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Operator Proficiency in Interpreting Ground Surveillance Radar Signals (AN/TPS-33)

by

Alfred J. Kraemer, David L. Easley,
Arthur L. Miller, and Paul H. Stevenson

U.S. Army Armor Human Research Unit
Fort Knox, Kentucky

Under the Technical Supervision of

The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
operating under contract with
THE DEPARTMENT OF THE ARMY

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SUBJECT: Operator Proficiency in Interpreting Ground Surveillance Radar Signals (AN/TPS-33)

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ARLINGTON, VIRGINIA 22314

1. The attached report is for your information and retention.

2. This report concerns a study made to measure the proficiency of operators in identifying signals of representative military targets produced on the AN/TPS-33 radar set.

3. This report is considered applicable and should be of interest to those concerned with combat surveillance and target acquisition matters.

4. It is desired that interested agencies review this report with a view toward making recommendations based on local experience with AN/TPS-33. Any comments or recommendations should be processed through appropriate headquarters.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

HERALD B. GALLINGER
Lt. Colonel, GS
Actg Chief, Human Factors and
Operations Research Division

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Report

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Approved:

NORMAN WILLARD, Jr.
Director of Research
U.S. Army Armor Human Research Unit
Fort Knox, Kentucky

WALTER J. DAVIES
Lt. Col., Armor Chief
U.S. Army Armor Human Research Unit
Fort Knox, Kentucky

MEREDITH P. CRAWFORD
Director
Human Resources Research Office

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HUMAN RESOURCES RESEARCH OFFICE
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CREDITS

Lt. Col. George H. Spires, Jr., was Military Chief of the Armor Unit during conduct of the research and preparation of this report.

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PROBLEM

The primary objective of this research was to measure the proficiency of trained AN/TPS-33 radar operators in identifying targets from the audio signals produced by the radar equipment. If the proficiency of the operators who had been tested was found to be not so high as the Army desired, exploratory work would be undertaken on training in signal interpretation.

METHOD

A test, consisting of audio signals generated by a variety of targets on the AN/TPS-33 radar set, was constructed and administered to 43 AN/TPS-33 radar operators in the Seventh Army. Twenty-eight of the operators had been trained at the Combat Surveillance and Target Acquisition Training Command (CSTATC), Fort Huachuca, Arizona, and 15 had been trained on the job. The 120 target signals for the test were recorded while representative military targets were moving within the beam of the radar, at various distances and speeds. All recording was done under the most favorable conditions, so that only skills involved in auditory perceptual judgment (signal interpretation) would be measured by the test.

After the results of the above measurement had shown that the field operators were not able to discriminate between tracked and wheeled vehicles, a training experiment was run to determine whether naive subjects could be taught to identify vehicle types on the basis of the unique characteristics of the signals on the radar. Ten junior-grade officers having no previous experience in hearing such signals were trained by means of taped recordings of audio signals produced by the AN/TPS-33 radar. The subjects were then tested on their ability to identify signals similar to those included in the training exercises.[1]

RESULTS

AN/TPS-33 radar operators were able, on the average, to discriminate between vehicles and troops on 92% of the signals. However, their average accuracy in distinguishing between tracked and wheeled vehicles was 52%—no better than chance. There were no differences of consequence between operators trained in school at the CSTATC and those trained on the job.

The AN/TPS-33 radar operators most frequently identified signals of vehicles traveling at the slowest speed as those of tracked vehicles, and signals of vehicles traveling at the fastest speed as those of wheeled vehicles, regardless of the actual vehicle type.

[1]Copies of training and test tapes and printed answers have been supplied to USCONARC, CSTATC, and the U.S. Army Armor School.

Naive subjects, after receiving experimental training in signal interpretation, were able to discriminate between signals for tracked and wheeled vehicles at a level that was significantly better than chance.

There was wide variation in the ability of individual subjects to distinguish accurately between radar signals for tracked and for wheeled vehicles both during training and during testing.

CONCLUSION AND IMPLICATIONS

Although the quality of the signals was far superior to that normally found under field conditions, the data obtained in this study do not substantiate the widely held belief that experienced ground surveillance radar operators can distinguish between signals generated by tracked vehicles and signals generated by wheeled vehicles.

