Personal Characteristics of Traffic-Accident Repeaters

The summary of an investigation conducted by the Center for Safety Education of the Division of General Education at New York University in cooperation with the Commissioners of the Connecticut Department of Motor Vehicles and the Michigan State Police

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We wish to express our appreciation also to the 513 drivers who were the subjects of the study. The accident-repeaters were summoned by the two states. But with few exceptions, their spirit of cooperation was noteworthy. Finally, we wish to thank the Hartford and Detroit industries who sent in the accident-free drivers.

The Center for Safety Education has never engaged in a project in which there has been more wholehearted cooperation and friendliness.

HERBERT J. STACK, PH.D.
Director, Center for Safety Education

PART I

WHY THIS INVESTIGATION?

Each year, two million new drivers are licensed in the United States. In 1947 the number of licensed operators had reached a grand total of more than 40 million, over three times the number in the rest of the world. Today, one out of three persons over 16 years of age holds a driver's license. With the number of motor cars on our streets and highways steadily mounting, with the increased traffic congestion and accidents, and with the urgent need for new and improved highways, motor transportation has become one of our great national problems.

This investigation is concerned primarily with one question only: What can be disclosed concerning the driver himself that will enable the states to improve driver-licensing procedures and contribute to highway safety?

There were several factors that prompted this investigation. First, motor vehicle administrators have expressed the need for reliable tests that will screen out incompetent operators. Some seek short knowledge-and-attitude tests to be used as a part of the examination for new drivers. Others have been looking for tests that might be used to indicate personality difficulties and other conditions of emotional maladjustment.

Secondly, Connecticut had already had one type of clinic where drivers were summoned for hearings after they had had a number of accidents or violations charged against them. The Commissioner was interested in diagnostic and prognostic tests of high reliability that would enable his hearings officers to study the drivers objectively. The same was true with regard to Michigan where the State Police summon for hearings those drivers who have had accidents or repeated violations. Only too often, cases involving decisions as to license suspensions are difficult to decide. Licensing departments do not wish to rule motorists off the highway; they are concerned more with finding out what is wrong with their driving and assisting them to make the necessary

corrections. A clinic is not a punitive measure; it is diagnostic, prognostic, and remedial.

A third and compelling reason for the investigation was to learn more about the personal characteristics of accident-*repeaters*.[1] Why was it that one group of ten truck drivers would run up a total of 8-million miles in a 10-year period without an accident, while another group in the same fleet and operating under the same conditions would have 50 accidents? How could this striking difference be accounted for? This was also important information for the management of commercial fleets, for the cost of such accidents runs into sizable figures.

The investigation was also concerned with corroborating the findings of other studies. As will be shown later in this monograph, many valuable studies of accident-repeaters had been carried on in previous years. The results of some of those studies were used in the determination of tests and techniques for the present investigation.

The Eno Foundation for Highway Traffic Control

There were also certain practical considerations that motivated this investigation. Research of this nature takes time, manpower, and finances. The Eno Foundation for Highway Traffic Control had provided a grant to the Center for Safety Education to be used for research on the driver. This larger research project is already under way, the various subproblems having been studied by Alvhh Lauer, Glenn Carmichael, J. Stannard Baker, Elbert Honeycutt, Milton D. Kramer, Herbert J. Stack, and Fred Hurd. The area covered in this monograph has to do with only one of the subproblems of the larger study.

Still another aspect of the study was the attitude of the Commissioner of Motor Vehicles of Connecticut, Elmer S. Watson, and of Commissioner Donald Leonard of Michigan. No investigation of this type, no matter how worth while it may appear, can

[1] Ordinarily, a "repeater" is a driver who has had two or more accidents. In this study, the seriousness of *repeaters* was construed on the basis of the number of accidents per 100,000 motor vehicle miles. The *most serious* repeaters were considered to be drivers with an accident *rate* of 25 or more accidents per 100,000 MVM.

be carried on without the fullest cooperation of state officials. In this respect the project was particularly fortunate.

The American Optical Company was also interested in the project and assigned three of its staff members to administer the tests and interpret the findings.

A CLINIC FOR DRIVERS

The idea of a clinic for drivers is not new. Several have been in operation for some years. In a Connecticut clinic during 1947–48, conferences were held with 475 drivers and 629 others were called for hearings. Various governmental and private agencies have been studying the Connecticut Motor Vehicle Department records, chiefly because the Connecticut record system is considered superior and the state administrators have been zealous to determine basic and contributing causes of traffic accidents.

As early as 1938, Congress studied Connecticut drivers, revealing that 4 per cent of 30,000 licensed in the state were involved in 36 per cent of the accidents reported for the entire group over a 6-year period.[2] This and additional statistics warranted the conclusion that "there must be something in the characteristics of some of the drivers who had no accidents, or only one, that makes them less susceptible to traffic accidents, and that there must be some reason that causes some of the accident-repeaters . . . . to be more than ordinarily susceptible . . . . Their excess accidents cannot be explained by chance but definitely must be attributed to predisposing characteristics of the individuals or of the conditions under which they do their driving."

DeSilva[3] also reported a study made in 1932 of the different age groups involved in accidents, while a study by Slocombe[4] in 1931 revealed that the greater number of repeaters were younger drivers. Yearly statistical reports have been used in the analytical

[2] *Motor Vehicle Traffic Conditions in the United States: The Accident-Prone Driver.* (House Document No. 462, Part VI). Washington, D. C.: United States Government Printing Office, 1938, p. 11.

[3] DeSilva, Harry R., *Why We Have Automobile Accidents.* New York: John Wiley & Sons, Inc., 1942, pp. 203.

[4] Charles S. Slocombe, *Summary of Studies of Accident Drivers in Connecticut and Massachusetts,* p. 9 (mimeo). Yale University Institute of Human Relations.

studies of motor vehicle accidents. The National Safety Council includes each year in its publication *Accident Facts* an analysis of state traffic records.

Clinics in Other States

Other states have held clinics of one type or another. The California Motor Vehicle Department, for example, following the early research of DeSilva at Harvard University, has had clinics in operation for several years. In Pennsylvania, the State Police have had clinics in operation at Philadelphia[5] and reported that "the success of the clinic method is indicated by the fact that 90 per cent of the defective drivers were rehabilitated."

Another type of clinic was established by Selling[6] in the Recorders Court in Detroit. This was called a "Psychiatric Clinic" and endeavored to demonstrate the importance of including research on driver emotions and attitudes. This Clinic is still maintained in the Court and is used by both the City and State Police Departments.

Other studies convinced the investigators that some type of test for measuring emotional maladjustments and psychosomatic characteristics was important. They were convinced too that the driver's knowledge of traffic, his safety practices, and his driver attitudes should be studied. Siebrecht's[7] techniques were studied and adopted in setting up a part of the interview form described later in this report.

The clinical approach received great impetus from DeSilva's study at Harvard and from his later research at the Yale School of Human Relations. These and other studies have been combined in the book "Why We Have Automobile Accidents." [8] In these

[5] T. L. Calahan, "Safe-Driver Clinics and Psychophysical Tests." *Safety Training Digest,* pp. 51–54. New York University Center for Safety Education, 1947.

[6] Lowell S. Selling, "Mental Hygiene Aspect of the Driver Accident." *Journal of the American Medical Association,* 115 (September 14, 1946), pp. 903–06.

[7] Siebrecht, Elmer B., *The Construction and Validation of a Scale for the Measurement of Attitudes toward Safety in Automobile Driving.* Doctoral dissertation at New York University, 1941, 142 pp.

[8] Harry R. DeSilva, *Why We Have Automobile Accidents.* New York: John Wiley & Sons, Inc., 388 pp.

studies DeSilva developed several instruments that have been used in several states as the basis for the construction of testing apparatus. Lauer[9] at Iowa State College developed several types of apparatus which were used in research conducted by several states, including Connecticut and Iowa. His tests, as well as DeSilva's, were reviewed by the investigators and selected for inclusion.

There have been numerous studies of vision since DeSilva's early work at Harvard and Lauer's at Iowa State College. Tests of vision have been included in practically all state license examinations. Yet too few basic facts exist covering the relation of vision to accidents, especially with regard to such aspects as lateral and vertical phoria, stereopsis, field of vision, and light adaptation. The Army and the Air Forces have made numerous studies, and tests of vision are being included in the examination given at most posts, camps, and other military installations. The investigators decided that the complete aspects of vision should be included in the tests, and arranged with the American Optical Company for the loan of testing instruments. Inasmuch as previous studies had shown that it was unimportant, it was later decided to exclude the test for color vision.

Fletcher,[10] in charge of research for the California State Division of Drivers' Licenses, has been operating clinics for several years. Summaries of his findings appear in "Visual Problems in Motor Vehicle Operation." Comparing 400 "good" and "bad" drivers, chiefly commercial fleet operators, he showed that "there was a significant difference in the scores . . . in six of the tests used and no difference in four."

Johnson[11] in his evaluation of psychophysical testing appearing in the "Psychological Bulletin" points out the weaknesses of many of the studies that have been conducted. He states that "certain

[9] Alvhh R. Lauer, "Facts and Fancies Regarding Driver Testing Procedures." *Journal of Applied Psychology* 216 (April 1937), pp. 173–184.

[10] Edwin D. Fletcher, *Visual Problems in Motor Vehicle Administration.* Duncan, Okla.: Optometric Extension Program, 1948.

[11] H. M. Johnson, "The Detection and Treatment of Accident-Prone Drivers." *Psychological Bulletin,* Vol. 43, No. 6, p. 495. Washington, D. C.: The American Psychological Association, Inc.

well known investigators have claimed special usefulness for their methods of detection, and their claims have been accepted uncritically by many reviewers. In few instances, indeed, has any evidence been submitted of the statistical reliability of these procedures; in still fewer has their validity been meaningfully discussed." He also emphasizes the possible value of biographical data.

Brody's research, "Personal Factors in Safe Operation of Motor Vehicles," [12] conducted at New York University in 1940, is one of the more recent investigations. He found that among the various factors that appear to differentiate accident-prone and accident-free drivers, low systolic blood pressure, side vision, choice reaction, personality adjustment, and passing (road test) appear to be the most important.

It is not possible in this brief report to mention the large number of studies conducted in the United States and foreign countries. A more complete report on these studies will be found in Johnson's article in the "Psychological Bulletin." [13] In the present study the recommendations of these studies were followed in the selection of the personal characteristics to be studied and the testing techniques to be used.

[12] Leon Brody, *Personal Factors in Safe Operation of Motor Vehicles.* New York University Center for Safety Education.

[13] Johnson, *op. cit.*, p. 495.

PART II

THE INVESTIGATION

The factors or characteristics to be investigated were selected largely from the recommendations of previous research studies (Part I). In addition certain factors were decided upon following conferences with psychologists and psychiatrists. The time-limit of an hour and a half precluded the use of longer tests. The following outline shows the factors that were selected and the tests or instruments used.

I. *Personal and Driving Record* (secured from interview and state records). — (1) Age, (2) Sex, (3) Years of driving, (4) Average mileage, (5) Total mileage (period of accidents), (6) Night mileage, (7) Education, (8) Occupation, (9) Serious illnesses, (10) Accidents, (11) Arrests for moving violations, (12) Suspensions, (13) Arrests and convictions (other misdemeanors), (14) Type of vehicle, (15) Physical disabilities, (16) Glasses worn, (17) Length of time present glasses worn, (18) When eyes were examined last. Certain other data were also secured as part of the 30-minute interview.

II. *Vision.* — The characteristics of vision that were studied were selected from the recommendations of Lauer, DeSilva, and Fletcher. The aspects tested are given below. Each is explained in the description of the test that appears later in the monograph.

Characteristic	*Instrument Used*
Visual Acuity	AO Sight Screener
Left eye, right eye, both eyes	"
Binocular Vision	"
Depth Perception	"
Vertical Phoria	"
Lateral Phoria	
Field of Vision	Brombach Perimeter
Glare Recovery	Feldman Adaptometer

III. *Knowledge and Information about Traffic Safety.* — Two new tests were prepared: the first, "The Driver's Knowledge

Test"; the second, "The State Traffic Safety Test." The combined tests included a total of forty-five questions.

IV. *Personality Adjustment.* — Following the suggestions of Selling's findings (Part I) and conferences with Dr. Arthur Weider, the Cornell Word Form (CWF_2) was selected.

V. *Systolic and Diastolic Blood Pressure.* — Following Brody's suggestion (Part I), ausculatory readings of systolic and diastolic pressures were taken at two different periods by a nurse. This test was not included in Michigan.

VI. *Hearing.* — The State test was used to determine whether subjects could hear instructions.

VII. *The Interview.* — This was an important part of the investigation and required 30 minutes. The questions were prepared following an analysis of the Siebrecht Attitude Scale, the Bell Personality Inventory, the Minnesota Multiphasic and other tests.

Areas	*Number of Questions*
Driving background and experience	11
Preferred speeds and practices	13
Driving attitudes	16
Personal information and socio-economic facts	11
Cultural, reading, and recreational interests	10
Health adjustment	14

These questions will be discussed later in the report.

