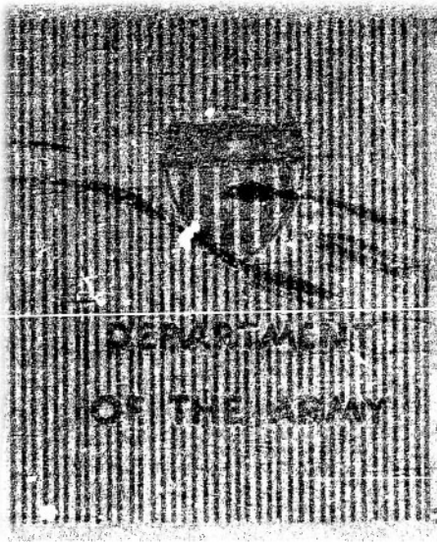
TECHNICAL RESEARCH REPORT
SRR 1074

DRIVER SELECTION TESTS
FOR
NON-ENGLISH SPEAKING NATIONALS

E. [illegible] LOVELAND
[illegible]

AMERICAN INSTITUTES FOR RESEARCH
[illegible]

A CONTRACT RESEARCH REPORT TO



THE ADJUTANT GENERAL'S OFFICE

PERSONNEL RESEARCH AND PROCEDURES DIVISION

PERSONNEL RESEARCH BRANCH

Army Project Number
29561000

Contract DA-49-083 OSA-521
A-5-128-(00)

PRB Technical Report 1074

DRIVER SELECTION TESTS FOR NON-ENGLISH SPEAKING NATIONALS

John C. Flanagan, Principal Technician
Edward H. Loveland, Project Director

American Institute for Research
410 Amberson Avenue
Pittsburgh 32, Pennsylvania

31 August 1953

PRB Reports are technical reports. They are intended primarily for research agencies in the Armed Forces as a means of guiding further research in the area of human resources. As research findings accumulate and suggest official action, recommendations are made separately to appropriate military agencies. Information of more general interest is presented in the Brief to this report.

DRIVER SELECTION TESTS FOR NON-ENGLISH SPEAKING NATIONALS

BRIEF

It has been the practice of the Army to employ motor vehicle drivers selected from nationals in overseas theaters of operation. It is desirable that these drivers be so selected as to insure the efficient operation of vehicles. The purpose of this study was to construct a battery of selection tests appropriate for non-English speaking nationals.

Eight non-language tests with pantomime instructions were developed. Two tests of the Army driver selection battery used for United States nationals were appropriately revised: Attention-to-Detail Test and the Two-Hand Coordination Test. One test, the Driver Judgment Test, was constructed to parallel the Army's Emergency Judgment and Driver Know-How tests. This test is a completely non-language problem-solving test. Five other non-language tests were constructed to cover mechanical principles, tool usage, driving concepts, and ability to perceive changes in detail of abstract patterns or of automotive equipment.

This battery of new tests was administered, along with the tests of the current Army driver selection battery, to United States Army Troops. The relationship between the two batteries was used as a tentative index of the usefulness of the newly developed battery. This relationship was found to be high enough (coefficients of .62 to .69) to demonstrate the feasibility of constructing driver selection tests which do not require the examinee to work with written or spoken language, and to justify the ultimate usefulness of the newly constructed battery. Further validation studies, however, would be desirable if appropriate samples can be obtained. The operational practicability of the non-language tests was indicated by the fact that the tests were successfully administered to two groups of twenty men by two enlisted men who had received but a minimum of training.

CONTENTS

		Page
BRIEF		
ACKNOWLEDGMENTS		iii
CHAPTER I	INTRODUCTION AND STATEMENT OF THE PROBLEM	1
CHAPTER II	THE APPROACH	2
CHAPTER III	SURVEY OF THE LITERATURE	5
CHAPTER IV	JOB ANALYSIS	7
CHAPTER V	TEST DEVELOPMENT	11
	Test Specifications	13
	Test Revision	14
	Test Construction	15
CHAPTER VI	RESULTS AND DISCUSSION	20
	Test Administration	20
	Relationship Between the Army and Experimental Batteries	21
	Principles for the Construction of Completely Non-Language Tests	27
CHAPTER VII	CONCLUSIONS	31
APPENDIX A	SUMMARY OF THE CRITICAL BEHAVIORS OF ARMY DRIVERS	
APPENDIX B	TEST RATIONALES	
APPENDIX C	ADMINISTRATION OF TESTS BY PANTOMIME	
APPENDIX D	STATISTICAL ANALYSIS	
APPENDIX E	SURVEY OF THE LITERATURE	

TABLES

Table		Page
1	Average Correlations Between Composite Scores on Army and Experimental Batteries	26
D-1	Intercorrelations of Tests of the Army Driver Selection Battery and Tests of the Experimental Battery for Selection of Indigenous Drivers - Group A	D-2
D-2	Intercorrelations of Tests of the Army Driver Selection Battery and Tests of the Experimental Battery for Selection of Indigenous Drivers - Group B	D-3
D-3	Means and Standard Deviations of Tests of the Army and Experimental Batteries	D-4
D-4	Correlations Between Experimental Tests and Composite Army Battery Score	D-6
D-5	Correlations Between Composite Scores on Army and Experimental Batteries	D-8
D-6	Reliabilities of Newly Constructed Tests	D-8
D-7	Means and Standard Deviations of Revised and Unrevised Forms of Army Tests for Different Orders of Test Administration	D-9
E-1	Validities of 12 Predictors of Ratings of Driver Performance	E-8

FIGURES

Figure		
1	Composition of Experimental Battery "A"	24
2	Composition of Experimental Battery "B"	25
3	Composition of Experimental Battery "C"	26
C-4	Method of Grasping Styli	C-33

I. INTRODUCTION AND STATEMENT OF THE PROBLEM

In order to utilize the human resources available in overseas theaters of operation most effectively, it has been the practice of the Armed Forces to employ indigenous personnel for various jobs connected with the conduct of military operations. The operation of motor vehicles is one such task for which native personnel are utilized. It is desirable to select native drivers in such a manner as to ensure the efficient operation of vehicles with a minimum number of accidents and maintenance costs.

The benefits of improved selection of indigenous drivers in foreign countries should be manifold. First, the use of qualified indigenous personnel as motor vehicle operators should release United States military personnel for other military duties. Economy in transportation and maintenance of drivers and dependents should greatly reduce the cost of operations in overseas commands. Second, there is reason to believe that more careful selection of native drivers will result in increased efficiency of operation and in reductions in accidents and maintenance costs. Further, employment of such drivers should contribute to improved relations between United States military organizations and local populations.

The Department of the Army is, at the present time, about to introduce a battery of personnel selection tests to select military motor vehicle drivers from among United States troops. Because of language and culture factors the Army battery, in its present form, cannot be administered to native personnel in foreign countries. The specific purpose of this research was to adapt and/or develop a battery of tests which would be appropriate for the selection of indigenous motor vehicle operators in foreign countries.

II. THE APPROACH

The project was, in accordance with contract provisions, divided into four definite research phases. The initial phase had two objectives. First, research was carried out to determine what factors best predict various criterion data. This was done by review and analysis of available reports of previous attempts to predict various criteria of motor vehicle operator performance. The results of the review and analysis are given in a subsequent section of this report. Second, a logical analysis of the presently used Army driver selection battery was made in order to infer the extent to which language and culture factors influence performance.

The second phase involved adaptation of presently used Army tests and the construction of new tests. Those tests judged to be relatively free from language and culture factors were revised in such a manner that they could be administered without the use of language. New tests were constructed to replace tests of the present battery which were judged to be highly subject to language and culture effects. A study of the Army driver's job was conducted to provide a rational basis for construction of new tests. The principal purpose of this study was to supplement information already available on the nature of the behaviors required by the Army driver's job.

Tests constructed were designed so that they could be administered by means of pantomime instructions. This eliminates the need for translation of test directions into the language of the examinees. During the test development process, pantomime test directions and test items were experimentally administered to immigrants enrolled in Americanization classes. In this way test constructors were able to judge the extent to which test materials were intelligible to persons

approximating foreign indigenous personnel. These preliminary tryouts permitted tentative estimates of difficulty levels and time requirements of experimental tests.

The third phase involved a study of the "equivalence" of the old and new batteries. For this purpose, both batteries were administered, in a counterbalanced sequence, to a sample of approximately 400 United States troops.[1] Tests were administered to subject groups of approximately twenty men, by two psychologists, assisted by six enlisted men who served as proctors. During the final stages of the testing operation, tests were administered to two groups of examinees by two selected enlisted men. This was done as a final test of the usefulness of the pantomime test directions.

The fourth phase was esentially a statistical phase. Intercorrelations of the tests of the Army and experimental batteries were computed in order to provide a basis for estimating the equivalence of the two batteries. In addition to the comparison of the two batteries permitted by a matrix of test intercorrelations, the multiple correlation between composite Army battery score and the "best" weighted combination of experimental tests was computed. For this purpose the subject group was divided into two random halves, and the standard partial regression weights from one half of the sample combined with appropriate battery-test correlations from the other half, to obtain two cross-validated estimates of the multiple correlation. Another comparison of the Army and experimental batteries was effected by computing the correlation between composite scores on the two batteries. The individual tests of each battery were given unit weights in the battery composite.

---

[1] Tests were administered to troops of the Reception Center, 3431 ASU, Fort Jackson, South Carolina.

Three sub-batteries of experimental tests were proposed for use with different cultural groups. The correlations between these sub-batteries and the two sub-batteries of Army tests administered at reception centers and at Fort Eustis were computed.

III. REVIEW OF THE LITERATURE

In order that the present project might benefit maximally from previous research in the field of motor vehicle operator selection, a review of studies in this area was conducted. A detailed discussion of studies reviewed is presented in Appendix E. What follows is a summary of conclusions drawn from this review.

The results so far obtained in driver selection studies do not warrant acceptance or rejection of any particular criterion measure or prediction device. There is reason to believe that the ultimate criterion of driver effectiveness is extremely complex. Such diverse factors as accident rates, driving skill, personality traits, and attitudes are undoubtedly parts of this ultimate criterion. However, more information as to the proportion of the ultimate criterion variance attributable to each of these components of driver performance is needed before improved criterion measures can be developed, and the relative validities of specific predictors can be more precisely determined.

Estimating the ultimate usefulness of the predictors reviewed would require knowledge of the reliabilities of these instruments and of the various criteria employed. Unfortunately, reliability data for the tests and criterion measures investigated are not reported in the majority of the studies reviewed.

One conclusion of practical importance may, however, be formulated on the basis of present information. Results obtained with paper and pencil tests and personal history items have compared favorably with those obtained from apparatus tests. In view of the greater cost of constructing mechanical apparatus tests then, it seems reasonable to focus future research on the paper-pencil type instrument.

Also, some specific areas for research are indicated. Several of the studies reviewed involved comparisons of "accident-repeater" and "normal accident" groups. Since individual differences in accident frequency are to be expected in any population on the basis of chance alone, it would be desirable to carry out investigations with groups selected by means of procedures which take such chance factors into consideration.

The need for more rigorously defined criteria of driving performance seems to be great. It would seem most profitable to orient criterion development efforts toward the determination of specific driving behaviors which may be used to define "successful" driving performance.

IV. JOB ANALYSIS

In order to provide a basis for development of tests to replace those of the present Army battery which were judged to be heavily loaded with language and culture factors, a study of the jobs held by Army motor vehicle drivers was conducted. This study was not intended to define the universe of criterion behavior exactly. Rather, it was intended to provide information, beyond that already available, relative to the nature of this behavior universe. Limitation of time and funds precluded setting a more ambitious goal for this job study.

It seemed particularly desirable to obtain information which would aid in identifying those aspects of criterion behavior in which there are significant individual differences. Such information provides a basis for inferring psychological attributes which differentiate between "good" and "poor" Army motor vehicle operators.

Several methods of obtaining job information were utilized. First, to accomplish the objective set forth above, the Critical Incident Technique developed by Flanagan (13,14) was employed. This technique was employed to determine those behavior requirements of the driver's job which are "critical" in that possession or lack of them differentiates between skillful, safe, drivers and those whose performance is unsafe or otherwise unsatisfactory. Information gained from the Critical Incident Technique was supplemented by information obtained from such sources as Army manuals for the selection and training of motor vehicle operators (10,31), direct observation of job performance, personal interviews with Army drivers and driver supervisors, and published descriptions of the duties involved in the Military Occupational Specialties of Army drivers (9).

The objective of the Army driver's job was defined by references to Army publications (10,30,31), and by personal interviews with Transportation Corps officers. This objective was: "To get a vehicle and its load to a given destination safely and on time." Such a definition provided a framework within which it was possible to formulate a series of interview questions designed to elicit reports of driver behaviors which were either effective or ineffective as means of attaining the objective of the driver's job. Such reports were obtained through group interviews with 203 drivers and driver supervisors at four military installations.[2] These interviews yielded 510 usable reports of effective and ineffective driver behavior. An additional 65 reports were found to be irrelevant to the investigation or otherwise inadequate, and were of necessity discarded. These unusable critical incident reports might be attributed to the fact that a sizable proportion of troops interviewed at one installation seemed to be drawn from relatively low social and educational strata. It is quite probable that individual interviews would have been more productive in these cases. However, the limitations previously mentioned precluded any use of techniques which would consume undue amounts of time.

The critical incident reports collected permitted the definition of eight behavior areas encompassing a total of 17 sub-areas of critical behavior. The behavior areas and their definitions are given in Appendix A.

Analysis of job study data collected revealed that the effective Army driver is one who:

1. inspects and carries out operating tests of his vehicle before, during, and after operation, to determine whether it and its parts are in good operating condition, and whether it has been properly serviced;

[2] The installations visited for job study purposes were: Ft. Eustis, Va., Ft. McPherson, Ga., Atlanta General Depot, Atlanta, Ga., and South Park Military Reservation, Pittsburgh, Pa.

2. cleans his vehicle, and services it with fuel, lubricants, coolants, and air for tires, when necessary;

3. makes minor repairs which do not require the attention of a trained mechanic;

4. selects the proper controls and control positions to effect required changes in the operating condition of his vehicle;

5. correctly manipulates and adjusts vehicle controls, alone or in conjunction with one another, to effect given changes in the vehicle's operating condition;

6. supervises vehicle loading done by loading crews, and takes corrective action when vehicle is improperly loaded;

7. when loading crew is not available, loads his vehicle properly by distributing load evenly over vehicle bed, keeping load within vehicle load limits, and secures load by placement and/or lashing;

8. makes emergency repairs and takes special precautions to avoid equipment failures;

9. devises ways and means of getting to his destination safely and on time despite obstacles attributable to weather and road conditions;

10. chooses correct courses of action in situations involving imminent danger to the vehicle and/or himself;

11. learns exact location of destination before leaving, and plans routes to avoid congested traffic conditions, avoiding unfamiliar and questionable routes;

12. anticipates delays and takes precautions to avoid them;

13. observes all civil and military traffic regulations;

14. takes safety precautions not required by civil and military driving regulations;

15. takes precautions to keep himself in condition to function efficiently;

16. takes initiative in getting work done;

17. attends to, and understands, oral, written, or graphic instructions of superiors.

The above-listed description of the effective Army driver provides a basis for inference of psychological traits or attributes which are necessary to

successful job performance. Accordingly, it was hypothesized that the following psychological attributes would be necessary for effective performance as an Army driver:

1. visual acuity
2. ability to perceive, visually, changes in detail
3. mechanical aptitude
4. ability to associate symbols (objects) with concepts of vehicle movement
5. sensori-motor coordination
6. ability to understand instructions
7. practical judgment in driving situations
8. ability to maintain proficiency in emergency situations
9. willingness to accept responsibility
10. knowledge of traffic rules and regulations

Measurement of all except three of the above mentioned attributes is feasible within the scope of the present contract. Examination of the job study data contained in Appendix A and the test rationales in Appendix B readily reveals that ability to maintain proficiency in emergency situations and willingness to accept responsibility are primarily personality variables. The measurement of these variables did not seem feasible within the scope of the present research project inasmuch as language and culture would be important factors in any such measurement. Construction of a test for the measurement of knowledge of traffic rules and regulations was impractical, since such rules and regulations vary considerably from one geographic location to another.

The test development efforts described in the following chapter were conducted within the frame of reference provided by the job study information presented here. Whenever tests of the presently used Army driver selection battery were to be replaced, tests measuring psychological attributes hypothesized to be related to job success were constructed.

V. TEST DEVELOPMENT

Tests of the present Army battery may be divided into three categories. The first group of tests consists of those in which items correspond more or less directly to job activities. The Driving Know-How (PRT 2412) and Emergency Judgment (CRT 87) tests are of this variety. These tests confront the examinee with problems similar to those encountered by motor vehicle operators. Such tests presuppose previous driving experience and are designed principally for selection among applicants who claim such experience.

A second group of tests are those which, while measuring aptitudes and skills hypothesized to be related to successful job performance, do not involve content specific to activities found in the motor vehicle driver's job. The Attention to Detail (PRT 2374), Two-Hand Coordination (PRT 2387), and Word Matching (CRT 207) tests fall into this test category. Tests of this type may be administered to individuals who have had no previous driving experience, and may therefore be used for selection of driver-trainees as well as experienced drivers.

A third category of psychological instruments contained in the Army battery deals with measurement of personal history factors hypothesized to be related to driving performance. The Army Self Description Blank, Transport, (CRT 257) is intended to measure personality variables which might be manifested in personal history factors; i.e., such things as the driver's accident record, general and social adjustment, etc. This instrument presents the examinee with dichotomous statements which he may either accept or reject as descriptive of himself, and with multiple-choice personal history items which require the examinee to mark the statement which is most descriptive of him.

The tests of the Army battery were subjected to a logical analysis of item content in order to estimate the extent to which language and culture factors affect test performance. Two tests stand out as being relatively free from influence by these factors. These are the Attention to Detail and Two-Hand Coordination tests. Neither of these tests requires the subject to make verbal responses or to understand verbal materials other than test instructions.

The Word Matching Test requires the subject to compare test stimuli visually with a standard stimulus and to mark the one test stimulus which is identical to the standard. The stimuli are simple three, four, and five letter English words. The stimulus size is gradually reduced. Two factors seem to be involved here: visual acuity and attention to detail. Each of these seems a necessary, but not sufficient, requirement for visual perception of details or changes in details. It would appear that this test could be given to subjects who do not understand English. They would be required to inspect the letter groupings and compare them with a given standard letter group. The extent to which meaningfulness, brought about by resemblance of English words to words in the examinee's own language, would affect test performance is difficult, if not impossible, to estimate. For this reason, and because it seemed more desirable from the standpoint of prediction by multiple regression techniques to utilize tests which measure the components involved in the Word Matching Test independently, this test was not selected for adaptation.

