

# Driver Characteristics and Speed Performance Related to the Facility

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● THIS PAPER reports on the results of an investigation of driver characteristics conducted at the Bureau of Highway Traffic, Yale University. Information used in the investigation was gathered with the cooperation of the state highway, police, and motor vehicle agencies of the states of Connecticut and Virginia.

Despite continuing improvements in motor vehicle accident rates it is generally agreed that the accident toll can be significantly reduced. Research on the driver-vehicle-highway relationship can provide information useful to agencies concerned with enforcement, engineering, education, and driver licensing in their endeavors to improve highway operations.

If it can be shown that a small group of operators is consistently responsible for a disproportionately large percentage of accidents and dangerous actions, elimination or improvement of these operators can be expected to reduce accidents if they can be identified at the earliest possible time. A possible approach to the identification problem involves relating driving record to some combination of personal characteristics of the operator. Another approach is to evaluate performance characteristics of the operator-vehicle combination under varying road environments and to relate this performance to the driving record. Inasmuch as most passenger cars and light trucks are capable of operating at the complete range of speed usually observed on the highway and relatively small changes in speed can be easily recorded, the freely chosen speed of operation should make an excellent performance characteristic to observe.

The object of this study was to gather facts on the relationship between free-speed performance of passenger cars and light trucks and the moving-violation and accident-responsible records of the operators under different road-way environment conditions. Personal and trip characteristics surmised to affect the speed of operation were taken into consideration.

## PREVIOUS STUDIES

Similar investigations were conducted prior to World War II by Tilden (1) and De Silva (2); and in 1950 by Lefevre (3). Tilden (1), at a rural Connecticut location, found that among vehicle owners operating at speeds in excess of 50 mph a significantly larger percentage had been involved in accidents and had more accidents than owners of vehicles traveling at speeds between 35 and 45 mph. De Silva (2), at six rural tangent locations in Connecticut, found that men owners operating at higher speeds were more likely to have accident and violation experience than their counterparts operating at moderate speeds. Lefevre (3), at two rural locations in New York, found that in the afternoon faster drivers had more accident experience than slower drivers.

This study differs from the previously reported studies in several significant ways. It was conducted in two states at 11 locations, providing greater opportunity for observed speeds to vary and including locations with more restrictive environments. Accident experiences where the operator was judged to have no responsibility were eliminated from consideration. Moving violations were considered in addition to accidents. Special attention was given to those operators whose driving record consisted solely of speeding violations. The population studied was restricted to light vehicles during week-day non-peak hours.

## DESCRIPTION OF FIELD STUDIES

Field observations were conducted on a city street in Connecticut, two-lane highways in both Connecticut and Virginia, a three-lane highway in Virginia, a four-lane undivided highway in Virginia, and a four-lane freeway in Connecticut.

It was desired that each highway selected for study provide two different environments affecting speed within a distance of a few miles. A first speed-measuring station was selected at a rural location where the operator was faced with no specific regulation or traffic or unusual roadway condition which would cause him to drive at other than a desired rural speed. A second speed-measuring station was selected where some condition of roadway, roadside development, or traffic regulation would make it prudent for the careful operator to drive at a lower speed than at the first station. It was also desired that the distance between these two points be approximately two miles, a distance over which free speed would generally be possible, yet long enough for variations in over-all speed to become apparent, and thus a third value of speed could be obtained. Satisfactory radio communication, camouflage of men and equipment, and convenient locations for conducting roadside interviews were other considerations in the selection of sites.

Locations meeting the foregoing requirements were found at four of the study sites. Only one speed-measuring station was used in the Connecticut city street survey and because of the similar environment, the second speed-measuring station on the Connecticut Freeway was not substantially different from the first station. Figures 1 and 2 show the aspects facing the driver at the two speed-measuring stations at the 4-lane Virginia study site.

The mission of the observers at the first speed-measuring location was to select free-moving vehicles registered in the state in which the study was being conducted, determine by radar the speed of these vehicles at this location, broadcast a description of the vehicles and registration numbers to the



Figure 1. First speed-measuring station, study 6; US 460, Virginia.



