

An Investigation of the Role of Psychological Factors in Motor Vehicle Accidents *

ROBERT V. RAINEY, JOHN J. CONGER, HERBERT S. GASKILL, DONALD D. GLAD, WILLIAM L. SAWREY, EUGENE S. TURRELL, CHARLES R. WALSMITH, and LEO KELLER, School of Medicine, Denver, Colo.

● **CONCERN WITH driver behavior as a major variable in motor vehicle accidents has drawn the interest and efforts of many investigators for at least two decades. These studies of human variables in accidents have ranged the broad spectrum of driver behavior, from a measurement of the most overt physical and psychophysical characteristics to an analysis of the most covert and subtle personality nuances.**

A review of these studies is beyond the present intent. The purpose of this report is to describe a driver research study at the University of Colorado School of Medicine, which has attempted to extend this research by incorporating in one program the major methods and variables emphasized by other investigators, as well as specific innovations particular to this research study.

The three major features of this program included:

- 1. A comprehensive research design in which many driver characteristics, physiological, psychophysical, and psychological, were simultaneously studied.**
- 2. A heightened concern with defining in operational terms such major variables as "accident", "attitudes", and "personality".**
- 3. An emphasis upon repeated cross-validation of early findings to guard against premature and unwarranted conclusions.**

The objective of this research has been to determine whether there are specific personal characteristics, and/or patterns of such characteristics, which clearly and consistently distinguish accident-repeaters from accident-free drivers.

From its conception in 1953, this driver research program has been financially supported by the Commission on Accidental Trauma, Armed Forces Epidemiological Board, and has been made possible through the interest and active cooperation of military personnel at Fitzsimons Army Hospital and Lowry Air Force Base, Denver, Colorado.

The two major phases of this research are discussed in the order of their temporal development.

PHASE I

The initial phase includes a series of studies during the period 1954 to 1956 focused exclusively upon airmen from Lowry Air Force Base.

This phase began in 1954 with a study of 110 airmen selected from the official Colorado motor vehicle accident files and Lowry Air Force Base ground safety records as having had one or more major (damage of more than \$50.00), legally responsible, motor vehicle accidents during the immediately preceding 12-month period. In addition, all squadrons of the base were surveyed to identify and locate airmen who had no motor vehicle accidents during a minimum 12-month residence and driving in the area.

These 110 airmen accident subjects were administered a comprehensive battery of psychological tests and measurements which included the following:

- 1. Psychomotor functions, such as simple and complex reaction time, eye-hand-foot coordination, and depth perception.**
- 2. Objective personality tests, such as the Minnesota Multiphasic Personality Inventory, and the Thurstone Temperament Schedule.**
- 3. Clinical (individual) personality measures, such as the Rorschach, the Sacks**

*** A report of the Driver Research Project, University of Colorado.**

Sentence Completion Test, and the Thematic Apperception Test.

4. Specific tests of personal characteristics, such as the Allport, Vernon and Lindzey Study of Values, the Taylor Anxiety Scale, and the Level of Aspirations Test.
5. Biographical questionnaires elaborating social background and personal history.

In addition, each subject was individually seen for a structured psychiatric interview, the latter portion of which was specifically directed to a detailed inquiry of the subject's lifetime driving history and his accident experiences.

By combining the official records available on these subjects with the subjective reports obtained in the psychiatric interview, the following two small groups of drivers were identified:

1. The accident-repeater group, which consisted of those airmen who had two or more major, responsible, motor vehicle accidents in the immediately prior 54-month period (N=15).
2. The accident-free group, comprised of those airmen who had no official or subjective record of accidents or hazardous violations for this same period (N=15).

These groups were matched for age, length of time driving, and miles driven per year. These selected and matched groups were then compared across tests, scales, and measurements of the comprehensive battery.

In recognition of the complexities involved and to preclude eliminating potentially promising areas of investigation, it was decided that items which differentiated accident and non-accident subjects at the 0.20 level of confidence or better would be retained for cross-validation.

In addition to this analysis of extreme groups, the data for all 110 airmen were subjected to a factor analysis to determine whether meaningful clusters of psychological and accident variables could be obtained, and to reduce the large number of measures to a more economical and efficient battery.

RESULTS OF 1954 STUDY

The correlations between accident variables and behavior measures were found to be low to moderate (none exceeding 0.27), due in part to the restricted range in the accident variables. The factor analysis based on this correlation matrix failed to reveal any significant over-all relationships between these two sets of variables, as indicated by factors heavily loaded on both accident and psychological measures. It was felt that this might be due partly to the restricted accident range, as well as to strong relationships among some of the psychological variables which would operate to mask any positive but weak over-all relationships between accident and psychological variables.