The Emergency Judgment Test presents the examinee with pictures of hazardous road situations and requires him to select from several verbally presented response alternatives the one response which would be appropriate to a particular road situation. Hence, in order to answer each test item correctly, the examinee is required to visualize each response and its consequences. To revise this test into a non-language form, it was necessary to select for revision those

items which could be presented in pictorial form. The number of items which could be so revised was limited. The information necessary to the solution of some items was such that pictorial representation required illustrating consequences, and hence gave too much information. Further, it seemed advisable to omit from a revised form of this test all items which deal with driving problems peculiar to American culture. This precaution was particularly applicable in the case of items which dealt with such things as traffic laws and regulations.

The Driver-Know-How Test (PRT 2412) involves much the same type of item content as the Emergency Judgment Test. Items of this test deal primarily with non-hazardous driving situations. The problems involved in revision of such a test to non-language form are identical to those encountered in connection with the revision of the Emergency Judgment Test.

The Army Self Description Blank, Transport, (CRT 257) is entirely verbal in nature. The subject matter contained therein seems to be highly cultural. It is difficult to predict what meaning and significance items of this type would have in non-American cultures. It seemed advisable therefore, to focus test development efforts on construction and adaptation of tests of basic aptitudes and skills, which promised greater usefulness in the selection of indigenous drivers in foreign countries.

Test Specifications

Prior to test construction it was decided that all tests constructed should have the following characteristics:

1. Tests sh ld be such that they can be administered through the use of pantomime instructions. The use of verbal test instructions makes it difficult to equate the amount of instructional information given to different language groups. As Biesheuvel (4) has pointed out, this is particularly true when involved phraseology is required to translate test instructions from one language to another.

2. All tests constructed should be amenable to objective scoring.

3. Tests should not require verbal responses by the examinees, nor should they require the examinee to respond to verbal stimuli. It is desirable, in this case, to avoid placing undue emphasis on verbal fluency.

4. Tests should be of the paper and pencil variety. This specification provides for elimination of the difficulties associated with transportation, manufacture, and storage of performance test materials and equipment.

5. It is desirable to avoid, as much as possible, use of test content (other than that involving motor vehicles) which is specific to only one culture.

The general procedure followed in the pantomime directions developed during the present study is for the examiner to show an assistant, by pantomime, what to do. Then, as the subjects watch, the assistant examiner demonstrates the correct procedure by doing practice items. The examinees then do practice items under supervision of the examining staff. Proctors are employed to assist in distributing test materials, seating examinees, and in correcting examinees' performance on practice items. The directions for giving pantomime instructions for tests constructed or revised are included in Appendix C.

Test Revision

Two tests of the present Army battery were revised in such a manner that they could be administered through the use of pantomime instructions to examinees. These were the Attention to Detail (PRT 2374) and Two-Hand Coordination (PRT 2387) tests.

The Revised Attention to Detail Test (CRT 271) is intended to measure visual efficiency while the eyes are moving. The subject is required to locate and count the number of "C's" in a line of "O's". Part I is double-spaced, while Part II is single-spaced. Two minutes are allowed for each part. The arrangement of test parts is the reverse of the one employed in the original form

of the test. This reversal was effected because the double-spaced part is much more suitable for pantomime demonstration purposes, and hence more suitable for the beginning of the test.

The Revised Two-Hand Coordination Test (CRT 284) is intended to measure accuracy of gross hand-arm movements in response to visual stimuli. It consists of three pairs of columns of staggered ½ inch circles connected by lines, on a 16" x 23" sheet of paper. The test sheet has a sheet of carbon paper, carbon side up, fastened to its back. The subject is given a pair of styli, with which he is required to strike within alternate left and right-hand circles as quickly as he can. Each strike leaves a scorable carbon dot on the back of the test sheet. Twenty-five seconds are allowed for each pair of columns.

Test Construction[3]

The test specifications set forth above required that any new tests constructed be of a completely non-language type. This requirement presented no inordinately great problems for the construction of tests of perceptual skills or abilities. Tests of this variety can be built so that the only verbal material necessary is in the test directions. The individual items of tests of this variety can be constructed so as to require no instruction except that given for the test as a whole. Hence, the development of pantomime instructions to convey test directions to examinees was the only major problem in this case.

The construction of tests of judgmental (or problem-solving) abilities, however, presented a rather unique problem. Information about the exact details of the problem involved in each individual test item is required for the solution of that particular problem. In a verbal test this information would be presented

[3] Rationales for all tests constructed may be found in Appendix B.

in the "lead" of each item. The chief test construction problem of the present project was to devise a method of conveying information about the specific problems involved in individual items to the examinee without the use of written or spoken language.

The technique devised consists of the presentation of problem situations to the examinee by means of pictures illustrating a series of "given" and "required" situations or conditions. The examinee is instructed, by pantomime, to look first at the "given" picture and then at the "required" picture. The examinee is then instructed to examine several pictures which are placed between those illustrating the given and required conditions. These pictures illustrate alternative means of effecting a change from the given to the required condition. The examinee is further instructed, by pantomime, to choose and mark that one alternative picture which depicts the correct, or best, course of action in the problem situation involved in each test item.

In view of the fact that the construction of completely non-language tests to measure the problem-solving abilities referred to above required utilization of a new, and hitherto untried, method of presenting test materials, it seemed wise to limit the amount of work devoted to the construction of tests of this type. Thus, the lengths of such tests were kept to a reasonable minimum until a preliminary tryout on a large sample could demonstrate their value. The formidable amount of art work (and hence, time) required for the construction of the new type of pictorial problem-solving items contributed to this decision.

A Mechanical Principles Test (CRT 279) was constructed to measure the subject's ability to understand mechanical relationships, with emphasis on those principles involved in the loading or supervision of the loading of trucks or other vehicles. The test is a three choice picture multiple-choice test. Each item consists of a row of three pictures, two of which depict impossible or

incorrect mechanical relationships and one of which correctly illustrates a mechanical principle. The subject is required to mark the picture which correctly illustrates a mechanical principle.

The Tool Usage Test (CRT 277) is intended as a measure of mechanical aptitude. Each item presents the subject with a mechanical problem requiring the use of tools. This is done through the use of pictures illustrating "given" and "required" situations. In most instances the "given" picture depicts an object which is disassembled or in need of repair or alteration. The "required" picture illustrates the correctly assembled, repaired, or altered object. The subject is required to select, from among four alternatives, the tool, or pair of tools, that should be used to carry out the required mechanical operations.

The Inspection Test, Form A, (CRT 273) is intended to measure ability to perceive changes in detail of complex non-cultural visual stimulus patterns. Each item contains a standard pattern composed of black on white circles, triangles, and squares. At the right of each standard pattern are five additional patterns, only one of which is different from the standard. The subject is required to mark the pattern which is different from the standard.

The Inspection Test, Form B, (CRT 274) is intended to measure the same function measured by Form A. The stimulus figures in this instance are automotive parts or equipment. The task of the examinee is identical to that involved in the Inspection Test, Form A.

The Driver Judgment Test (CRT 280) is a picture multiple-choice test designed to measure ability to choose correct ways to accomplish tasks required of Army drivers. Items deal with such things as vehicle loading, correct driving techniques, and general safety precautions. Each item presents a problem situation to the examinee by means of pictures illustrating "given" and "required" conditions. The "given" picture presents a current situation or condition which is to be

changed to a second condition or situation illustrated by the "required" picture. Three alternative pictures are presented between the "given" and "required" pictures. Two of these illustrate incorrect methods of effecting the change required by the item, while the third depicts the correct method. The subject is required to mark the picture which illustrates the correct method of effecting the required change.

The Driving Concepts Test (CRT 278) is intended to measure intellectual abilities associated with learning to drive a motor vehicle. The psychological activity involved in learning to drive requires the association of objects with their meanings. In this particular case, the objects are vehicle controls and their meanings are reflected in the consequences of their activation or positioning. For example, the learner is required to associate movement of the vehicle in a right-hand direction with turning the steering wheel in that direction. The Driving Concepts Test requires the subject to associate several concepts involved in motor vehicle operation with geometric symbols. The concepts used in the test are "moving slowly", "moving quickly", "stopping", "moving to the right", and "moving to the left". The first three concepts mentioned are represented by a square, a circle, and a triangle respectively. The right-left concepts are represented by black and white symbols respectively.

Each concept is introduced to the examinees by placing beneath the symbols that represents it a column of pictures, each illustrating that concept. The relationship between each concept and its appropriate symbol are explained by pantomime. In this way six columns of pictures are used to illustrate the test concepts. Examinees are given a short series of practice items on which their performance can be checked and corrected by examining personnel.

The test itself is divided into three parts. The items of Part I each consist of one of the pictures used to illustrate the concepts presented in the

instructional items, and four symbols, from which the subject is required to select the one which represents the concept illustrated by the picture. Part I serves as a training section requiring ability of the type required by tests of the "symbol-digit" type. Part II consists of the same type of items used in Part I. However, the pictures used to illustrate the concepts are different from those used in the first part of the test. The subject is thereby required to understand the concepts in order to apply them to the new pictures. Part III presents the subject with items of the same vareity except that the pictorial illustrations of the driving concepts involve motor vehicles. The subject must decide whether the vehicle in each picture is going to the right or the left, and whether it is going slowly, going fast, or stopping, in order to answer the test items. Since the pictures used in Part III provide no definite information as to whether the vehicle depicted is going fast, slow, or is stopping, the examinee's response may be influenced by what he feels should be done in particular situations. To the extent that responses are so influenced, Part III will measure his knowledge of accepted driving procedures in addition to his ability to understand and generalize concepts. It is designed to be administered only to those examinees who have had, or claim to have had, previous driving experience.

VI. RESULTS AND DISCUSSION

When test construction had been completed, it remained to determine the extent to which the experimental battery for the selection of indigenous drivers in foreign countries was equivalent to the present Army driver selection battery. Insofar as the Army battery may be considered a valid predictor of effective performance as an Army driver, the relationship between the experimental tests and this battery provides a tentative index of the ultimate usefulness of the experimental battery. It is recognized that all that can be shown directly by a comparison of the two batteries is the extent to which they measure the same psychological factors. Final evaluation of the experimental battery will be dependent upon future research directed toward the validation of the experimental tests against a criterion of indigenous driver effectiveness.

Test Administration

In order to determine the equivalence of the two batteries, both were administered, in a counterbalanced order, to troops of the Reception Center at Fort Jackson, South Carolina. Tests were administered by Edward H. Loveland and Clifford P. Hahn of the American Institute for Research staff, assisted by six enlisted men of the Eighth Infantry Division. Although 405 men were tested, some were prevented from taking all of the tests by heat sickness, illnesses of other types, and administrative difficulties. Since the use of multiple regression techniques was contemplated, it was desirable to exclude from the statistical analysis performed the test scores of those who did not take all tests. Thus, data on 340 subjects were available for the determination of the relationship between the two batteries.

Subjects were selected in accordance with specifications agreed upon in conference with in-service staff members of the Personnel Research Branch. The variable employed in the selection of subjects was score on Aptitude Area I of the Army Classification Battery. The specifications set forth in the above-mentioned conference required a subject group with a mean Aptitude Area I score between 80 and 90, and a standard deviation of approximately 15. The mean score of the group of 340 subjects used in the determination of the equivalence of the two batteries was 87.8, with a standard deviation of 13.3. Aptitude Area I scores for the total group tested ranged between 59 and 125.

Relationship Between the Army and Experimental Batteries

The tests of the experimental battery may, for the purpose of discussion, be divided into three groups. The first group consists of those tests of the present Army battery which were revised so that they could be administered through the use of pantomime instructions. The Two-Hand Coordination Test and the Attention to Detail Test make up this group. The extent to which these tests measured the same psychological factors before and after revision can be inferred from the correlations between the original and the revised forms of the two tests. Examination of the data contained in tables D-1 and D-2, which are included in Appendix D, reveals relatively high correlations between the revised and unrevised forms of these tests. In the case of the Attention to Detail Test, the correlations computed from data obtained from two subject groups are .65 and .67. The correlations between the revised and unrevised forms of the Two-Hand Coordination Test are .67 and .64 for the two subject groups. Lauer (23) estimated the test-retest reliability of this test to be .63. Taking this reliability into consideration, the obtained relationship between the verbally administered form and the form administered by pantomime is quite high.

The Driver Judgment Test belongs in a second category of tests. As indicated earlier in this report, only a very few of the items contained in the Driver Know-How and Emergency Judgment tests could be revised to non-language form. The job study conducted clearly indicated the need for a test to measure the subject's ability to solve problems involved in driving a motor vehicle. The Driver Judgment Test represents an attempt to measure this factor by completely non-language means. While the items contained in this test are similar in nature to those of the Emergency Judgment and Driver Know-How Tests, they do not require the examinee to read, or otherwise work with, verbal material. To the extent that the verbal factor is removed from the newly developed test, one can expect the correlation between it and the two previously mentioned tests of the Army battery to be lowered. Items contained in the Driver Judgment Test were based on reports of effective and ineffective driver performance gathered during the job study, and on information provided by Army Technical Manuals (10,31). The relationships between this test and the Driver Know-How (.38 and .30) and Emergency Judgment (.37 and .38) tests are substantial, although understandably lower than the two tests of the first group for which only the test directions were revised.

A third category of tests in the experimental battery is made up of those tests which were constructed primarily on the basis of the study of the Army driver's job. These tests included the Driving Concepts Test, Mechanical Principles Test, Tool Usage Test, and the two Inspection Tests. There are no tests in the present Army battery which can be considered analogous to these instruments. All of these tests, with the exception of the Tool Usage Test, show substantial relationships to tests of the Army battery, however.

Perhaps the most meaningful comparison of the Army and experimental tests that can be made involves an examination of the relationship between the two batteries. This relationship will indicate the extent to which the batteries measure the same psychological factors, and hence, provide an estimate of their "equivalence".

Two methods of estimating the relationship between the two batteries were employed. First, the correlation between the Army battery composite score and the tests of the experimental battery was computed. A "cross-validation" technique, which utilized data from two groups of subjects, was employed so that the obtained correlations would not be spuriously increased by peculiarities of the particular groups of subjects tested.[4] The two estimates of the correlation between the two batteries obtained in this manner were .68 and .66. Second, the correlation between composite scores on the two batteries, when the tests of each battery were given unit weights, was computed. This statistic was .62 and .69 for the two subject groups.

Both sets of correlations between the Army and experimental batteries were substantial. The batteries may therefore be said to be measuring largely the same factors. However, it is advisable to consider the question as to how highly the two batteries should correlate. In order to examine this question in more detail, let us consider two limiting cases. First, if there were no relationship between the two batteries (r = .00), one could expect the experimental tests to predict only those aspects of a criterion of driving performance which are independent of the present Army criterion of driver effectiveness. It is highly unlikely that there are many aspects of driver performance which are not related to the Army criterion in some way. Hence, a correlation between the two batteries approaching zero would not be desirable. Second, if the relationship between the two batteries were perfect (r = 1.00), we could expect that, since the two batteries were measuring exactly the same thing, the experimental battery would measure the same proportions of the same factors measured by the Army battery. The correlation between the Army criterion of driver effectiveness and the Army

[4] This cross-validation technique is described in Appendix D.

driver selection battery is .38. While this is a substantial relationship, it leaves most of the criterion to be predicted by other measures. The newly constructed tests were designed to predict not only those aspects of successful driving performance predicted by the Army battery, but other aspects which were defined by a study of the Army driver's job. While one would therefore expect a substantial correlation between a composite of these experimental tests and the tests of the Army battery, this correlation could not be expected to approach unity since the experimental tests were designed to measure something in addition to the factors measured by the Army battery. On the basis of this reasoning, it seems clear that the correlations obtained between the two batteries fall within a range that is optimum in terms of the desired relationship between the two batteries.

In accordance with the wishes of Transportation Corps officers, several batteries were assembled for selection among applicants from different cultural levels. The composition of these batteries was discussed in conferences with officers of the Transportation Research and Development Station. First, a "basic battery" to be used in primitive cultures, where literacy or even minimum acquaintance with tools and mechanized vehicles cannot be assumed, was assembled. This battery, hereafter referred to as "Battery A", is as indicated in Figure 1.

Test	Army Designation	Testing Time
Revised Attention to Detail	CRT 271	10 min.
Revised Two-Hand Coordination	CRT 264	10 min.
Inspection, Form A	CRT 273	20 min.

Figure 1. Composition of Experimental Battery "A".

The total testing time, including time required for giving pantomime instructions, is forty minutes. For the two subject groups employed, the average correlation between a composite of these three tests and a composite of the six tests of the present Army battery is .57.

A second battery which we will refer to as "Battery B", was assembled for selection among applicants with a cultural level such that they could be assumed to be familiar with, and perhaps be able to use, mechanical and vehicular equipment. This battery would consist of the tests listed in Figure 2.

Test	Army Designation	Testing Time
Driving Concepts I,II,III*	CRT 278	20 min.
Driver Judgment*	CRT 280	13 min.
Revised Two-Hand Coordination	CRT 284	10 min.
Inspection, Form B	CRT 274	15 min.
Revised Attention to Detail	CRT 271	10 min.
Mechanical Principles	CRT 279	12 min.

Figure 2. Composition of Experimental Battery "B".

* The Driver Judgment Test and Part III of the Driving Concepts Test would be administered only to those applicants who claim previous driving experience.

The total testing time for this battery, including time required for giving test directions, is one hour and twenty minutes. The average correlation between a composite score on this group of tests and a similar composite of the six tests of the Army battery is .64.

It would also be desirable to have a third battery for use with applicants whose cultural level is somewhere between that of the two groups just mentioned. This group might well be more heterogeneous than the other two groups, in that some of the people contained therein would be only slightly above the "primitive" level, while others might have some knowledge of mechanical and vehicular equipment. For this type of applicant group, "Battery C", outlined in Figure 3, is proposed.

Test	Army Designation	Testing Time
Revised Two-Hand Coordination	CRT 284	10 min.
Inspection, Form A	CRT 273	20 min.
Driving Concepts I,II,III	CRT 278	20 min.
Mechanical Principles	CRT 279	12 min.
Revised Attention to Detail	CRT 271	10 min.