Figure 2. Second speed-measuring station, study 6; US 460, Virginia.

other stations, broadcast a signal at the time of arrival of the vehicles at the point, and obtain speed distributions and classify native and out-of-state vehicles.

The men at the second speed-measuring point had the mission of determining the elapsed time between arrival of the studied vehicles at the first and second locations, determining the spot speed of the vehicles at that point, and developing speed distributions and classifications.

Interviews with the operators of studied vehicles were conducted at the interviewing station. The interviewers obtained the following information from the operator through direct observation, questions, or reference to the operator's permit:

1. Origin and destination of the trip.
2. Degree of familiarity with the highway.
3. Relationship to owner of vehicle.
4. Estimate of annual mileage.<sup>1</sup>
5. Sex.
6. Age.
7. Full name.
8. Town of residence.
9. Registration number of vehicle.
10. Time of interview.

<sup>1</sup> Except Study No. 1, Merritt Parkway, Connecticut.

The field studies were conducted between 9:00 a. m. and 4:00 p. m. on the dates shown in Table 1. All studies were conducted on a dry road surface with clear or overcast skies and with seasonal temperatures.

TABLE 1  
FIELD STUDY DATES AND LOCATIONS

Study No.	Location	Dates	No. of Interviews	Avg. Daily Traffic
1	Merritt Pkwy., Stratford, Conn.	July 10-13, 1950	727	25,000
2	Dixwell Ave., Hamden, Conn.	Nov. 8-10, 1950	441	13,000
3	US 44, Canton, Conn.	Aug. 28-30, 1950	376	4,000
4	US 250, Short Pomp, Va.	Dec. 12, 13, 1950	414	4,700
5	US 360, Virginia	Dec. 11, 14, 1950	266	8,000
6	US 460, Disputanta, Va.	Dec. 15, 1950	231	4,500

### OFFICE STUDIES

After matching and coding, the cards containing all field information were taken to the motor vehicle agencies and information was obtained on the moving violation and accident experience of the operators from 1945 to June 1957. Accident reports were studied and the following information obtained as to location, amount of property damage, number of personal injuries, and whether or not the operator being studied could be assigned any responsibility for the occurrence of that accident. This responsibility was defined as contributing to the accident through failure to operate in a reasonably prudent manner. For example, many intersectional accidents were considered as occurring because of actions of both drivers. In rear-end accidents, the operator of the rear vehicle was frequently held solely responsible.

In order to generally equalize exposure time the 1957 licensing status of the operators was determined. Only those oper-

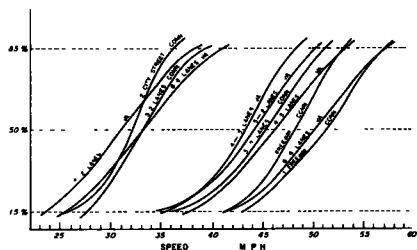


Figure 3. Cumulative speed distribution curves, 1950 speed study.

ators who were still licensed or who had lost their license through motor vehicle violations and accidents were considered in the analysis. This group is not fully representative of the population observed on the highways in 1950, because those individuals who had moved or who were no longer licensed for other reasons were not included in the group. Separate analysis of the larger population is not included in this report.

### SPEED DISTRIBUTIONS

It was found that the mean speeds of the groups studied were representative of the

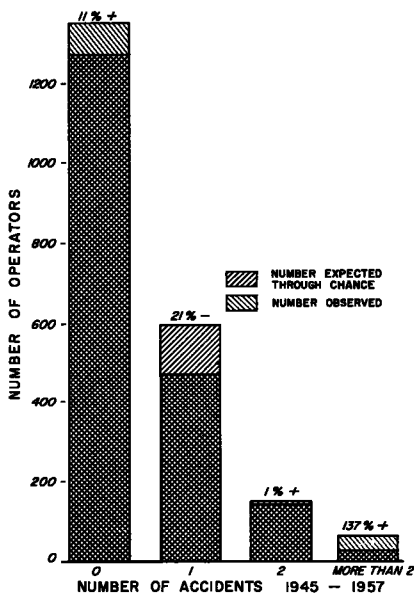


Figure 4. Comparison of observed accident experience with chance distribution.