VIII. *Stability-Frustrations Test.* — This will be explained later in the report. It was constructed by members of the Center staff.

SELECTING AND MATCHING THE DRIVERS

One of the most important phases of the project was that of selecting and matching the drivers. It was comparatively easy for the driver-licensing authorities to summon the accident-repeaters for hearings; in the majority of cases they would have been summoned in the due process of state regulations.

The greater difficulty was that of securing the accident-free drivers and matching them with the repeaters. Commissioners can issue summonses for violators, but drivers with no accidents

cannot by any stretch of the imagination be called violators. It was necessary to contact industries, commercial fleets, insurance companies, and to convince managements that they should instruct certain of their accident-free drivers to report to the Clinic. While the actual testing time was an hour and a half, in some cases it meant the loss of half a day to the subject. Some of the drivers volunteered, but in the final matching it was necessary to discard many cases because they could not be paired.

Connecticut Procedures

1. Approximately 137 repeaters were summoned to report to the Clinic, of whom 122 appeared and were tested. In addition, 137 accident-free drivers were tested.
2. They were told the purposes of the Clinic, and that the findings would have no effect upon the status of their licenses.
3. After the tests had been scored and interpreted, the drivers were notified by letter of any disabilities disclosed.
4. "Repeaters" and "free" were matched by sex, type of vehicle, and mileage.

It was not found possible to match drivers by age, except among the more serious accident-repeaters, nor was it possible to match by mileage in the low-accident group, because there was an insufficient number of accident-free commercial operators.

Michigan Procedures

1. There was one important difference in the methods of driver selection used by Connecticut and Michigan. Connecticut drivers had received letters from the commissioner informing them that the results of the tests *would have no effect on the status of their operators' licenses. Michigan drivers, on the contrary, were promised no such immunity.* They were summoned to the Clinic and had no knowledge of what was coming. No publicity had been given out regarding the Clinic.

Repeaters in Connecticut, therefore, appeared freer to express their real feelings; Michigan drivers, while cooperative, were more cautious.

2. The Michigan State Police had worked for four weeks before the Clinic opened to select more serious accident-repeaters and comparable free drivers, and it was therefore possible to get a better matching of the groups, as is shown in Table I.

3. Matched pairs of drivers were given code numbers and after registration were known only by these numbers.

The following table shows the matching of comparable groups in the two states:

Table I

COMPARABLE DATA ON MATCHED GROUPS

	Connecticut		*Michigan*		*Grand Total*		
	"Repeaters"	*"Free"*	*"Repeaters"*	*"Free"*	*"Repeaters"*	*"Free"*	*Both*
Tested	122	137	130	124	252	261	513
Discarded	29	44	30	24	59	68	127
Tabulated	93	93	100	100	193	193	386
Sex (male)	99	99	91	91			
Average Age	32.7	44.2	36.2	36.5			
Driving Experience	14.9	17.8	17.5	18.3			
Average Mileage	73 matched (Conn.)		34,000	30,000	18,750		23,222
	20 not matched (Conn.)		64,000	17,000			
Type of Vehicle							
light truck	23	17	6	6			
heavy truck	42	31	11	18			
taxi	3	3	14	10			
bus	2	2	10	11			
passenger car	23	40	59	55			
Accidents	325		528		853		
Accidents per Driver	3.4		5.3				
Accidents per 100,000 Miles	3.5		24.8				
Violations	338		769		1,107		
Suspensions	112		16				

Observations

1. It will be noted that matching in Connecticut was not as satisfactory as in Michigan. In Connecticut, there was a difference

of twelve years in the average age; in Michigan it was identical, thirty-six years.

2. The Michigan drivers were more serious traffic offenders than the Connecticut group. Efforts were made in Michigan to bring in the worst cases, so that the accident experience per driver was 5.3 as compared to Connecticut's 3.5. But this frequency does not show the real difference: On a mileage basis Michigan drivers had 24.8 accidents per 100,000 miles; in Connecticut this average was 3.5. The Michigan sampling was therefore made up of drivers who should show characteristics of accident-repeaters more significantly than those in Connecticut; they were much more serious cases.

3. Approximately 20 of the Connecticut repeaters had low accident frequencies—less than one per 100,000 miles. Their accident record, on a mileage basis, was not much worse than the average Connecticut motorist's. They were repeaters only because they had such a high annual mileage, nearly ten times that of the average motorist.

4. With regard to the accident frequencies reported for both Michigan and Connecticut, it should be noted that *all* accidents in which a driver had been involved were taken into consideration. In perhaps 30 per cent of these, the driver in question was found to be *not* at fault.

ACCIDENTS AND EXPOSURE

Motor vehicle department statisticians have become increasingly aware of the necessity of utilizing accident data on the basis of exposure expressed in motor vehicle miles (M.V.M.) per accident. Yet this is no easy task, because few drivers keep an accurate record of their mileage. Only too often the vehicle may be driven by several operators in the family or in the fleet.

The investigators found it difficult to obtain reasonably fair approximations of yearly mileage, especially for the war years, when driving was restricted. Fortunately, the gasoline tax has provided states with figures that can be used in estimating gross

mileage of vehicles. From such figures for Connecticut and Michigan, it was noted that the total mileage during the war years ranged from approximately 50 to 60 per cent of the 1941 and 1947 figures. The following table shows mileage and accident statistics for both states.

Table II

MILEAGE AND ACCIDENT STATISTICS[14]
CONNECTICUT AND MICHIGAN

	Connecticut Average 1938–1948*	*Michigan Average* 1947 Only*
Mileage in 100-million miles	41	176
Annual accidents	19,900	137,619
Registered vehicles	535,000	1,826,000
Licensed operators	627,000	2,511,000
Mileage per vehicle per year	7,700	9,645
Mileage per operator per year	6,600	7,013
Mileage per each vehicle per accident	208,000	128,000
Accidents per vehicle per 100,000 miles	0.48	0.78

* The Connecticut statistics were taken from *Accident Facts,* 1947, the official publication of the Connecticut Department of Motor Vehicles; the Michigan, from *Motor Vehicle Traffic Accident Experience in Michigan, Year 1947* (mimeo.), prepared by the Michigan State Police.

The average yearly mileage of operators becomes a highly important factor in determining the records of accident-repeaters. The taxicab or commercial fleet operator who drives 70,000 miles a year would have more than ten times the exposure of the average passenger car driver. The woman driver who covers only 3,000 miles a year would require more than twenty-three years to equal one year's mileage of the operator of a commercial vehicle. Statistics of this kind are often ignored when women are compared to men on the basis of accident experience. It is entirely possible that the so-called accident-free drivers are accident-free in name only; their yearly mileage is so low that it does not reach the exposure criterion.

[14] All accidents referred to in this study are *moving* accidents.

High Mileage Drivers

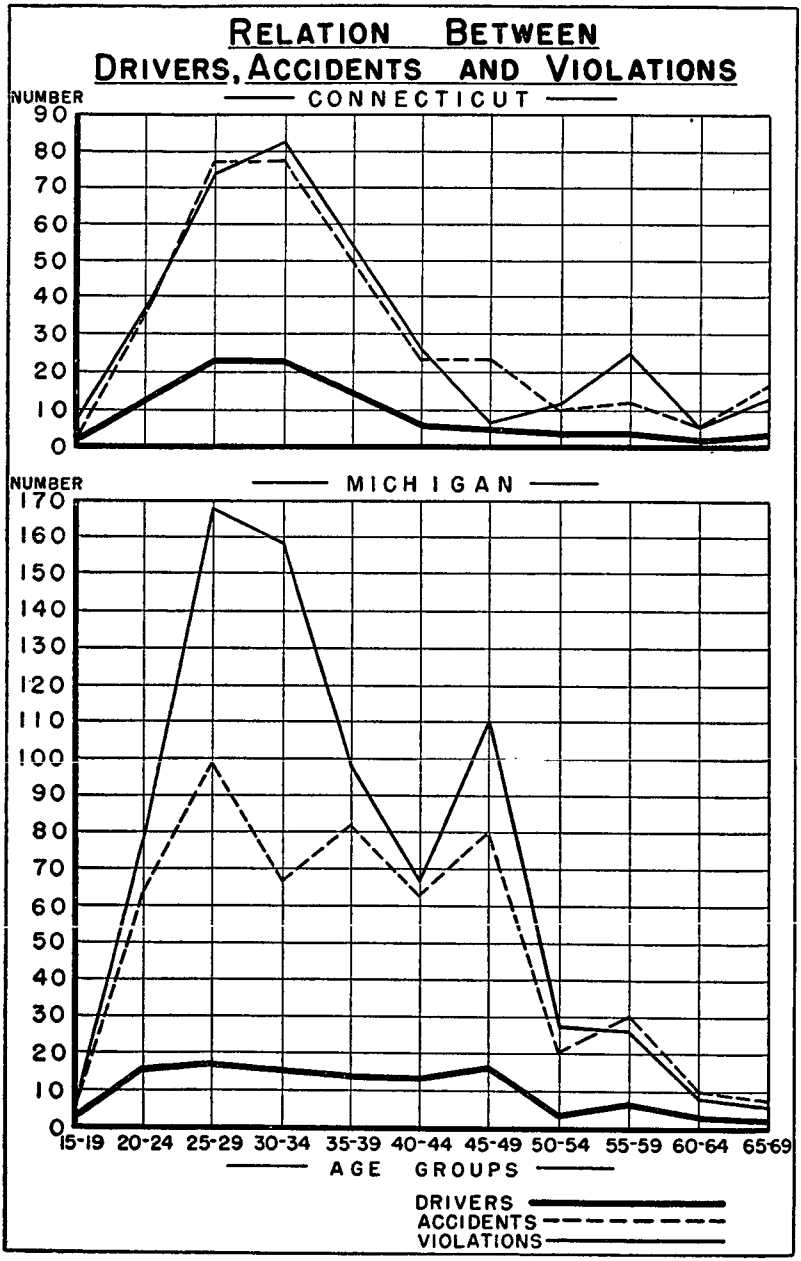
The accident-free drivers were selected, therefore, from among those with high mileages. The average mileage of accident-free operators was 26,000—a total of well over 260,000 miles for the 10-year period. The ninety-three accident-free drivers had operated a total of 21 million miles without a reportable accident or recorded violation. This is equivalent to more than 800 times around the earth at the Equator, or 3,000 round trips across the United States.

In Michigan, the annual mileage of accident-free drivers was 23,222. In the ten-year period, the 100 drivers might have operated 20-million miles. Repeaters had a total mileage under 15-million.

Insurance Loss Costs

This investigation was not concerned with losses resulting from accidents. However, certain observations can be made that show the importance of insurance costs. These obviously do not include the entire economic cost, which would involve loss of time, repair of disabled vehicles, and the like. They include only estimates of losses arising from public-liability and property damage insurance claims, exclusive of claims involving collison insurance.

1. In the two states, 193 drivers were involved in a total of 853 accidents.
2. On an average 70 per cent of the accidents involved property damage and 30 per cent personal injury (P.D. and P.I.).
3. The average claim cost for P.D. is approximately $60; for P.I. or public liability, $500. Since a large number of commercial vehicles were involved, this average might be higher. These figures may therefore be taken as a minimum.
4. The estimated claim costs for accidents involving property damage would be about $36,000.
5. The P.L. costs would be approximately $127,500 on the basis of average claim costs.



The high correlation between accidents and violations is shown by the above graphs. The best indication that a driver will have accidents is his record of repeated violations. *Violations, in a sense, can be called "symptoms" of accidents to come.*

6. Assuming only one claim for each accident, the loss costs would be $127,500.
7. However, it is found that most accidents involve two or more claims. The total cost might very easily exceed $300,000.
8. Going still further, certain of the accident-repeaters had ten or more accidents. Such drivers would be extremely poor insurance risks.
9. One group of drivers is costing in insurance claims well over $300,000. Another group, the accident-free, is costing but little. They and countless other "free" drivers are paying the costs of the "repeaters" through their insurance premiums.

STATISTICAL TERMS AND PROCEDURES[16]

This research study was undertaken chiefly for the benefit of motor vehicle administrators and others interested in the improvement of driver licensing procedures. In the analysis of the clinic results, wide use was made of the statistical method of interpretation. For those who are not familiar with this method, the following explanation should be useful, since much of the meaning of the data in this report depends upon an understanding of various statistical terms and procedures.

Mean. — The *mean* (M) is a simple statistic used to express the average typical representative score or standing of a group. It is found by dividing the sum of all the scores by the number of individuals in the group.

Standard Deviation. — The degree of variability of "spread" of the individual scores is expressed by the *standard deviation* (S.D.), which shows the relative homogeneity of a group. A small S.D. shows that the group is made up of individuals of nearly the same ability, while a high S.D. shows that we are dealing with a wide range of abilities. The formula is:

$$\text{S.D.} = \sqrt{\frac{\Sigma\, x^2}{N}},$$

where $\Sigma\, x^2$ = the sum of the square of each difference between the average score and each actual score made, and N the total number of scores.