Figure 3. Composition of Experimental Battery "C".

This battery may be administered in one hour and twelve minutes. The average correlation between composite score on the five tests named in Figure 3 and the six tests of the Army battery is .65.

The Army tests are, at present, divided into two sub-batteries for operational purposes. Battery I, given at the reception center, consists of the Attention to Detail and Driver Know-How tests, and the Army Self Description Blank, Transport. Battery II, given at the operating installation consists of the Word Matching, Two-Hand Coordination, and Emergency Judgment tests. It would be interesting to examine the correlations between composite score on each of the three batteries proposed for use with different cultural groups and the two sub-batteries of Army tests. These are given in Table 1 below.

Table 1

Average Correlations Between Composite Scores on Army and Experimental Batteries*

	Army Battery I	Army Battery II	Complete Army Battery
Battery A	.44	.57	.57
Battery B	.56	.62	.64
Battery C	.53	.63	.65
Total Experimental Battery	.53	.63	.66

* Computed through use of Fisher's Z transformation, from the correlations obtained from Group A and Group B. The original correlations, obtained from the two samples, are given in Table D-5, which may be found in Appendix D.

Principles for the Construction of Completely Non-Language Tests

A second result of research conducted under the present contract was the formulation of some principles for the construction of completely non-language tests. This information should facilitate future test development efforts of this kind.

The problems involved in construction of new tests centered about the presentation of information to the subject without the use of written or spoken language. As in the case of any test, the examinee must be supplied with sufficient information to permit understanding of both the general test task (e.g., whatever is to be done to the test as a whole and to all of the items in it) and the specific details of the task (or problem) involved in each individual test item. It is important to ensure that information provided does not contain, or otherwise reveal, the correct answers to problems presented in individual test items. Further, information must be presented in an unambiguous fashion. These problems, which are commonplace to the constructor of tests to be administered by means of verbal instructions, achieve increased importance and complexity in the construction of completely non-language tests.

In the development of tests of perceptual skills or abilities, the construction of completely non-language items constitutes much less a problem than the construction of such items for tests of judgmental, or problem-solving, abilities. In the former type of test, items may consist of symbols, geometric forms, or simple pictures. The general test task usually requires the subject to perceive differences, similarities, or the presence or absence of details. Ordinarily, test items would be presented in the same manner for both language and non-language test administration. The problems presented by individual items are highly similar to the general test task. That is, the amount of additional information that must be provided for each individual test item is relatively small.

The test of judgmental ability, like the perceptual test, requires the presentation of information about the exact nature of the general test task. However, while this general test task may be adequately explained by pantomime, the specific problem involved in each item requires transfer of additional information to the examinee. Since spoken or written language cannot be used in a completely non-language test, the exact nature of this specific problem must be evident to the examinee from perusal of the item itself. In the tests constructed for this project, pictorial representation was used to convey necessary information about specific problems involved in individual test-items to the subject. Problem situations were presented to the examinee by means of pictures illustrating a series of "given" and "required" situations or conditions. The examinee was instructed, by pantomime, to look first at the "given" picture and then at the "required" picture. The subject is then instructed (by pantomime) to examine several pictures which are placed between those illustrating the given and required conditions. These pictures illustrate alternative means of effecting a change from the given to the required situation. The examinee is further instructed, again by pantomime, to choose and mark that one alternative picture which depicts the correct, or best, course of action in the problem situation involved in each test item.

The pictorial item types developed are new. Consequently, some of the factors which make for complete and unambiguous transfer of required information to the examinee remain to be discovered. However, as a result of test development efforts conducted within the present project it is possible to formulate the following tentative rules for the construction of pictorial items for completely non-language tests.

1. Visual cues as to relative sizes of objects involved in pictorially presented problems should be sufficient to prevent misinterpretation of item content.

Example: If a broken chain is to be repaired, the size of the chain will, to some extent, determine the tools which should be used to effect repairs. This would be of utmost importance in a tool usage test.

2. Visual cues as to the material from which pictured objects are made should be sufficient to prevent misinterpretation. It might even be advisable to call attention to these cues when giving test directions, if differences in the materials from which objects are made may affect the subjects' interpretation of test items.

   Example: Whether a solid rod is made of wood or steel is an important consideration in deciding how it may be smoothed or cut.

3. If "before" and "after", or "given" and "required", pictures are to be used to define a problem situation, the connection between (and sequence of) the two pictures should be clearly indicated by such cues as similarities in the nature and arrangement of objects contained therein. The factors that vary from one picture to the other should contribute to the examinee's understanding of the problem presented by the test item.

   Example: Consider an item which, in effect, requires the examinee to identify the correct method of separating two automobiles which have locked bumpers. The "given" and "required" pictures would show the vehicles with locked and unlocked bumpers. It is imperative not only that the vehicles in the two pictures be clearly the same, but also that the alternative pictures (methods of separating the autos) be such that they may easily be perceived as representing a transition from the "given" to the "required" situation.

4. Orientation cues, such as linear perspective, interposition of objects, shading, etc., should be employed to clarify the arrangement of objects or persons in a pictorially presented problem situation.

   Example: Consider an item which is supposed to test the examinee's knowledge of the correct way to park a motor vehicle on a hill. One detail which is important in determining the correct answer to such a problem is whether the vehicle is facing up or down hill. It is of utmost importance that the slope of the hill, and the positioning of the truck on it, be made clear to the subject.

5. A premium should not be placed upon visual acuity. The subject should be easily able to discern details necessary for definition of a problem situation.

   Example: If an item is designed to test ability to choose the correct tool for threading a drilled hole, the holes illustrated in the "given" and "required" pictures, (and the threads in the "required" picture) should be large enough to ensure that all individuals to whom the item will be administered will be able to discern the essential difference between the "given" and "required" pictures.

6. Test reproduction should be of sufficiently high quality to ensure that defects in reproduction will not cause the examinee to misinterpret test items.

Example: Consider a test item designed to measure ability to perceive damage to or difference between mechanical parts. If a test of this type is reproduced by the Multilith process, it is possible that lint may accumulate on the offset plate, causing breaks in, or spots on, mechanical parts illustrated. Such reproduction flaws may easily be interpreted by the subject as a defect in the part illustrated.

VII. CONCLUSIONS

A battery of eight completely non-language predictors of effective indigenous driver performance was developed. These tests were administered, along with the six tests of the Army driver selection battery, to United States troops at Fort Jackson, South Carolina. The relationship between the experimental battery and the Army battery was used as a tentative index of the ultimate usefulness of the experimental battery. Several conclusions may be drawn from the research carried out. These are:

1. The feasibility of constructing psychological tests which measure a variety of abilities and do not require the examinee to respond to, or otherwise work with, written or spoken language, was clearly demonstrated.
2. The completely non-language problem-solving test of the type represented by the Driver Judgment Test provides a useful and novel method for testing not only persons who cannot understand the language of the test administrator, but also persons who are illiterate. The principles formulated for the construction of such tests should be of considerable value in future test construction efforts of this kind.
3. The operational practicability of the non-language tests developed under this contract was indicated by the fact that the tests were successfully administered to two groups of twenty subjects by two enlisted men who received relatively brief training.
4. The relationship between the battery developed for the selection of foreign drivers and the present Army driver selection battery was found to be within a desirable range. This relationship is high enough to justify the conclusion that insofar as the present Army battery may be

considered a valid predictor of driver effectiveness, the experimental battery shows promise of ultimate usefulness as a predictor of indigenous driver performance. This conclusion is strengthened by the fact that the new tests constructed for this project were based in large measure upon a study of the Army driver's job.

5. The fact that the three sub-batteries proposed for use with different cultural groups correlate significantly and appreciably with the two sub-batteries of Army tests, and with the complete Army battery, suggests that these sub-batteries, like the total battery, will be useful for selection among foreign applicants for jobs as motor vehicle drivers. Selection of tests for the three experimental batteries was based primarily upon suggestions of Transportation Research and Development Station officials.

6. While the experimental battery, as presently constituted, shows promise of ultimate usefulness, final evaluation of the battery must await validation against a criterion of indigenous driver effectiveness. Officials of the Transportation Research and Development Station have recommended that the tests be given a field tryout, for validation purposes, in one or more of several overseas theaters. Success in driver training was recommended as a possible criterion for validation purposes.

BIBLIOGRAPHY

1. Adjutant General's Office. Personnel Research in the Army, VI. The Selection of Truck Drivers. Psychol. Bull., 1943, 40, 499-508.

2. Allgaier, E. Experience Counts. Publ. Safety, 1939, 15, No. 6, 21.

3. Bartelme, Phyllis R., Fletcher, Edwin D., Brown, Clarence W., and Ghiselli, Edwin E. The Prediction of Driving Skill. J. Appl. Psychol., 1951, 35, 98-100.

4. Biesheuvel, S. Psychological Tests and Their Application to Non-European Peoples. The Yearbook of Education, Evans Brothers, Ltd., London, 1949.

5. Bransford, T. L. Relation of Performance on Driver's Tests to Automobile Accidents and Violations of Traffic Regulations in the District of Columbia, Ph.D.Dissertation, American University, Washington, D. C., 1939.

6. Brody, L. Personal Factors in Safe Operation of Motor Vehicles. Center for Safety Education, New York University, 1941.

7. Cleeton, G. U. Measuring Susceptibility to Accidents in Street Car Operators. Studies in the Psychology of Vocational Adjustment: Miscellaneous Papers, Pittsburgh, Pa., Carnegie Institute of Technology, 1940.

8. Cobb, P. Automobile Driver Tests Administered to 3,663 Persons in Connecticut, 1936-37 and the Relation of Test Scores to the Accidents Sustained. Unpubl. Report to Highway Res. Bd., Washington, D. C., July, 1939.

9. Department of the Army, Special Regulations. Military Occupational Specialties. SR-615-25-15. Washington, D. C.: U. S. Government Printing Office, 1950.

10. Department of the Army, Technical Manual. Driver Selection and Training. TM 21-300. Washington, D. C.: U. S. Government Printing Office, 1951.

11. DeSilva, H. R. Normal Versus Accident Drivers. J. Psychol., 1939, 7, 337-342.

12. _____, Robinson, P., and Forbes, T. W. Some Psychological Factors in Accident-Repeater Drivers. J. Abnorm. Soc. Psychol., 1939, 34, 124-128.

13. Flanagan, John C. Job Requirements. In Current Trends in Psychology. Pittsburgh: University of Pittsburgh Press, 1949, 32-54.

14. _____, et al. Critical Requirements of Research Personnel: A Study of Observed Behaviors of Personnel in Research Laboratories. Pittsburgh: American Institute for Research, March 1949.

15. _____. Important Equations Relating to Multiple Correlation. Unpubl. Paper, University of Pittsburgh, 1952.

16. Forbes, T. W. Age Performance Relationships Among Accident-Repeater Automobile Drivers. J. Consult. Psychol., 1938, 2, 143-148.

17. Ghiselli, E. E., and Brown, C. W. Factors Related to the Proficiency of Motor Coach Operators. J. Appl. Psychol., 1947, 31, 477-479.

18. _____ and _____. The Prediction of Accidents of Taxicab Drivers. J. Appl. Psychol., 1949, 33, 540-546.

19. Goldstein, L. G., Van Steenberg, N. J., and Birnbaum, A. H. Evaluation of Instruments to Select Safe Drivers. PRS Report 962, TAGO, 1952.

20. Johnson, L., and Evans, J. E. The Determination of Characteristics Involved in the Ability to Drive an Automobile with Emphasis on the Reactions of the Drivers. Iowa State College J. of Science, 1938, 12, 415-440.

21. Kraft, M. A., and Forbes, T. W. Evaluating the Influences of Personal Characteristics. Proc. Highway Res. Bd., 1944, 24, 278-291.

22. Lauer, A. R. Tests of Motor Vehicle Drivers and the Relation of the Test Scores to the Officially Recorded Accidents Sustained. Unpublished Report to Highway Research Board, Washington, D. C., 1939. (Microfilm)

23. _____. Aptitude Tests for Army Motor Vehicle Operators. PRS Report 981, TAGO, 1952.

24. Mintz, A., and Blum, M. Accident Proneness is Overrated. Paper read before the Eastern Psychological Association, Philadelphia, Pa., 1948.

25. Mosier, Charles I. Symposium: The Need and Means of Cross-Validation I. Problems and Designs of Cross-Validations. Educational and Psychological Measurement, 1951, 11, 5-11.

26. Ruch, F. L., and Wilson, C. A New System for Selecting Safe Drivers. Comm. Car. J., 1948, 76, No. 2, 66-68.

27. Thorndike, Robert L. The Human Factor in Accidents. Project Number 21-30-001, Report No. 1, USAF School of Aviation Medicine, Randolph Field, Texas, February, 1951.

28. Uhlaner, J. E., Van Steenberg, N. J., and Goldstein, L. G. The Development of Criteria of Safe Driving for the Individual. PRS Report 935, TAGO, 1952.

29. Waits, J. V. The Use of the American Transit Motor Ability Test in the Selection of Bus and Streetcar Operators. Proc. of the 26th Annual Meeting of the Highway Research Board. 1947, 340-353.

30. War Department, Basic Field Manual. Motor Transport. FM 25-10. Washington, D.C.: U. S. Government Printing Office, 1942.

31. War Department, Technical Manual. Driver's Manual. TM 21-305. Washington, D.C.: U. S. Government Printing Office, 1944.

32. Weiss, A. P., and Lauer, A. R., et al. Psychological Principles in Automobile Driving. Ohio State University Stud., Contributions to Psychology, 1930, 11, 1-165.

APPENDIX A

Summary of the Critical Behaviors of Army Drivers

A. Selection of Proper Controls and Control Positions

Choice of the correct control or control position to effect a given change in the operating condition of the vehicle.

B. Adjustment of Vehicle Controls

Manipulation of gear shift lever, clutch, brakes, accelerator, steering wheel, and other vehicle controls, alone, or in conjunction with other controls, to effect changes in the operating condition of the vehicle.

III. Loading Vehicle

Definition

This area concerns the loading or supervision of the loading of the vehicle. This includes seeing that materials and equipment placed in the vehicle are properly distributed and secured by either placement or lashing; taking corrective action when vehicle is loaded improperly; checking security of load en route to destination; checking to see that vehicle is not overloaded.

A. Supervision and Checking Loading Done by Loading Crews

Seeing that loading crews do not overload vehicle; checking to see that load is evenly distributed and properly secured; taking corrective action when vehicle is improperly loaded.

B. Loading Vehicle and Securing Cargo

Distributing load evenly over bed of vehicle; keeping load within vehicle load limits; securing load by placement and/or lashing to prevent shifting.

IV. Problem Solving

Definition

This area concerns the solution of practical problems which arise in the course of the driver's work. It involves devising ways and means of getting to a destination in spite of obstacles attributable to weather, road conditions, and equipment failures. This includes making emergency repairs; taking special precautions to prevent equipment failures attributable to weather conditions and solving procedural problems involving the choice of a correct course of action in situations not involving equipment failures.

A. Solving Mechanical Problems

Making emergency repairs and taking special precautions to avoid equipment failures attributable to weather conditions. This area does not include behaviors which are included in the first echelon maintenance duties of the driver; but instead involves solution of novel mechanical problems.

B. Solving Procedural Problems

Devising ways and means of getting to a destination in spite of obstacles attributable to weather, road conditions, and equipment failures. This includes dealing with difficult driving situations, and making sound procedural decisions. It does not include making emergency repairs or solution of problems under emergency conditions.

C. Solving Procedural Problems in Emergency Situations

Solving problems involving the choice of a correct course of action in situations involving imminent danger to the vehicle and/or the driver.

V. Planning Ahead

Definition

This area concerns the planning of job behavior in terms of expected or possible future events. It includes taking precautions for delivery of the vehicle and its load to the destination at the proper time; anticipating possible difficulties and preparing means of dealing with them. It involves planning routes to avoid congested traffic areas, and taking whatever precautions are necessary to avoid getting lost.

A. Planning Trip

Planning routes to avoid congested traffic conditions; taking precautions to learn the exact location of destination; avoiding unfamiliar and questionable routes.

B. Anticipating Difficulties

Anticipating possible delays en route and making preparations to avoid them; arranging to have vehicle loaded well in advance of departure time; leaving early to allow for delays.

VI. Taking Safety Precautions

Definition

This area involves obedience of traffic regulations and attention to environmental conditions and adjustment of driving behavior in terms of these conditions.

A. Conforming to Traffic Regulations

Observing all civil and military traffic regulations.

B. Adjusting Driving Behavior to Environmental Conditions

Taking safety precautions not required by civil or military driving regulations by adjusting driving behavior in terms of environmental conditions.

VII. Accepting Responsibility

Definition

This area includes those behaviors which demonstrate the driver's acceptance of his share of the work of his organization. It includes taking the initiative and getting the work of the organization done, doing extra work when a need arises, maintaining driving schedules, and reporting for duty at the proper time and place. It also includes those behaviors related to the driver's efforts to maintain his own physical effectiveness.

A. Maintaining Physical Effectiveness

Taking precautions to keep himself in condition to function efficiently.

B. Performance of Duty

Taking the initiative in getting work done; doing extra work when the need arises; maintaining driving schedules; reporting for duty at the proper time and place.

VIII. Attending to and Understanding Instructions

Definition

This area involves attention to, comprehension and execution of oral, written, or graphic instructions of superiors.

APPENDIX B

Test Rationales

TEST RATIONALE

Behavior Unit: Inspecting vehicle

Definition of Job Element Involved:

This element concerns the ability of the subject to inspect a vehicle visually for the purpose of locating damaged or loose parts, and for the purpose of ascertaining whether it has adequate amounts of fuel, lubricants, coolants, hydraulic fluids, and air pressure for brakes and/or tires.

This element DOES NOT INCLUDE the ability to make repairs.

Job Context in Which This Element Occurs:

The behavior involved in this element occurs during regular first echelon maintenance of the driver's vehicle. Before, during, and after each trip, the driver is required to inspect his vehicle in the manner described above. At these times, the driver must also inspect the vehicle to see whether all lug bolts are tight, whether ignition wires are securely fastened to the correct terminals, whether the vehicle contains the proper tools and equipment, and whether fuel, oil, coolant, and hydraulic lines are free from leaks. In general, the driver is required to inspect the vehicle to determine whether parts are missing, whether inappropriate vehicle parts have been used, whether vehicle parts have been changed in shape or otherwise deformed, whether vehicle parts are correctly arranged with respect to the vehicle as a whole and with respect to other vehicle parts, and whether vehicle parts have been broken.

