

## RELATION between PSYCHOLOGICAL TESTS and DRIVER PERFORMANCE

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THE North Carolina State College through its Extension Division established a Driver Training School on August 8, 1949 for training tractor-trailer truck drivers.

Psychological research was one of the aims of the training program when the school was organized. The research program embodied interviews, psychological testing, psychological paper-and-pencil tests, and accident follow-up. The purpose of this report is to show the relationship between psychological tests and tractor-trailer driver performance.

Using the Cornell Word Form Test, the Eno Foundation for Highway Safety (3) found that accident repeaters were more emotionally unstable than the accident-free drivers. The drivers were commercial-vehicle operators, as well as noncommercial, and were matched (N = 193) as to sex, type vehicle operated, and mileage. The difference found between the two groups was significant at the 5-percent level of confidence.

Ghiselli and Brown (2) compared accident records for the first 5 weeks of employment with psychological test scores for 67 taxicab drivers. With accidents, a mechanical-principals test correlated 0.11; a total-interest score, 0.23; dealing with people, 0.11; and related occupations, 0.20.

Ghiselli and Brown (1) found that a learning period exists for street-car and motor-coach operators. Improvements in accident records were evident after the first 6 or 7 months of operation, and accident rates were reduced considerably after this time. They found that the reduction of accidents approached the shape of the common-learning curve. It was concluded that "for motor-coach and street-car operators it is simple enough to learn the motor coordinations involved, but complex activities such as judgments of speed, spatial relations, and division of attention, performed under conditions of stress are the difficult aspects of learning the job."

Research by The Adjutant General's Office (4) on selection of truck drivers yielded low coefficients of reliability for criterion data. One index of driving ability was the score the driver obtained on the Road Test Check List. An examiner observed and checked items best describing the driver's performance in a standardized skill test situation. The reliability coefficient of the check list was 0.82 by the split-half method after correction by the Spearman-Brown formula. Scores on the check list given by different examiners at different times correlated 0.53. General ratings of 127 men by several examiners on the same day yielded an average correlation of 0.72 between judgments of the different raters. The article states that the low reliability of these criteria could very likely be improved by proper training of examiners.

## METHODS AND PROCEDURES OF THIS STUDY

The paper-and-pencil tests used were the Otis SA Test of Mental Ability (Higher Form B), the Bennett Test of Mechanical Comprehension (Form BB), the Kuder Vocational Interest Test (Form B), the Bernreuter Personality Inventory, and the Minnesota Multiphasic Personality Inventory (Group Form). All tests were administered during the trainees' 6-week training period.

The subjects are over-the-road drivers (haul freight over long distances as opposed to the local-delivery personnel) and were of the dual-operation category (two drivers ride together, one drives and the other sleeps). All the drivers were from six large companies operating on the East Coast with home terminals in North Carolina.

Accident records were found to be the most suitable index for the criterion of job performance. The accident data were secured by the writers who were granted access to the files of each company employing drivers from the school. The accident records were found to be adequately maintained and were labeled in a similar manner. All companies classified accidents as preventable or nonpreventable. In some cases the chargeability of the accidents were determined by a board of safety supervisors in the personnel and safety departments. However, in some companies classifications were made by the safety director alone. An accident was preventable if the driver could have foreseen and avoided the accident by any conceivable means and nonpreventable if the accident could not have been prevented.

An accident score was derived from each man's record in the following manner:

$$\frac{\text{Months Worked}}{3 \times \text{no. preventable accidents} + 2 \times \text{no. of nonpreventable accidents.}}$$

Rather than use the number of accidents alone as the criterion, the writers thought that some adjustment should be made for experience. The longer a man has driven the more susceptible he had been to hazardous conditions and accident-producing situations. These factors fail to remain equivalent if the drivers have been operating for varying lengths of time. By utilizing months worked in the above formula, such inequalities have been considerably alleviated, although not perfectly controlled.

After going over approximately 400 accident records, the writers also felt that some distinction should be made between the accident categories of preventable and nonpreventable in arriving at an accident score. In almost every nonpreventable accident examined, there were factors operating or conditions present which lessened or prevented the possibility of a driver foreseeing and avoiding an accident. Therefore, it was felt that a system of weights would tend to equate variation between these two types of accidents. Figure 1 shows that the distributions of preventable and nonpreventable accidents are practically identical. The variances of the two curves are not significantly different from each other. This justifies the addition of the two scores.

One other factor considered in the analysis of the group should be men-

tioned: No driver was included in the study who had not driven at least 6 months. This would represent approximately 30,000 mi. of driving. A follow-up of the school's trainees has revealed that of the number who have accidents (some had no accidents), the greatest proportion had the majority of their accidents during the first 6 months.

