DRIVER RESPONSE TO ROADSIDE OBSTACLES

Patrick O'Leary
Cheryl Bettinardi
Tim Daniel
Edward Nielsen
David G. Curry, Ph.D.
Packer Engineering
Naperville, IL

It is often contended in court cases that a prudent driver when encountering obstacles adjacent to the side of a roadway (e.g., a stopped vehicle or pedestrian) will decrease their speed of travel and/or shift their lane position in order to allow greater margin of safety. A search of the available literature, however, has not produced any validation that this assertion is in fact true, or a quantification of the level of such avoidance maneuvers. This study examined the behavior of drivers in response to four different scenarios involving obstacles adjacent to the roadway: 1) a vehicle parked on the shoulder of the road, 2) a parked vehicle and a visible pedestrian adjacent to it, 3) a pedestrian alone, and 4) a baseline condition with no obstacle present on the roadside. Dependent measures included change in passing vehicle velocity and the displacement of the passing vehicle from the edge of the roadway. The results indicated statistically significant changes in both the speed and lane position of the passing vehicle.

INTRODUCTION

Many automobile accidents involve interactions between vehicles proceeding within travel lanes and vehicles or pedestrians adjacent to the side of the roadway. While there has been some research performed with regard to average vehicle speeds within construction zones (e.g., Sisiopiku, 1999; Dewar and Olsen, 2002), we have been able to locate little or no experimental data regarding the avoidance behaviors of typical motorists in areas with roadside obstacles, but without typical warning indicators such as signs, barriers, flagmen, etc. Further, the studies that have been conducted in construction zones have focused primarily on the relative travel velocities of vehicles through the zone, and not the lateral separation distance between themselves and potential obstacles adjacent to their path of travel. Results of construction zone studies have been less than promising from a safety perspective, usually finding that drivers familiar with a road are less apt to decrease speed and that speed through construction zones average well above the posted speed limits.

Given the lack of response in clearly delineated hazardous areas, one questions how the typical driver responds to situations regarding which they are not forewarned and where speed limits are not reduced. This study was designed to evaluate these issues. The working hypotheses were that the presence of a parked vehicle in close proximity to the roadside would result in significant reduction in passing vehicle velocity and an increased distance from the side of the road.

METHOD

Subjects

Fifty different subject vehicles were evaluated within five different conditions. These subject vehicles were chosen at random based on their travel past the test site and were unaware of their involvement in the study. Vehicles selected for inclusion included only passenger vehicles (e.g., cars, passenger vans, and light trucks) and not larger commercial vehicles.

Procedure

The selected test location was on a north-south two-lane, non-residential roadway with low traffic flow (an approximate average of one vehicle every 30 seconds) and no construction. The roadway was absent of hills or bends for over 1000 feet (approximately 305m) in either direction of the test location. On the day of data collection, the weather was clear and sunny and data collection occurred during the midday hours (from 11:00 a.m. to 2:00 p.m.), maximizing visibility and minimizing any potential glare impacts from low sun elevations. Lane width of the subject roadway was 11'4" (3.45m) between center dividing line and the fog line at the outer edge of the road. The posted speed limit in the area was 45 mph (72.4 km/h).

The experimental setup involved the use of a video camera focused on the fogline to the outside edge of the lane of travel and an experimenter with an instant-on radar gun, both of which were hidden from view of oncoming vehicles. The roadside obstacles---either a pedestrian, a midsized vehicle (a 1994 black Chevrolet S-10 pickup truck, or both---was positioned on the shoulder of the roadway two feet from the inside edge of the fogline. For conditions in which the pedestrian was present, he was positioned in front of the passenger side taillight of the vehicle ("in front of" refers to the direction of oncoming traffic---in practice, the vehicle was parked facing in the same direction as traffic.) Chalk was used to mark lines one foot apart, parallel to the fog line on the roadway itself. These marks were undetectable to oncoming motorists, and were used to scale the distance between the passenger side wheels of passing vehicles and the fogline when the video was examined.