Psychological Aspects of This Element:

The psychological activity involved in this element requires attention to, and visual perception of, the presence or absence of conditions or details, or changes in conditions or details of automotive equipment.

Appropriate Test:

The psychological functions involved in this element are probably measured in part by the Attention to Detail Test presently used by the Adjutant General's Office. It seems advisable, however, to develop an "Attention to Detail Test" which involves actual inspection of a variety of complex forms or objects. An "inspection" test is proposed for this purpose. This test should be a non-verbal multiple-choice test. A figure should be presented at the left of each line. At the right of each figure should be a series of similar figures, only one of which will be different from the given figure. The task of the examinee should be to indicate (or mark) the figure which is different from the one given at the left of each item.

It would seem logical to hypothesize that test items should be as much like inspections performed on the job as possible, both with respect to the nature of their content, and the nature of the tasks required of the examinee. This hypothesis might be tested by including in the experimental form of the test a group of items which, while requiring the examinee to select a figure different from a given figure, would not be based upon actual inspections performed on the job. The two sets of items could then be compared on the basis of item-criterion and inter-item correlations.

TEST RATIONALE

Behavior Unit: Solving procedural problems

Definition of Job Element Involved:

This element concerns the individual's ability to arrive at sound solutions to current problems which arise in the course of the driver's job. It involves choosing a correct course of action when faced with an obstacle to continued progress toward a destination. It also involves making sound procedural decisions where no barrier to continued progress exists. This requires a knowledge of correct driving techniques.

This element DOES NOT INCLUDE the ability to solve mechanical problems or to make emergency repairs. It DOES NOT INCLUDE the ability to solve procedural problems in emergency situations.

Job Context in Which This Element Occurs:

When blocked by soft sand or marshy ground which cannot be easily circumnavigated, the driver must either devise a means of crossing the soft terrain or be prevented from getting his vehicle to his destination. One effective solution to problems of this sort involves the use of the winch with which some vehicles are equipped. The winch cable is secured to an immovable object on the other side of the soft ground. Engine power is then used to re-wind the cable and thereby pull the truck across the soft ground. In a situation such as the one described, the driver must consider the applicability of such alternative behaviors as attempting to drive across the soft ground, winching the truck across, using the driving wheels in addition to the winch, or detouring to another route.

Psychological Aspects of This Job Element:

The psychological activity involved in this element involves the consideration and evaluation of different solutions to procedural problems in the light of past experience and training. It also involves devising solutions to entirely novel procedural problems. The psychological functions involved here are probably part of what is generally termed intelligence, applied to particular situations involved in driving.

Appropriate Test:

A test of this function should be designed to be given to persons who have had driving experience. The present Driving Know-How Test probably measures the psychological functions involved in this job element. The problem of devising a test for this element then reduces to developing a test which may be administered without the use of language, if necessary, to people from various geographic areas, who claim driving experience. The approach which seems most promising is to construct a picture multiple-choice test containing items of the variety found in the Army Driving Know-How Test. Such a test could be administered through the use of pantomime instructions. One cultural factor

which, at first, would seem to complicate the test construction problem is the side of the road on which driving is permitted. It is possible, however, to construct alternate forms of a test of this type for areas in which driving is on either the right or left side of the road. Only one form is proposed for the experimental battery.

The test should contain items of the following type:

The "lead" would be in the form of two pictures, one at the left, and one at the right of each item. The picture at the left would depict an existing situation (what the driver or the vehicle is doing). The picture at the right would depict a desired future situation (what the driver or vehicle is supposed to do). Between the two "lead" pictures should be three pictures depicting three alternative courses of action, only one of which would be the correct way of moving from the existing situation to the desired one.

Example:

Picture of truck with flat tire	man fixing flat with truck half in slow lane, half on shoulder	same, truck parked in slow lane	same, truck completely on shoulder	truck traveling along, flat fixed

TEST RATIONALE

Behavior Unit: Solving procedural problems in emergency situations

Definition of Job Element Involved:

This element concerns the individual's ability to choose a correct course of action in situations involving imminent danger to the vehicle and/or himself. The critical aspect of this element is the emergency situation in which the behavior takes place. The behaviors included in this element could well be included in other elements if removed from the emergency context in which they occur. This element DOES NOT INCLUDE the ability to solve procedural problems in non-emergency situations.

Job Context in Which This Element Occurs:

The behavior involved in this element is required at irregular intervals. This is, of course, an artifact of its nature. It is necessary for a driver to solve procedural problems which occur in emergency situations without allowing the emotional stress which usually accompanies such situations to interfere with the speed or adequacy of his behavior. An example of effective behavior in an emergency situation can be seen in the case of the driver who turned a runaway truck on to a sandy beach so that the soft sand would assist in slowing the vehicle's movement.

Psychological Aspects of This Element:

The psychological activity involved in this element is more dependent upon personality variables than upon aptitude for solving problems. Specifically, it involves the ability of the individual to maintain proficiency in a situation involving danger to himself and/or his vehicle.

Appropriate Test:

Measurement of the psychological factors involved in this element does not seem feasible within the scope of the present research project. One of the major problems involved in such measurement is that of approximating an actual emergency situation. Since the emergency context in which job behavior occurs is the critical aspect of this element, the extent to which measurement of the factors involved is feasible will be limited by the degree to which the test situation appears as a real emergency to the examinee. Further, language and culture would be important factors in any measurement of the personality variables involved in this element.

TEST RATIONALE

Behavior Unit: Solving mechanical problems

Definition of Job Element Involved:

This element concerns the ability of the individual to make emergency repairs and to take special precautions to avoid equipment failures.

Job Context in Which This Element Occurs:

If, en route to his destination, a driver's vehicle breaks down, he must either call for assistance or repair his vehicle. The latter course of action is not required in cases involving second or higher echelon repairs. There are instances, however, when assistance is not readily available. In these cases the driver who is able to make emergency repairs is the one who gets his load to his destination safely and on time. One example of this behavior is seen in the case of the driver who removed a bent rear drive shaft, transferred power to his front wheels, and continued on to his destination using front wheel drive. Another example is seen in the case of the driver who improvised a substitute for brake fluid when his fluid supply was lost. A third example is provided by one driver who rigged a set of dual wheels equipped with chains to the front end of his vehicle in order to provide increased traction in snow.

Psychological Aspects of This Element:

One of the factors involved in this element is the ability of the individual to devise ways of putting damaged equipment, or equipment which is otherwise mechanically non-operational, in operating condition. A second factor involved is the ability to understand mechanical relationships and to diagnose troubles which involve these relationships. These factors are included in what is commonly termed "Mechanical Ability".

Appropriate Test:

A paper and pencil test is proposed for the measurement of the function involved in this element. This test will consist of items in which a pictorial representation of an unassembled, unrepaired, or unfinished object is presented, along with a representation of the assembled, repaired, or finished object. The task of the examinee is to select, from among several alternatives, the correct tool or tools to effect the required changes in the object in question. The item format would be as follows:

picture of object or parts of object in unrepaired, unfinished or unassembled condition	pictures of tools or pairs of tools	picture of object in finished, repaired, or assembled condition.

Directions for this test could be given by pantomime. It seems reasonable to hypothesize a relatively high degree of relationship between ability to choose the correct tools for the performance of a mechanical task of an automotive nature and the ability to do the same thing for the performance of mechanical tasks of a non-automotive nature. Items involving situations of the latter type would be of considerable importance for the evaluation of subjects with little or no automotive background. The Mechanical Principles Test, described elsewhere, may also be applicable to this job element.

This test would also be applicable to job behaviors involved in making minor repairs.

TEST RATIONALE

Behavior Unit: Loading and securing cargo

Definition of Job Element Involved:

This element concerns the ability of the driver to distribute cargo evenly over a vehicle bed, to restrict the weight of materials or personnel loaded to vehicle load limits, and to secure cargo by placement and by lashing to prevent shifting.

Job Context in Which This Element Occurs:

Ordinarily, Army drivers are only required to supervise loading done by work crews. On infrequent occasions, however, drivers are required to load or reload their own vehicles. In such instances the driver must place his cargo so that it will not be damaged or lost. This requires that heavy objects be placed at the bottom of the load, that weight be evenly distributed and not in excess of load limits of vehicle, and that cargo be lashed with rope secured by appropriate knots.

Psychological Aspects of This Element:

The psychological activity involved in this element requires application of a limited number of physical principles to the loading of a motor vehicle. Such concepts as center of gravity, moments, inertia, centrifugal and centripetal force, must be utilized in correctly placing cargo. It is not necessary, however, for the subject to recognize the physical principles by name.

Appropriate Test:

A non-language paper and pencil test is proposed for the measurement of the factors involved in this job element. This test should require the subject to demonstrate understanding of the mechanical principles involved in the loading and securing of cargo. Each item could consist of a row of pictures, only one of which correctly illustrates a mechanical principle. All other pictures would illustrate incorrect or impossible mechanical relationships. The subject would be required to mark the picture which correctly illustrates the mechanical principle involved in a given test item.

A test of this variety may be of some use in predicting successful performance of other job elements which involve mechanical factors.

TEST RATIONALE

Behavior Unit: Supervising and checking loading done by loading crews

Definition of Job Element Involved:

This element involves seeing that loading crews do not overload a vehicle, checking to see that cargo is evenly distributed and properly secured, and initiating corrective action when a vehicle is improperly loaded. This element DOES NOT INCLUDE loading vehicles and securing cargo.

Job Context in Which This Element Occurs:

Ordinarily an Army vehicle is loaded by a loading crew. The driver is required to supervise the loading process. In the event that the vehicle is improperly loaded, the driver must initiate corrective action by directing the attention of the loading crew or their superior to the fact.

Psychological Aspects of This Job Element:

The psychological factors involved in this element include the willingness of the driver to supervise the loading process and to insist upon corrective action on the part of the loading crew. These are not skill or aptitude variables, but are instead personality variables.

Appropriate Test:

It does not seem feasible to measure the personality factors involved in this job element with non-language instruments. The ability factors involved in this job element are to be measured by the Mechanical Principles Test referred to elsewhere.

TEST RATIONALE

Behavior Unit: Selecting proper controls and control positions

Definition of Job Element Involved:

This element involves selection of the correct control or control position to effect a given change in the operating condition of a motor vehicle. This involves a knowledge of the location of particular controls. It also involves knowledge of what happens when a particular pedal, switch, or lever is activated, or when a particular control is placed in a given position.

This element DOES NOT INCLUDE the ability to manipulate or adjust vehicle controls. It DOES NOT INCLUDE the choice of a correct course of action in a problem situation, but instead occurs only after such a choice has occurred.

Job Context in Which This Element Occurs:

The behavior involved in this element occurs repeatedly during the operation of a motor vehicle. The driver, having determined what changes are to be made in the operating condition of the vehicle, is required to select a control or control position, or a series of controls and control positions, which will effect the desired changes. An example can be found in starting of the vehicle's engine, which requires the operator to select and locate such controls as the ignition switch, the throttle, the clutch pedal, and the starter button. The course of action in this case is prescribed in standard operating procedures for the vehicle. The problem involved for the operator is the identification of the correct controls and control position (e.g.: "ON" position of the ignition switch must be located and the consequences of such positioning understood).

Psychological Aspects of This Job Element:

This element is probably of greater importance in driver-trainee performance than in the performance of experienced drivers. The psychological activity involved in this element involves the association of objects with their meanings. In this particular case the objects are vehicle controls, and their meanings are reflected in the consequences of their activation or positioning. For example, the driver-trainee must associate movement of the vehicle in a right-hand direction with turning the steering wheel in that direction.

Appropriate Test:

A Driving Concepts Test is proposed for the measurement of psychological factors involved in this job element. This test would require the subject to demonstrate ability to understand and generalize such concepts as "slow", "fast", "stop", "right", and "left". The test should be such that it may be given in whole, or in part, to persons without motor vehicle driving experience. This test should be of the non-language variety and amenable to administration through the use of pantomime directions.

TEST RATIONALE

Behavior Unit: Attending to and understanding instructions

Definition of Job Element Involved:

This element concerns the ability of the subject to attend to, and correctly carry out, oral, written or graphic instructions.

Job Context in Which This Element Occurs:

The behavior involved in this job element occurs throughout the course of the driver's job. Prior to departure, the driver is given instructions by a dispatcher. These instructions pertain to the driver's destination, and/or special details involved in the task which the driver is to carry out. The instructions may vary considerably in complexity, although they are ordinarily simple and brief. On those occasions in which the driver must ask directions en route to his destination, the ability to understand instructions is also required.

Psychological Aspects of This Element:

The psychological activity involved in this element is probably part of what is generally termed intelligence. Insofar as attention is a necessary condition for perception and understanding of instructions, the willingness and ability to attend becomes part of the psychological factors involved in this job element. This willingness would depend largely upon such variables as motivation and the personality make-up of the individual.

Appropriate Test:

The intellectual factors involved in this job element should be measured by the Driving Concepts Test, which is designed to measure understanding and generalization of concepts involved in driving a motor vehicle. Measurement of the personality variables involved in this element does not seem feasible within the scope of the present project, inasmuch as language and culture would play an important role in any such measurement.

APPENDIX C

Administration of Tests by Pantomime

Administration of Tests by Pantomime

The aptitude tests for foreign motor vehicle drivers are designed so that they may be administered by pantomime. This provides for administration of the tests to persons who do not speak English by examiners who do not speak the language of the persons being tested.

The general procedure followed in giving test directions by pantomime is for the examiner to show an assistant examiner, by pantomime, what to do. Then, as the subjects watch, the assistant examiner demonstrates the correct procedure by doing practice items. Examinees then do practice items under the supervision of examining personnel. A proctor is employed to assist in distributing test materials, in seating examinees and in correcting examinees' performance on practice items.

Learning to Administer Tests by Pantomime

The efficient use of pantomime test directions requires some practice on the part of the examiner-assistant examiner-proctor team. Experience has shown that persons of average intelligence may learn to administer tests by this method within one to two days. The following steps are suggested for training sessions:

1. Examiner, assistant examiner, and proctor should study all test directions and test materials thoroughly. Each person should be at least familiar with the duties of the other members of the team. A certain amount of self-recitation will facilitate the learning process at this stage.

2. The three-man testing team should hold a "practice" session during which the tests should be administered to two or three associates who can later comment on what they did or did not understand. Additional practice sessions should be held if possible. During these additional sessions, the team should rotate roles (i.e., the examiner acts as proctor, the proctor as examiner, etc.).

3. The tests should be administered to a group of persons as nearly like the applicant population as possible. For reasons of test security, the purpose of the tests need not be revealed. This session should serve as a sort of "dress rehearsal".

The examiner should not hesitate to repeat pantomime instructions whenever there is doubt that the examinees understand the exact nature of the task they are to perform.

Importance of Following Instructions

The examiner is responsible for ensuring that test administration directions are followed exactly as they are given in the manual. Timing of tests must be in strict accordance with the time limits given in test administration manuals.

Arranging Testing Materials and Facilities

A room large enough to seat 10 persons comfortably at tables, or other writing surfaces, is needed for test administration. The room should be well lighted and ventilated. The examiner should arrange testing materials, before each testing session, so that all materials will be readily available when needed. Pencils should be checked after each test is administered, to ensure that they contain enough lead for the remaining tests. This should be done even if pencils are checked immediately before testing.

Identification of Subjects

The following system for identifying examinees and their test booklets seems to be most desirable:

1. Each applicant to be tested is assigned an identification number by an interviewer prior to testing. This number is entered on the examinee's personnel records. The examinee is then given a card on which his number is printed.

2. Upon entering the testing room, each examinee is assigned a seat corresponding to his identification number.

3. During the testing session each examinee is given test booklets on which his identification number has been stamped. In this way test scores may be entered upon appropriate personnel records by reference to identification numbers, and the many confusions which might arise from use of names alone can be avoided.

The above identification system is especially desirable whenever there is any danger that examiners may not be able to read examinees' handwriting or when examinees are unable to write.

Use of Demonstration Charts

Large charts, 44" x 27", are used to demonstrate correct test procedures to examinees. Each chart consists of a greatly enlarged replica of the demonstration items in the subjects' test booklets. Pictorial illustrations in the test booklets are enlarged four times on the demonstration charts. The demonstration charts used by the examiner are covered with transparent cellulose acetate sheeting. If a china-marking pencil is used for demonstrating test items, the chart may be wiped clean with a dry cloth whenever necessary.

Charts may be fastened to an easel, or to a wall if an easel is not available. It is important, however, that the chart, and all the details of the material contained thereon, be easily visible to all examinees. The examiner should check this before attempting to administer the tests.

Provision should be made, prior to testing, for one or more members of the examining team to remove charts from the wall or easel quickly and noiselessly after each test has been administered.

Scoring Tests

Tests should be hand-scored by responsible persons. It is especially important to ensure that scoring keys, or answers to any test items, do not become available to unauthorized persons.

The total score on each test is obtainable from the scoring formula indicated in the following figure.

Test	Army Designation	Scoring Formula
Revised Attention to Detail	CRT 271	R
Driver Judgment	CRT 280	$R-\frac{W}{2}$
Driving Concepts	CRT 278	R
Revised Two-Hand Coordination	CRT 284	R
Inspection, Form A	CRT 273	$R-\frac{W}{4}$
Inspection, Form B	CRT 274	$R-\frac{W}{4}$
Mechanical Principles	CRT 279	$R-\frac{W}{2}$
Tool Usage	CRT 277	R

Figure C-1. Scoring Formulas for Experimental Tests*

* Where

R = Total number of items answered correctly

W = Total number of items answered incorrectly

ATTENTION TO DETAIL TEST

DIRECTIONS FOR GIVING PANTOMIME INSTRUCTIONS

Note: Examinees should be handled in small groups of not more than 10 examinees per group.

Materials Needed:

1. One large demonstration chart
2. One demonstration easel for examiner
3. Two black china-marking pencils; one for the examiner, and one for the assistant
4. Test booklets for examinees, examiner, and assistant
5. Soft lead pencils for examinees and the proctor
6. Stopwatch for examiner

Personnel:

Examiner, Assistant Examiner, and one Proctor

Procedure:

1. Seat examinees a sufficient distance apart to discourage copying of answers. Examinees should have a writing surface available. Examinees should be seated so that they may see without difficulty everything the examiner does. Examiner should place himself and his demonstration easel in a position such that his demonstration materials and his actions may be easily observed by all the examinees. The assistant should be seated either on a raised platform or at a point where he and his actions may be easily seen by all of the examinees. The proctor should be placed so that he will not distract the examinees from the instruction procedure.
2. Proctor gives each examinee a pencil and the test booklet with the examinees' identification number on its cover (FACE DOWN).
3. Examiner fastens the large demonstration model on a wall or an easel.