[16] For further explanation, see Garrett, H.E., *Statistics in Psychology and Education*. New York: Longmans, Green and Co., 1947.

Standard Error of the Mean. — The *standard error of the mean* (σM) is a measure of the "trueness" of the average group score; i.e., the relative degree to which the *obtained mean* is free from or has been affected by errors or sampling and measurement. The reliability of the mean increases as its *standard error* decreases. The formula is:

$$\sigma M = \frac{\sigma}{\sqrt{N}},$$

where σ = the standard deviation of the mean and $\sqrt{N}$ the square root of the number of scores.

Standard Error of the Difference. — The *standard error of the difference* (σD) between the scores of two groups identifies the degree of fluctuation that can be expected in the difference, from errors that might affect the mean score of each group. The formula is:

$$\sigma D = \sqrt{(\sigma M_1)^2 + (\sigma M_2)^2},$$

where $(\sigma M_1)^2$ and $(\sigma M_2)^2$ are the squared values of each mean's standard error.

Critical Ratio. — The *critical ratio* (C.R. or t) between the mean scores of two different groups is a measure of the significance we can justifiably attach to this difference. The term "significance" has a special statistical connotation which should be explained: Upon simple observation, two groups may appear to be different on the basis of the scores made by each of them. This difference, however, may be only a chance occurrence or a coincidence resulting from a freak distribution of test scores, and to call this difference a significant one would not be correct. Only after a critical ratio has been computed can any real significance be attached to a difference in average scores. When the *critical ratio* is above certain standard values established according to the law of *normal* probability, the difference between groups as shown by a difference in mean scores is said to be a "significant" one; i.e., it indicates a "true" difference, one that further testing of the groups would substantiate. The formula is:

$$\text{C.R.} = \frac{D}{\sigma D},$$

when D = the difference in average scores, and σD the standard error of this difference.

Chi Square Test. — The chi square test is used also to determine the "significance" of a difference between groups that is disclosed by the

distribution of the members of each group in certain categories under observation. In this study the chi square test is used to determine the degree to which the classification of drivers according to a practice, an opinion, or an attitude is *dependent* upon their being either "repeaters" or "free" drivers. In this way association between accident experience and other characteristics can be established. The formula is:

$$\text{Chi Square} = \sum \left[\frac{(\text{fo} - \text{fe})^2}{\text{fe}} \right],$$

where fo = the observed distribution, and fe the distribution that would be expected if the two groups were normally and equally distributed.

In reporting the statistical implications of both *critical ratio* and *chi square test,* two expressions, "level of confidence" and "chances in 100 of a real difference" are used:

Level of Confidence. — This is expressed in percentage, 1 per cent, 5 per cent, 10 per cent, and merely means that the investigators are willing to risk being wrong one, or five, or ten times out of 100 when they claim a "true" or significant difference exists between the groups. The 1% level of confidence is, of course, the most reliable.

Chances in 100 of a Real Difference, reported for example as 98, means that if a difference of the order obtained in the one trial were obtained successively in 100 trials, 98 of the test results could be attributed to a significant and basic difference between the groups, and in only 2 trials would the difference be due to chance. Thus a great deal of significance can be attached to the difference obtained.

KNOWLEDGE AND INFORMATION

Motor vehicle administrators in general are aware of the fact that the public should be well informed regarding traffic regulations, rules of the road, safe driving practices, and the other fundamentals of safe operation of vehicles. Michigan and Connecticut require not only all new drivers to study the Drivers' Manual, but they grasp every opportunity to educate the public through the newspapers, the radio, motion pictures, and other media. In addition they supply both the elementary and secondary schools with instructional materials. This is true especially of the high school driver-education program.

Table III

KNOWLEDGE AND INFORMATION TEST

CONNECTICUT

Test	"Repeater" Group Mean	S.D.	σM	"Free" Group Mean	S.D.	σM	D	σD	t[3]	Significance Percent Level[1]	Chances[2]
Center	17.44	3.02	.319	18.62	3.08	.325	1.18	.455	2.60	1.0	99
Conn.	14.25	2.43	.255	15.04	1.96	.208	0.79	.833	.95	..	66

Test	Percentage of "Repeaters" Failing	σ%	Percentage of "Free" Failing	σ%	D%	σD%	t	Significance Percent Level[1]	Chances[2]
Center	21	4.08	12	3.38	9.0	5.3	1.7	10.0	91

MICHIGAN

Test	Mean	S.D.	σM	Mean	S.D.	σM	D	σD	t	Significance Percent Level[1]	Chances[2]
Center	16.70	3.54	.356	18.80	3.72	.372	2.10	.514	4.10	1	99+
Michigan	16.37	2.13	.204	17.23	1.92	.192	0.86	.280	3.07	1	99+

Test	Percentage of "Repeaters" Failing	σ%	Percentage of "Free" Failing	σ%	D%	σD%	t	Significance Percent Level[1]	Chances[2]
Center	24	4.3	12	3.3	12.0	5.4	2.22	5.0	97
Michigan	17	3.8	9	2.9	8.0	4.7	1.70	10.0	91

NOTE: A score of 14 or below is considered as failing in both the Center and the Michigan Test.

[1] Level of confidence. (See Definitions, p. 21.)

[2] Chances of 100 of real difference. (See Definitions, p. 21.)

[3] In this and subsequent tables, all interpretations of significant data are based upon either critical ratio or chi square values. (See "Statistical Terms and Procedures," page 20.)

Three tests[15] were prepared to measure the knowledge and information of the groups: the first, a "Knowledge Test for Automobile Drivers;" the second and third, 20-question tests covering motor vehicle regulations and rules of the road for each state. The validity of these tests was determined by the following methods:

1. An analysis of unsafe acts resulting in accidents
2. An analysis of violations reported in each state, indicating either a lack of information or faulty attitudes
3. A study of emergency driving situations to determine how a lack of information regarding correct procedures might lead to accidents
4. An analysis of other tests to include items previously validated.

The reliability of the Center test had been determined previously ($r = .65$), but since only one half of the test was used (25 items), its reliability calculated from the Froelich "Simple Index

[15] These tests consisted of a series of questions or statements concerned with traffic regulations, safe-driving practices, and rules of the road. A typical and significant test is presented in the Appendix.

of Test Reliability" formula, using the 386 test scores of the two states, dropped to .58. The reliability of the two state traffic tests was found to be .52 and .50, which while lower was satisfactory for group comparisons.

Observations

1. Results from both Connecticut and Michigan show that, on the average, the free drivers tested made significantly better scores than the repeaters on the Center for Safety Knowledge-Test for Automobile Drivers.
2. The same results show that *a significantly greater percentage of repeaters failed the Center Test.*
3. The average scores made on the Michigan Test show that *the free drivers as a group exhibited significantly more knowledge and information of traffic regulations than the repeaters.*
4. *A greater percentage of repeaters failed the Michigan Traffic Regulations Test.*
5. In general, the data show repeatedly that *the free groups tested were significantly superior to the repeaters in their knowledge and information regarding safe driving.*
6. These clinical results disclose the presence of *a real and significant difference between repeaters and free with respect to driving knowledge and information.*
7. These data can be taken as good evidence that *lack of knowledge of safe driving is directly related to traffic accidents.*
8. *Certain types of tests, particularly the Center for Safety Knowledge Test for Automobile Drivers, have value in a rough screening of poorly informed and hence unreliable drivers.*
9. It is interesting to note that the average scores made on the Center Test by the free drivers in Connecticut and Michigan were approximately the same, 18.6 and 18.8 respectively. This is indicative of the consistency of measurement which this test exhibits when applied to different groups of substantially the same type, and is good evidence of the average knowledge of safe driving practices and traffic regulations possessed by the average "better" driver.
10. It should be noted that the average score of the repeaters in Connecticut on the Center Test was better than that of the repeaters in Michigan. This is clearly consistent with the conclusion that there is a definite relationship between a lack of driving knowledge and traffic accidents; the data have already identified the repeater problem as more serious among the Michigan drivers than the Connecticut drivers tested.

Scores Made by Michigan Serious Accident-Repeaters

Of the 100 accident-repeaters participating in the Michigan Clinic, those whose accident frequencies fell within the range of 25 to over 100 accidents per 100,000 miles were selected as serious offenders. Twenty-one repeaters were so identified. The twenty-one free drivers matched with these serious repeaters were selected according to the conventional matching plan of the study described earlier in this report; that is, on the basis of comparable driving exposure, driving experience, age, type of vehicle driven, and occupation.

The twenty-one serious offenders and the corresponding number of free drivers were treated as a separate group in order to corroborate previous findings relative to driving knowledge and information and to point out more significantly the direct relationship which exists between a lack of driving knowledge and motor vehicle accidents.

An analysis of the Knowledge and Information Test data obtained on the twenty-one serious accident-repeaters and the corresponding free drivers follows.

Table IV

KNOWLEDGE AND INFORMATION TEST, SERIOUS REPEATERS

1 — entire "free" group
2 — serious "repeaters"
3 — matched "free"
4 — significant level of confidence in percentage
5 — significant chances in 100 of a real difference

AVERAGE SCORES

	1			*2*			*3*						*4*	*5*
Test	*M*	*S.D.*	σM	*M*	*S.D.*	σM	*M*	*S.D.*	σM	*D*	σD	*t*	*L*	*C*
Center	...	...	...	15.4	4.05	.885	17.9	4.18	.915	2.5	1.27	1.97	5	95
Center	18.8	3.72	.372	15.4	4.05	.885	...	...	...	3.4	.96	3.54	1	99+
Michigan	...	...	...	15.1	2.44	.532	17.1	2.49	.544	2.0	.76	2.64	1	99+
Michigan	17.23	1.92	.192	15.1	2.44	.532	...	...	...	2.13	.565	3.77	1	99+

PERCENTAGE OF GROUPS FAILING

	"Free"		*"Repeaters"*		*Matched "Free"*					*4*	*5*
	Failing	$\sigma\%$	*Failing*	$\sigma\%$	*Failing*	$\sigma\%$	$D\%$	$\sigma D\%$	*CR*	*L*	*C*
Center	...	...	38.0	10.60	14.0	7.60	24.0	13.0	1.85	10.0	94
Center	12.0	3.30	38.0	10.60	...	...	26.0	11.1	2.34	2.0	98
Michigan	...	...	24.0	9.40	14.0	7.60	10.0	12.1	.83	...	59
Michigan	9.0	2.90	24.0	9.40	...	...	15.0	9.3	1.62	...	89

Observations

1. *The matched free group made an average score on the Center Test 2.5 points higher than the serious repeaters,* indicating a significant difference between the two groups.
2. *The serious repeaters compare even more unfavorably with the entire free group with respect to driving knowledge and information than do the entire repeater group. The entire repeater group scored 2.1 points poorer than the free, while the serious repeaters scored 3.4 points poorer.* The statistics show that both of these figures *denote a "true difference" between the groups* (99 out of 100 trials) and cannot be attributed to chance alone.
3. While only 11 per cent more failures in the Center Test were found among the entire repeater group than among the entire free group, 26 per cent more were found among the serious repeaters. This shows that even though approximately the same proportion of failures were found in the matched free group as in the entire free group, a *lack of adequate driving knowledge and information is found more frequently in a group as the accident frequency rises.*
4. *A much greater difference in average scores on the Michigan Test is shown between the serious repeaters and the matched free group than between the entire "repeater" and "free" groups.* While the matched free group maintained an average group score of approximately 17, the serious repeaters dropped to an average score of 15.1. (The average score of the entire repeater group was 16.37). This, again, indicates that *as the accident experience of a group becomes worse, the tendency for the group to exhibit poorer driving knowledge and information becomes more pronounced.*
5. While on the Michigan test, the difference in proportion between the serious repeaters and the matched free failing the test does not appear highly significant, the increase in proportion to 24 per cent of serious repeaters as compared to 9 per cent of the entire free group failing has somewhat greater significance. This indicates that the ability of the Michigan Test to disclose significant differences between the groups increases as the seriousness of accidents increases. While these data were not included above in tabular form, it is interesting to note that when the 10 most serious offenders were segregated from the 21 now under consideration, the ability of the Michigan Test to differentiate significantly between the former and the entire free group seemed to become even greater.
6. *In general, groups with very high accident frequencies seemed to be less well informed than those with lower accident frequencies,*

while those with no accident experience appeared to be decidedly superior to both groups in this respect. These data substantiate the conclusions drawn previously that inadequate knowledge and information of safe driving practices and traffic regulations is directly related to motor vehicle accidents.

Item Analysis

An item analysis was then made of the test questions to ascertain the percentage of drivers failing each question. This analysis is being furnished the Department of Motor Vehicles to indicate certain subjects on which the drivers appear to be poorly informed. It is always a question as to which types of test questions are the most important. Some typical examples follow.