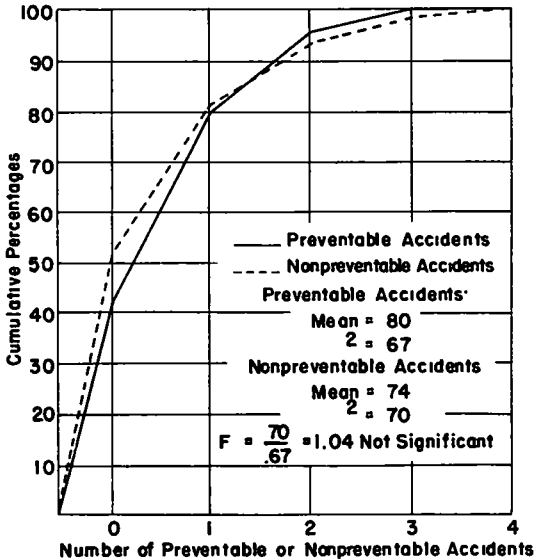


Figure 1. Distributions of cumulative percentages of preventable and nonpreventable accidents.

9.34 months of work and a sigma of 3.18; the accident group had worked 9.36 months and had a sigma of 3.21.

In Part 2 the group consisted of approximately 100 subjects who had driven an average of 10.82 months with a sigma of 3.65. Pearson-product moment correlations were utilized to determine the relationship between the psychological tests and the criterion.

Part 3 consisted of approximately 31 drivers who had been on the job from 12 to 18 months. The average time driven was 15.72 months with a sigma of 1.84. A Pearson product-moment correlation was used to determine the relationship between test scores and the criterion.

## RESULTS

The  $t$  ratios obtained between the matched groups and the correlation coefficients for the two groups working varying lengths of time are shown in Tables 1 and 2, respectively.

The direction of relationship for the matched groups can be determined by examining the mean scores of the two groups.

The distribution of accident scores for the 6-to-18 months group as shown in Figure 2 has a tendency towards bimodality with the majority of the subjects having low accident scores. Skewness is positive. It is realized that, in some studies which have utilized accidents alone, the distribution has been a poisson one.

Although only 31 drivers were available who had worked more than 12 months, bimodality found in the 6-month group disappeared.

The study is divided into three parts: In Part 1 an accident group of 30 drivers was matched with an accident-free group on the basis of months worked. These groups were then compared on the basis of differences in mean test scores and  $t$  ratios were utilized to test the significance of the difference. The accident-free group had a mean of

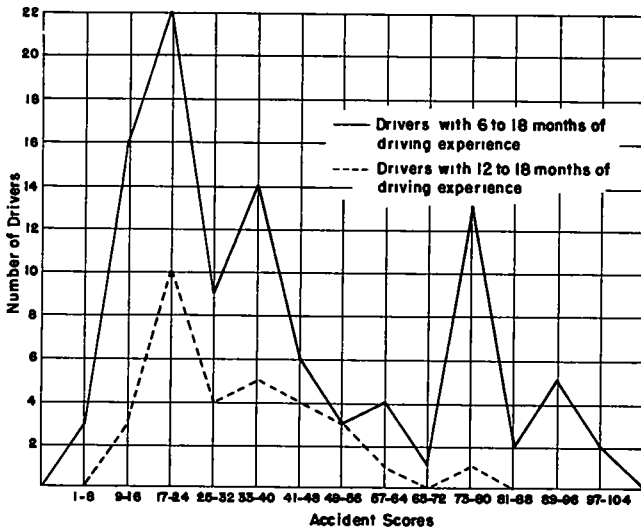


Figure 2. Distribution of accident scores for truck drivers.

ing great comprehension of mechanical principles. This was not true, however, on computational interest—accident drivers have higher interest in computational activities.

In the second part of the study, a significant negative correlation was obtained between the B2-S scale, and the accident index; a significant positive correlation was obtained between the Bennett test and the criterion. These results tend to substantiate the results disclosed in Part 1.

In the third part, only one correlation of significance was obtained and this was between the Kuder Mechanical Interest scale and the criterion indicating positive relationship.

Differences in results among the three groups were indicated. The writers are inclined to believe, however, that such differences may be due primarily to sampling and operation of uncontrollable factors. There may be changes in psychological composition due to the hazardous conditions of the job, the dual type of operation, and the disruption of home life. Also, selective factors, such as discharge from the job and voluntary terminations, may alter the nature of the group so that the psychological traits of drivers who remain on the job longer vary appreciably from the ones who stay for shorter intervals. In this connection it should be mentioned that ideally one should give these tests periodically to detect and evaluate such personality changes.