4. Examiner raps for attention, turns over his test booklet so that the "X" is at the top of the practice page, and points to assistant's booklet, in full view of examinees. Assistant slowly and deliberately turns over his booklet so that the "X" is at the top of the page. Examiner then points to examinees' test booklets and repeats turning motion with his own booklet to indicate that examinees should follow suit. Proctor checks to see that all examinees have followed directions correctly.

5. Examiner raps for attention. He holds a test booklet next to demonstration chart and points first to the top line of the test booklet and then to the top line of the chart. This motion is intended to indicate that the demonstration material represents the test material. The same procedure is repeated for the second line and as many of the remaining lines as is necessary to convey the idea.

6. Assistant and examinees watch while examiner points with pencil to each "C" in the first practice line of the demonstration booklet. The pointing should be done slowly and deliberately. The examiner then makes a number of vertical lines in the answer space equal to the number of "C's" in that line.

7. Examiner then points to each vertical line and then to the "C" that it represents. It is important that the nature of the task be made very clear by these movements. These and other pantomime instructions should be repeated as often as necessary to convey the idea intended.

8. Examiner repeats procedures 6 and 7 for practice line 2.

9. Examiner repeats procedures 6 and 7 for practice lines 3, and 4, only this time he tries to convey the idea that speed is important. Examiner runs his finger rapidly from left to right over the practice lines. He also points to a watch or other familiar timing device in the examinees' culture. He then goes through the test procedure with obviously hurried movements and points again to the timing device when finished.

10. Examiner points to assistant and then to items 5 through 12 on the demonstration chart. Assistant goes to the demonstration chart and holds his pencil in the air awaiting the signal to begin work. The proctor should check to ensure that examinees' pencils are on their writing surfaces. The examiner points again to the remaining practice lines, pauses, starts his stopwatch in a very obvious fashion, and points to assistant and then to the demonstration chart.

11. Assistant begins work on item 5 in a very slow manner. The examiner stops the assistant, shakes his head to indicate disapproval, points to the timing device again, and makes rapid movements across the demonstration booklet with his hand. The assistant nods his head to indicate that he now understands, and continues work with obviously hurried movements to convey the idea that speed is important. When the assistant has finished, the examiner vigorously nods approval.

12. The examiner indicates by holding his pencil in the air that examinees should do likewise. The proctor and the assistant should check to make sure the examinees do not begin work before the signal is given. The examiner then pauses, starts his stopwatch in an obvious fashion, and points to examinees and then to their test booklets to indicate that they should begin. The proctor and the assistant should assist the examinees, urging them to hurry by means of hand movements where possible and cautioning them not to turn the page to test items. When examinees finish the practice items, the proctor and the examiner indicate by motions that examinees are to lay their pencils on their writing surfaces.

13. When it is clear that all examinees understand the test procedure, the examiner folds over his test booklet to reveal the test items. He then points to the assistant, the examinees, and their respective test booklets to indicate they are to fold their test booklets in the same manner. (It is advisable for the examiner to repeat the folding process.) The proctor should check to see that examinees pencils are on their writing surfaces and not in their hands.

14. When examinees finish folding, the examiner points to the first item and runs his hand down all the test items to indicate that examinees are to do all the test items beginning at the top of the page.

15. Examiner raps for attention, picks up pencil and holds it in the air. By pointing he indicates that examinees are to do likewise. The assistant holds his pencil in the air. The examiner then pauses, starts his stopwatch in a very obvious fashion, and at the same time points to the assistant and examinees and to their test booklets to indicate that they are to begin the test items. Proctor makes certain that examinees begin immediately and follow the correct procedure.

Assistant should begin work in a very obvious fashion and continues to work along with examinees until it is clear that the test is smoothly under way.

16. At the end of 2 minutes, examiner raps for attention, and together with assistant, indicates that pencils should be laid down. This signals the end of Part I. Proctor collects test papers and prepares for Part II.

17. Proctor distributes Part II booklets, face down, and checks to see that all pencils are in usable condition.

It is important at this point to make sure that examinees do not turn to test items and begin test.

18. Examiner then turns over cover page of his test to reveal test items. He points to assistant, the examinees, and to their respective test booklets, and indicates by a repeating of the folding process, that they are to do the same thing. Proctor checks to see that examinees follow directions and that their pencils are on their writing surfaces and not in their hands.

19. When examinees have finished folding, examiner runs his finger down the page of test items to indicate that examinees are to answer all items.

20. Examiner raps for attention, picks up pencil and holds it in the air. By pointing, he indicates that the examinees are to do likewise. The assistant holds his pencil in the air. The examiner then pauses, starts his stopwatch in a very obvious fashion, and at the same time points to the assistant and examinees and to their test booklets to indicate that they are to begin the test items. Proctor makes certain that examinees begin immediately and follow the correct procedure.

21. At the end of 2 minutes, examiner raps for attention, and together with assistant indicates that pencils should be held up. This signals the end of Part II. Proctor collects test papers and prepares for the next test.

INSPECTION TEST, FORM A

DIRECTIONS FOR GIVING PANTOMIME INSTRUCTIONS

Note: Examinees should be handled in small groups of not more than 10 examinees per group.

Materials Needed:

1. One large demonstration chart
2. One demonstration easel for examiner
3. Two black china-marking pencils, one for examiner, one for assistant
4. Test booklets for examinees and assistant
5. Soft lead pencils for examinees and proctor
6. Stopwatch for examiner

Personnel:

Examiner, Assistant Examiner, and one Proctor

Procedure:

1. Seat examinees a sufficient distance apart to discourage copying of answers. Examinees should have a writing surface available. Examinees should be seated so that they may see without difficulty everything the examiner does. Examiner should place himself and his demonstration easel in a position such that his demonstration materials and his actions may be easily observed by all the examinees. The assistant should be seated either on a raised platform or at a point where he and his actions may be easily seen by all of the examinees. The proctor should be placed so that he will not distract the examinees from the instruction procedure.
2. Proctor gives each examinee a pencil and the test booklet with the examinee's identification number on its cover (FACE DOWN).
3. Examiner fastens the large demonstration model on a wall or easel.

4. Examiner raps for attention, turns over his test booklet so that the title "Inspection" is at the top of the practice page, and points to assistant's booklet in full view of examinees. Assistant slowly and deliberately turns over his booklet so that the title "Inspection" is at the top of the page. Examiner then points to examinees' test booklets and repeats the circular turning motion with his own booklet to indicate that examinees should follow suit. Proctor checks to see that all examinees have followed directions correctly.

5. Examiner raps for attention. He holds a test booklet next to demonstration chart and points first to the top line of the chart and then to the top line of the test booklet. This motion is intended to indicate that the demonstration material represents the test material. The same procedure is repeated for the second line and as many of the remaining lines as is necessary to convey the idea.

6. Assistant and examinees watch while examiner points first to the "given" figure in the first practice line of his demonstration chart, and then to each of the following identical figures. Pointing back to the "given" figure after each of the test figures until he reaches the figure which is different from the "given" figure. He points to the "different" figure, and, in a very obvious fashion, looks back at the "given" figure, shakes his head from side to side to indicate that this figure is not like the original. He then draws an "X" through that figure.

7. Examiner then points to the "given" figure in the second item and proceeds to point to each of the alternative figures and the reference figure as in 6 above. When he gets to the "different" figure he pauses, and in a very obvious manner looks back at the "given" figure, shakes his head from side to side to indicate that the figures are not identical, and draws an "X" through the different figure.

8. After he has finished, examiner points to assistant and then to the practice items on the demonstration chart. The assistant goes to the chart, holds his china-marking pencil in the air, and waits for the signal to begin. Proctor should check to see that examinees' pencils are on their writing surfaces while directions are being given.

9. The examiner pauses, again points to the remaining practice items, starts his stopwatch in an obvious manner, and points to the assistant. Assistant begins work immediately but works very slowly. Examiner stops assistant, shakes his head and indicates disapproval, points to timing device again, and makes rapid movements across the demonstration chart with his hand.

Assistant nods head to indicate that he understands and completes the remaining practice items with obviously hurried movements to indicate that speed is important. When assistant has finished, examiner nods approval.

10. Assistant cleans marks from the demonstration chart with a cloth.

11. Examiner indicates by holding his pencil in the air, that examinees are to do likewise. Proctor and assistant should check to see that all examinees follow instructions. Examiner points to the demonstration chart and the practice items. He then pauses, starts his stopwatch in an obvious fashion, and at the same time, points to examinees and to their test booklets to indicate that they are to begin.

The assistant examiner and the proctor should check to see that examinees begin work immediately, and assist them (by pantomime) when necessary. Proctor and assistant should urge examinees to hurry, by means of hand movements, and check to see that they do not turn the page to the test items.

When examinees finish practice items, testing personnel indicate by motions that they are to lay their pencils on their writing surfaces.

12. When it is clear that all examinees understand the test procedure, the examiner folds over his test booklet to reveal test items. He then points to the assistant, the examinees, and indicates by repeating the folding process that they are to fold over their test booklets in the same way. Proctor checks to see that examinees' pencils remain on their writing surfaces.

13. When examinees finish folding, examiner raps for attention, points to first item and runs his hand down all the test items to indicate that examinees are to do all test items beginning at the top of the left hand page.

14. Examiner raps for attention, picks up his pencil and indicates by motions that examinees are to do likewise. The assistant holds his pencil in the air. The examiner again runs his hand down the test items, pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to the examinees and their test booklets to indicate that they are to do the test items. Proctor makes certain that examinees begin immediately and follow the correct procedure.

Assistant should begin work in an obvious fashion and continue to work along with examinees until it is clear that the test is smoothly under way.

15. At the end of <u>16 minutes</u>, examiner raps for attention, and, together with assistant, indicates that pencils should be held up. This signals the end of the test. Proctor and assistant examiner collect test papers.

INSPECTION TEST, FORM B

DIRECTIONS FOR GIVING PANTOMIME INSTRUCTIONS

Note: Examinees should be handled in small groups of not more than 10 examinees per group.

Materials Needed:

1. One large demonstration chart
2. One demonstration easel for examiner
3. Two black china-marking pencils, one for examiner, one for assistant
4. Test booklets for examinees and assistant
5. Soft lead pencils for examinees and proctor
6. Stopwatch for examiner

Personnel:

Examiner, Assistant Examiner, and one Proctor

Procedure:

1. Seat examinees a sufficient distance apart to discourage copying of answers. Examinees should have a writing surface available. Examinees should be seated so that they may see without difficulty everything the examiner does. Examiner should place himself and his demonstration easel in a position such that his demonstration materials and his actions may be easily observed by all the examinees. The assistant should be seated either on a raised platform or at a point where he and his actions may be easily seen by all of the examinees. The proctor should be placed so that he will not distract the examinees from the instruction procedure.
2. Proctor gives each examinee a pencil and the test booklet with the examinee's identification number on its cover (FACE DOWN).
3. Examiner fastens the large demonstration model on a wall or easel.

4. Examiner raps for attention, turns over his test booklet so that the title "Inspection" is at the top of the practice page, and points to assistant's booklet, in full view of examinees. Assistant slowly and deliberately turns over his booklet so that the title "Inspection" is at the top of the page. Examiner then points to examinees' test booklets and repeats the circular turning motion with his own booklet to indicate that examinees should follow suit. Proctor checks to see that all examinees have followed directions correctly.

5. Examiner raps for attention. He holds a test booklet next to demonstration chart and points first to the top line of the test booklet and then to the top line of the demonstration chart. This motion is intended to indicate that the demonstration material represents the test material. The same procedure is repeated for the second line and as many of the remaining lines as is necessary to convey the idea.

6. Assistant and examinees watch while examiner points first to the "given" figure in the first practice line of his demonstration chart, and then to each of the following identical figures. Pointing back to the "given" figure after each of the test figures to indicate that these are identical, he continues through the line of figures until he reaches the figure which is different from the "given" figure. He points to the "different" figure, and, in a very obvious fashion, looks back at the "given" figure, shakes his head from side to side to indicate that this figure is not like the original. He then draws an "X" through that figure.

7. Examiner then points to the "given" figure in the second item and proceeds to point to each of the alternative figures and the reference figure as in 6 above. When he gets to the "different" figure he pauses, and in a very obvious manner looks back at the "given" figure, shakes his head from side to side to indicate that the figures are not identical, and draws an "X" through the different figure.

8. After he has finished, examiner points to assistant and then to the practice items on the demonstration chart. The assistant goes to the chart, holds his china-marking pencil in the air, and waits for the signal to begin. Proctor should check to see that examinees' pencils are on their writing surfaces while directions are being given.

9. The examiner pauses, again points to the remaining practice items, starts his stopwatch in an obvious manner, and points to the assistant. Assistant begins work immediately but works very slowly. Examiner stops assistant, shakes his head and indicates disapproval, points to timing device again, and makes rapid movements across the demonstration chart with his hand.

Assistant nods head to indicate that he understands and completes the remaining practice items with obviously hurried movements to indicate that speed is important. When assistant has finished, examiner nods approval.

10. Assistant cleans marks from the demonstration chart with a cloth.

11. Examiner indicates by holding his pencil in the air, that examinees are to do likewise. Proctor and assistant should check to see that all examinees follow instructions. Examiner points to the demonstration chart and the practice items. He then pauses, starts his stopwatch in an obvious fashion, and at the same time, points to examinees and to their test booklets to indicate that they are to begin.

The assistant examiner and the proctor should check to see that examinees begin work immediately, and assist them (by pantomime) when necessary. Proctor and assistant should urge examinees to hurry, by means of hand movements, and check to see that they do not turn the page to the test items.

When examinees finish practice items, testing personnel indicate by motions that they are to lay their pencils on their writing surfaces.

12. When it is clear that all examinees understand the test procedure, examiner folds over his test booklet to reveal test items. He then points to the assistant, the examinees, and indicates by repeating the folding process that they are to fold over their test booklets in the same way. Proctor checks to see that examinees' pencils remain on their writing surfaces.

13. When examinees finish folding, examiner raps for attention, points to first item and runs his hand down all the test items to indicate that examinees are to do all test items beginning at the top of the first page.

14. Examiner raps for attention, picks up his pencil and indicates by motions that examinees are to do likewise. The assistant holds his pencil in the air. The examiner again runs his hand down the test items, pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to the examinees and their test booklets to indicate that they are to do the test items. Proctor makes certain that examinees begin immediately and follow the correct procedure.

Assistant should begin work in an obvious fashion and continue to work along with examinees until it is clear that the test is smoothly under way.

15. At the end of 10 minutes, examiner raps for attention, and, together with assistant, indicates that pencils should be held up. This signals the end of the test. Proctor and assistant examiner collect test papers.

TOOL USAGE TEST

DIRECTIONS FOR GIVING PANTOMIME INSTRUCTIONS

Note: Examinees should be handled in small groups of not more than 10 examinees per group.

Materials Needed:

1. One large demonstration model for examiner
2. One demonstration easel for examiner
3. Two black china-marking pencils; one for the examiner and one for the assistant
4. Test booklets for examinees, examiner, and assistant
5. Soft lead pencils for examinees and proctor
6. Stopwatch for examiner

Personnel:

Examiner, Assistant Examiner and one Proctor

Procedure:

1. Seat examinees a sufficient distance apart to discourage copying of answers. Examinees should have a writing surface available. Examinees should be seated so that they may see without difficulty evenything the examiner does. Examiner should place himself and his demonstration easel in a position such that his demonstration materials and his actions may be easily observed by all the examinees. The assistant should be seated either on a raised platform or at a point where he and his actions may be easily seen by all of the examinees. The proctor should be placed so that he will not distract the examinees from the instruction procedure.
2. Proctor gives each examinee a pencil and the test booklet with the examinee's identification number on its cover (FACE DOWN).
3. Examiner fastens the large demonstration model on a wall or easel.

4. Examiner raps for attention, turns over his test booklet, and points to assistant's booklet, in full view of examinees. Assistant slowly and deliberately turns over his booklet. Examiner then points to examinees' test booklets and repeats motion with his own booklet to indicate that examinees should follow suit. Proctor checks to see that all examinees have followed directions correctly.

5. Examiner raps for attention. He holds up a test booklet next to demonstration chart and points first to the top line of the test booklet and then to the top line of the demonstration chart. This motion is intended to indicate that the demonstration material represents the test material. The same procedure is repeated for the second line and as many of the remaining lines as are necessary to convey the idea.

6. Examiner points to first demonstration item (machine screw, metal strap, metal block) and then holds up the actual parts.

7. Examiner puts the metal strap in place and starts the machine screw in the threaded hole with his fingers.

8. Examiner holds up the hammer, shakes his head to indicate that it is not the correct tool. He repeats this procedure for the cold chisel and the combination pliers.

9. Examiner picks up screw driver, nods his head to indicate that it is the correct tool, and drives the machine screw into the threaded hole to fasten the two parts together in the prescribed manner.

10. He puts down the screw driver, holds the assembled parts next to the picture of the assembly on the demonstration chart, and marks an "X" through the picture of the screw driver.

11. Examiner motions for assistant to come to the demonstration chart, points to second demonstration item, and then to the assistant, in that order. Assistant

goes to the demonstration chart and holds his china-marking pencil in the air, awaiting the signal to begin. Examiner pauses, starts his stopwatch in a very obvious fashion, and again points to the practice items and then to the assistant. Assistant begins work immediately. Assistant points to the picture of the log at the left, then to the picture of the log split into four pieces at the right. After studying this picture in an obvious manner, he points to the hammer, and shakes his head to indicate that it is not the correct tool. He repeats this procedure for the screw driver. He then points to the axe, nods his head to indicate that this is the correct tool, and marks it with an "X". The assistant continues on to the fourth choice, points to the pliers, shakes his head to indicate that it is not the correct tool, and turns to face the examiner. Examiner approves assistant's performance by a nod and motions for assistant to lay down his pencil.

12. Examiner points to the picture of the log, to the picture of the split log, and then to the axe. He then pantomimes a chopping operation to demonstrate the use of the axe.