The video camera was placed away from the road and behind a telephone pole, thus hiding it from the subjects' view. The camera recorded the lines on the road as well as the position of passing traffic. The radar gun was positioned approximately 40 feet (12.2m) away from the center of the lane in question and one hundred forty feet up the roadside from the location of the roadside "obstacle" (i.e., prior to the point at which the passing vehicle reached the obstacle). A telephone pole 750 feet (228.6m) in advance of the obstacle's location was used as a marker for the point at which a vehicle's velocity would be recorded as it approached the obstacle locale. Data were collected regarding the make, model, color, and speed of the passing vehicles. These data were collected so that each vehicle could be correlated with the video to allow collection and matching of lane position data.

Data was collected for four different conditions: 1) no obstacle present, 2) mid-sized vehicle without active hazard flashers, 3) mid-sized vehicle without flashers and pedestrian, and 4) pedestrian only. Dependent measures were change in velocity of the approaching vehicle between the initial measurement point and a point parallel with the roadside obstacle, and the distance between the fogline and the passenger-side wheels of the passing vehicle. Following initial data collection, partial data were collected for an additional condition (vehicle only with flashers active). This final condition was run to ascertain whether passing vehicle behavior was affected providing some type of additional alert to the oncoming drivers. Only speed data were collected for this comparison.

Data Analysis

Due to the offset position of the radar unit, a correction factor was used to calculate the actual forward travel velocity of the passing vehicles. The corrected velocity data were then analyzed to determine the mean velocity change under each scenario. The distance between the vehicle and the fogline was analyzed by examining the video of the passing vehicles and scaling the distance based on the chalked pavement markings.

One-way ANOVAs were used to identify significant main effects for both passing vehicle speed change and distance to the fogline. Once main effects were identified, Dunnett two sided T-tests were then performed comparing each of the three test conditions against the "No Obstacle" baseline condition.

RESULTS

Significant main effects were found for both fogline separation distance and passing vehicle speed [$F(3,193) = 23.02$, $p \leq 0.001$ and $F(3,194) = 5.19$, $p \leq 0.002$, respectively]. Dunnett two-sided T-tests were performed to identify the locus of the significant main effects. Results indicated that for the fogline distance metric, all three of the test conditions were significantly different from the baseline ("No Obstacle") condition at a $p \leq 0.001$ level. For the speed change measure, only the conditions where the vehicle was present on the side of the road differed significantly from the baseline: pedestrian only ($p<0.644$), vehicle only ($p<0.004$), vehicle and pedestrian ($p \leq 0.006$). Summary data showing the average value for the dependent measures under each condition are presented in Table 1. Graphic depictions of the change in vehicle velocity and distance from the fogline across conditions are presented in Tables 1 and 2.

Condition	Fogline Distance (ft)	Initial Speed (mph)	Passing Speed (mph)	Speed Difference (mph)
Baseline (No Obstacle)	2.6	47.2	47.2	0.0
Pedestrian Only	3.5	47.5	47.0	0.5
Pedestrian & Vehicle	4.3	47.4	45.9	1.5
Vehicle Only w/o Flashers	3.8	47.3	45.7	1.6
Vehicle Only w/Flashers		46.9	45.3	1.6