None of the tests show significant relationships with the criterion for all three groups. However, the Bennett Test of Mechanical Comprehension and the B2-S scale of the Bernreuter gave results significant at the

In the first part of this study, significant differences were found on the B1-N, B2-S, and B4-D scales of the Bernreuter Personality Inventory, the Bennett Test of Mechanical Comprehension, and the computational scale of the Kuder Vocational Interest. On the Bernreuter scales, the accident-free group tended to make higher scores on B1-N and lower scores on B2-S and B4-D than the accident group. This means that the accident-free drivers tend to be tense, less self-sufficient, and less dominant than the accident driver. On the mechanical-comprehension tests, the accident-free driver made higher scores indicat-

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR PSYCHOLOGICAL TESTS FOR ACCIDENT AND ACCIDENT-FREE GROUPS AND RELATIONSHIP OF THE TWO GROUPS ON THESE TESTS EXPRESSED BY  $t$  RATIOS

Psychological Test	Accident Group N = 30		Accident-free Group N = 30		t
	Mean	$\sigma$	Mean	$\sigma$	
Otis Self Administering Test	24.53	8.50	26.10	9.08	.584
Bennett Mechanical Comprehension	21.47	8.67	27.90	10.51	2.568 <sup>a/</sup>
Kuder - Mechanical	95.13	13.32	96.50	11.63	.411
Computational	34.54	7.20	30.60	6.26	2.155 <sup>a/</sup>
Scientific	63.93	11.37	62.30	13.53	.467
Persuasive	67.33	15.14	67.67	12.76	.104
Artistic	47.47	12.07	48.70	11.54	.390
Literary	38.20	9.57	38.03	7.61	.072
Musical	13.07	8.38	14.83	7.06	.779
Social Service	77.67	14.57	78.20	14.60	.147
Clerical	54.60	10.49	48.87	8.70	1.647
Bernreuter - B1-N	19.43	17.90	33.47	22.36	3.146 <sup>b/</sup>
B2-S	42.43	23.58	31.20	19.15	2.138 <sup>a/</sup>
B4-D	67.43	19.61	53.83	23.19	2.455 <sup>a/</sup>
M.M.P.I. - K Scale	17.30	4.30	16.30	4.67	.908
Hypochondriasis	16.37	4.56	17.53	3.98	1.169
Depression	16.77	2.81	16.77	3.35	.000
Hysteria	1.63	1.35	2.57	2.70	1.800
Psychopathic Deviate	16.30	2.87	16.57	3.60	.312
Interest Scale	20.60	4.10	21.30	4.86	.716
Paranoia	7.47	2.16	8.13	2.31	.803
Psychasthenia	7.03	5.36	7.53	6.08	.408
Schizophrenia	7.00	5.14	8.17	4.80	.742
Hypomania	17.00	3.48	16.40	3.02	.648

a/ - Significant at 5-percent level.

b/ - Significant at 1-percent level.

5-percent level for the drivers who had worked from 6 to 18 months and also for the matched groups. In general one may say that the more proficient drivers have a better understanding of general mechanical principles than the ones who have poorer accident records. One may also surmise that the negative relationship between self-sufficiency and the better drivers indicates that they are dependent upon others and therefore more hesitant and cautious in their driving habits. These drivers are more likely to size up traffic situations before proceeding.

However, one cannot select a driver on the basis of a particular area of interest or one personality trait without examining all test results. It is the pattern of abilities, interests, or personality traits that should receive consideration collectively rather than any one or two taken alone. In this respect a multiple correlation would be the best statistical treatment for one to utilize because it permits a multiple analysis of numerous factors and their interaction.

TABLE 2

MEANS AND STANDARD DEVIATIONS FOR PSYCHOLOGICAL TESTS AND  
PEARSON PRODUCT MOMENT CORRELATIONS FOR EACH TEST WITH  
ACCIDENT SCORES FOR TWO GROUPS OF DRIVERS