13. Assistant removes marks from demonstration chart with a cloth.

14. Examiner holds his pencil in the air and motions for assistant and examinees to follow suit. He points to the practice items on his demonstration model. He then pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to examinees and to their test booklets to indicate that they should begin. Proctor should assist examinees when necessary, and urge them to hurry whenever it appears that they are working too slowly. Proctor should also ensure that examinees do not turn the page to the test items. (Proctor and assistant help examinees check and/or correct their answers.)

When examinees finish, proctor and examiner indicate by motions that they are to lay their pencils on their writing surfaces.

15. When it is clear that all examinees understand the test procedure, the examiner folds over the first page of his booklet to reveal the first two pages of test items. He opens his booklet to show that there are several more pages of test items. He then points to the assistant, the examinees, and indicates by repeating the folding process that they are to fold over the first pages of their test booklets in the same way. Proctor checks to see that examinees' pencils remain on their writing surfaces.

16. When examinees finish folding, examiner raps for attention, points to first test item and runs his finger down all the items on that page. He repeats this procedure for all the pages.

17. Examiner raps for attention, picks up his pencil and indicates by motions that examinees are to hold theirs in the air. Assistant holds his pencil in the air. The examiner again runs his finger down the test items, pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to examinees and their test booklets to indicate that they are to do the test items. Proctor and assistant make sure that examinees begin immediately and continue on after they reach the bottom of each page.

18. At the end of 8 minutes, examiner raps for attention, and, together with assistant, indicates that pencils should be held in the air. This signals the end of the test. Proctor and assistant collect test papers.

DRIVING CONCEPTS TEST

DIRECTIONS FOR GIVING PANTOMIME INSTRUCTIONS

Note: Examinees should be handled in small groups of not more than 10 examinees per group.

Materials Needed:

1. One large demonstration chart
2. One demonstration easel
3. Test booklets for examiner, assistant, and examinees
4. Soft lead pencils for examinees and proctor
5. Two black china-marking pencils; one for examiner, one for assistant
6. Stopwatch for examiner

Personnel:

Examiner, Assistant Examiner, and one Proctor

Procedure:

1. Seat examinees a sufficient distance apart to discourage copying of answers. Examinees should have a writing surface available. Examinees should be seated so that they may see without difficulty everything the examiner does. Examiner should place himself and his demonstration easel in a position such that his demonstration materials and his actions may be easily observed by all the examinees. The assistant should be seated either on a raised platform or at a point where he and his actions may be easily seen by all of the examinees. The proctor should be placed so that he will not distract the examinees from the instruction procedure.
2. Proctor gives each examinee a pencil and the test booklet with the examinees' identification number on its cover (FACE DOWN).
3. Examiner fastens the demonstration model for Part I on a wall or easel.

4. Examiner raps for attention, turns over his test booklet, and folds back the cover to reveal the demonstration and practice items, and points to assistant's booklet, in full view of examinees. Examiner then points to examinees' test booklets and repeats the turning and folding motion with his own booklet to indicate that examinees should follow suit. Proctor checks to see that all examinees have followed directions correctly.

5. Examiner raps for attention. He holds up a test booklet next to the demonstration chart, pointing to first page of booklet and to demonstration chart. This is to indicate that the two are the same. Examiner repeats this motion several times.

6. Examiner raps for attention. He points to the picture of the horse under the black rectangle, then to the rectangle. He points to the picture of the boat under the black rectangle, then to the rectangle again. The same is done for the hoop and box pictures. Examiner continues procedure for the pictures under the black circle and under the black triangle.

7. Examiner raps for attention. He points to the black rectangle, then to assistant. Assistant walks very slowly across the room from left to right. Examiner points to picture of horse under black rectangle, then to assistant. Assistant again walks slowly across the room from left to right. Procedure is repeated for pictures of hoop and box. Examiner then points to black circle, and to assistant. Assistant takes one step from left to right, comes to military halt, clicking heels. This is repeated for each picture under the black triangle.

8. Examiner raps for attention. He points to the black rectangle, then to the pictures underneath it. Assistant walks from left to right. Examiner points to black circle and pictures underneath it; assistant runs from left to right. Examiner points to black triangle and pictures underneath it; assistant comes to a military halt.

9. Examiner now points to white symbols. He points to white rectangle, assistant walks from right to left. Examiner points to picture of horse under white rectangle, then to picture of horse under black rectangle. He again points to horse under white rectangle, assistant walks slowly from right to left. He points to horse under black rectangle, assistant walks slowly from left to right. Examiner points to white circle, assistant runs from right to left. Examiner points to each picture under white circle, and points with finger to the left. He points to each picture under the black circle, and moves his finger from left to right.

10. Examiner raps for attention. He indicates first practice item on demonstration model. He moves his finger from left to right, pointing in the direction of the motion. Then he points to the three black symbols in the key. He runs in place, then points to black circle. Slowly he crosses out the black circle in the sample item.

11. Examiner then has assistant demonstrate second practice item. Assistant points to picture of galloping horse, moves his finger from right to left to indicate the direction of motion, runs, makes a fast rotary movement with his hands, and marks the white circle. Examiner indicates approval.

12. Examiner and examining staff check to see that examinees' pencils are laying on their writing surfaces. Examiner then picks up his test booklet, points to the four practice items. (This procedure should be repeated, if necessary, so that all examinees may see it.)

13. Examiner then picks up his pencil and motions for examinees to hold their pencils in the air. When all examinees have complied, the examiner again points to the practice items, pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to examinees and their test booklets to indicate that they should begin.

Proctor should assist examinees when necessary. <u>Examining personnel should make sure that examinees do not turn page to test items</u>.

14. When examinees have completed the practice items, and when it is clear that they understand the test procedure, examiner motions for examinees to lay their pencils on their writing surfaces. Proctor checks to see that this is done.

15. Examiner turns to the test items of Part I in his booklet and indicates that examinees are to do the same.

16. Examiner picks up his pencil and motions for examinees to hold their pencils in the air. When all examinees have complied, the examiner points to the test items of Part I, pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to examinees and to their test booklets to indicate that they are to begin the test items. Proctor and assistant make sure that examinees begin immediately and do not turn back to the practice items or ahead to Part II.

17. After 5 minutes, examiner raps for attention and indicates that pencils are to be laid down. He holds up his test booklet and turns to Part II. He then repeats the starting procedure given in (16) above. Proctor should check to see that examinees do not turn back to Part I or ahead to Part III.

18. After 5 minutes examiner raps for attention and indicates that pencils are to be laid down. He holds up his test booklet and turns to Part III. He then repeats the starting procedure given in (16) above. Proctor should check to see that examinees do not turn back to Parts I or II.

19. After 5 minutes, examiner raps for attention and indicates that pencils are to be put down. Proctor collects booklets.

DRIVER JUDGMENT

DIRECTIONS FOR GIVING PANTOMIME INSTRUCTIONS

Note: Examinees should be handled in small groups of not more than 10 persons per group.

Materials Needed:

1. One large demonstration chart for examiner
2. One demonstration easel
3. Two black china-marking pencils; one for examiner, one for assistant
4. Test booklets for examinees, examiner and assistant
5. Soft lead pencils for examinees, examiner
6. Stopwatch for examiner
7. Cardboard model of steering wheel

Personnel:

Examiner, Assistant Examiner, and one Proctor

Procedure:

1. Seat examinees a sufficient distance apart to discourage copying of answers. Examinees should have a writing surface available. Examinees should be seated so that they may see without difficulty everything the examiner does. Examiner should place himself and his demonstration easel in a position such that his demonstration materials and his actions may be easily observed by all the examinees. The assistant should be seated either on a raised platform or at a point where he and his actions may be easily seen by all of the examinees. The proctor should be placed so that he will not distract the examinees from the instruction procedure.
2. Proctor gives each examinee a pencil and the test booklet with the examinee's identification number on its cover (FACE DOWN).
3. Examiner fastens large demonstration chart on a wall or on an easel.

4. Examiner raps for attention, and folds back the cover to reveal the demonstration and practice items, and points to assistant and assistant's booklet. Assistant folds the cover of his booklet in the prescribed manner.

Examiner then points to examinees' test booklets and repeats the folding motion with his own booklet to indicate that examinees should follow suit.

Proctor checks to see that examinees follow directions correctly and do not turn to test items.

5. Examiner raps for attention. He holds up a test booklet next to the demonstration chart, pointing to first page of booklet, and to demonstration chart. This is to indicate that the two are the same. Examiner repeats this motion several times.

6. Examiner raps for attention. He points to the first demonstration item and indicates, by pantomime, that the truck in the illustration is to make a right turn. He then points to the assistant. Assistant picks up the cardboard steering wheel and demonstrates the first alternative by turning the steering wheel to the right. The examiner nods his head to indicate that this is the correct procedure.

7. Assistant then demonstrates the remaining alternatives, while the examiner indicates that each is incorrect.

8. The examiner marks an "X" through the correct answer.

9. Examiner motions for assistant to pick up his pencil and come to the demonstration chart. Examiner points to the second demonstration item and then to the assistant.

Assistant studies the item in an obvious manner and indicates, by pantomime, that the vehicle is to turn left. He then marks the correct alternative.

The examiner indicates approval and then pantomimes the correct movement of the steering wheel with the cardboard wheel.

10. Examiner points to the third demonstration item and then to the assistant. The assistant studies the item in an obvious manner, first pointing to the "given" picture and then to the "required" picture. He then points to each alternative in turn, indicating approval of the correct alternative (the brake pedal) and disapproval of the incorrect alternatives. He marks an "X" through the correct alternative.

Examiner indicates approval of the assistant's performance.

11. Examiner holds his pencil in the air and motions for assistant and examinees to follow suit. He points to the practice items in his test booklet. He then pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to examinees and to their test booklets to indicate that they should begin. Proctor and assistant should assist examinees when necessary, and urge them to hurry whenever it appears that they are working too slowly. Proctor and assistant should also ensure that examinees do not turn the page to the test items.

When examinees finish, proctor and examiner indicate by motions that they are to lay their pencils on their writing surfaces.

12. When all examinees have finished, examiner proceeds to demonstrate practice items. Proctor and assistant help examinees check and/or correct their answers.

13. When it is clear that all examinees understand the test procedure, examiner folds over the first page of his booklet to reveal the first two pages of test items. He opens his booklet to show that there are more pages of test items. He then points to the assistant, the examinees, and indicates by repeating the folding process that they are to fold over the first pages of their test booklets in the same way.

Proctor checks to see that examinees' pencils remain on their writing surfaces.

14. When examinees finish folding, examiner raps for attention, points to first test item and runs his finger down all the items on that page. He repeats this procedure for all the pages.

15. Examiner raps for attention, picks up his pencil and indicates by motions that examinees are to hold their pencils in the air. Assistant holds his pencil in the air. The examiner again runs his finger down the test items, pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to examinees and their test booklets to indicate that they are to do the test items. Proctor and assistant make sure that examinees begin immediately and continue on after they reach the bottom of each page.

16. At the end of 8 minutes, examiner raps for attention and, together with assistant indicates that pencils should be laid down. This signals the end of the test. Proctor and assistant collect test papers.

TWO-HAND COORDINATION

DIRECTIONS FOR GIVING PANTOMIME TEST INSTRUCTIONS

Note: Examinees should be handled in small groups of not more than 10 persons per group.

Materials Needed:

1. Two test sheets for the examiner and his assistant, and a third to be fastened to the wall of the examining room
2. Two pairs of styli for the examiner and assistant
3. Test sheets and styli for examinees
4. Examining tables on which test sheets may be fastened
5. Masking tape for fastening test sheets to tables
6. Stopwatch for examiner

Personnel:

Examiner, Assistant Examiner, and one Proctor

Procedure:

1. Arrange seats for examinees a sufficient distance apart to allow freedom of movement of both arms. Each examinee should have a writing surface of sufficient size to support an entire test sheet. Examinees should be seated so that they may see without difficulty everything that the examiner does. The proctor should be so placed that he will not distract the examinees.
2. Have proctor fasten a test sheet on which is stamped the examinee's identification number to each examinee's writing surface so that the word "START" is directly in front and at the top, and the bottom edge is even with the edge of the writing surface. Test sheets should be secured to writing surfaces with masking tape so that they will not slip while the examinees are taking the test. Do not distribute styli to examinees at this time.

3. Examiner fastens a demonstration test sheet to a wall or easel, where it may be easily seen by all examinees.

4. Examiner raps for attention, and points to the demonstration test sheet. He then runs his fingers down the individual pairs of columns. He repeats the motion, only this time he emphasizes the fact that he is following the connecting lines.

5. Examiner picks up a pair of styli, and by pantomime, demonstrates the correct method of grasping them. He then goes to the demonstration model and demonstrates the use of the styli on the center pair of columns. He slowly and deliberately strikes the first circle in the left-hand column with the stylus held in his left hand, and then the first circle in the right-hand column with the stylus held in his right hand. He continues on down the two columns in this manner until all the circles have been struck.

6. Examiner then repeats the demonstration given in (5) with considerable speed. He does the same for the two remaining pairs of columns.

7. Examiner then begins to repeat the demonstration for the two center columns, only this time he begins to strike simultaneously with his left and right hands. He quickly stops and indicates disapproval of this method by facial expression and by shaking his head from side to side. He then repeats the correct method and indicates approval, by means of facial expression and by nodding his head.

8. Examiner motions for assistant to come to the demonstration model. Assistant goes to the chart.

9. The examiner indicates by pantomime that the assistant is to touch each circle of the center pair of columns in the prescribed fashion, <u>using the balls of his index fingers instead of styli</u>. The examiner demonstrates a vigorous tapping of the demonstration sheet and indicates by facial expression and by

a negative head movement that this vigorous tapping is incorrect. He then demonstrates a light tapping movement and indicates approval. The assistant nods and pantomimes the correct type of movement to indicate that he understands.

10. The examiner points to the center pair of columns on the demonstration sheet and then to the assistant. The assistant holds his fingers poised over the starting position, awaiting the signal to begin. The examiner pauses, points first to the assistant, then to the test sheet, and starts his stopwatch in an obvious fashion. The assistant begins work immediately and touches each circle lightly and in the prescribed manner. When the assistant finishes the first pair of columns he stops and faces the examiner. The examiner indicates approval.

11. The examiner raps for attention and motions for the examinees to hold their fingers poised over the starting point on their test sheets. The assistant and the proctor stand by to prevent examinees from striking their test sheets with too much force. (This would make marks on the sheet.)

Note: It is advisable for the proctor to take a position near those examinees who are farthest from the examiner and the assistant to take an intermediate position. In this way the examiner may supervise the performance of examinees who are nearest him.

12. Examiner points to examinees and then to their test sheets to indicate that they are to begin. As soon as an examinee demonstrates that he understands the test procedure he should be stopped.

13. When it is evident that all examinees understand the way in which the circles are to be struck, the examiner again motions for the assistant to come to the demonstration sheet.

14. When assistant comes to the demonstration chart, the examiner gives him a pair of styli. The examiner then, in full view of all the examinees, demonstrates that the styli should be held between the thumb and four fingers of each hand as shown in the illustration below.

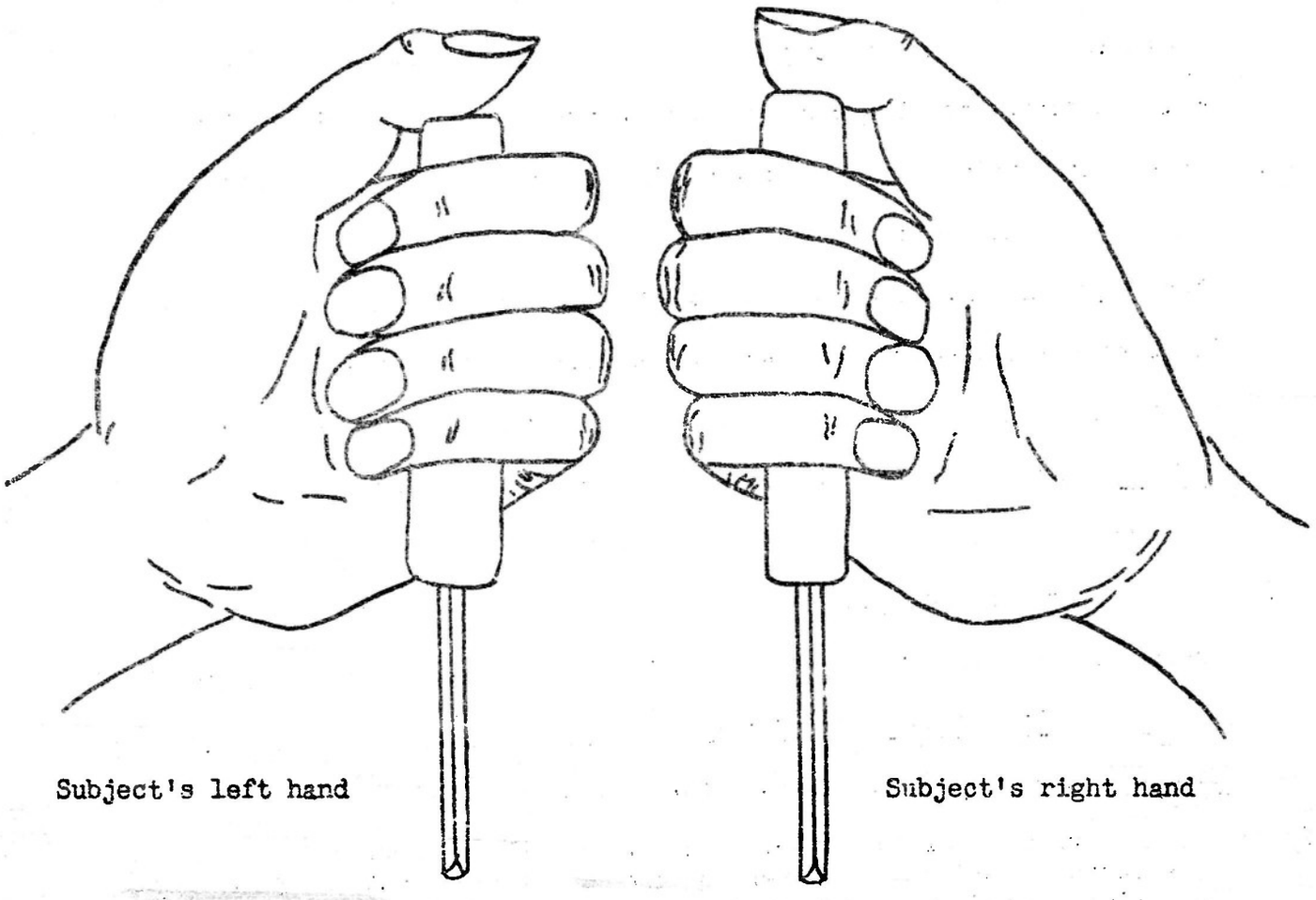


Figure C-4. Method of Grasping Styli

15. Assistant grasps styli correctly and holds them up so that the examiner and the examinees may see the way in which they are held. The examiner indicates approval.