With regard to the analysis of the accident-repeater and accident-free groups, of the 51 measures on which they were compared, 11 reached or exceeded the predetermined 0.20 level of significance.

CROSS-VALIDATION (1955)

In a cross-validation study carried out in 1955, all discriminating psychometric scales, supplemented by additional objective measures, including the Siebrecht Attitude Scale and a paper-and-pencil psychomotor test (Nesberg and Smith Motor Decision Test), were administered to another small sample of accident-repeater and accident-free airmen drivers selected on the same basis as the previous groups (A=15; NA=25).

RESULTS OF CROSS-VALIDATION STUDY (1955)

Most of the psychometric measures which initially appeared to discriminate between these groups failed to discriminate in cross-validation.

One test, however, the Allport, Vernon and Lindzey Study of Values, proved highly stable. Cut-off scores for two scales of this test previously established on the 1954 group accurately identified the accident status of 73 percent of the 1955 subjects.

1956 CROSS-VALIDATION OF CLINICAL MATERIAL

In 1956, in a further study directed to the cross-validation of clinical (individual) personality tests, the Rorschach and Thematic Apperception tests, which had earlier discriminated between the 1954 groups, were administered to another sample of accident-repeater and accident-free drivers selected on the same basis as the previous groups (A=10; NA=10). This most recent study included physiological measures, such as blood pressure, galvanic skin response, muscle tremor, and respiration rates under resting and stress conditions, as well as individual intelligence tests and a test of driver ability (American Transit Motor Abilities Test).

In addition, the modified Allport, Vernon and Lindzey Study of Values was readministered and again identified the accident status of 73 percent of the subjects of this new sample.

OVER-ALL CONCLUSIONS

All conclusions discussed are derived from this series of studies on small groups of highly selected accident-repeater and accident-free airmen drivers.

Statistical analyses of the various scales and measures failed to reveal any significant difference between these groups with regard to physiological reactions, under either resting or stress conditions. There were no differences with regard to psychomotor functions such as coordination, discrimination, and simple or complex reaction time. In addition, most objective personality inventories and tests of such specific characteristics as manifest anxiety, level of aspiration, and I.Q., failed to discriminate between these groups.

Of the psychometric measures already cross-validated, two scales of the modified Allport, Vernon and Lindzey Study of Values have in several studies discriminated these selected groups at better than the 0.10 level of significance. The moderate but stable discriminating function of these scales deserves comment.

In a comparison of these two extreme groups, accident-repeater status appears associated with significantly higher scores on the A scale, whereas accident-free status appears associated with significantly higher scores on the R scale.

The possible meaning of these associations can best be understood, first by referring to the Allport, Vernon and Lindzey interpretation of these scales, then by a considered projection of these values into general personal-social behavior.

Allport, Vernon and Lindzey interpret a high A score to reflect a "heightened concern with aesthetic experience," including "the appreciation of harmony, beauty, and the artistic episodes of life." In social affairs, they suggest that "such persons tend toward individualism and self-sufficiency."

Projecting beyond this general interpretation, it is suggested that in the present context high A scores may represent not only the aesthetic appreciation which Allport, Vernon and Lindzey emphasize, but also two other, possibly more significant, features as well. The first is that this scale, associated with accident-repeaters, may reveal an overemphasis on self-determination and self-sufficiency, which, in their heightened emphasis on individualistic expression, may reflect a rejection of conformity standards and conventional modes of behavior. The second, and equally important, is that the prime requisite of "feeling" represented in the A scale may reflect a tendency to respond to events and to other persons on a highly-charged emotional basis.

With respect to the R scale, associated with accident-free status, a similar analysis may be proposed. Allport, Vernon and Lindzey interpret high scores on this scale to reflect an individual whose "highest value is a sense of unity" and who "seeks to comprehend the cosmos as a whole, to relate himself to its embracing totality." Projecting this value to a perhaps more narrow domain of self and society, one may also consider that this scale, in some part, reflects a tendency to conformity behavior and to the resolution of conflicts through the acceptance of conventional standards and practices. Coupled with this tendency to uncritically accept, believe, and act, there may also be reflected a lessened sense of self-sufficiency and a greater basic reliance on authority-prescribed modes of behavior.