PERCENTAGE OF ACCIDENT-REPEATERS FAILING

	Connecticut	*Michigan*
Failing on the meaning of a flashing red light	58.0	23.0
Ignorant of best way to stop a car on a snow-covered road	25.0	28.0
Ignorant of number of car lengths required to stop a car going 40 miles an hour	43.0	Not included
On the question: "Your car X is being overtaken by another car Y on a 2-lane road. Just as the overtaking car draws alongside yours, its driver, seeing that an oncoming car Z is near, starts to drop back into line again. You can reduce the danger to all three cars by (1) accelerating, (2) applying the brakes, (3) keeping your speed constant, (4) blowing your horn as a danger signal." The best answer is (1) but 53 per cent of the Connecticut and 47 per cent of the Michigan drivers checked one of the others.	53	47
On the meaning of the road traffic sign, 52 per cent of the Connecticut repeaters failed and 56 per cent of the Michigan. This may be excusable, for these signs are not too numerous in many of the states. They are the standard sign of the national code.	52	56

Which of these questions is most important? The investigators have not attempted to determine. The accident-free drivers had almost as high a percentage of incorrect answers on some of the questions as the repeaters. The investigators must conclude that many drivers are not well informed regarding the provisions of the State Code or the best driving practices. Evidence points to the fact that accident repeaters are poorly informed. Significant proportions of the serious repeaters in Michigan failed both tests. There is much that can be done by the states to increase the general knowledge of traffic safety.

PERSONALITY ADJUSTMENT

The Cornell Word Form is a psychological test useful for the detection of personality disturbances, performing the task in a manner not easily apparent to the subject being tested. It consists of a list of stimulus words next to each of which are two other words. The subject is asked to choose the one he thinks fits better the stimulus word. It is his choice of response words which gives some insight into his emotional adjustment.

Connecticut Results

The test was given to both accident-repeaters and an equal number of accident-free drivers. Taking a score of 9 or more "wrong" associations as indicative of emotional instability, the investigators found that 20.4 per cent of the repeater group and 10.8 per cent of the free group were earmarked. While the mean number of "wrong" associations for the former group was 4.9, the mean for the latter group was 4.2. Applying statistical procedures to test the reliability of this difference, the investigators found that there were 93 chances in 100 that the obtained difference was not due to chance factors but was significant.

Table V

RESULTS ON CORNELL WORD FORM
(CONNECTICUT)

"Repeaters" *Percentage above 9*	$\sigma\%$	*Accident-Free* *Percentage above 9*	$\sigma\%$	$\sigma D\%$	t	*Significance* *Level*[1]	*Chances*[2]
20.43	4.2	10.75	3.2	5.3	1.83	10%	93

[1] Level of confidence.
[2] Chances in 100 of a real difference.

Michigan Results

The Cornell Word Form was administered in Michigan to the repeaters and free groups in the same manner as in Connecticut, a score of 9 or more "wrong" associations being interpreted as indicative of emotional instability. The serious repeaters and corresponding free group were segregated from the other groups and treated separately, in accordance with the system used in reporting the data on the Knowledge and Information Tests. The results are given below.

Table VI

RESULTS ON CORNELL WORD FORM
(MICHIGAN)

1 — entire "repeater" group in percentage
2 — entire "free" group in percentage
3 — serious "repeaters" in percentage
4 — matched "free" group in percentage
5 — significant level of confidence in percentage
6 — significant chances in 100 of real difference

1		2		3		4					5	6
Failing	$\sigma\%$	*Failing*	$\sigma\%$	*Failing*	$\sigma\%$	*Failing*	$\sigma\%$	$D\%$	$\sigma D\%$	t	L	C
28.0	4.5	7.0	2.6	...	...	...	...	21.0	5.2	4.05	1	99+
...	...	...	...	23.8	9.3	4.8	4.7	19.0	10.4	1.83	10	93
28.0	4.5	...	...	...	...	4.8	4.7	23.2	6.5	3.58	1	99+
...	...	7.0	2.6	23.8	9.3	...	...	16.8	9.7	1.73	10	92

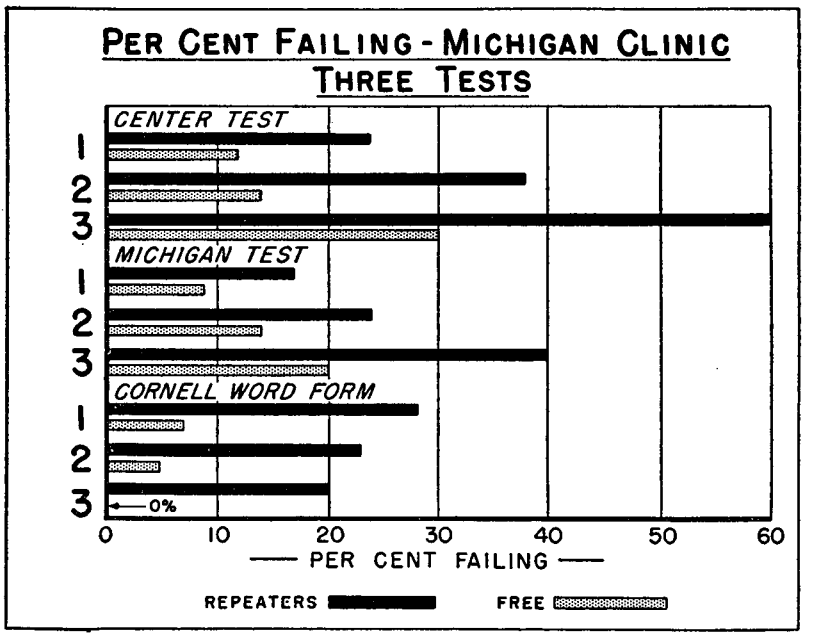
Observations

1. *A significantly higher proportion of repeaters than free, all groups, scored 9 or above on the C.W.F. In 99 out of 100 trials, these figures indicated a "true difference" between the groups and cannot be attributed to chance alone.*
2. *These data can be taken as good evidence that personality maladjustment or emotional instability is directly related to motor vehicle accident experience.*
3. An even greater difference in the proportion of all repeaters and the small matched free group scoring 9 or below on the test is noted. This substantiates the conclusion previously drawn that, in general, *drivers with accident experience exhibit a stronger tendency toward emotional instability than those who have had no accidents.*

4. This significant difference between repeaters and free drivers is further seen in the comparisons between the entire free group and the serious repeaters, and between the serious repeaters and the matched free group. The level of significance in these cases, however, is not as striking as in those already noted. *This would seem to point to the fact that while the C. W. F. has high value in screening persons with maladjustments in personality, and while disorders of such nature appear to be definitely related directly to accident experience, the Cornell Word Form appears to be better able to discriminate significantly at low accident frequency levels than at high.*

PERFORMANCE UNDER "STRESS" AND "FRUSTRATION"

Adequate knowledge, skills, and good intentions are not in themselves insurance against driving accidents if performance behind the wheel is affected adversely by emotional instability. Certain



Number 1 indicates both entire groups; number 2, the twenty-one serious repeaters and the matched free; number 3, the ten most serious repeaters and the matched free.

individuals who manifest stability under normal conditions may suddenly become angry, or unduly aggressive or submissive, or "go to pieces" as a result of conditions which cause reactions of annoyance, stress, "upset," frustration, or combinations of these. Conceivably, if manifested when driving, such traits may incline a person toward accident involvement.

In an attempt to secure further data on this problem, the present investigators constructed and utilized a device designed to measure the degree of motor movement control when exposed to frustrating and annoying situations. Exploration into this matter stemmed from the consideration that when a group is exposed to such situations, differences in the ability to control motor movements may be expected. For instance, the person whose frustration tolerance is lower will show a higher amount of disruption; in a sense his control of motor movements will be impaired more than the person's whose frustration tolerance is higher.

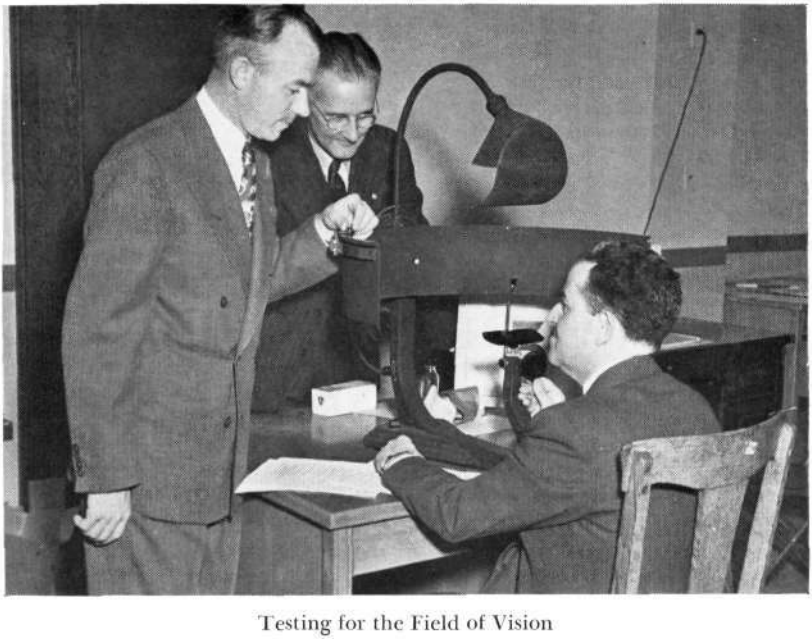
The building of the device, therefore, entailed the consideration that inefficient coordination of muscles and bodily movements and an unbalanced emotional system frequently go hand in hand, and that mental instability may be evidenced in uncertain and jerky muscular actions. In a driving situation, inefficient movements of this kind, or the underlying conditions they indicate, may prove serious, however harmless or inconsequential they are in different circumstances. The emotionally unstable driver may "blow up" and invite a crash, whereas the emotionally stable driver, because of a better response, could be expected to avoid the accident or at least strive to reduce its severity.

As constructed and administered, the device called for a comparatively simple motor activity; viz., the guiding of a stylus through a brass plate in which a curving pathway had been cut. With the stylus inserted equidistant from the sides of the pathway, there was about an eighth of an inch clearance on each side. The instrument was constructed and wired so that each time the stylus touched the plate as the subject moved it through the pathway, an electrical counter recorded the touch. The total number of touches or contacts could then be obtained.

Measuring Motor Performance

The Interview Was a Friendly Discussion

Measuring Vision with the Sight Screener



Testing for the Field of Vision

The test, which was given in a separate room, was administered as follows:

1. The subject was greeted by the examiner in a pleasant manner, after which the device was explained to him.
2. The subject was given a trial without recording the score, and was told that his next attempt would be scored.
3. After the words "Now go ahead," the subject repeated the performance, and this time his score was recorded.
4. In a stern and disappointed voice, the examiner then said: "That was disappointing, and a very poor score. What *IS* the matter with you! Now make a second trial. I don't think you'll get a good score, but go ahead anyway." The subject then made another attempt and his score was recorded.
5. The examiner then said: "That is *still* a bad score. Now do it again." Just as soon as the subject began, the examiner closed a switch that turned on a loud buzzer and lights that flashed on and off. A loud klaxon horn, on the floor and unseen by the subject, was honked abruptly at four specific points, while each time the subject made a touch a bell gave out a loud clang. At the completion of the performance, the score was recorded. In Michigan, a recording was made of a series of noises closely associated with emergency situations; i.e., (1) police siren, (2) fire engine siren, (3) screeching brakes, (4) train whistle, (5) voice yelling "get over on your own side of the road," etc. This was played back with a standard intensity during the 60-second period of the third trial.

The investigators do not make any claims for this instrument. They do, however, wish to point out certain facts based upon the data in the following tables.

In this brief report it is not possible to show many of the original findings in tabular form. Data pertaining to the comparison of the scores made on Trials I, II and III by repeaters and free are omitted here. These data were tabulated in the original report to show the comparative effects of distracting and frustrating conditions on the motor performance of the two groups, and the comparative improvement on practice made by each group in the course of the successive trials. The results of these findings are included in the following observations.

