the centerline of the steering wheel averaged 2.65 in. and varied greatly among vehicles, as the range was -0.12 to 6.27 in. Vehicles in PE accidents (2.79 in.) were aligned slightly more rightward than vehicles in UA incidents (2.51), but this difference was not reliable, $F(1,72)=1.02$, $p=.39$. When comparing incident type, both the involved vehicles (2.66 in.) and peer vehicles (2.65 in.) had almost identical right edge of brake to steering-wheel centerline distances, and was not significantly different, $F(1,72)=0.07$, $p=.84$. The interaction between incident type and involved/peer was not reliable, $F(1,72)=0.03$, $p=.88$. Taken together, these data provide no evidence that the location of the brake pedal laterally from the steering-wheel centerline was a factor in either UA or PE incidents.

Horizontal Separation

Overall, the horizontal pedal separation was 2.58 in. UA and PE vehicles had nearly equivalent separation distances (2.61 vs. 2.55 in., respectively) that were not statistically different, $F(1,72)=0.11$, $p=.80$. The involved vehicles had slightly smaller horizontal pedal separation than the peer vehicles (2.44 vs. 2.72 in., respectively); but, this difference was not significant, $F(1,72)=2.42$, $p=.14$. Similarly, differences among vehicle subgroups were not significant, $F(1,72)=2.25$, $p=.14$. These results suggest that horizontal separation is not a factor in both PE and UA incidents.

Vertical Separation

The vertical separation between the brake and accelerator was nearly identical between UA vehicles (2.50 in.) and PE vehicles (2.45 in.), and not significantly different, $F(1,72)=0.22$, $p=.72$. The involved vehicles had slightly larger vertical separation than the peer vehicles (2.62 vs. 2.33 in., respectively), but these differences failed to reach significance, $F(1,72)=2.67$, $p=.11$. Furthermore, the
Table 1. Mean (SDs) Pedal-Configuration Measures for Involved and Peer Vehicles for UA and PE Incidents

<table>
<thead>
<tr>
<th>Measure</th>
<th>Unintended Acceleration</th>
<th>Pedal Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Involved</td>
<td>Peers</td>
</tr>
<tr>
<td>Right Edge of Brake to Steering Wheel Center</td>
<td>2.49 (1.45)</td>
<td>2.53 (1.49)</td>
</tr>
<tr>
<td>Horizontal Brake-Accelerator Separation</td>
<td>2.56 (0.55)</td>
<td>2.66 (0.58)</td>
</tr>
<tr>
<td>Vertical Brake-Accelerator Separation</td>
<td>2.59 (0.94)</td>
<td>2.41 (0.88)</td>
</tr>
</tbody>
</table>

Note: Measures are in inches and SDs are in parentheses.

somewhat larger peer versus involved difference for the PE accidents as compared to the UA accidents was not significant, $F(1,72)=0.37$, $p=.55$. Overall, these data provide no evidence that the vertical separation between the brake pedal and accelerator pedal was a factor in either UA or PE incidents.

**DISCUSSION**

Some researchers have hypothesized that the configuration and/or placement of vehicle pedals may be related to pedal-error accidents (e.g., Pollard & Sussman, 1989; Schmidt, 1989; 1993). According to this argument, when the pedals are shifted to the left, a driver making a move to the brake pedal is more likely to reach the accelerator instead. This hypothesis has been widely discussed in both litigation and research settings (e.g., Brackett et al., 1989; Pollard & Sussman, 1989; Reinhart, 1994), and has been the subject of various media reports (e.g., ABC, 1997). The findings reported here fail to support this hypothesis. On the other hand, the results of this study are consistent with other earlier efforts that studied pedal configuration as a contributor to unintended acceleration. In one study, Rogers and Wierwille (1988) examined various pedal configurations in a fixed-base driving simulator, and found no evidence that pedal errors were related to the configuration of the pedals. Also, Vernoy and Tomerlin (1989) studied subjects in stationary vehicles of various designs (and hence, with various pedal configurations), and also found no relationship between the pedal design and pedal misapplications. Reinhart (1994) discussed several studies by NHTSA that also failed to find a relationship between pedal design and unintended acceleration. In short, we know of no convincing evidence that the pedal design is related to episodes of unintended acceleration.

The results of our study provide little evidence for the hypothesis that vehicles with leftward-biased pedal clusters, or those with a small gap (i.e., distance between the right edge of the brake and left edge of the accelerator) are in some way prone to either UA or PE accidents. Instead, these results are consistent with the notion that response errors, such as those resulting from
variability in movement control, are responsible for these pedal misapplications.

REFERENCES