At present, operators appear to be basing their identification of type of vehicle (tracked or wheeled) on characteristics of the audio signal that are caused by the speed of the vehicle. Since each type of vehicle contributes unique characteristics to the audio signal, additional training emphasis needs to be given to distinguishing between the vehicle characteristics and the speed characteristics of the audio signal.

Naive operators can be taught to discriminate between the signals produced on the AN/TPS-33 radar by tracked and by wheeled vehicles.

The wide but consistent individual differences in performance found in the exploratory training study suggest that to obtain a high level of performance from ground surveillance radar operators in discriminating between signals of different types of vehicles may be a problem of selection as much as or more than a problem of training.

While the data on this study were collected on the AN/TPS-33 radar, the implications may also apply to other ground surveillance radars insofar as their audio signals are comparable to those of the AN/TPS-33.

RECOMMENDATIONS

1. It is recommended that training for operators of the AN/TPS-33 ground surveillance radar or equipment having similar signal characteristics[a] include increased emphasis on distinguishing between the signals of tracked and wheeled vehicles.

2. It is recommended that criteria, based on aptitude for identifying audio signals, be established for selecting operators for radar equipment having signal characteristics similar to those of the AN/TPS-33 equipment.

[a]Training of ground surveillance operators is guided by Army Subject Schedule 17-13.

DESCRIPTION
OF THE RESEARCH

Operator Proficiency in Interpreting Ground Surveillance Radar Signals (AN/TPS-33)

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OBJECTIVE

Ground surveillance radar operators must be skilled in detecting, locating, and identifying moving targets. The purpose of the present study was to measure the proficiency of AN/TPS-33 operators in one of these three skills—the ability to identify targets from the characteristics of the audio signals produced on the radar. If the proficiency of the tested operators was found to fall below the level desired by the Army, exploratory work on development of improved training methods for signal interpretation would be undertaken.

BACKGROUND

Ground surveillance radar of the AN/TPS-33 type is used, particularly during conditions of limited visibility, to augment the surveillance capability of military units such as armor battalions and infantry battle groups. Because target information on this radar is presented by an audio signal, the proficiency of the operator in interpreting target signals determines the usefulness of the system.

The AN/TPS-33 is a medium-range radar that detects moving targets in line of sight, with a maximum range of 18,000 to 20,000 meters. The radar set, when in place, consists of a rotary antenna, antenna drive, and transmitter mounted on a pedestal. A telescope is mounted on the antenna to provide an optical axis for the orientation of the radar set. A control box is connected to the set by a 150-ft. cable to permit remote-control operation; thus, the operator can perform his job from a covered and concealed position removed from the antenna site. The radar has two beam widths, 10° for searching and 3° for tracking.

The ground surveillance radar is designed to detect moving targets, such as vehicles and personnel, which are indicated by audio tones in the operator's headset. The operator can analyze these audio tones to determine the type and speed of the detected target.

No formal program of instruction in signal interpretation exists for ground surveillance radar operators. Training is specified very generally in Army Subject Schedule 17-133,[1] the objective of which is to qualify such operators for duty in all Active Army and Reserve component units as authorized by TOE or TD.

[1]Department of the Army, *MOS Technical Training of Ground Surveillance Radar Operators, MOS 113.1, MOS 133.1*, ASubjScd 17-133, Washington, March 1961.

It has generally been thought that radar operators can readily discriminate between audio signals produced on the ground surveillance radar sets. However, preliminary examination of the nature of the target signals indicated that special training may be required before operators can be expected to achieve a high degree of proficiency in interpreting the radar signals.

Initially, the researchers planned to use the short-range AN/PPS-4 radar set to produce the target signals for this study, but the AN/TPS-33 was substituted because it was more readily available at the time this phase of the study was undertaken. The aural display of this equipment is similar enough to both the AN/PPS-4 and the AN/TPS-25 (another medium-range set) that the data obtained in the present study may be applicable to these sets, as well as being of interest in connection with other sets under development.

MEASUREMENT OF PROFICIENCY

Method

Only skills involved in auditory perceptual judgment (signal interpretation) were to be measured in testing operator proficiency. Therefore, no attempt was made to duplicate all field conditons in recording the target signals to be used in testing proficiency; instead, efforts were directed to employing optimum signal returns.