Table VII

Scores on Motor Performance Test

CONNECTICUT

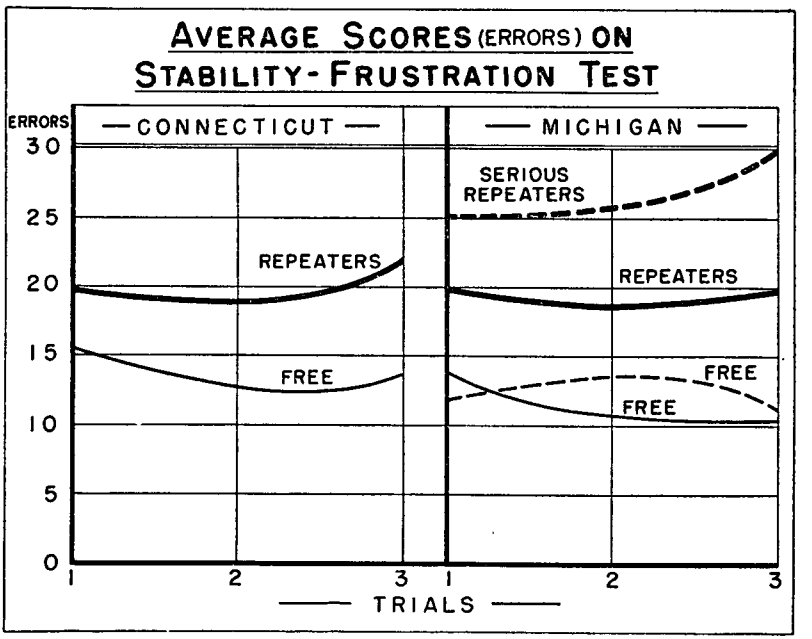
	Repeaters			*Free*							
	Mean	*S.D.*	*σM*	*Mean*	*S.D.*	*σM*	*D*	*σD*	*t*	*Level*[1]	*Chances*[2]
Trial I	19.78	10.58	1.10	15.34	9.08	.947	4.44	1.45	3.06	1	99+
Trial II	18.76	10.26	1.07	12.68	8.44	.880	6.08	1.39	4.38	1	99+
Trial III	21.06	12.09	1.26	13.78	9.72	1.013	7.28	1.62	4.49	1	99+
				MICHIGAN							
				Entire Groups							
Trial I	19.90	9.95	.995	13.80	7.40	.74	6.10	1.24	4.60	1	99+
Trial II	18.50	12.40	1.240	10.60	6.60	.66	7.90	1.41	5.60	1	99+
Trial III	19.30	13.60	1.360	10.40	6.25	.63	8.90	1.50	5.82	1	99+
				Serious Repeaters and Matched Free							
Trial I	21.90	10.20	2.23	13.70	5.97	1.30	8.20	2.58	3.18	1	99+
Trial II	20.80	14.20	3.10	13.10	4.86	1.06	7.70	3.27	2.36	2	98
Trial III	23.30	13.80	3.01	9.70	4.64	1.01	13.60	3.18	4.27	1	99+
				Most Serious Repeaters and Matched Free							
Trial I	25.00	9.66	3.06	11.80	6.86	2.17	13.2	3.75	3.52	1	99+
Trial II	25.70	15.90	5.04	13.60	4.64	1.47	12.1	5.25	2.31	2	98
Trial III	29.90	18.50	5.85	11.10	5.23	1.65	18.8	6.06	3.10	1	99+

[1] Significant level of confidence in percentage.
[2] Chances in 100 of a real difference.

Observations

1. The test device differentiated between the repeater and the free groups on the basis of average motor movement control exhibited by each.
2. In both Connecticut and Michigan, in every instance *the accident-free groups scored consistently fewer errors in all motor performance test trials than did the repeater groups.*
3. The average motor performance of the free groups was significantly better than that of the repeaters.
4. *The superiority of the free group over the repeaters* in this respect shows a *true difference* between the groups and cannot be attributed merely to chance.
5. Michigan results seem to indicate that motor movement control varies inversely as accident frequency. *Motor movement control is poorest among those with the highest frequency.*

6. This can be taken as good evidence that there is a direct relationship between motor movement control and traffic accidents.
7. Both groups in Connecticut and Michigan tended to improve their average performance on Trial II.
8. Only the free groups, however, on the average maintained this tendency toward improvement in Trial III.
9. Both the Connecticut and Michigan results show that the tendency *toward progressively improved motor performance on trials is a significant one and not a chance occurrence.*
10. In neither clinic was evidence found that showed a similar, significant pattern of improvement, upon practice, on the part of repeaters.
11. The investigators do not wish to claim any special value for this test. However, they do wish to point out that the four groups of drivers exhibited significant differences in their reactions, the free being generally superior to the repeaters in motor control, and showing greater resistance to annoying and frustrating conditions.



Because comparatively little definite knowledge has been gained concerning the significance of purely psychological features of an individual's personality with respect to his driving performance, *a personal interview* designed to investigate this particular area was administered in both Connecticut and Michigan Clinics. By this means data were collected on a number of *personality traits, opinions, general driving experience and practices, attitude toward traffic regulations and general driving situations, socio-economic status, personal adjustment, recreational interests, and health.* These were studied in terms of significant association with driving experience.

In administering the interview, a number of precautions were taken to guard against obtaining thoughtless, dishonest, and unreliable responses. These included the following:

1. To insure privacy, the interview areas were screened off from other testing areas.
2. Every attempt was made to establish friendly, informal rapport.
3. No uniforms or other marks of special identification or authority were worn by the interviewers.
4. Each driver was welcomed cordially, seated in a comfortable armchair, encouraged to remove his coat, to smoke if he wished, and was shown every courtesy that would establish an atmosphere of friendliness.
5. Throughout the interview, care was taken to keep the driver at ease and to maintain his confidence and cooperation.

Presentation of Data

In both the Connecticut and Michigan Clinics no significantly strong differences between the repeaters and the free were noted with regard to general driving background and experience. Replies to questions relating to learning to drive, car ownership, the use of a radio while driving, and questions of a similar nature seemed to be indiscriminately distributed among each group. Michigan repeaters showed a stronger tendency to return lights to bright when the driver of an approaching automobile failed to dim his, while the free showed a stronger tendency to flicker

and return his lights to dim regardless of the practice of the other driver. This may give some insight into the relationship between courteous driving, attitude, and accident experience.

The comparative socio-economic status of the repeaters and the accident-free groups investigated in Connecticut and Michigan is shown in Table VIII. Generally speaking these data do not appear to be highly indicative of differences between the groups. In noting the greater number of unmarried drivers among Connecticut repeaters, it should be borne in mind that a significant number were younger, the average ages of the Connecticut repeaters and free being 32.7 and 44.2; the Michigan, 36.2 and 36.5.

Table VIII

SOCIO-ECONOMIC STATUS

	Connecticut		*Michigan*	
	Accident Repeaters	*Accident Free*	*Accident Repeaters*	*Accident Free*
Occupation				
Trades, services, utilities	41	32	33	40
Transportation	38	28	48	44
Salesmen	9	8	5	3
Business owners and executives	4	8	7	3
Professionals and semi-professionals	1	14	2	1
Other	0	3	5	9
Marital Status				
Married	61	87	73	70
Single	26	4	21	24
Widowed, separated, divorced	6	2	6	6
Record of Other Arrests				
None on other than traffic charges	72	84	84	98
One on other than traffic charges	11	6	13	2
Two on other than traffic charges	5	2	2	0
Three on other than traffic charges	5	1	1	0
*Average Number of Dependents**				
Wife, children, parents, etc.	2.4	2.4	2.2	2.4
Average Education				
Highest school grade completed	9.7	10.4	9.4	10.7
Average Income				
Weekly wage or salary	75.00	70.00	56.00	66.00

* Not included are 21 accident-repeaters and 21 accident-free who had no dependents.

Of the Michigan repeaters, 16 per cent, in comparison to 2 per cent of the free, reported one or more arrests, while in Connecticut the percentage of repeaters was 36, and of free, 16. This may indicate disregard and disrespect for law and regulation as a general reaction on the part of some individuals.

Attitudes

One part of the interview was designed to evaluate attitudes. This was done by presenting the driver with a series of questions and statements pertaining to certain driving practices, matters of law enforcement and traffic court rulings, training procedures. The distribution of replies to some of these items was expected to indicate characteristic trends in practice or opinion, certain prevalent feelings or attitudes, that would show typical *differences* between the repeater group and the free.

The method used to evaluate the extent to which a variation in the replies of each group gave evidence of a basic difference between them was the chi square test—a statistical procedure to determine whether an observed difference between two groups has real significance as to fundamental difference, or whether it results from chance and is meaningless. Whenever the investigators report that a certain item shows a significant difference between the groups, it should be understood that the chi square test has been applied and values obtained to justify the conclusion.

One example, and an explanation of the calculation used and values received in applying the chi square test, is included here.

Example . . . Connecticut Clinic

Item . . . . . Almost anything can be fixed up in the courts if you have money enough.

Distribution of replies	*Agree*	*Undecided*	*Disagree*
Repeaters	34	11	48
Free	21	6	66

Comparing the distribution of replies with the distribution that would be expected if there were *no* difference between the groups,

and referring to standard tables based upon the normal probability curve, the following values were obtained:

Chi square = 7.38 P = .02 – .05
Chances in 100 of a real difference = 95+

The figure 95+ means that in 95 out of 100 comparisons of these groups, obtaining a difference as great as the one obtained in this trial could be looked upon as highly significant of a basic difference between the groups; and, inversely, that in only 5 out of 100 comparisons could such a difference be attributed to chance alone. Having obtained a difference of this order then, we can assume with confidence that the two groups actually show a different trend in opinion or attitude on this item, and that the repeaters as a group seem to have a stronger tendency to express a "bad" attitude toward the enforcement of laws by the courts than the free.

In the Connecticut Clinic, repeaters and free took significantly different stands on a number of items. The Connecticut repeaters exhibited a much stronger tendency to agree that:

—*Driving is a competitive affair in which each operator is out for himself (95+).*[17]

—*Almost anything can be fixed up in the courts if you have enough money (95+).*

—*Success is more dependent upon luck than upon real ability (90+).*

—*The decisions of judges in courts are determined mainly by their personal prejudices (98+).*

In the Michigan Clinic, however, no significant differences were found in the attitudes which these items measured. Likewise, the evidence found in the Connecticut Clinic that the accident-free drivers believed very strongly in the *justness of court decisions* (95+), and that *drivers who are arrested for accidents or violations should be sent to required traffic-safety classes (95+)* was lacking in the Michigan Clinic.

[17] Figures in parentheses refer to "probability," in this and subsequent instances; i.e., chances in 100 of a real difference.

An interesting observation made in the Connecticut Clinic was that the accident free group, contrary to what might be expected, felt that *laws are so often made for the benefit of small, selfish groups that one loses respect for the law* (98+). This was the one exception to the otherwise substantiated claim that free drivers, in general, exhibit a "better" attitude than repeaters.

In the Michigan Clinic, significant differences between the two groups were noted on three additional items. Michigan repeaters felt that:

—*they had often been punished without cause (99+).*

—*if several people find themselves in trouble, the best thing for them to do is agree upon a story and stick to it (99+).*

—*it is all right to get around the law if you don't actually break it (98+).*

Attitude on Drinking

In the interview was the question: "After how many drinks is your driving affected?" Subjects were asked to indicate the number of drinks, running from one to ten and above. In the Connecticut Clinic, 21 per cent of the repeaters felt that their driving was not affected until they had had five or more drinks, while only 12 per cent of the free had this same opinion. Moreover, there were in this group repeaters who claimed excessively high tolerance to alcohol; ". . . . . a pint of whiskey," ". . . . . 15 or 20 drinks," ". . . . . 10 highballs" were some of the responses given. There were only four free drivers who gave similar responses.

It should be noted that in states where chemical tests for intoxication are used, the amount of alcohol in six cocktails or seven bottles of beer may be sufficient to produce a condition measured chemically as "under the influence." Driving is obviously affected considerably before the stage of intoxication known as *under the influence* is reached. It appears that accident-repeaters may have an inflated idea of how much they can drink before their driving is affected.

Michigan results in this respect are interesting but less indicative of any clearly defined trend among the repeaters or

free. Thirty-two per cent of the free and 25 per cent of the repeaters set their tolerance to beer at over five bottles, and 15 per cent of the free compared to 18 per cent of the repeaters estimated their driving would not be affected by less than six highballs. The differences between the groups are not significant enough for conclusions.

Attitude Toward Driving Ability

When asked to rate themselves as drivers in comparison with all others they meet on the road, 75 per cent of the Connecticut repeaters and 82 per cent of the free groups claimed to be excellent. In Michigan more than 50 per cent of each group rated themselves as "average." When asked the question "Do you know anyone who drives better than you?" 56 per cent of the Connecticut free group answered "No." It is interesting to note that the accident-repeaters appeared to be less egotistical about their driving, for only 41 per cent knew no one who drove better than they. No one in either group considered himself a poor driver in comparison with others he meets on the road. This is not highly significant data, but the same type of reply pattern to this question was observed in the Michigan Clinic.

In the Connecticut Clinic, responses to the question "How often do you find yourself taking unwise or foolish chances in your driving?" showed that 77 per cent of the free group compared to 56 per cent of the repeaters claimed that they seldom or never took chances. In the Michigan Clinic the greatest majority of *both* groups made this claim, with no significant difference noted between them.

Driving Speeds

The three interview questions having to do with driving speeds; i.e., greatest speed ever driven, preferred average daylight speed, and preferred average night speed, show some significant preferences and practices among the Connecticut repeaters.

It should be noted that in all instances a larger proportion of

accident-repeaters appear in the highest speed category. It is interesting to note also that the accident-free drivers more often than the repeaters show a preference for a more moderate average daylight speed. In the case of preferred night speed, the distribution of the large proportion of accident-free drivers in the lowest speed bracket would seem to indicate a significantly stronger tendency toward cautious night driving.