16. The examiner points to the assistant and then to the first pair of columns. He repeats this procedure and indicates by pantomime that the assistant is to stop at the end of the first pair of columns. This can be done by pointing to the other pairs and expressing disapproval in the manner indicated previously. This should be repeated, if necessary, to convey the idea to the examinees. The assistant nods to indicate that he understands.

17. The examiner motions for the assistant to hold his styli over the starting point of the first pair of columns. After the assistant has complied, the

examiner pauses, points to the assistant and then to the demonstration sheet, and starts his stopwatch in an obvious manner. The assistant begins work with obvious speed.

18. At the end of 25 seconds, the examiner raps for attention and simultaneously calls "Stop". The assistant immediately stops and raises his styli from the test sheet.

19. The examiner repeats procedures 16, 17, and 18 for the second and third pair of columns.

20. When it appears that examinees understand the test procedure, assistant and proctor distribute styli to the examinees. Testing personnel should check to make sure that examinees do not begin test until told to do so.

21. Examiner raps for attention and motions for the examinees to pick up and grasp their styli in the prescribed manner. (It may be necessary to repeat the grasping directions.)

22. Examiner runs his finger down the center pair of columns. He then indicates, as in procedure 16, that examinees are not to do the second and third pair of columns.

23. Examiner motions for examinees to hold their styli over the starting point for the first pair of columns. Proctor and assistant should check to see that examinees follow the correct procedure and do not begin the test until the signal to begin is given.

24. The examiner then pauses, points to the examinees and then to their test sheets, and starts his stopwatch in an obvious manner. The assistant and proctor check to see that examinees begin immediately and do not continue on to other pairs of columns.

25. At the end of 25 seconds, the examiner calls "Stop", raps for attention, and motions for examinees to lay their styli on their writing surfaces. Assistant and proctor check to see that instructions are followed.

26. Examiner repeats procedures 21 through 25 for the second pair of columns.

27. Examiner repeats procedures 21 through 25 for the third pair of columns. Proctor and assistant pick up styli and test sheets and prepare for the next test.

MECHANICAL PRINCIPLES TEST

DIRECTIONS FOR GIVING PANTOMIME TEST INSTRUCTIONS

Note: Examinees should be handled in small groups of not more than 10 persons per group.

Materials Needed:

1. One large demonstration chart for examiner
2. One demonstration easel
3. Two black china-marking pencils; one for examiner, one for assistant
4. Test booklets for examinees, examiner and assistant
5. Soft lead pencils for examinees, examiner
6. Stopwatch for examiner
7. Demonstration materials -- these include an operational wooden model of two interlocking gears, and a teeter board and fulcrum with six equally heavy wooden blocks.

Personnel:

Examiner, Assistant Examiner, and one Proctor

Procedure:

1. Seat examinees a sufficient distance apart to discourage copying of answers. Examinees should have a writing surface available. Examinees should be seated so that they may see without difficulty everything the examiner does. Examiner should place himself and his demonstration easel in a position such that his demonstration materials and his actions may be easily observed by all the examinees. The assistant should be seated either on a raised platform or at a point where he and his actions may be easily seen by all of the examinees. The proctor should be placed so that he will not distract the examinees from the instruction procedure.

2. Proctor gives each examinee a pencil and the test booklet with the examinees' identification number on its cover (FACE DOWN).

3. Examiner fastens the large demonstration model on a wall or easel.

4. Examiner raps for attention, turns over his test booklet, and points to assistant's booklet, in full view of examinees. Assistant slowly and deliberately turns over his booklet. Examiner then points to examinees' test booklets and repeats motion with his own booklet to indicate that examinees should follow suit. Proctor checks to see that all examinees have followed directions correctly.

5. Examiner raps for attention, picks up his test booklet and folds back cover to reveal demonstration and practice items. He motions for assistant and examinees to follow suit. Proctor checks to see that examinees follow the correct procedure.

6. Examiner raps for attention. He holds his test booklet next to the demonstration chart and points first to the top line of the demonstration page and then to the top line of the demonstration chart. This motion is intended to indicate that the demonstration material represents the test material. The same procedure should be repeated for the second line and as many of the remaining lines as are necessary to convey the idea.

7. Examiner sets up teeter-board, fulcrum (without blocks) to correspond to first demonstration item. He then points to the first picture and indicates, by shaking his head, that it is incorrect. He repeats this procedure for the second picture. He points to the third alternative and indicates by nodding that it is correct. He then places a block on the teeter-board and points first to the correct alternative and then to the teeter-board to indicate that they are the same. He marks an "X" over the third picture.

8. Examiner then motions for assistant to pick up his pencil, and points to the first demonstration item and then to the assistant. The assistant goes to the chart, studies the item, and marks it correctly.

9. Examiner points to second demonstration item, to assistant, and then to the demonstration model. Assistant points to the first picture of the two gears, studies it in an obvious manner, and shakes his head to indicate that it is not correct. He pantomimes the movement of the gears as it is given in the picture and again indicates disapproval. He points to the second picture, studies it, nods his head to indicate that it is the correct answer, pantomimes the movement of the gears, and operates the wooden model to demonstrate the movement. He then marks an "X" on the second picture. The examiner indicates approval.

10. Examiner points to assistant and then to the third demonstration item. The assistant studies the item and then marks it in the correct manner. The examiner indicates approval and demonstrates the item with the teeter-board.

11. Examiner and examining staff check to ensure that examinees' pencils are laying on their writing surfaces. Examiner then picks up his test booklet, points to practice items, running his finger down the page over all the practice items. (This procedure should be repeated if necessary so that all examinees may see it.)

12. Examiner then picks up his pencil and motions for examinees to hold their pencils in the air. When all examinees have complied, the examiner again points to the practice items, pauses, starts his stopwatch in a very obvious fashion, and, at the same time, points to examinees and their test booklets to indicate that they should begin.

Proctor should assist examinees when necessary, and instruct them to hurry whenever it appears that they are working too slowly. Examining staff should also ensure that examinees do not turn page to test items. As examinees finish, the examining staff should check to see that they put their pencils on their writing surfaces.

13. When it is clear that the examinees understand the test procedure, examiner picks up his test booklet and folds over the practice page to the test items. He opens his booklet to show that there are several more pages of test items. He then points to the assistant and to the examinees and indicates by repeating the folding process that they are to turn to the practice items.

Proctor checks to see that examinees follow the correct procedure and that their pencils remain on their writing surfaces.

14. When examinees finish folding, examiner raps for attention, holds up his test booklet and runs his finger down all the items of the first two pages. He repeats this procedure for the remaining pages.

15. Examiner raps for attention, picks up his pencil and indicates by motions that examinees are to hold theirs in the air. Assistant holds his pencil in the air. The examiner again runs his finger down the test items, pauses, starts his stopwatch in a very obvious fashion, and at the same time, points to examinees and their test booklets to indicate that they are to do the test items. Proctor and assistant make sure that examinees begin immediately and continue on after they reach the bottom of each page.

16. At the end of 6 minutes, examiner raps for attention, and, together with assistant, indicates that pencils should be placed on the examinees' writing surfaces. This signals the end of the test. Proctor and assistant collect test papers.

APPENDIX D

Statistical Analysis

STATISTICAL ANALYSIS

In the determination of the relationship between the two batteries, the Army battery was used as the criterion, or reference, variable. Two methods of comparing the two batteries seemed advisable. First, the relationships between individual tests of the Army and experimental batteries may be obtained by examination of a matrix of intercorrelations among the tests. Second, the relationship between the two groups of tests will be indicated by the aggregate correlation between the experimental tests and a composite Army battery score. In accordance with the suggestion of the in-service staff of the Personnel Research Branch, tests of the Army battery received unit weights in the composite. The subject group was divided into two subgroups of 170 subjects each. This division was accomplished by assigning every second man tested to one subgroup and the remaining men to the other subgroup. After such a subdivision had been effected, it was possible to obtain two estimates of the relationship between the composite Army battery score and the tests of the experimental battery, which were relatively unbiased by sampling error. This was done by means of a double cross-validation analysis.[5] As a first step in this analysis, a matrix of the intercorrelations of the tests of the two batteries was constructed from data obtained from each of the two subsamples. Table D-1 presents the matrix obtained from subgroup A data, while Table D-2 presents the matrix obtained from subgroup B data. Means and standard deviations of Army and experimental tests are presented in Table D-3.

---

[5] This method is described in detail by Mosier (25). Essentially, it involves computation of standard partial regression weights separately for each of two samples. The correlations from each sample are then used with the weights obtained on the other sample to obtain two aggregate correlations which do not capitalize on the sampling peculiarities of either sample.

Table D-1

Intercorrelations of Tests of the Army Driver Selection Battery and Tests of the Experimental Battery for Selection of Indigenous Drivers - Group A(N=170)

NAME OF TEST	Army Designation		Var. No.	110	121	122	129	130	140	150	160	211	212	219	220	231	232	233	239	240	251	252	260	270	310	320
Army Self Description Blank	CRT	257	110		.08	.05	.07	.30	.00	-.07	.22	.10	.05	.09	.11	.07	.12	.14	.12	-.03	.09	.00	.25	.22	.15	.21
Attention to Detail I			121			.70	.92	.19	.09	.40	.17	.47	.54	.6	-.05	.06	.17	.13	.13	.21	.27	.25	.02	.09	.11	.19
II			122				.93	.24	.19	.41	.25	.60	.61	.67	.04	.20	.20	.16	.21	.32	.32	.30	.07	.10	.20	.28
Total	PRT	2374	129					.23	.16	.44	.23	.58	.62	.67	.00	.15	.20	.16	.19	.29	.32	.30	.05	.10	.17	.26
Driver Know-How	PRT	2412	130						.24	.25	.60	.23	.07	.17	.30	.28	.35	.32	.35	.16	.33	.11	.26	.18	.47	.51
Word Matching	CRT	207	140							.21	.25	.23	.25	.26	.18	.31	.20	.20	.28	.17	.27	.24	.06	.00	.32	.20
Two-Hand Coordination	PRT	2387	150								.28	.25	.31	.31	.12	.14	.21	.18	.19	64	.36	.28	.08	.14	.24	.25
Emergency Judgment	CRT	87	160									.18	.08	.14	.38	.34	.42	.41	.43	.18	.38	.17	.33	.15	.51	.38
Revised Attention to Detail I			211										.64	.91	.09	.22	.20	.16	.22	.38	.47	.35	.18	.07	.25	.23
II			212											.90	.07	.12	.10	.03	.10	.25	.26	.35	.12	.01	.16	.14
Total	CRT	271	219												.09	.19	.17	.11	.18	.35	.40	.39	.17	.04	.23	.20
Driver Judgment	CRT	280	220													.37	.32	.32	.38	.07	.26	.22	.48	.20	.46	.31
Driving Concepts I			231														.68	.68	.91	.19	.39	.24	.34	.06	.51	.34
II			232															.68	.88	.12	.35	.28	.38	.14	.53	.35
III			233																.87	.14	.41	.28	.32	.22	.48	.40
Total	CRT	278	239																	.17	.43	.30	.39	.15	.57	.41
Revised Two-Hand Coordination	CRT	284	240																		.34	.27	.17	.02	.22	.17
Inspection, Form A	CRT	273	251																			.44	.32	.11	.42	.35
Inspection, Form B	CRT	274	252																				.20	.22	.25	.24
Mechanical Principles	CRT	279	260																					.25	.43	.36
Tool Usage	CRT	277	270																						.17	.34
Aptitude Area I	APR	*	310																							.56
Mechanical Aptitude	APR	*	320																							

Note: An r of .20 is required for significance at the 1% level of confidence.
An r of .15 is required for significance at the 5% level of confidence.

* From Army Personnel Records

Table D-2

Intercorrelations of Tests of the Army Driver Selection Battery and Tests of the Experimental Battery for Selection of Indigenous Drivers - Group B(N=170)

NAME OF TEST	Army Designation		Var. No.	110	121	122	129	130	140	150	160	211	212	219	220	231	232	233	239	240	251	252	260	270	310	320
Army Self Description Blank	CRT	257	110		.13	.08	.12	.35	.28	.02	.20	.11	.10	.11	.23	.14	.22	.25	.22	-.03	.02	.14	.33	-.01	.26	.28
Attention to Detail I			121			.70	.92	.27	.35	.34	.26	.50	.46	.53	.14	.36	.32	.34	.39	.24	.25	.31	.10	.07	.25	.26
II			122				.92	.24	.43	.40	.03	.66	.59	.68	.13	.38	.33	.33	.39	.32	.35	.35	.15	.06	.32	.26
Total	PRT	2374	129					.27	.43	.40	.28	.62	.57	.65	.15	.41	.35	.36	.42	.31	.32	.37	.14	.07	.31	.28
Driver Know-How	PRT	2412	130						.40	.19	.64	.14	.18	.17	.38	.36	.30	.33	.38	.17	.33	.34	.31	.15	.57	.64
Word Matching	CRT	207	140							.21	.42	.40	.31	.39	.29	.43	.37	.39	.44	.22	.38	.40	.34	.19	.48	.39
Two-Hand Coordination	PRT	2387	150								.12	.23	.32	.30	.06	.21	.17	.25	.24	.07	.34	.23	.14	-.08	.18	.20
Emergency Judgment	CRT	87	160									.08	.09	.09	.37	.39	.30	.36	.40	.10	.28	.32	.2[illegible]	.23	.49	.55
Revised Attention to Detail I			211										.67	.92	.11	.20	.15	.09	.17	.31	.34	.38	.11	.09	.18	.20
II			212											.91	.11	.21	.15	.14	.20	.35	.34	.30	.10	.06	.17	.25
Total	CRT	271	219												.12	.22	.17	.13	.20	.36	.37	.37	.11	.08	.19	.24
Driver Judgment	CRT	280	220													.35	.30	.32	.37	.03	.26	.30	.41	.18	.48	.46
Driving Concepts I			231														.68	.71	.90	.19	.36	.46	.44	.09	.47	.47
II			232															.66	.88	.10	.26	.38	.47	.00	.45	.44
III			233																.88	.16	.30	.42	.45	.07	.49	.38
Total	CRT	278	239																	.18	.36	.40	.50	.07	.53	.49
Revised Two-Hand Coordination	CRT	284	240																		.33	.31	.07	-.06	.13	.21
Inspection, Form A	CRT	273	251																			.55	.33	.05	.42	.44
Inspection, Form B	CRT	274	252																				.35	.13	.40	.44
Mechanical Principles	CRT	279	260																					.07	.42	.47
Tool Usage	CRT	277	270																						.10	.18
Aptitude Area I	APR	*	310																							.67
Mechanical Aptitude	APR	*	320																							

Note: An r of .20 is required for significance at the 1% level of confidence.
An r of .15 is required for significance at the 5% level of confidence.

* From Army Personnel Records

Table D-3

Means and Standard Deviations of Tests
of the Army and Experimental Batteries

Test	Army Designation	Group A Mean	Group A S.D.	Group B Mean	Group B S.D.
Army Self Description Blank	CRT 257	82.79	10.54	83.38	9.72
Attention to Detail	PRT 2374	30.52	6.86	29.51	7.77
Driver Know-How	PRT 2412	21.81	7.01	21.98	7.51
Word Matching	CRT 207	40.07	8.06	39.01	8.40
Two-Hand Coordination	PRT 2387	135.21	20.30	130.85	23.00
Emergency Judgment	CRT 87	16.59	4.11	16.32	4.28
Revised Attention to Detail	CRT 271	29.22	7.25	28.68	7.19
Driver Judgment	CRT 280	7.27	3.74	7.07	3.85
Driving Concepts I		14.11	5.13	13.43	4.99
Driving Concepts II		14.69	4.08	13.98	4.53
Driving Concepts III		14.19	3.92	14.08	4.45
Driving Concepts Total	CRT 278	42.99	11.65	41.41	12.41
Revised Two-Hand Coordination	CRT 284	133.75	19.80	128.28	19.94
Inspection, Form A	CRT 273	24.22	7.36	22.83	6.95
Inspection, Form B	CRT 274	24.89	5.79	23.92	6.50
Mechanical Principles	CRT 279	13.65	4.04	12.85	4.24
Tool Usage	CRT 277	18.04	2.93	18.65	5.83
Aptitude Area I	APR*	88.99	13.60	86.68	12.77
Mechanical Aptitude	APR*	94.56	14.86	92.24	15.58

* From Army Personnel Records

In order to effect the above-mentioned double cross-validation type of analysis, it was necessary to compute the correlations between individual tests of the experimental battery and composite score on the Army battery. This was done through use of a technique presented by Flanagan (15). The method is essentially the following:

Let c represent a weighted composite using any weights W_1, W_2....., W_n as multipliers of standard measures, and

let o represent a criterion or dependent variable, and

let the numbered variables 1 to n represent independent variables being used to predict o.

Then it may be shown that

$$\sigma_c^2 = W_1^2 + W_2^2 + ... + W_n^2 + 2W_1W_2r_{12} + 2W_1W_3r_{13} + ...\text{etc.}, \text{ and}$$

if A_1, A_2.....A_n are defined as,

$$A_1 = W_1 + W_2r_{12} + W_3r_{13} + ... + W_nr_{1n}, \text{ and so forth}$$

which would result from multiplying the rows of a correlation matrix by the appropriate weights and summing for specific columns,

then

$$\sigma_c^2 = W_1A_1 + W_2A_2 + ... + W_nA_n.$$

The statistic σ_c^2 may easily be obtained, then, by multiplying the column sums by their appropriate weights and summing over all columns.