The study of operator proficiency was carried out in three steps. First, target signals produced on the AN/TPS-33 radar set were recorded on master tapes. Second, a proficiency test of signal interpretation was assembled, using the taped sounds. Finally, the test was administered to a sample of AN/TPS-33 ground surveillance radar operators.

Preparing the Signal Sample

A sample of signals that radar operators might be expected to identify was recorded at Fort Knox, Kentucky. Targets were selected from the list supplied in Army Subject Schedule 17-133. The speed, number, and direction of movement of the targets were varied to produce the kinds of target variations that would occur during typical surveillance missions. Vehicle targets were recorded at three locations, so that both background (amount and type of foliage) and distance (2,400, 5,600, and 14,500 m. from the radar position) could be varied. Personnel targets were located at a fourth site approximately 100 meters from the radar, which had been moved to ground level.

Over all, 96 combinations of vehicle target variables were run The vehicles at the nearest and farthest sites moved toward and away from the radar along a line that cut the axis of the beam at a 30° angle; targets at the intermediate site moved, for most of the run, along a line parallel to the axis of the beam. Personnel targets were recorded moving toward the radar.

The types of moving targets and the combinations of variables recorded were as follows:

Targets	Speeds	Distances
Vehicles	5, 10, 15, and 20 mph	2,400, 5,600, and 14,500 m.
2 M48A2 tanks		
1 M48A2 tank		
2 jeeps		
1 jeep		
2 APCs		
1 APC		
2 2 1/2-ton trucks		
1 2 1/2-ton truck		
Personnel	Marching and running	100 m.
Infantry squad (12 men)		
4 men		
1 man		

Each vehicle target was recorded once at each distance at each of the four speeds (5, 10, 15, and 20 mph). The three personnel targets were recorded at 100 meters once at each rate of movement (marching and running).

The areas used for producing the vehicle signals were selected because they provided good roads and the necessary lines of sight to the beam of the radar, which was placed on the roof of an 11-story building at Fort Knox. Radio communication between the radar site and the target sites was maintained during the recording sessions.

Three AN/TPS-33 radar operators, who had been trained at Fort Huachuca, worked two at a time to operate the set during the recordings. Recordings were made directly from an output socket of the set. Headphones connected to a second output socket enabled the operator to track the moving vehicle and monitor the quality of the signal.

To preclude any other vehicular movement in the run areas, road guards were stationed at the perimeters of these areas. In addition, the areas had been chosen so that all roads or paths within the 90-meter range gate of the radar could be monitored. To further restrict the area in which movement was being detected, the narrow 3° beam of the radar was used.

At the beginning of each recording session, the radar was ranged in on the target site by running one vehicle through a set of stopping and starting maneuvers. During these recording runs, all movement of vehicles and personnel was monitored by observers to ensure that they were following the prescribed courses.

All recordings were made with a tape recorder (Ampex Model 601-2), using low print-through Mylar tape of 1 1/2 mils because of its high resistance to stretching under conditions of excessive heat and dampness. The quality of the recorded signal was monitored from a

headset connected to the tape output of the recorder. To prevent later confusion, a voice announcement of the identity of the target signal was recorded on the tape immediately preceding the target signal. During the recording of the signals, the microphone input was disconnected to preclude pickup of any noise that occurred in the recording room.

Assembling the Proficiency Test

The recorded target signals were assembled to make up the proficiency test. The items available for the test consisted of 96 recordings of vehicle targets (the same eight vehicle targets, recorded at four speeds at each of three sites), and 6 recordings of personnel targets (some of which were used twice). The 32 vehicle items for one distance and a set of 8 personnel items were used to make up each of three parts of the test, which thus contained three groups of 40 items each.

Each item in a group was randomly assigned a number from 1 to 40 to determine the order of presentation of the target signals on the tape. A voice announcement of the number of each item was recorded on the master tape, preceding and following the appropriate signal.

Initially, signal lengths of 30 to 45 seconds were used, with intersignal intervals of 30 seconds. Since a pretest of six operators at Fort Benning, Georgia, indicated that these times could be reduced, the recorded signal for the test lasted approximately 30 seconds. The interval between items was approximately 30 seconds for the first 10 items, and approximately 15 seconds for the remaining 30 items.

