Calspan

AN EXPERIMENTAL STUDY OF AUTOMOBILE DRIVER CHARACTERISTICS AND CAPABILITIES

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SUMMARY OF CONCLUSIONS

A large body of information has been accumulated on driver characteristics and capabilities in the baseline experiments performed in this program. Results and conclusions are given throughout the discussions of these data but, since these sections also contain detailed information on individual maneuvers and driver operations, the major conclusions of the study may not be readily apparent. To cover several broad topics of interest, the conclusions are collected here under the following headings:

- Driver Description
- Acceleration-Velocity Performance
- Speed and Accuracy
- Familiarity With the Test Vehicle
- Vehicle Characteristics
- Surprise Intrusion
- Age and Sex
- Steering and Braking

  and, finally,
- The Average Driver

Our conclusions will, of course, be based on the results observed in this program; they will be presented in the context of trends and liklihoods. In many cases, however, comparisons have been made using the Student's t as the measure of significance. In this summary, those statements and numerical values that were associated with levels of significance between .001 and 0.1 will simply be marked with an asterisk (*).

The comments which follow contain a number of specialized terms and references which relate to particular details of the program. So that these remarks may be understood in context, a very brief background on the study is provided here.

Approximately 100 drivers drove one of two test vehicles in five trials through a continuous course consisting of several incidents requiring driver action for successful negotiation. The total subject sample was separated into several groupings (having similar makeup with respect to sex, age, and driving experience).

Familiarity with a vehicle-type (Groups A, B and C using a standard production automobile) as a factor in performance was studied with a portion of the subjects. Vehicle characteristics as a factor was investigated with two groups, D using a modified configuration of the standard vehicle and Cs (a subgroup of C) using the standard vehicle. The major differences in the modified vehicle were larger tires, quicker steering, and reduced understeer.

The driving incidents were given descriptive names which identify some major characteristic of the maneuver.

Geometrical details are given in the body of the report. Individual performance in these incidents was measured in terms of lateral acceleration, speed, success/failure, etc. and then combined for the various groups to give means and standard deviations for these various factors.

Driver Description

- About 8 in 10 of the female subjects rated themselves as average drivers; the other 2 as above average. Among the male subjects a majority, about 54%, considered themselves above average - the remainder as average. Only one subject in 108 declared himself to be a below average driver.

- The test observers rated most of the subjects as average but also rated more subjects as above average than as below average; their rating distribution was "biased" towards the high side.

- When driver self-ratings are compared with test observer ratings the female subjects agreed with the observers 67% of the time; the male subjects 45% of the time. A little less than 3 in 10 females and a little more than 4 in 10 males rated themselves higher than the test observers rated them.

- 75% of the subjects used right-foot braking; only 20% chose to use the shoulder harness available in the test vehicles.

- About 75% of the subjects declared that they had never in their driving experience driven a car harder than in their test runs.

Acceleration-Velocity Performance

- For all subjects, in almost all of the tasks, an <u>increase</u> in mean lateral acceleration occurred between the first run and the fastest run (usually the 5th); this increase amounted, on the average, to 0.1g. Similarly, average speed through the course increased from about 28 mph to 36 mph.

- In the two dry surface maneuvers in which peak lateral acceleration used by the subjects was the metric of interest - the Avoidance Maneuver and the Ess turn - the drivers of the Standard car averaged a maximum lateral g of about 0.45g. In contrast, the expert drivers in the study consistently used values at or near the limit-of-performance of the vehicle - i.e. - 0.60g to 0.65g.

- In those maneuvers in which the primary metric was a steady-state acceleration-velocity pair (i.e. $\overline{A}y$ - $\overline{V}$) the drivers of the Standard vehicle averaged about .4g over a speed range of about 25-40 mph. The drivers of the Modified car averaged somewhat higher lateral accelerations - roughly .45g over the speed range of 25-40 mph.

Speed and Accuracy

- All drivers averaged a reduction in time-in-course (without regard to failures) from the first run to the fastest run of about 20%.

- 98% of all fastest runs (without regard to failure) occurred in the 4th and 5th runs. The frequency distribution of time-in-course was nearly the same for the Standard car drivers (Groups AB and C); this was not the case, however, with the Cs and D groups (i.e. Std. vs. Mod. car).

- For the Standard car drivers the difference between the fastest run with failures and without failures was about 5 seconds, on the average - i.e. - 125 sec. vs. 130 sec. For the expert drivers the fastest run without failure was about 106 sec.

- Maximum instantaneous speed at any point in the course averaged about 55 mph for all drivers.

- The overall failure rate, all drivers, all runs averaged about 8%; the failure rate increased between the first run and fastest run from about 5% to about 11%.

- The Wet Surface maneuver produced the highest failure rate (not counting the Surprise Intrusion). About 22% of the subjects had at least one failure in this maneuver. The Avoidance Maneuver and Ess turn ranked behind the Wet Surface in difficulty; the Large Radius Arcs and Gravel Turn gave the drivers the least difficulty.