Table IX

SPEED EXPERIENCE AND PREFERENCE

		M.P.H.	*Repeaters*	*Free*
Greatest speed driven		100+	21	10
Chi square	6.09	60–90	57	73
P	.05–.02	40–50	15	10
Chances in 100 of real difference	95+			
Preferred daylight speed		55+	16	6
Chi square	6.26	45–50	48	61
P	.05–.02	30–40	29	26
Chances in 100 of real difference	95+			
Preferred night speed		55+	8	6
Chi square	6.85	45–50	28	14
P	.05–.02	30–40	57	73
Chances in 100 of real difference	95+			

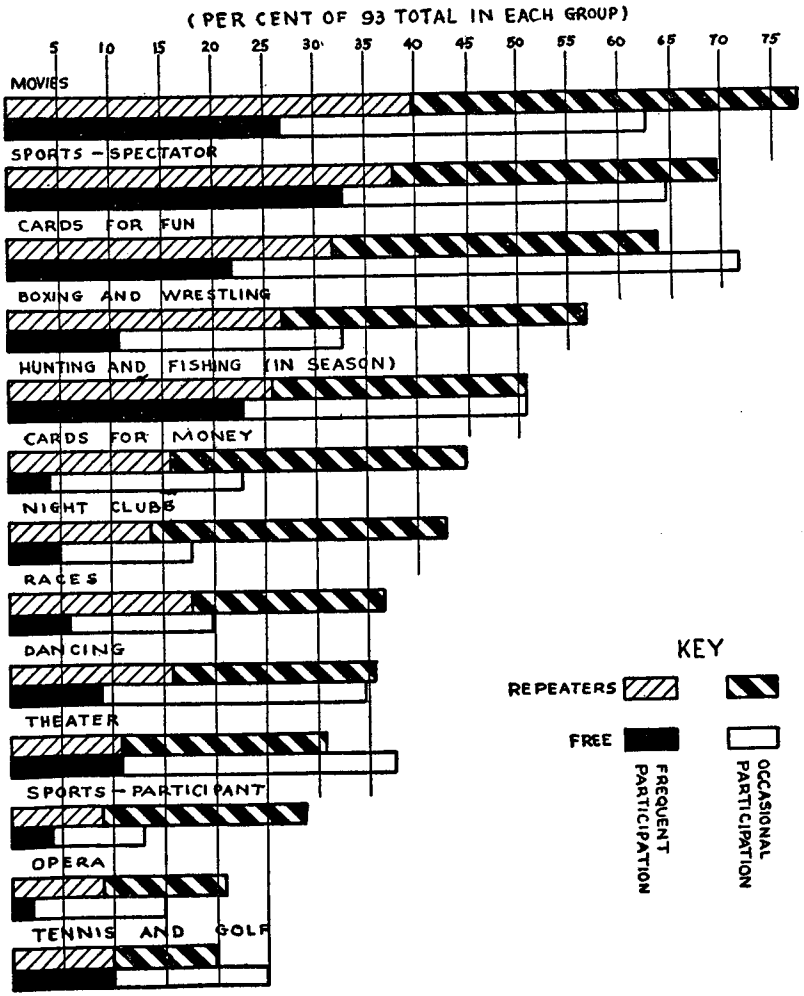
In the Michigan Clinic, the differences between the groups were not as significant. Both the repeaters and free showed a preference for an average daylight speed of about 53 m.p.h. The average night speed preferred by the repeaters was 45.5, compared to 41.4 for the free. While the Michigan results are not strongly conclusive, they seem to support the observation that free drivers as a group tend to be more cautious night drivers.

Recreation, Health, and Home Adjustment

No significant differences were found between the groups in either Clinic with respect to recreational participation, general health and health practices, or home adjustment.

SYSTOLIC AND DIASTOLIC BLOOD PRESSURE

Blood pressure readings were taken at two points: first, when the driver was seated after he had entered the Clinic; second, approximately thirty minutes later, when he was being interviewed sitting in a comfortable armchair. Both systolic and diastolic readings were taken by the usual ausculatory method. The investi-



Recreational Activities of Drivers

gators did not use the cold pressure test suggested by Brody, nor did they use a Tycos Sphygmomanometer. Brody found a significant difference between accident-repeaters and accident-free, with 77 per cent of the repeaters below the normal range of systolic blood pressure.

There was no significant difference between the two groups in the Connecticut investigation. The difference in mean deviations was only .8 mm., using established norms for the various age levels as a base.

In both groups there was a drop in blood pressure of several millimeters between the first and second (basal) reading. This might have been expected, for during the second reading the subjects were resting and any tension or anxiety that may have existed would have diminished.

Dr. Eugene E. Lamoureaux of the Connecticut State Department of Health examined the data and pointed out:

There is no significant difference in the blood pressure readings of the two groups, and the results of this survey do not prove to be of value in attempting to predict the accident histories of a group of drivers.

Dr. William Goldring of New York University who examined the findings added that:

This lack of significance may be more apparent than real in the sense that there may be a significant correlation between accident-proneness and persons with high blood pressure except that the blood pressure level as a single observation cannot be used to answer this question. This is so because the blood pressure level is extremely variable and subject to many influences, most of which cannot be evaluated nor indeed are clearly understood.

COMPARATIVE VISUAL CAPABILITIES

A. Tests[18]

1. *Sight-Screener.* — This instrument is a portable vision checking device designed primarily for securing information useful to the professional man in evaluating the visual efficiency of industrial workers, but one which also measures the visual capabilities which have generally been regarded as important for

[18] All tests used were manufactured and distributed by the American Optical Company.

safe and efficient seeing on the highway. Although the instrument is designed to measure visual capabilities on far and near seeing tasks, only the far vision tests were used at the Clinics. The visual functions tested included:

a. Simultaneous binocular perception: the ability to see with both eyes together at the same time.

b. Visual acuity (1) right eye, (2) left eye, and (3) both eyes together: the ability to correctly identify Snellen type letters of different sizes.

c. Stereoscopic depth perception: the ability to recognize the apparent relative distance of objects when images are focused on disparate retinal areas of the two eyes.

d. Ocular muscle balance: the ability of the eyes to maintain (1) vertical and (2) lateral balance when dissociation is induced by artificial means.

2. *Brombach Perimeter.* — This instrument is a standard clinical device designed for the purpose of obtaining complete measures of visual fields in all planes for both moving, stationary, and colored test objects. At the Clinics, however, the measurements were limited to the horizontal plane, since vision in this plane was regarded as most likely to have relevance for efficient driving on the highway.

3. *Feldman Adaptometer.* — This instrument is another standard clinical device designed to measure the rate of dark adaptation, or more specifically, the time required for a subject to identify correctly the position of a dimly illumined target after exposure to a bright light for a fixed period of time.

B. Testing procedures

1. *Order of Testing.* — With but few exceptions, subjects were tested first on the *Sight Screener,* and immediately thereafter on the *Perimeter.* The Adaptometer was administered after the questionnaires and the interview, but before the Maze Test.

2. *Test Conditions.* — The first two tests were administered in a room in which both daylight and artificial illumination were available. Subjects were seated at the testing tables with eyes turned entirely away from the light source so that no direct glare could be encountered. In the *Sight Screener,* controlled illumination was provided entirely from within the instrument. On the *Perimeter,* supplementary lighting designed to reflect on the test targets was provided from a shielded light source of fixed intensity. The *Adaptometer* testing was conducted in completely darkened rooms especially constructed for the purpose.

3. *Test Administrators.* — At both Clinics personnel were carefully trained and given practice in operating the instruments, giving directions, recording scores, etc. The various tests were given by both company representatives and members of the State Motor Vehicle or Police Department. For several practical administrative reasons, randomization of testing orders and examiners could not be carried out successfully; hence part of the variance between groups may be derived from slightly differing testing methods among technicians or slightly varying methods for the same technician at different times.
4. *Wearing of Corrections.* — Technicians questioned each subject in regard to wearing a correction. Subjects who habitually wore corrections only for reading were tested without them; those who wore prescriptions regularly were tested with them on.

Methods of Analysis of Data

Scores made on each of the twelve sub-tests of the battery were tabulated for the four criterion groups tested at the two Clinics. In addition, scores made by four criterion sub-groups containing the twenty-one cases with the highest accident rates per 100,000 miles and the corresponding accident-free cases were tabulated separately. The data were grouped into 2 x 2 tables and the statistic, chi square, was calculated for each of the groupings to determine the probability with which the obtained differences could be expected to occur on the assumption that the samples (the groups) were drawn from a population homogeneous in respect to visual capabilities. Probability values (P) were taken from Fisher's tables of chi square for one degree of freedom. Where the probability values were found to be .05 or less, they are denoted by an asterisk in the tables. Such values are generally regarded as statistically significant and it seems reasonable to reject the hypothesis that the two group samples were drawn from a homogeneous population.

Discussion of Results

A. General Considerations

It should be noted that accident records were compiled over a period varying from a few months to several years. During that time visual capabilities may have varied for some persons; vision changes somewhat with age and a number of the persons tested in both groups were wearing corrections which had been acquired

recently. Ideally, visual capabilities would have to be determined at the time that accidents occur. But obviously that was not possible in a study such as the present one.

A second point of considerable importance concerns the fact that it was not possible to match accident-repeater and accident-free cases for both exposure and age at the Hartford Clinic. In both the total and high-rate groups, the accident-free cases averaged over ten years older. And only for the twenty-one high-rate repeaters could controls, matched in terms of exposure, be secured. Inasmuch as other studies have shown that visual capabilities tend to decline with age, one would expect the accident-free groups to contain smaller proportions of cases with higher ratings in the tests than the younger accident-repeater group. Thus, when the accident-repeater group shows lower test ratings than the accident-free, it appears that we are dealing with a group difference which could be expected to increase if the accident-free group were at the same age level as the accident-repeater group.

B. *Specific Findings* (In the following tables "R" denotes accident-repeaters; "F," accident-free cases; "high rate," serious repeaters.)

1. *Sight Screener*

Table X

SIMULTANEOUS BINOCULAR PERCEPTION

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
Test Indication	*R*	*F*	*R*	*F*	*R*	*F*	*R*	*F*
Has simultaneous perception	85	89	19	21	96	99	20	21
Suppresses, alternates, etc.	8	4	2	0	4	1	1	0
N =	93	93	21	21	100	100	21	21

* Chi square—0.802 P (probability)—50 .30

* In this and subsequent vision table, "degrees of freedom" values were taken as 1.

Although the differences in the table above are not statistically significant according to the criteria that we have laid down, cases of inability to perceive binocularly are more frequent in all of the accident-repeater groups. This is essentially a function of the greater number of cases in the accident-repeater group who had substantially reduced acuity in the right or left eye, five at Hartford and four at Detroit having no better than 20/100 vision in one eye.

Table XI

Acuity, Right Eye

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
	R	*F*	*R*	*F*	*R*	*F*	*R*	*F*
20/20 and above	34	42	5	7	68	82	11	17
20/30 and below	59	51	16	14	32	18	10	4
N =	93	93	21	21	100	100	21	21
Chi square =	1.424		0.466		5.021		2.679	
P (probability) =	.30	.20	.50	.30	*.05	.02	.20	.10

Here a statistically significant difference emerges in the Detroit "total" group. In the Detroit total "R" group there were four cases with less than 20/70 acuity, whereas in the "F" group there were none. At Hartford there were two cases in the total "R" group having acuity below 20/70, while there were none this poor in the "F" group.

Table XII

Acuity, Left Eye

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
	R	*F*	*R*	*F*	*R*	*F*	*R*	*F*
20/20 and above	48	43	12	8	70	82	12	14
20/30 and below	45	50	9	13	30	18	9	7
N =	93		21	21	100	100	21	21
Chi square =	0.538		1.527		3.947		0.389	
P (probability) =	.50	.30	.30	.20	*.05	.02	.70	.50

Here also there is a statistically significant difference in the Detroit "total" group. In neither the "R" or the "F" groups were there cases with less than 20/70 acuity. However, in the Hartford total "R" group there were three cases with acuity below 20/70.