## DRIVING RECORD DISTRIBUTIONS

Table 2 presents the distributions of convictions and responsible accident records. The Virginia operators were responsible for an average of 0.43 accidents compared to 0.51 for the Connecticut drivers. The average number of moving violation convictions was 0.32 for the Virginia drivers and 0.79 for the Connecticut operators.

Further analysis of Table 2 shows that from 74 to 87 percent of the operators had only one responsible accident or moving violation in the 12-year period. The operators with two or more responsible accidents and more than one moving violation ranged from 2.4 to 5.7 percent of the group studied. This small group had from 11 to 30 percent of the accidents and from 17 to 38 percent of the convictions. If the data were distributed according to chance, small percentages of the operators would be expected to have relatively large percentages of the driving records. Figure 4 shows the number of operators with varying numbers of responsible accidents observed in the studies compared

with the number expected from a chance distribution. There are 11 percent more operators with no accidents than expected, 21 percent fewer with one accident, and 137 percent more than expected with more than two accidents.

If the acquisition of driving records is the result of chance variation, the operators with difficulties before 1951 should have the same probability of difficulty from 1951 to 1957 as those who had no record in the earlier period. Figures 5 and 6 present results obtained when record experience in the 1945-1950 period was used as a basis

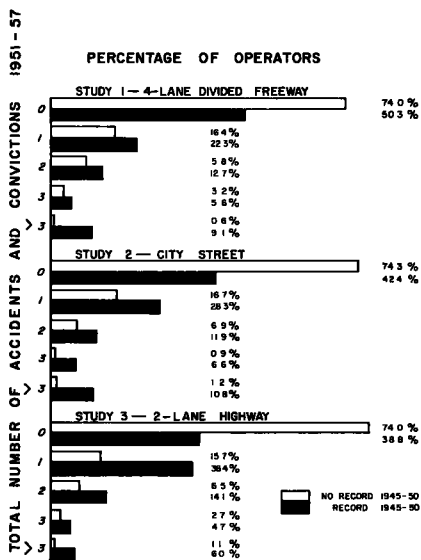


Figure 5. Experience record, 1951-1957; Connecticut studies.

for comparison of records in the 1951-1957 period. Generally, although 25 percent of the operators without trouble in the earlier period had records in the 1951-1957 period, approximately 50 percent of the operators with records from 1945 to 1950 also had accidents or violations in the later period. Operators who had records in the earlier period also had significantly more accidents and convictions in the later period.

A further investigation was made of the 1951-1957 period based on classifying the operators into groups with and without two or more responsible accidents and convictions in the 1945-1950 period. The 1951-1957 record experience is similarly classified and the results are shown in Figure 7.

In all studies a larger percentage of operators with multiple accident and conviction experience in the earlier period recorded two or more record items in the 1951-1957 period than did the operators with fewer records in the early period. In the case of the Connecticut city street study, 42.6 per-

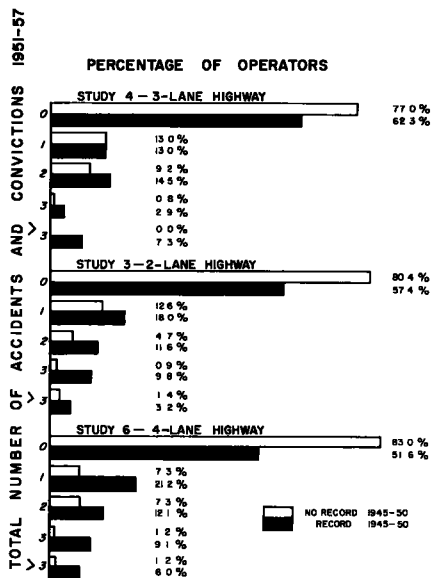


Figure 6. Experience record, 1951-1957; Virginia studies.

cent of the 1945-1950 multiple-record operators had two or more records from 1951-1957, whereas only 12.1 percent of the operators with better early records were involved in multiple-record experience in the later period.