Familiarity With the Test Vehicle

- Although the familiarity criteria used (for the Standard test car) were relatively crude no large differences attributable to familiarity were detectable in most of the course tasks. However, in the Wet Surface maneuver the unfamiliar drivers (Group C) did not perform as well as the familiar drivers (Group AB); they had a higher failure rate, more failures at lower speeds and a higher frequency of loss-of-control failures.

- Based on the mean time-in-course for fast runs (runs 4 and 5) no statistically significant difference was found between Groups AB (familiar) and C (unfamiliar) drivers of the Standard car. However, the familiar drivers (Group AB) did have a much lower standard deviation indicating, possibly, a greater consistency in performance.

- The difference between Group AB (familiar) and Group C (unfamiliar) time-in-course without failure was 1 second, on the average - i.e. - 129 sec. vs 130 sec. The difference is not significant.

Standard vs Modified Vehicle

- In a number of the individual tasks (Best Successful Run) the drivers of the Modified car (Group D) were willing to push the car harder than the Standard car drivers (Group Cs); their Off Road Recovery entry velocity was a little higher, their Large Radius Arcs $\overline{A}y$ was 0.05g higher, their peak Ay in the Avoidance Maneuver and the Ess turn were from .06g to .10g higher,[*] their Gravel Turn $\overline{A}y$ was .06g higher, and their Small Radius Arc $\overline{A}y$ was .09g higher.[*] In the Wet Surface maneuver the Group D drivers tended to be more aggressive but, at the same time, they had fewer losses of control, than the Group Cs drivers.

- Based on the fast runs (runs 4 and 5) data the Modified car drivers used a lower mean time-in-course, by 7 seconds,[*] than the Standard car drivers; a slightly larger difference (i.e. about 9 seconds)[*] existed in the fastest run without failure data. However, the Modified car drivers had a slightly larger fastest run failure rate.

- For roughly equal failure rates the Group D drivers tended to go through the course faster than the Group Cs drivers.

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[*] Statistically significant, $p < .10$.

Surprise Intrusion

A portion of the subject sample was exposed to a surprise situation in which a large but lightweight plastic object was hurled into the path of the vehicle on the last run of a set.

- In 34 cases in which the plastic barrel was satisfactorily ejected and quantitative performance data are available, only one subject successfully avoided the object.

- Mean reaction time (time between ejection of the object and first evidence of driver avoidance action - braking or steering) was .65 seconds.

- In 75 % of the cases, first reaction was pure braking or combined steering and braking.

- Mean approach speed was 54 mph. In the one successful avoidance of collision, approach speed was only 44 mph.

Age and Sex

- The mean fastest run without failure for all drivers of the Standard car was about 129 seconds. For the males this figure was 123 seconds; for the females it was 137 seconds - i.e. - the males drove the course much faster.*

- On the other hand, the fast run (runs 4 and 5) failure rates for all Standard car female drivers was less than 1/2 that for all male drivers.

- If fast run (runs 4 and 5) failure rate is plotted against time-in-course for all Standard car drivers (Groups AB and C) the highest failure rate (23.2%) is associated with males in the 16-24 yr. age bracket; this group had the second lowest time-in-course. The lowest failure rate (<3%) and the highest time-in-course (148 sec.) is associated with females 45 yrs. and olders. If two "extreme value" subjects are removed from the 75 subject sample an inverse relationship between failure rate and time-in-course results. In this case the ranking on a scale of "boldness" - i.e. - achieving low time-in-course (TIC) but taking failures in the process is:

  25-44 yr. males (highest failure rate, lowest TIC)
  16-24 yr. males
  45 and older males
  16-24 yr. females
  25-45 yr. females
  45 and older females (lowest failure rate, highest TIC)

Steering and Braking

- No significant correlation of steering rates employed in transient maneuvers with the primary test variables (familiarity, vehicle type) were found in a limited analysis. Subjects were able to employ steering rates of over 500 deg/sec with success.

- Steering rates of more than 800 deg/sec were employed in collision-avoidance efforts but the vehicle was frequently not under driver control in these conditions.

- Brake usage patterns varied widely over the subject groups. Frequency, pedal force level, constancy of application, rate of application - all were quite individualistic (but often consistent within one subject) for both slowing the vehicle and stopping.

- Average deceleration in the hard stop required at the end of each trial for all subjects was .60g. This value was achieved in a large portion of the stops ($\cong$ 75%) without lockup.

Average Driver

The principal conclusions to be drawn from the experimental results with respect to developing a characterization of the average driver are as follows:

- Under unfamiliar route conditions, the average driver utilizes maximum lateral accelerations of about .3g in the speed range of 25 - 40 mph.

- Under near-optimum operating conditions, (route familiarity, no other moving vehicles in the area, no solid roadside obstacles), the average driver is willing to utilize maximum lateral accelerations of about .4g in the speed range of 25 - 40 mph.

- Assuming normal distributions, less than 20% of all drivers will exceed the above values by as much as .1g.

- The average driver is willing to utilize full tractive acceleration capabilities of a vehicle and full braking capabilities of his vehicle in straight line paths.

- A substantial percentage of drivers cannot satisfactorily control their vehicle under relatively mild skid - inducing situations.