Table 1: Summary of Results

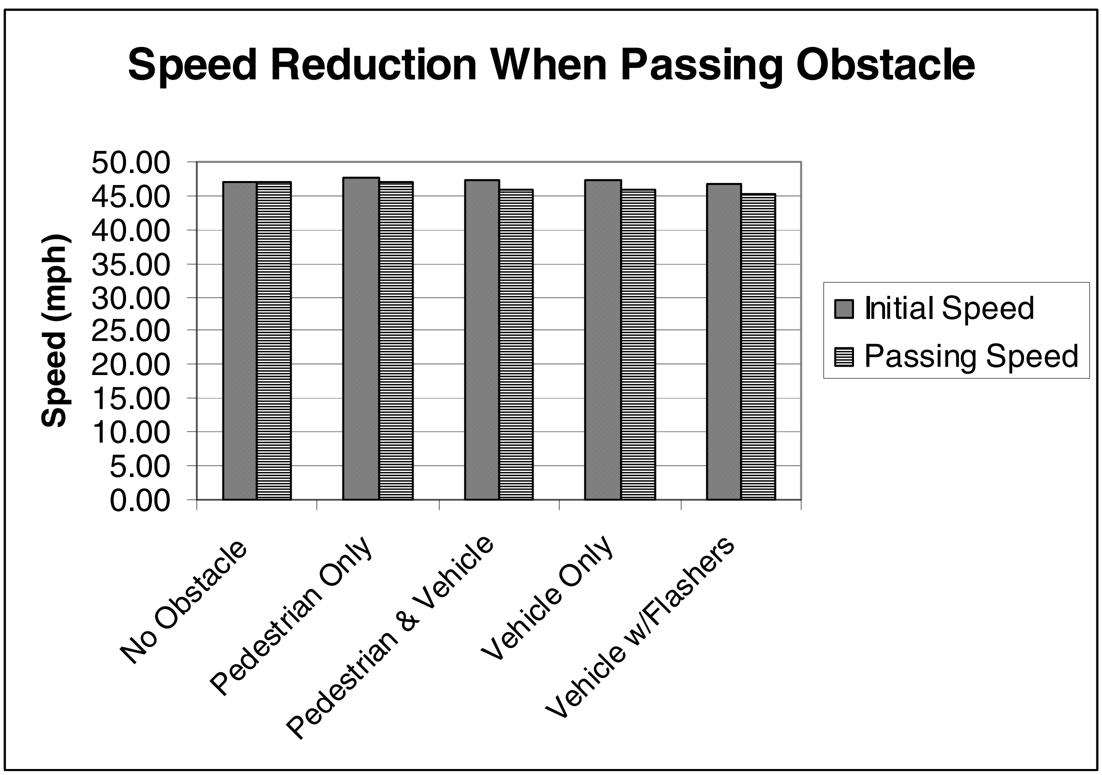

Table 1

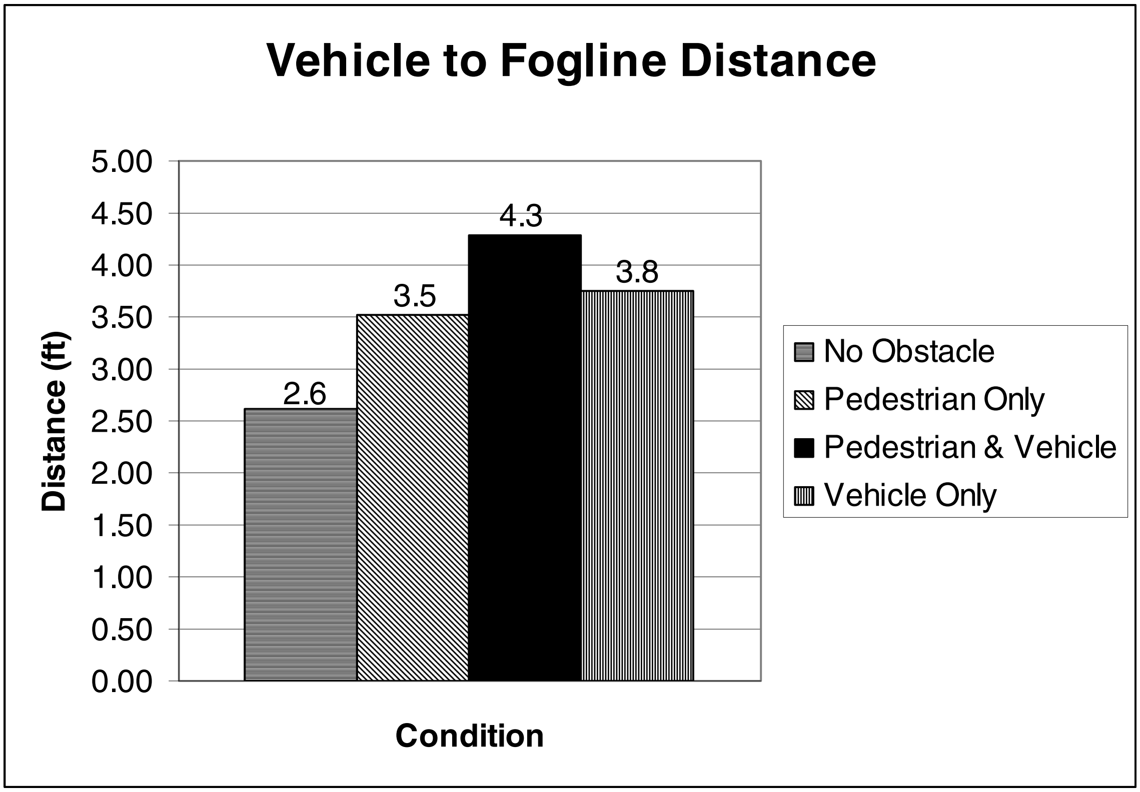

Table 2

It should be noted that the first two conditions using a vehicle as the roadside obstacle in the table above are based on the hazard flashers being in the "Off" setting. When the data for the partial condition evaluating the effect of active hazard flashers on passing vehicle speed were examined, it was found that mean change in speed of the passing vehicles was an identical reduction of 1.6 mph regardless of whether or not flashers were active.