### EFFECT OF EXPOSURE

Table 3 presents the relationship between estimated annual mileage and multiple-record experience. For the operators with a maximum of one accident or conviction in the 1945-1950 period, increasing annual mileage resulted in a statistically significant (Chi-square test) increase in the percentage of operators with multiple records in the 1951-1957 period. However, for those operators with more than one accident or conviction in the early period there was no significant tendency for a larger percentage of the operators to have multiple experience from 1951 to 1957 as the estimated annual mileage increased. The Connecticut studies show a slight, but not significant increase in percentage with multiple records with increasing mileage, whereas the Virginia studies show a decrease.

TABLE 3  
EFFECT OF EXPOSURE ON MULTIPLE-RECORDS EXPERIENCE

1945-1950 Record	Percentage of Operators with Multiple Records in 1951-1957					
	0-10,000 Miles Ann.		10-20,000 Miles Ann.		More than 20,000 Miles Ann.	
	Conn.	Va.	Conn.	Va.	Conn.	Va.
0.1	8.8	6.6	13.4	10.5	17.6	16.8
Multiple	31.6	37.5	33.3	28.6	37.2	20.0

In summary, these studies show that for the group studied a small percentage of operators have been consistently involved in a disproportionately large percentage of the multiple accident and conviction experience.

### SPEED-RECORD STUDIES

The relationship between speed of operation and driving record was investigated from a number of approaches. The analysis of speed was based on the mean speed of the operators and the variance (the square of the standard deviation), a measure of "scatter" or dispersion. The speed change between stations was developed as an absolute value, as well as a change in percentile speed. Operators were classified in three groups by record experience—those without driving records from 1945 to 1957, those with one or more responsible accidents or convictions in this period, and those with two or more accidents or convictions in both the 1945-1950 and 1951-1957 period.

The speed study locations were classified as unrestricted or restricted, depending on the nature of the road environment. The results are presented in Table 4.

The mean speeds of the operators with records at all seven unrestricted speed

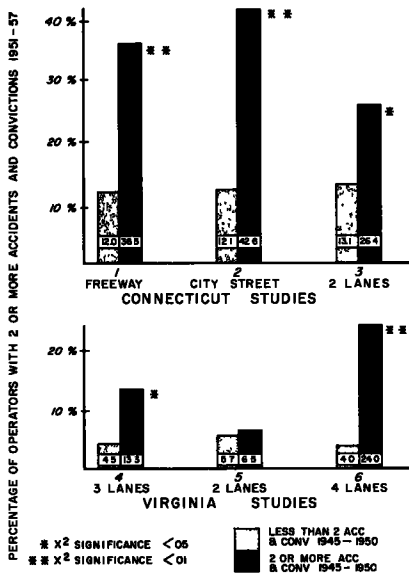


Figure 7. Multiple driving record experience, 1951-1957.

**TABLE 4**  
**SUMMARY OF SPEED STUDY RESULTS**

Study		Record Operators			No-Record Operators			Test of Significance	
		No.	Mean	Variance	No.	Mean	Variance	Variances	Mean
<b>(a) Unrestricted Speed Location</b>									
1-1	Freeway, Conn.	295	52.00	43.77	279	51.10	40.27	-	1
1-2	Freeway, Conn.	248	48.00	31.50	227	47.79	31.82	-	-
3-1	2 lanes, Conn.	134	45.17	46.07	136	44.90	37.53	-	-
4-1	3 lanes, Va.	132	46.53	59.73	199	45.39	45.64	1	-
4-2	3 lanes, Va.	113	43.18	49.30	183	42.13	31.11	2	-
5-1	2 lanes, Va.	102	44.82	39.78	173	43.42	51.31	-	1
6-1	4 lanes, Va.	61	50.88	59.42	137	48.77	46.83	-	1
<b>(b) Restricted Speed Location</b>									
2-1	City St., Conn.	212	31.67	24.66	173	31.24	17.97	1	-
3-2	2 lanes, Town, Conn.	113	34.52	26.80	116	34.21	23.66	-	-
5-2	2 lanes, Devel., Va.	98	32.11	52.19	159	32.12	39.32	1	-
6-2	4 lanes, Town, Va.	46	35.02	65.76	125	33.55	50.90	-	-
<b>(c) Over-All Speed</b>									
1	Freeway, Conn.	272	54.07	34.93	259	53.05	36.65	-	1
3	2 lanes, Conn.	123	42.67	23.49	123	42.34	20.31	-	-
4	3 lanes, Va.	109	47.83	53.72	179	45.55	41.48	-	2
5	2 lanes, Va.	96	45.88	41.88	153	44.63	35.80	-	-
6	4 lanes, Va.	56	50.66	51.11	130	47.31	45.41	-	2

<sup>1</sup> Significant at 5 percent level.