Table XIII

Acuity, Both Eyes

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
	R	*F*	*R*	*F*	*R*	*F*	*R*	*F*
20/20 and above	68	60	13	12	86	95	9	14
20/30 and below	25	33	8	9	14	5	12	7
N =	93	93	21	21	100	100	21	21
Chi square =	1.603		0.988		4.712		2.403	
P (probability) =	.30	.20	.50	.30	*.05	.02	.20	.10

Table XIV

Stereoscopic Depth Perception

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
	R	*F*	*R*	*F*	*R*	*F*	*R*	*F*
105% (Shepard-Fry Scale)	51	52	10	9	37	58	7	11
90% and below	42	41	11	12	63	42	14	10
N =	93	93	21	21	100	100	21	21
Chi square =	0.022		0.988		8.842		1.445	
P (probability) =	.90	.80	.50	.30	.01		.30	.20

Differences are significant for the Detroit "total" group again. It is of interest to note that eight of the ten persons who scored below the test minimum were accident-repeaters. *These results bear out the implication of Test I: inability to utilize the two eyes together efficiently is more often a characteristic of the accident-repeater group.*

Table XV

Vertical Ocular Muscle Balance

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
	R	*F*	*R*	*F*	*R*	*F*	*R*	*F*
Less than ½ imbalance	62	78	12	18	70	83	14	17
½ imbalance or more	31	15	9	3	30	17	7	4
N =	93	93	21	21	100	100	21	21
Chi square =	7.392		2.916		4.701		0.493	
P (probability) =	*.01		.10	.05	*.05	.02	.50	.30

Here are found the most consistently significant variations between the two groups. Both the Hartford and Detroit "total" groups show statistically significant differences, while in the "high rate" groups trends are in the same direction as well. Good ocular muscle balance is an especially important factor in efficient seeing. *When a driver with inadequate muscle balance becomes fatigued or is under the influence of alcohol, diplopia or double vision is more likely to occur.*

Table XVI

Lateral Ocular Muscle Balance

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
	R	*F*	*R*	*F*	*R*	*F*	*R*	*F*
Less than 2 imbalance	50	58	12	15	50	65	12	14
2 imbalance or more	43	35	9	6	50	35	9	7
N =	93	93	21	21	100	100	21	21
Chi square =	1.414		0.933		4.604		0.404	
P (probability) =	.30	.20	.50	.30	*.05	.02	.70	.50

Further evidence of the importance of good ocular muscle balance is exemplified in the statistically significant difference found for the Detroit "total" group. Of the thirteen cases showing six or more prism diopters of lateral phoria in that group, ten were accident-repeaters.

2. *Brombach Perimeter*

Table XVII

Lateral Visual Fields

Right Eye, Temporal Side

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
Measure	*R*	*F*	*R*	*F*	*R*	*F*	*R*	*F*
80 degrees and over	36	33	4	6	71	77	11	16
79 degrees and under	57	60	17	15	29	23	10	5
N =	93	93	21	21	100	100	21	21
Chi square =	0.208		0.525		0.935		2.591	
P (probability) =	.70	.50	.50	.30	.50	.30	.20	.10

Right Eye, Nasal Side

	Connecticut				*Michigan*			
	Total		*High Rate*		*Total*		*High Rate*	
Measure	*R*	*F*	*R*	*F*	*R*	*F*	*R*	*F*
55 degrees and over	25	23	4	4	77	60	15	11
54 degrees and under	68	70	17	17	23	40	6	10
N =	93	93	21	21	100	100	21	21
Chi square =	0.112		0		6.770		1.615	
P (probability)	.80	.70	1.0		*.01		.30	.20

Measuring Glare Recovery on the Adaptometer

Measuring Field of Vision with the Perimeter

Table XVII *(continued)*

Left Eye, Temporal Side

	Connecticut				Michigan			
	Total		High Rate		Total		High Rate	
Measure	*R*	*F*	*R*	*F*	*R*	*F*	*R*	*F*
80 degrees and over	28	38	4	7	73	73	15	16
79 degrees and under	65	55	17	14	27	27	6	5
N =	93	93	21	21	100	100	21	21
Chi square =	2.348		0.493		0		0.123	
P (probability) =	.20	.10	.50	.30	1.0		.80	.70

Left Eye, Nasal Side

	Connecticut				Michigan			
	Total		High Rate		Total		High Rate	
Measure	*R*	*F*	*R*	*F*	*R*	*F*	*R*	*F*
55 degrees and over	45	36	5	7	69	59	15	11
54 degrees and under	48	57	16	14	31	41	6	10
N =	93	93	21	21	100	100	21	21
Chi square =	1.771		0.466		2.170		1.615	
P (probability) =	.20	.10	.50	.30	.20	.10	.30	.20

Although other studies have revealed significant differences with respect to lateral fields, in this one no clear-cut trends are evident either in the "total" or "high rate" groups. Indeed, the only statistically significant findings, right eye—nasal side, of the Detroit "total" group, favored the "R" group. However, the difference was in the higher proportion of the "R" group who had fields of 55° and over; one case in the "R" group had a *total* field for the right eye of only 14°, possibly because of a developing cataract. This person was 70 years of age and accumulated accidents at a rate estimated to be one for every thousand miles driven. How long this "tunnel vision" defect had been present could not be determined, but it is clear that perception of objects on his right side is at present considerably limited.

3. *Feldman Adaptometer*

Table XIX

Rate of Dark Adaptation

	Connecticut				Michigan			
	Total		High Rate		Total		High Rate	
	R	*F*	*R*	*F*	*R*	*F*	*R*	*F*
Less than 5 minutes	44	44	12	11	49	58	11	9
5 minutes or more	49	49	9	10	51	42	10	12
N =	93	93	21	21	100	100	21	21
Chi square =	0		0.096		1.628		0.382	
P (probability) =	1.0		.80	.70	.30	.20	.70	.50

No consistent trends are apparent in any of the groups with respect to this visual function. However, a substantial number of persons in both "R" and "F" groups were found to have relatively slow rates of dark adaptation, some being unable to identify the position of the test object when as many as eight minutes had elapsed. Others, with more rapid recovery rates, were able to identify its position correctly in less than two minutes.

CONCLUSIONS

1. There is a wide range in the driving exposure (M.V.M.), the accident-experience, and the violation-record of accident-repeaters. The best indication of the seriousness of the repeater's record is his accidents and violations per 100,000 M.V.M.
2. Accident-repeaters and accident-free drivers have been found to differ in many personal factors and characteristics. On the other hand there are certain characteristics in which there appear to be little significant differences.
3. Clinical techniques can be used to determine the differences between repeaters and free drivers.

Most Significant Differences

4. There is a close relationship between accidents and violations. A cumulative record of both provides the best picture of the driving practices of the licensed operator.
5. Repeaters are not as well informed regarding safe driving practices and regulations as are the free.
6. This lack of information tends to increase among those with high accident frequencies.
7. Repeaters tend to have more personality maladjustments than free. These tend to increase among the more serious repeaters.
8. They also have poorer motor control under normal conditions as well as under conditions of frustration and annoyance.
9. Serious repeaters tend to be more upset by frustrations and annoyances than comparable free drivers.
10. The attitudes toward certain aspects of driving are significantly poorer among repeaters.

11. Connecticut repeaters show a significant preference for higher speeds. This was not borne out in Michigan except for night driving.

12. Connecticut repeaters indicate a higher estimate of their ability to consume intoxicating beverages without their driving being affected.

13. More repeaters than free have been arrested on charges other than traffic.

14. The ability to see with both eyes together at the same time appears to be a visual characteristic of accident-free drivers more than of accident-repeaters.

15. Accident-free drivers also appear to be superior to repeaters with regard to depth perception and ocular muscle balance.

16. No significantly strong differences appear between repeaters and free with regard to visual fields or rate of dark adaptation.

17. In addition, when the groups are well matched as in the Michigan total group, free drivers are significantly superior to repeaters with regard to visual acuity.

18. No significant differences were found in the following: (a) systolic and diastolic blood pressure, (b) recreational interests, (c) average education, (d) weekly income, (e) health adjustment and practices, (f) home adjustment.

PART III

RECOMMENDATIONS

In every state from 5 to 10 per cent of the drivers constitute a serious problem. These are the repeaters and chronic violators—drivers who have far more than their share of accidents. Some have accident rates of from twenty-five to fifty times that of the average driver.

It has been demonstrated that these repeaters have personal characteristics that contribute to accidents. They have psychophysical deficiencies or disabilities, and in a sense, are the sick drivers. These conditions in some instances may be corrected; in others, compensated for. In other cases, the disability is so serious that suspension is the only alternative.

In view of this, the following recommendations are made:

1. That the states establish clinics to investigate accident "repeaters" and to attempt to remedy disabilities. In smaller states, the work could be done in one large clinic; in larger, in several clinics located in centers of population.

2. Serious accident repeaters and chronic violators would first be summoned to clinics. A point system might be established as in Connecticut, where drivers are called in when they have 5 points against them.

3. All states should adopt an accident record system to use in connection with clinics.

4. These clinics would be operated by examiners of the drivers license department. Examiners with experience and training in psychology should be assigned to operate the clinics.

5. In addition, clinics could be used to secure supplementary data regarding drivers called in for hearings, at which suspension or revocation of licenses is being considered. Clinical data would give hearings officers objective data.

Large Clinic Equipment

Equipment	*Testing*	*Time Minutes*
1. Personal Record Sheet		
2. Sight Screener (or equivalent)	Acuity, depth perception, muscle balance, binocular vision	7
3. Perimeter	Field of Vision	3
4. Light Adaptation	Adaptometer	8
5. Knowledge Test*	Traffic Information	15
6. Cornell Word Form*	Personality Adjustment	10
7. Motor Performances	Stability	5
8. Attitude Test*	Attitudes	10
9. Reactometer	Selective Reaction	5

* Can be administered to several drivers at a time.

For the small clinic, it is suggested that a part of the equipment listed above be used—such as: Items 1, 2, 3, 5, 6, 7, and 8.

Operation

1. Drivers summoned to clinics would first fill out Form 1—Personal Record Sheet.
2. They would then be interviewed by the examiner. In the course of the interview, certain indications of disabilities would be noted. The driver would then be sent to take specific tests at the clinic or to get a complete check-up.
3. Low or failing scores in tests would indicate the need for corrective action.
4. On the completion of tests, drivers would return to examiner who would recommend corrective action.
5. A complete manual on testing procedures and corrective action would be prepared in each state.
6. The clinical staff would consist of two or more examiners and a clerk.

Corrective Action

It is not possible in this brief monograph to go into many phases of corrective action. The interview, for example, can be an ex-

cellent method of securing correction and improvement of drivers.

The following are examples of corrective action:

Driver poorly informed—Require him to study state manuals and report for a second test in three weeks. Also suggest that he join a driver training course for adults (example, Detroit Police Courses for Drivers).

Fails state test in visual acuity—Temporary suspension until driver can see vision specialist and have condition corrected.

Poor scores on adaptometer—Discourage driving at night. Emphasize slow speeds and caution. In serious cases, suggest vision specialist.

Poor scores on Cornell Word Form—This test screens out 35 to 50 per cent of persons with personality maladjustments (and also some normal individuals). Examiner should try to find source of difficulty, why driver is poorly adjusted. The case may be referred to a social case worker, or when necessary, to the family physician. Michigan also refers some cases to the Detroit Psychiatric Clinic.

These are examples of corrective action. Many of the disabilities revealed by tests can be corrected.

It is clear that the routine use of a battery of vision tests such as were employed in this study by motor vehicle licensing examiners would uncover a substantial number of cases with visual efficiency below acceptable standards. Undoubtedly, many of them could raise their visual capability to meet these standards through treatment by members of the eye-care professions. The few whose capabilities were not improvable could, depending on their past safety records, be given restricted licenses or, as a last resort, have their drivers licenses revoked.

Many commercial fleets and some insurance companies are also convinced of the value of the clinical approach. Some are utilizing tests in driver selection; others, for the study of repeaters.

The same tests recommended for states could readily be used by private agencies.

Conclusions

Psychophysical testing cannot be hurried and must be accurate. The value of a testing program in the rehabilitation of drivers, and the resulting reduction in the cost of accidents, more than compensate for the expense involved in maintaining a clinic for this purpose.

—Traffic accidents cost heavily in deaths, injuries and property damage

—Repeaters are responsible for a significant percentage of these accidents

—Repeaters have disabilities that can be identified

—Many of these disabilities can be corrected or compensated for

—It becomes a responsibility of the state and the management of motor transport agencies to find out the disabilities of drivers and attempt to correct them

—While the periodic examination of all drivers is desirable, it is still a long way off. The first step toward this can be the examination of the *sick* drivers, the 5-10 per cent who are serious accident repeaters.

IMPLICATIONS

Important implications can be drawn from this study. If the sampling of drivers tested in these clinics represents a cross-section of accident repeaters in the states, there is much that can be done to improve conditions.

1. The lack of information among both *repeaters* and *free* as measured by tests indicates the need for a more complete program of education and training of the motoring public. Some state departments do have well-organized programs of driver-education with a staff to handle details, but a majority have done comparatively little. The surface has hardly been scratched. A recent survey conducted by the Accident Prevention Department of the

Association of Casualty and Surety Companies in connection with the Annual Driver Education Award for High Schools shows many states with less than 5 per cent of their eligible students enrolled in driver education classes. Yet other states have 50 to 100 per cent enrolled. Far more can be done to raise the general level of information of drivers. The President's Conference on Highway Safety, the National Committee for Traffic Safety, and many other agencies and organizations have urged this, but progress appears to be unusually slow. The Eno Foundation for Highway Traffic Control issued a publication in 1946—"Traffic Safety Education—A Guidebook for State and Civic officials." Other agencies have issued similar types of manuals; yet few states have well-organized education programs.

2. Tests show that far more attention must be paid to the improvement of the attitudes of drivers. While we have known in the past that attitudes were important, comparatively little has been done in an organized way to direct specific efforts toward the improvement of attitudes. For example, many state courses of study in driver education, while freely admitting the importance of attitudes among the objectives established for the course, fail to follow up by providing for types of instruction that will tend to improve attitudes.