DISCUSSION

The results indicated that there were statistically significant change in vehicle position and speed when passing an obstacle along the roadside. Average distance with no obstacle present between the fogline and the passing vehicle was approximately 2.6 feet (0.8m). Given an average vehicle width of 6 feet (1.83m) including mirrors and a lane width of 11'4" (3.45m), this indicates that motor vehicle operators normally traveled almost exactly in the center of their own lane when proceeding down the roadway. The extra distance which the passing vehicles moved to their left when approaching the parked vehicle and visible pedestrian on the side of the road (the most robust movement) corresponded to a position in which the vehicles driver side would be approximately 1 foot (0.3m) from the center dividing line between the lanes. It is interesting to note that the subject vehicles rarely intruded into the lane of oncoming traffic, even when no oncoming traffic prevented them from doing so. It is also interesting to note that the passing motorists shifted their lane position less for a pedestrian than for a stopped vehicle alone, but shifted the greatest distance under the condition where both were present.

While the decrease in vehicle speed was also statistically significant for conditions where a vehicle was present, it is, however, questionable how much practical benefit would be gained due to the level of speed reduction. The average speed of all vehicles proceeding past the test point under the baseline condition was approximately 47 mph (75.6 km/h). The maximum speed reduction observed across conditions was 1.58 mph (2.54 km/h) for the "vehicle only" conditions), a difference of approximately 3.5%. The actual reduction in stopping distance for the oncoming vehicle in response to an unexpected action on the part of the roadside obstacle (e.g., the stopped vehicle attempting to return to the road or the pedestrian straying into the road in an attempt to re-enter his vehicle) would be on the order of 7 feet (2.13m) assuming 0.7 G braking on the part of the oncoming driver; alternatively, the speed reduction would provide an additional 0.1 seconds for the oncoming driver to respond. Such a benefit would likely be more or less negligible in a real world situation.

On the other hand, that fact that a significant change occurred in either lane position or speed does indicate a recognition on the part of the oncoming driver that the roadside hazard did indeed exist. It has been shown that there is considerable reduction in driver reaction time based on state of awareness alone, ranging from approximately 1.5 seconds for an unalerted driver to 0.75 for a driver expecting to respond to an event (Green, 2000). It is possible that rather than a measurable change in velocity, oncoming drivers attempt to deal with such potential roadside obstacles by decreasing the likelihood that they will interact with them (i.e., allowing greater separation distance as they pass) and granting them increased attention, rather than by reducing their speed of travel past them.

CONCLUSION

While it was observed that the average driver does appear to adjust his/her lane position and speed of travel when encountering roadside obstacles, the degree of such adjustment (at least in terms of velocity) appears to be less than might otherwise be expected. Typically, drivers did not leave their own lane of travel to allow for more extended separation between their own vehicle and one parked adjacent to the roadway, but did shift their lane position to increase lateral separation between themselves and an obstacle as they passed. Given that the greatest lane position shift occurred when both a pedestrian and vehicle were visible, there appears to be some active weighting process occurring, in which greater risk was associated with the presence of both obstacles potentially interacting with each other.

The speed reduction of the oncoming vehicles, though statistically significant, was less than had been anticipated by the experimenters. The practical value of such a reduction is questionable, as is whether the reduction was a conscious act on the part of the oncoming drivers. It is possible that the oncoming drivers are relying on a greater level of attention being focused on the obstacle leading to a more rapid response to potential conflicts than on a speed reduction to allow longer to react.

Further research is needed on this topic. Variables of interest for future investigation include the effects of speed limit, multi-lane versus single lane roadways (i.e., the effect on 4-lane versus 2-lane roadways), lane width, and oncoming traffic

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