<sup>2</sup> Significant at 1 percent level.

locations were higher than those of the non-record drivers. Three of these differences were statistically significant. The range in differences of means was from 0.2 to 1.4 mph. At six of the seven unrestricted locations the variance or "scatter" of the speed of the operators with records was greater than the variance of the no-record operators. These differences were significant for only two studies.

At the four restricted-speed locations, although the record operators had slightly faster mean speeds at three of the stations none of these differences were significant, ranging from 0.3 to 1.5 mph. At all four locations the variances of the record operators were greater than those of the non-record operators and the results were significant at two of the locations.

At the five study locations where over-all speeds between the two spot-speed measuring stations were obtained, the record operators also had higher mean speeds than the no-record operators. These differences were significant for three of the studies. The differences ranged from 0.3 to 2.4 mph. The variances of the record operators exceeded those of the no-record drivers in four of the five studies. None of these differences was individually significant.

#### TRIP AND PERSONAL CHARACTERISTICS

Similar analyses were undertaken to determine if trip length, road familiarity, ownership, sex, age, or annual mileage developed different speed-record relationships. There were 200 comparisons by individual characteristics between record and no-record

operators. Operators with records had higher mean speeds in 145 of these comparisons and their variances exceeded the no-record driver population variances in 144 cases.

The analysis of individual characteristics showed significant tendencies for several characteristics. Operators with records who were men, were born from 1899 to 1928, with annual mileages in excess of 10,000 miles, on trips of greater than 50 miles in length, or who were vehicle owners, had higher mean speeds than their no-record counterparts in more than 90 percent of the comparison. No personal or trip characteristic exhibited an unusual tendency toward variance differences between record and no-record operators.

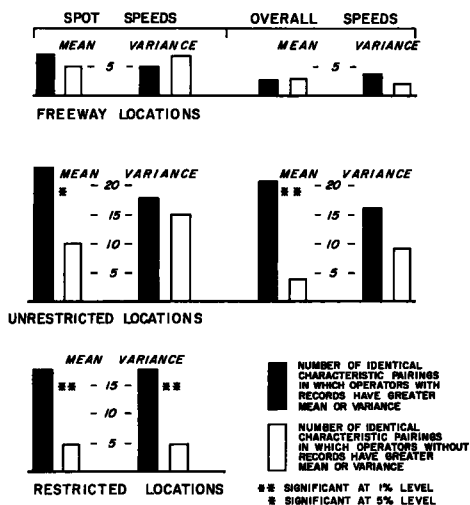


Figure 8. Effect of roadway type.

Non-owners, women, those born before 1899 and after 1929, and those with annual mileages less than 10,000 miles are the characteristics for which there was the least tendency for operators with records to have greater mean speeds than those without records.

When individual characteristics were compared by type of facility only one characteristic showed a significant difference. The record operators born before 1899 had greater variance than the no-record operators at all seven unrestricted speed stations, but had less variance at all four restricted locations.

Tests of complementary characteristics showed a tendency toward higher mean speeds by record operators for owners and

relatives compared to non-owners and employees, men compared to women, those born from 1899 to 1928 compared to both older and younger operators, and those with greater annual mileages compared with less active operators.

Relatively few of the differences were large enough to be statistically significant with the samples obtained in the study. Only 34 of the 200 variance comparisons and 36 of the 200 comparisons of means were significant at the 5 percent level, generally the record operator means and variances being significantly greater than the no-record operators. The maximum significant difference in variance indicated a 15 to 85 percentile range of 21 mph for record operators compared with 10 mph for no-record drivers. The maximum difference in mean speeds was on the Merritt Parkway, where the mean speed of the youngest record drivers was 57.3 mph compared with 49.1 mph for the young operators without records.