If S is defined as

$$S = W_1r_{o1} + W_2r_{o2} + ... + W_nr_{on}, \text{ then}$$

$$r_{oc} = \frac{S}{\sigma_c}.$$

This is a perfectly general formula for determining the correlation between one variable and any weighted composite of other variables. For the special case where the weights $W_1, W_2 \ldots\ldots W_n$ are the least squares regression weights (beta's), it can be shown that

$$r_{o1} = A_1,\ r_{o2} = A_2 \text{etc.},\quad S = \sigma_c^{\,2},\ \text{and}$$

$$R_{o.12\cdots n} = r_{oc} = \frac{S}{\sigma_c} = \frac{\sigma_c^{\,2}}{\sigma_c} = \sigma_c = \sqrt{\sigma_c^{\,2}} = \sqrt{S}$$

Following this method, unit weights were applied to the tests of the Army battery and the correlations between the individual tests of the experimental battery and composite Army battery score were obtained. The correlations between experimental tests and composite Army battery score, obtained in this manner, are given in Table D-4.

Table D-4

Correlations Between Experimental Tests and Composite Army Battery Score

Test	Group A (N=170)	Group B (N=170)
Revised Attention to Detail	.46	.45
Driver Judgment	.30	.38
Driving Concepts	.44	.55
Revised Two-Hand Coordination	.40	.37
Inspection, Form A	.49	.44
Inspection, Form B	.31	.47
Mechanical Principles	.29	.40
Tool Usage	.22	.15

The data contained in Table D-4 were treated in two ways. First, the standard partial regression weights for each experimental variable were computed for each subject group separately. The weights obtained from each sample were then combined with the correlations from the other sample to obtain two aggregate correlations, which may be taken as estimates of the correlation between the "best" weighted combination of experimental tests and composite score on the Army battery. These correlations were .68 and .66 for groups A and B respectively.

A second treatment given the data contained in Table D-4 involved an extension of the method described above for determining the correlation between one variable and any weighted composite of other variables. Here, composite score on the Army battery is treated as the criterion, or dependent, variable, and the tests of the experimental battery as the variables being used to predict it. Each correlation in Table D-4 may then be regarded as the correlation between a predictor and a criterion. By applying unit weights to the tests of the experimental battery, the correlation between composite scores on the two batteries was computed to be .62 and .69 for groups A and B respectively.

The Army tests are, at present, divided into two sub-batteries for operational purposes. Battery I, given at Reception Centers, consists of the Attention to Detail and Driver Know-How tests, and the Army Self-Description Blank. Battery II, given at Fort Eustis, consists of the Word Matching, Two-Hand Coordination, and Emergency Judgment tests. The correlations between composite scores on these Army sub-batteries and similar scores on three experimental batteries proposed for use with different cultural groups were computed. These correlations, along with correlations between the composite scores on the complete Army and experimental batteries, are given in Table D-5. Data are presented separately for each of two subject groups.

Table D-5

Correlations Between Composite Scores on Army and Experimental Batteries

	Army Battery I		Army Battery II		Complete Army Battery	
	Group A	Group B	Group A	Group B	Group A	Group B
Battery A	.45	.43	.57	.57	.59	.55
Battery B	.45	.60	.57	.66	.59	.6[illegible]
Battery C	.49	.56	.59	.66	.63	.68
Complete Experimental Battery	.48	.58	.58	.67	.62	.69

Reliability coefficients for new tests constructed under this project were computed by appropriate methods. For those tests which were not speed tests, the "split-half" method, corrected for length by the Spearman-Brown formula, was employed. For the two tests which were speed tests (the two Inspection tests), the correlation between separately timed halves, corrected by the Spearman-Brown formula, was used as an estimate of test reliability. The reliability coefficients so computed are shown in Table D-6.

Table D-6

Reliabilities of Newly Constructed Tests

Test	Army Designation	Number of Items	Reliability*	N
Driver Judgment	CRT 280	20	.57	348
Driving Concepts	CRT 278	60	.94	396
Inspection, Form A	CRT 273	40	.71	394
Inspection, Form B	CRT 274	40	.63	395
Mechanical Principles	CRT 279	20	.74	396
Tool Usage	CRT 27[illegible]	30	.20	390

* Corrected by the Spearman-Brown formula.

When length of test is taken into consideration, the reliabilities of five of the six tests listed in Table D-6 are satisfactory. The Tool Usage Test was not included in the proposed experimental batteries because of its unreliability.

One final point of interest concerns the order in which the revised and unrevised forms of the Attention to Detail and Two-Hand Coordination tests were administered. As was indicated earlier in this report, the revised and unrevised forms of each test were administered in a counter-balanced order. In this way part of the subject group was given the revised forms first, while the remaining subjects took the unrevised forms first. One might ask how scores on the two sets of tests compared when each form of each test was administered without the other form preceding it. Table D-7 presents means and standard deviations of scores on the revised and unrevised forms of the above-mentioned tests for two orders of testing.

Table D-7

Means and Standard Deviations of Revised and Unrevised Forms of Army Tests for Different Orders of Test Administration

	Unrevised Form Given First			Revised Form Given First		
Test	Mean	S.D.	N	Mean	S.D.	N
Attention to Detail	28.30	6.35	147	31.32	7.78	193
Two-Hand Coordination	125.59	19.10	147	138.69	22.03	193
Revised Attention to Detail	30.22	7.09	147	27.97	7.18	193
Revised Two-Hand Coordination	134.77	19.75	147	128.15	19.82	193

APPENDIX E

Review of the Literature

REVIEW OF THE LITERATURE

The Problem of Defining the Job

Although numerous driver selection studies have been carried out during the past twenty-five years, there seems to be no general agreement, even today, as to what constitutes "success" as a motor vehicle operator. A variety of operational definitions of success have been used in the development of "intermediate" criteria of driver performance.

It might be expected that the variations in criterion formulation would be accompanied by even greater differences in the types of predictor devices employed. This was found to be the case. Scores of different instruments, ranging from simple paper and pencil tests to elaborate mechanical apparatus tests, have been used in experimental, as well as industrial and military, driver selection studies.

Evaluation of these techniques through comparison of independent studies is complicated, if not obviated, by differences in the criteria employed, by conflicting results, and by a dearth of statistical analyses. Further, none of the studies reviewed reports relationships of sufficient magnitude to warrant complete acceptance of a particular predictor or combination of predictors.

A consideration of past investigations, is, however, useful as a tentative index of the value of the various criteria and predictors that have been used, and consequently of value in indicating which of these show the most promise for further research. To facilitate the limited comparisons that may be made, the studies reported herein are grouped according to the type of criterion used. The following discussion represents an attempt to point up the relative usefulness of the various techniques that have been used to predict each criterion.

Accident Indices

Studies which used some type of accident index as a criterion constituted by far the majority of studies reviewed. Since the type of accident index used varied somewhat, studies will be grouped according to the specific type of accident index employed.

Accident Frequency

Six of the studies reviewed employed raw accident frequencies as criterion measures. Bransford (5) administered the Harvard Traffic Bureau series to 481 subjects, and correlated the results with official accident reports on these subjects from 1931 - 1938. The highest correlations were obtained between accident frequency and the biographical predictors, especially annual mileage (.29), years licensed (-.24), and age (-.16). The visual and psycho-motor test correlations with accident frequency ranged from -.09 for a color vision test to .03 for a glare test. The lowest relationship was obtained between this criterion and a test of depth perception (.01). Lauer (22) obtained accident frequencies for 1014 commercial drivers from company records and personal interviews, and correlated these with scores on a battery of 13 tests. The largest correlation coefficients were obtained for education (-.17), a hearing test (-.14), a glare test (.14) and reaction time deviation (-.12). The others ranged in magnitude from .05 to .08, with astigmatism, drivometer contacts, height, and change in body resistance, reaching the latter figure. Ruch and Wilson (26) administered a battery of seven perceptual and psycho-motor tests to 530 bus and streetcar operator applicants. On the basis of their test performance, the subjects were divided into three groups. In a follow-up study, the high scoring group was found to average 1.4 accidents per year as contrasted to 2.6 for the lowest group, and 1.8 for the entire operating force. Ghiselli and Brown (17) used education, experience, age, and intelligence as predictors of accident frequency and obtained coefficients of

-.13 for experience (N=363), .05 for education (N=247), -.01 for the other two variables (N=247). Allgaier (2) analyzed 5541 AAA driving history records, and concluded that driving ability improves up to about 45 years of age and then drops off. He suggests that factors correlated with age, such as mature judgment, should be included in selection batteries. No statistical analyses are given. Cobb (8) administered some thirty predictors to 3663 subjects and correlated test scores with accident frequency, making his the most extensive investigation of all. The largest coefficients reported are for annual mileage (.199), General Aptitude (-.195), education (-.190), years licensed (.127), time to perform task (.112), and strength of grip (.102).

Accident-Repeaters vs. Volunteer Accident-Free or "Normal" Drivers

Several studies compare the test performance of groups of people classified as "accident repeaters" with performance of groups of volunteer accident-free or "normal" drivers, and report some statistically significant results. However, the value of these results is doubtful. In the first place, little information is given in regard to the composition of the volunteer groups, making comparisons relatively meaningless. Secondly, the determination of what constitutes an accident repeater is a procedure varying greatly in different studies. And as Thorndike (27), Mintz and Blum (24), and others have pointed out, it is to be expected on the basis of chance alone that some drivers will have more than one accident over a given period of time. Brody (6) defined accident-repeaters as drivers with three reported accidents over a six-year period, and compared the test performance of 26 of these with that of an equal number of accident-free drivers. Significant between-groups differences were found with respect to measures of side vision, proper passing and stopping, personality adjustment, and systolic blood pressure. Brody also suggests that proper attitudes toward traffic regulations are more important than knowledge of driving principles or overall intelligence. DeSilva (11) obtained test performance

and biographic data on 199 volunteer drivers and 56 accident repeaters. No tests of significance or correlations are reported, the author basing his conclusions on differences in the raw data. The repeaters are reported to have shown a fairly consistent deficiency in sensory-motor capacities, and also appeared to be of lower educational, economic, and social status. In a similar study, DeSilva, Robinson, and Forbes (12) administered several psycho-motor tests to 142 accident repeaters and 52 volunteers. Their results were consistent with the previous study; the repeaters manifesting deficiencies in motor skills, peripheral vision, hearing, and a number of personal history items. Again, no statistical analyses are reported. Forbes (16) administered the Harvard Traffic Bureau battery to 138 repeaters and 52 volunteers with average accident records. Significant differences were found on brake reaction time, vigilance-brake reaction time, steering, and braking-steering balance. Cleeton (7) used simulated streetcar controls and signal lights, in conjunction with distractor devices to measure the performance of high and low-accident streetcar operators. No data or statistical analyses are given, but the author concludes that such testing can select safe operators and that an attention-reaction test contributes the most to selection.

Accident-Occurrence vs. Non-Occurrence

In a number of studies an attempt was made to discriminate between drivers who had had accidents and drivers who had not. The difference between the criterion formulation used here and that used in the preceding paragraph is that here no connotation of "accident-proneness" or even of accident-repetition is present.

Weiss and Lauer (32) conducted an experiment involving 357 subjects and ten types of predictors. Ability to make automotive manipulations was measured on a driving apparatus, but a significant difference was reported only for

stopping time. Among a group of "personal tempo" tests, a rate of writing test yielded the only significant difference. All other predictors either resulted in nonsignificant differences, or were not subjected to statistical analysis. Some of the variables involved in these other predictors were speed estimation, head movements during driving, reaction time, vision, recklessness, and social characteristics. Although the results appear rather discouraging, it should be pointed out that the various tests were administered to relatively small groups, and were intended primarily as exploratory techniques. Ghiselli and Brown (18) studies 67 taxicab drivers hired during the same three month period. A battery of tests was administered at the time of application, and individuals exhibiting marked deficiencies were rejected. Nineteen drivers incurred at least one accident during their first five weeks of employment, and 48 were accident-free during the same time interval. Test scores of these groups were compared. A dotting test yielded a biserial validity coefficient of .35, a tapping test .47, and some sections of an interest inventory .20 or higher. Personal history items, a mechanical principles test, reaction speed, distance judgment, and distance discrimination were found to be relatively unrelated to the criterion.

Accident Responsibility Rating

Waits (29) attempted to determine the effectiveness of the American Transit Motor Ability Test (an apparatus test) by comparing the scores of 290 streetcar and bus operators with their "accident responsibility" records. This latter measure involved rating individuals on a five point scale of responsibility for each accident incurred. Test scoring methods were revised to maximize test validity. Tests so scored were not cross-validated. Splitting the subjects into two groups at the mean of the responsibility rates, and correlating with test scores yielded a biserial coefficient of -.54. This statistic should be interpreted with caution in view of the derivation of scoring procedures on the validation sample.

Accident Rate vs. Accident Expectancy

Kraft and Forbes (21) selected 482 streetcar operators as representative of the operating personnel of a midwestern transit company with respect to age and accident frequency. For each operator the ratio of incurred accidents to expected accidents was calculated. The expected number of accidents was defined in terms of vehicle mileage, number of hazards on each route, seasonal variation in hazards, and hourly variation in hazards. The ratios of incurred to expected accidents were compared with the personal and medical histories of the operators. Despite the corrections in the criterion, the magnitude of the relationships obtained was small.

Work Sample Criteria

Another group of studies, much smaller than the group employing accident index as a criterion, involve criteria based on observations of the subjects' driving behavior. In the studies considered below, these behaviors are recorded on pre-constructed check-lists during the course of a standardized road test.

Johnson and Evans (20) defined driving ability in terms of performance on a four-mile road test. Subjects were rated on a check-list, and classified as "good" or "poor" according to their standing in the upper or lower half of the sample. Nine tests of reaction time and vision were administered, and reliability and validity coefficients obtained. Split-half reliability coefficients ranged from .736 for foot-braking time to .901 for simple reaction time. Two groups of subjects were employed. For the first sample, consisting of 140 War Department drivers, speed-of-foot movement was the only valid predictor, and it was also significantly correlated with the other tests. In a second trial on 38 Iowa State College students, speed-of-foot movement, choice reaction time, and foot reaction time each correlated significantly with the criterion. Again, the test

intercorrelations were high. Tests of light and dark adaptation rates yielded no significant relationships to road test performance in either subject group. A report of research conducted by the Adjutant General's Office (1) summarizes the findings of approximately 40 studies carried out at several Army installations. A road test described in this report consisted of standardized tasks on which errors could be observed and recorded objectively. The split-half reliability of the road test was computed as .82 in a sample of 155 cases. A correlation of .53 was obtained between a road test used as a predictor and a criterion road test. The two road tests were separated by an interval of three months. On a sample of 282 drivers, a Driver Experience Inventory correlated .26 with the road test criterion. Bartelme, Fletcher, Brown, and Ghiselli (3) administered a road test that involved tests of a) driving forward and backward 100 feet on a straight line; b) driving forward and backward in a narrow lane; c) aligning a car with marks on the roadway; and d) brake reaction time and stopping distance. Eight paper and pencil and performance tests were correlated with total road test score on subject samples ranging in size from 128 to 217 persons. The largest coefficients were obtained for distance discrimination (.21) and steering (.20), the others varied between .02 and .08. When the samples were broken down into sub-groups according to type of vehicle driven (light, medium, heavy), most of the coefficients increased in magnitude. Thus, for operators of light vehicles (N between 37 and 72), distance discrimination correlated .46 with the criterion, the paper-pencil test battery .24, and steering .23.

Rating Scale Criteria

Lauer (23) used ratings of drivers, obtained through use of a criterion instrument developed by the Adjutant General's Office (28), to validate a number of driver selection tests. The rating form consisted of a "halo" scale on

Appearance and Military Bearing, intended as a suppressor to draw off personal feelings, rating scales on Near Accidents, Reaction to Sudden Changes, Effect of Temper on Driving, and Knowledge of Own Limitations, and a check list of 15 undesirable driving habits. The rating instrument is so scored that a low total score is indicative of good performance. The predictor battery was developed and modified on the basis of three series of try-outs. In the last try-out the battery was validated on a sample of 331 Army drivers. The results are given in Table E-1 below:

Table E-1

Validities of 12 Predictors of Ratings of Driver Performance

Variable	Validity Coefficients
1. Word Matching	-.13
2. Lateral Perception	-.15
3. Emergency Judgment	-.19
4. Driver Know-How	-.28
5. Difference Detection	-.15
6. Two-Hand Coordination	-.20
7. Visual Acuity	-.14
8. Attention to Detail	-.29
9. Driver's Self Description Blank	-.18
10. Composite PRT 565	-.12
11. Mechanical Aptitude (from Army Classification Battery)	-.23
12. Automotive Information (from Army Classification Battery)	-.24

Goldstein, Van Steenberg, and Birnbaum (19) used the same criterion as the one described for Lauer's study above to evaluate seven predictors of driver performance. These were: a Reaction to Signals Test, a Hidden Figures Test, an Attention to Detail Test, a Speed of Marking Test, a Path Tracing Test, a Two-Hand

Coordination Test, and a Driving Know-How Test. Of these, performances on Path Tracing, Two-Hand Coordination, and Driving Know-How Tests were reported to have been "moderately" related to criterion scores (r=.21, .21, .32 respectively). The validation study was carried out on a sample of 200 drivers, each having been rated on the criterion instrument by at least four raters.

Summary and Conclusions

As was pointed out in the introductory remarks to this section, the results so far obtained in driver selection studies do not warrant acceptance or rejection of any particular criterion measure or prediction device. There is reason to believe that the ultimate criterion of driver effectiveness is extremely complex. Such diverse factors as accident rates, driving skill, personality traits, and attitudes are undoubtedly parts of this ultimate criterion. However, more information as to the proportion of the ultimate criterion variance attributable to each of these components of driver performance is needed before improved criterion measures can be developed, and the relative validities of specific predictors can be more precisely determined.

Estimating the ultimate usefulness of the predictors reviewed would require knowledge of the reliabilities of these instruments and of the various criteria employed. Unfortunately, reliability data for the tests and criterion measures investigated are not reported in the majority of the studies reviewed.

One conclusion of practical importance may, however, be formulated on the basis of present information. Results obtained with paper and pencil tests and personal history items have compared favorably with those obtained from apparatus tests. In view of the greater cost of constructing mechanical apparatus tests, then, it seems reasonable to focus research on the paper-pencil type instrument.

Also, some specific areas for research are indicated. In the discussion of the "accident-repeater" vs. "normal accident" group type of criterion, it was noted that individual differences in accident frequency are to be expected in any population on the basis of chance alone. It would be desirable to carry out investigations with groups selected by means of procedures which take such chance factors into consideration.

The need for more rigorously defined criteria of driving performance seems to be great. It would seem most profitable to orient criterion development efforts toward the determination of specific driving behaviors which may be used to define "successful" driving performance.