This interpretation, that the stable differences found on these objective scales re-

flected underlying differences between these groups with regard to conventionality and to emotionalized responsiveness, generated the following hypotheses:

1. Accident-repeater subjects would be more unconventional in their opinions, attitudes, and social behaviors than the non-accident subjects.
2. Accident-repeater subjects, when compared with the non-accident group, would show a higher level of excitability or tensions, less ability to tolerate or sustain this tension, and hence a tendency to act out these emotions, tensions, or impulses in behavior.

These hypotheses were tested out in the most recent study, which consisted of an intensive psychological and psychiatric evaluation of each subject of the accident-repeater and non-accident groups.

Objective rating scales were developed, and the psychiatric interview transcripts, test protocols, and individual psychological reports were rated "blind" and independently for the variables of conventionality and impulse-control, as well as for twelve other variables hypothesized to be significantly related to accident frequency.

Accident-repeater and non-accident subjects differed significantly ($p=0.10$) on six of these variables, the accident-repeater group being rated high on tension (anxiety) and unconventional behavior, and low on hostility/control ratio and tension tolerance. These clinical and psychometric findings suggest that, for the airmen groups studied, acceptance or rejection of conformity standards and conventional modes of behavior, and the degree and effectiveness of impulse control, are major personal characteristics related to accident frequency.

PHASE II

The second phase of this driver research is a more recently initiated "predictive" study of young "pre-drivers". This research evolved from a recognition of some inherent limitations of the earlier studies. Primarily, these limiting features concerned the following:

1. The transient nature of the airman population of a training base. The resultant small number of 12-month residence drivers available for initial selection severely restricted the subsequent sample size of accident-repeater and accident-free drivers.
2. The necessity of obtaining a large amount of objective biographical data and selected psychological tests on this population, prior to their beginning driving experiences, so as to eliminate the possible confounding influence of any later accident experiences.

In 1956, the University of Colorado School of Medicine, in cooperation with the Denver Public Schools and the Colorado Motor Vehicle Division, initiated a large-scale, long-range study incorporating these essential features.

SUBJECTS

The subjects of this study consisted of the entire sophomore class, 4,500 pupils, of the five Denver public high schools. The sophomore group was selected because their median age of 15 years is immediately prior to the licensing age of 16, hence probably represents the closest approximation to the attitudes and characteristics subsequently active in the initial driving experiences.

METHOD

There are three basic components of this program, as follows:

1. Testing—A selected battery of psychological tests, including the Allport, Vernon and Lindzey Study of Values; the Guilford-Zimmerman Temperament Survey; an objectively scored group from the Thematic Apperception Test; and a project-designed measure of risk-taking attitudes, was routinely administered to all sophomores.
2. School Records—The Denver public school system maintains a cumulative record on each pupil dating from initial entry into the school system. These records provide

a valuable source of supplementary data, including biographical information; teacher ratings on a variety of personal-social behaviors; descriptions of assets and liabilities in peer and authority relations; test scores on standardized measures of intelligence, personality, aptitudes, interest, and achievement; and descriptions of any serious physical handicaps and disabilities. The cumulative record available for each sophomore subject has been microfilmed. Analysis of a random sample of these records indicates that in 65 percent of the sample these records have been maintained continuously since the first grade, thus providing 10 years of longitudinal biographical information on the subjects.

3. **Driving Records**—With the cooperation of the Colorado Motor Vehicle Division, a double-entry card system has been developed which insures that beginning with the initial licensing, all accident/violation experiences of these sophomore subjects will be recorded routinely on duplicate project cards, already inserted in the master files of the Colorado Motor Vehicle Division. Thus, a continuous, objective, and standard driving history record will be available for each project.

In 1957 this program was expanded to include the seven suburban high schools surrounding the metropolitan Denver area. With the addition of the 2,600 sophomores of these schools, approximately 7,000 subjects are now participating in this program.

Current efforts are directed to the scoring and classification of this voluminous information for I. B. M. coding and analysis. It is estimated that this data reduction phase will be completed within two years.

A preliminary statistical analysis of the relationships between test and biographical data, and driving records for selected subjects, is tentatively planned for 1960, at which time the majority of the subjects of the study will have had three years of driving experience.

In conclusion, the predictive nature of the second phase of this research must be emphasized. The goal of this current pre-driver study is to determine the possibility of predicting subsequent driving behavior, as defined by the presence or absence of motor vehicle accidents and/or hazardous violations, from an analysis of antecedent, pre-driving attitudes and personal-social characteristics.