The only characteristic group with no significant differences in mean or variance between record and no-record operators was the group of women operators. Drivers

TABLE 5  
COMPARISON OF SPEEDS OF WORST, OTHER RECORD,  
AND NO-RECORD OPERATORS

Study No.	Location	Speed (mph)					
		Worst Operators		Other Record Operators		No-Record Operators	
		Mean	Var.	Mean	Var.	Mean	Var.
1	1	53.2	37.0	51.9	44.3	51.1	40.3
	2	49.4	25.7	47.9	31.9	47.8	31.8
	1-2	54.6	43.1	54.0	34.0	53.0	36.6
2	-	32.9	24.9	31.5	24.9	31.2	18.0



whose annual mileage exceeded 10,000 miles per year recorded no significant differences in variance between record and no-record operators. No significant differences were found in mean values between record and no-record operators for those who drove less than 10,000 miles per year.

No single characteristic produced a significant difference in means or variances between record and no-record drivers in as many as one-half of the comparisons. Characteristics which most frequently resulted in significant differences with record operators driving faster or with more dispersion than no-record operators were owners and relatives, men, those with higher annual mileages, those born from 1899 to 1928, those on short trips, and those very familiar with the highway.

Most of the significant differences by characteristic were found in the Virginia studies. Thirty of the 36 significant mean differences and 25 of the 34 significant differences in variance were recorded in Virginia. Eleven of the 16 significant means at unrestricted locations were in the Virginia studies and 15 of the 17 significant differences in means for over-all speeds were also found at the Virginia study locations. Sixteen of the 18 significant variance differences at unrestricted locations were found in the Virginia studies.

Comparisons were made of the differences of speed and variance of groups of record and no-record operators who were identical in all measured personal and trip purpose characteristics. In 65 percent of the comparisons the drivers with records had a higher mean speed than those without records. In 63 percent of the comparisons, the record operator group had greater variance than their no-record counterparts.

#### EFFECT OF ROADWAY ENVIRONMENT

Nine of the most popular identical characteristic populations were used in an analysis of differences in spot and over-all speeds for unrestricted, restricted, and freeway locations. Figure 8 presents the results of this analysis. At the freeway locations there was little difference in the number of pairs in which record operator means and variances exceeded those of the no-record operators. At the rural unrestricted locations the mean speeds of the record operators frequently exceeded the speed of their no-record counterparts. At the restricted locations the differences were highly significant, with the record operators having greater mean speeds and variances than no-record operators in 18 comparisons and the no-record drivers being greater in only 5 cases.

#### OPERATORS WITH WORST DRIVING RECORDS

An analysis was also made of those operators with two or more responsible accidents or convictions in both the 1945-50 and 1951-57 periods. The results of the Virginia and US 44 studies are not presented because of the few drivers with this type of record observed in these studies. In the Connecticut freeway and city street studies, the operators with the worst records had speeds slightly greater than other operators with records, as shown in Table 5.

#### SPEED-CHANGE

An analysis was also made of the speed change between the first and second speed-measuring points. No significant differences were detected between operators with records and those without records by speed change, whether measured in miles per hour or in percentile differences.

#### OTHER OPERATORS

The results of the studies described in this paper apply only to those operators who, in addition to being licensed in 1950, in general have been licensed continually since that time. Several hundred operators who were licensed in 1950 do not meet these requirements and information on these operators is not presented in this report. A separate analysis was made for the 1945-50 period and there is general agreement between the results found for this group and the results presented in this report.

### SUMMARY AND CONCLUSIONS

This study, conducted in two states, shows that for a group of more than 2,000 week-day, non-peak hour, long-time resident operators on a variety of different road facilities a small group has been consistently involved as a responsible party in a large percentage of accidents, and that the group with accidents and moving violations tends to operate at slightly higher average speeds and to be more variable in speed than those without records.

No characteristic of trip length, road familiarity, sex, age, ownership, or annual mileage individually or collectively contributed outstandingly to observed differences between the record and no-record groups. A tendency was noted for groups of operators with records to have higher average speed and more variability than groups without records as the road environment deteriorated from freeway conditions to restricted urban-type conditions.

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