Psychological Test	Worked from 6 to 18 months			Worked from 12 to 18 months				
	Mean	$\sigma$	N	r	Mean	$\sigma$	N	r
Otis Self-Administering	25.18	9.05	99	-.040	25.70	9.70	30	-.255
Bennett Mech. Compr.	24.64	10.09	99	.197 <sup>a/</sup>	26.80	10.21	30	.185
Kuder Mechanical	96.40	12.96	100	.062	100.64	5.96	31	.443 <sup>b/</sup>
Computational	31.52	7.20	100	-.108	29.48	6.31	31	-.239
Scientific	62.41	13.14	100	-.039	62.03	14.27	31	-.087
Persuasive	68.53	14.27	100	.058	69.68	13.80	31	.164
Artistic	47.90	11.18	100	.058	45.29	10.78	31	-.142
Literary	39.22	10.61	100	-.027	41.23	11.14	31	.074
Musical	15.34	8.19	100	-.004	17.10	9.22	31	-.181
Social Service	76.76	14.26	100	.056	75.52	14.77	31	.165
Clerical	50.97	12.50	100	-.054	49.19	9.37	31	.181
Bernreuter B1-N	26.82	21.71	98	.155	28.28	20.37	29	-.080
B2-S	35.30	22.37	98	-.228 <sup>a/</sup>	34.00	21.75	29	-.147
B4-D	57.06	23.24	98	.033	55.79	22.59	29	.092
MMPI K Scale	16.31	5.21	100	.022	14.35	4.01	31	.017
Hypochondriasis	16.29	2.47	100	.064	15.29	2.25	31	.010
Depression	16.24	4.44	100	-.034	15.68	3.61	31	-.202
Hysteria	2.06	4.19	100	.069	2.03	4.42	31	.148
Psychopathic Deviate	16.58	4.52	100	.040	15.10	3.82	31	-.034
Interest Scale	20.49	4.15	100	.027	21.23	3.78	31	.028
Paranoia	7.89	2.87	100	-.007	8.19	3.20	31	.106
Psychasthenia	7.10	5.32	100	-.082	8.35	5.42	31	-.268
Schizophrenia	7.03	5.48	100	-.104	8.77	6.88	31	-.188
Hypomania	17.22	4.27	100	-.075	18.32	4.61	31	.070

a/ - Significant at 5-percent level.

b/ - Significant at 1-percent level.

### CONCLUSIONS

This study, like many in the past, has shown some relationships between psychological traits and driver performance. Unlike many, it has disclosed the importance of the personality of the driver as a factor in safety. Conclusions are as follows:

1. Accident rates, even though determined on the basis of miles driven per accident, continue to follow the Poisson distribution. This implies that correlational indices need to be interpreted with caution.

2. Safe drivers tend to be more tense, less self-sufficient, less dominant, as shown by the Bernreuter Personality Inventory. These same trends are demonstrated on the MMPI test (hypochondriasis and hysteria scale) even though differences were not shown to be statistically significant.

3. Safe drivers tend to make higher scores on the Bennett Mechanical Comprehension test.

4. The first 6 months of driving experience appears to be a learning period because of the high incidence of accident rates.

TABLE 3

COMPARISON OF THREE GROUPS OF DRIVERS, ACCIDENT VERSUS NONACCIDENT, THOSE WHO WORKED 6 TO 18 MONTHS, AND THOSE WHO WORKED 12 TO 18 MONTHS

Psychological Test	Accident vs. Nonaccident		Worked 6 to 18 Months	Worked 12 to 18 Months
	t ratio	Direction	r	r
Otis Self Administering	.584	N-A	-.040	-.255
Bennett Mech. Compr.	2.568 <sup>a/</sup>	N-A	.197 <sup>a/</sup>	.185
Kuder Mechanical	.411	N-A	.062	.443 <sup>b/</sup>
Computational	2.155 <sup>a/</sup>	A	-.108	-.239
Scientific	.467	A	-.039	-.087
Persuasive	.104	N-A	.058	.164
Artistic	.390	N-A	.058	-.142
Literary	.072	A	-.027	.074
Musical	.779	N-A	-.004	-.181
Social Service	.147	N-A	.056	.165
Clerical	1.647	A	-.054	.181
Bernreuter B1-N	3.146 <sup>b/</sup>	N-A	.155	-.080
B2-S	2.138 <sup>a/</sup>	A	-.228 <sup>a/</sup>	-.147
B4-D	2.455 <sup>a/</sup>	A	.033	.092
MMPI K Scale	.908	A	.022	.017
Hypochondriasis	1.169	N-A	.064	.010
Depression	.000	-	-.034	-.202
Hysteria	1.800	N-A	.069	.148
Psychopathic Deviate	.312	N-A	.040	-.034
Interest Scale	.716	N-A	.027	.028
Paranoia	.803	N-A	-.007	.106
Psychasthenia	.408	N-A	-.082	-.268
Schizophrenia	.742	N-A	-.104	-.188
Hypomania	.648	A	-.075	.070

a/ - Significant at 5-percent level

b/ - Significant at 1-percent level

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