3. Tests reveal a significant percentage of maladjusted or emotionally disturbed persons among the accident repeaters and some among the free.

Here again a program of education is needed on one hand, and on the other a clinical approach to locating and attempting to remedy these disabilities. States must take action on extreme cases, such as serious cases of epilepsy, narcolepsy, drug addiction and chronic alcholism. In addition, they should set up practices that will provide for the examination by medical doctors of the more serious cases of personality maladjustment such as those suffering from psychoses.

4. Visual defects, especially extreme cases of low acuity, muscular imbalance, low field of vision, and poor glare recovery have an important place as underlying causes of accidents. Far more can be done to locate these cases, correct them or, if it seems

necessary, rule drivers off the road. Here again education has an important job to do. States should have testing apparatus available that can be used for a careful measurement of such disabilities.

APPENDIX

In addition to those previously recognized for their contributions to this undertaking, the following people rendered valuable assistance in the administration of clinical tests and in various other phases of the investigation:

Connecticut

Motor Vehicle Department. — Supervising Inspector, William J. Hilliard; Thomas J. Marks, Special Assistant; Inspectors William J. Kirscho, Donald C. Frost, Donald J. Sullivan, and Timothy C. Davis.

State Highway Department. — Dr. G. Albert Hill, Commissioner; W. Howard Sharp, and Samuel Levin.

Michigan

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Department of State. — Harold Boyse and Andrew Robinson.

Detroit Police Department. — Sgt. John Howie.

Center for Safety Education

Earl E. Clarke, Leo Doyle, Lt. G. G. Morgan, Harold Riess, James Springer, and Major W. W. Wagner.

KNOWLEDGE TEST FOR AUTOMOBILE DRIVERS*

NEW YORK UNIVERSITY
DIVISION OF GENERAL EDUCATION
CENTER FOR SAFETY EDUCATION

Short Form

Fill in the following blank spaces, read the following directions for answering the test questions, and then start immediately with the test. WRITE PLAINLY.

Name_____ Age_____ Date_____

Position or School_____ No. of Years a Driver_____

City_____ State_____

The test consists of two parts: Part I, of 25 true-false statements; and Part II, of 25 multiple-choice statements.

PARTS	SCORE
I	
II	
TOTAL	

DIRECTIONS FOR PART I. Some of the following statements are true; some are false. Read each statement through carefully. If you think a statement is TRUE, place an X in the proper square under TRUE. If a statement is FALSE, place an X in the proper square under FALSE. The following statement is an example:

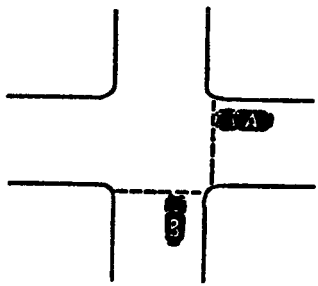
	True	*False*
As a rule motorists under 20 years of age are safer drivers than those over 40 years of age.....	☐	☒

PART I

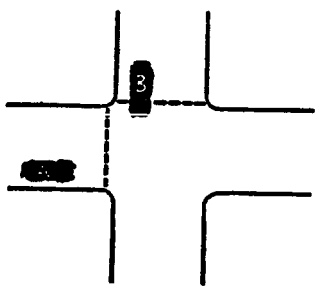
1. It is not necessary for you to follow the directions of road signs in the vicinity of your home if you are entirely familiar with the conditions where the signs are posted.	☐	☐
2. When a left turn is to be made on multiple-lane streets at an intersection, you should always make the turn from the lane nearest the center line.	☐	☐
3. The practice of crossing the center line on a curve is all right providing you can see 300 feet ahead.	☐	☐
4. It is better to rely on a quick dash of speed to get through an intersection ahead of another vehicle than to reduce your speed in expectation of trouble as you approach the intersection.	☐	☐
5. A stated speed limit sign really means that you should keep your speed definitely below the stated limit when the road is wet.	☐	☐
6. It requires the same distance to slow down from 60 miles per hour to 50 miles per hour as from 40 miles per hour to 30 miles per hour.	☐	☐
7. Defective eyesight will affect a driver more adversely in night driving than in day driving.	☐	☐
8. A rear view mirror can be relied upon for a complete view of what is behind your car.	☐	☐
9. You may legally exceed the speed limit when you are driving an injured person to the hospital.	☐	☐
10. In preparing to make a right-hand turn you should drive your car so near to the right-hand curb (or line of parked cars) that no other driver may pass you on your right.	☐	☐
11. More fatal accidents take place on clear, dry days than on stormy days.	☐	☐
12. New nonskid tires have done away with the danger of skidding on wet pavements.	☐	☐
13. Your vision to the sides decreases as the speed of your car increases.	☐	☐

*Items in this test selected from the original Abercrombie Driver Test.

	True	False
14. A pedestrian who has the right of way on a crosswalk in the daytime must yield it after dark because drivers cannot see him very well.	☐	☐
15. When you intend to turn or stop, the law does not require you to give a hand signal unless there is a vehicle following yours.	☐	☐
16. When you back your car, you have the right of way because you cannot see very well while driving backward.	☐	☐
17. The amount of alcohol in one cocktail is sufficient to decrease one's keenness of vision.	☐	☐
18. It is all right to warm up the car engine by running it in a closed garage provided you open the doors just as soon as you smell the carbon monoxide exhaust fumes.	☐	☐
19. If a driver seriously injures a pedestrian, legally at fault, the driver does not have to make out an accident report.	☐	☐
20. When you drive out of a filling-station yard, street traffic on your left has the right of way.	☐	☐
21. It is not necessary to slow down at an unprotected intersection if you do not see any cross traffic.	☐	☐
22. When you drive down a long hill, it is all right to hold the clutch pedal down if you leave the gear shift lever in high position.	☐	☐
23. For a quick emergency tire repair on the highway you should jack up your car on the pavement.	☐	☐
24. In the accompanying picture car B, being on the left, should yield the right of way to car A.	☐	☐



25. In the accompanying picture, car A should yield the right of way to car B because car B entered the intersection first.	☐	☐



PART II

DIRECTIONS: Read each of the following statements carefully. Four possibilities for completing each statement are given. Select the one that you think completes the statement most correctly and place an X in the square under the proper number. Notice how the sample is answered:

	1	2	3	4
SAMPLE: The speed of your car will be increased if you feed more: (1) Oil (2) Gasoline (3) Water (4) Electricity	☐	☒	☐	☐

1. Most traffic accidents are the result of:
(1) Mechanical defects in automobiles (2) Defects in the road (3) Errors in drivers' judgment (4) Adverse weather conditions. ☐☐☐☐

2. Visibility is best at night when driving on roads made of:
(1) Asphalt (2) Dirt (3) Brick (4) Concrete ☐☐☐☐

3. A good driver, suddenly finding the foot brakes not functioning, will attempt to control the car for stopping by:
(1) Turning off ignition (2) Pushing the clutch pedal down and letting it up, repeating this several times (3) Driving onto the shoulder of the road to slow down the car (4) Double-clutching the gear into second position and using engine compression. ☐☐☐☐

4. When ascending a hill behind a transport truck, you should:
(1) Stay far enough behind the truck so that it does not block your view of oncoming traffic (2) Stay close to the rear of the truck so that no other car from behind can get in between you and the truck (3) Blow your horn (daytime) or flick your lights (night time) to let the truck driver know you wish to pass (4) Speed up and make a quick pass around the truck. ☐☐☐☐

5. When driving around a curve on the highway you should:
(1) Accelerate at the beginning of the curve and apply the brakes just before reaching the straightaway (2) Slow down before reaching the curve, depress the clutch, and coast around the curve (3) Slow the car down with the engine before reaching the curve, start around the curve, and accelerate just before reaching the straightaway (4) Start into the curve at the speed the car is traveling and apply the brakes only if necessary. ☐☐☐☐

6. In crossing trolley car tracks on a wet street, you should:
(1) Turn gradually across the tracks (2) Cut across the tracks at a wide angle (3) Drive on the tracks before crossing them (4) Make it a practice never to cross trolley tracks on wet days. ☐☐☐☐

7. If application of the brakes at 20 miles per hour requires 25 feet to bring a car to a dead stop, the required distance at 40 miles per hour would be:
(1) 40 feet (2) 50 feet (3) 75 feet (4) 100 feet. ☐☐☐☐

8. You are driving at the speed limit and a driver behind sounds his horn and starts by. You should:
(1) Decrease your speed slightly and give way to him (2) Block him to let him know he is already driving at the speed limit (3) Speed up to get out of his way (4) Let him by and then overtake him. ☐☐☐☐

9. Night traffic on the roads is much less than day traffic; but night accidents in proportion to the traffic are far more numerous than day accidents. The main reason is:
(1) Visibility is poor (2) Drunken drivers are more numerous (3) Pedestrians walk on the wrong side of dark roads (4) People drive faster at night than during the day. ☐☐☐☐

10. For safety when driving through an intersection, you should:
(1) Glance right and then left in approaching the intersection (2) Look into the mirror to see how close you are being followed (3) Glance left and then right in approaching the intersection (4) Keep your eyes straight ahead to see what dangers you might face. ☐☐☐☐

11. If steam forms on the inside of the windshield, you should:
(1) Increase your speed by ten miles per hour (2) Stop every mile and wipe it off (3) Open a window slightly (4) Wipe it off frequently while driving. ☐☐☐☐

12. If you are involved in an accident you should first:
(1) Notify the police (2) Assist the injured (3) Drive away quickly (4) Notify your insurance company ☐☐☐☐

13. When the right wheels of your car slip off the edge of the pavement, you should:
(1) Slow down gradually until you can steer back onto the pavement at a convenient place (2) Turn back onto the pavement quickly before your car has lost any of its momentum (3) Apply the brakes quickly in order to keep from rolling over into a ditch (4) Turn off the ignition, coast to a stop, and then back up onto the pavement ..... ☐☐☐☐

14. You are driving on a snow-covered road and have to make a stop quickly. The best way to do this is to:
(1) Slam the brakes on hard (2) Roll down the window and signal (3) Turn off the ignition and apply the hand brake (4) Pump the brake pedal ..... ☐☐☐☐

15. In bringing a car to a complete nonemergency stop from a speed in excess of 30 miles per hour, you should:
(1) Depress the clutch and brake pedals at the same time (2) Depress the clutch pedal first and then depress the brake pedal (3) Depress the clutch and brake pedals together and then place the gear shift lever in neutral (4) Depress the brake pedal first and depress the clutch pedal later .... ☐☐☐☐

16. Most automobile skids are the result of:
(1) Under-inflated tires (2) Too much snow or ice on the road (3) Over-inflated tires (4) Driving too fast on slippery road surfaces ..... ☐☐☐☐

17. A red signal that flashes on and off, on and off, means:
(1) Stop (2) Slow down (3) Blow the horn (4) Shift to second gear ..... ☐☐☐☐

18. Most city traffic accidents take place:
(1) In the morning rush (2) In the noon rush (3) In the evening rush (4) Late at night ..... ☐☐☐☐

19. In preparation for a right turn the most important thing for you to do is:
(1) Drive in the extreme right lane (2) Check your mirror for conditions in the rear (3) Blow your horn lightly (4) Give a hand signal ..... ☐☐☐☐

20. When driving in a fog at night you will have the best possible visibility by using:
(1) The upper headlight beam (2) The lower, or passing, headlight beam (3) The parking lights (4) No lights at all ..... ☐☐☐☐

21. When driving behind a school bus which makes a sudden stop, you should:
(1) Slow down and pass if no children cross the road (2) Pass the bus, sounding your horn as you go by (3) Bump into the bus lightly (4) Stop behind the bus and wait for it to proceed before you start up again ..... ☐☐☐☐

22. Your car (A) is being overtaken by another car (B) on a two-lane road. Just as the overtaking car draws up alongside yours, its driver, seeing that an oncoming car (C) is near, starts to drop back into line again. You can help reduce the danger to all three cars by:
(1) Accelerating (2) Applying the brakes (3) Keeping your speed constant (4) Blowing your horn as a danger signal ..... ☐☐☐☐

23. In the situation above (#22) you are driving car (C). You can help reduce the danger to all three cars by:
(1) Blowing your horn (2) Keeping your speed constant (3) Moving toward the center of the road to scare car (B) back into line (4) Applying the brakes ..... ☐☐☐☐

24. Figure A (below) indicates a standard sign as used on roads in the United States:
(1) Railroad crossing (2) Stop (3) Speed limit (4) Curve ..... ☐☐☐☐

25. Figure B (below) indicates a standard sign as used on roads in the United States:
(1) Stop (2) Underpass (3) Railroad crossing (4) Traffic signal ahead ..... ☐☐☐☐

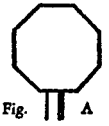


Fig. A

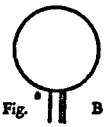


Fig. B

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