Administering the Proficiency Test

The test was administered to 43 AN/TPS-33 radar operators in the Seventh Army at various sites during August 1961. School training had been given to 28 of these operators at Fort Huachuca and the remaining 15 operators had been trained on the job. The sample included all operators available at the time of the study.

The operators' experience varied widely in amount and type. The amount of relevant experience was generally dependent upon when the unit had received ground surveillance radar sets. Some operators had been limited to such duties as the setting up of equipment and the general operation of the system, rather than the detection and identification of targets, but all men in the sample were assigned as AN/TPS-33 operators at the time of testing.

The test was administered to the operators in groups. The size of a group depended on the number of operators who reported for testing at a given location, eight men being the maximum. Seating arrangements precluded sharing of information by the operators.

The test tape was played on the Ampex Model 601-2 tape recorder. The signal from the recorder was fed through an amplifier (Knight Model KN-400) to which a junction box was connected. Shielded audio-cables led from this junction box to individual volume control boxes, the headsets were also connected to the control boxes. The actual AN/TPS-33 headset was used by 36 operators, and 7 operators,

for whom AN/TPS-33 headsets were not available, used hi-fi headsets (Knight Model KN-400).[1] Since the maximum volume possible on the control boxes was uncomfortably loud, operators were instructed to adjust the sound intensity to a comfortable level. Throughout the test, the quality of the playback signal was monitored by the test administrator.

Part of an answer sheet is reproduced in Figure 1. Subjects were required to make several choices on each item—first on general and then on more specific categories of target information. On each item, the operator first chose between "vehicles" and "troops." If he chose "vehicle," subsequent choices led to more specific identification, and then to estimates of speed and number of vehicles. If the choice was "troops," subsequent choices led to estimates of number and speed. For

Answer Sheet for Proficiency Test

SIGNAL IDENTIFICATION TEST FOR GROUND SURVEILLANCE RADAR OPERATORS

Part _____ No. _____
Date _____ Start _____

Last Name | First Name | MI | Rank | MOS | Organization | Date of Birth

(a) "I'm very sure" (b) "I'm pretty sure" (c) "I'm not sure" (d) "It's a guess"

Test Item 1

Vehicle a b c d
- Tracked a b c d
  - Tank a b c d
  - APC a b c d
- Wheeled a b c d
  - Truck a b c d
  - Jeep a b c d

5 Mph a b c d
10 Mph a b c d
15 Mph a b c d
20 Mph a b c d

Number of Vehicles
One a b c d
Two a b c d

_____ Troops a b c d
- Marching a b c d
- Running a b c d

Number of Troops
One Man a b c d
Four Men a b c d
Squad of Men a b c d

Test Item 2

Vehicle a b c d
- Tracked a b c d
  - Tank a b c d
  - APC a b c d
- _____
- Wheeled a b c d
  - Truck a b c d
  - Jeep a b c d

5 Mph a b c d
10 Mph a b c d
15 Mph a b c d
20 Mph a b c d

Number of Vehicles
One a b c d
Two a b c d

_____ Marching a b c d

Number of Troops
One Man a b c d

Figure 1

[1]Analysis of results showed that the group using the hi-fi headsets performed at about the same level as the group using the AN/TPS-33 headsets.

each category, the subject marked the degree of confidence—(a) through (d) on the answer sheet—with which he made the response.

A practice tape of 5 items was administered to make certain that the operators understood how to record their answers during the test. The subjects were monitored throughout the test to ensure that they followed instructions and did not share information. Rest periods of approximately five minutes were scheduled after every 20 items.

Results and Discussion

The percentages of correct responses made by the operators on the test are shown in Table 1. The operators had little difficulty in discriminating between vehicles and troops; their average performance level at this stage was 92%. However, their average accuracy in discriminating between tracked and wheeled vehicles (52%), and between types of tracked or wheeled vehicles, was approximately what could be expected on the basis of guessing alone. Although the percentage of correct identifications was somewhat higher in specialized categories dealing with numbers and speed of movement, these data have only limited value because so many operators were not able to make the primary discriminations.

Table 1

Percentage of Correct Responses on the Proficiency Test for All Operators
(N = 43)

Choice	Chance Score[a]	Number of Responses[b]	Actual Score[b]	Standard Deviation
	%		%	
Vehicle(s) or Troops?	50	4,880[c]	91.9	5.7
If Vehicle(s)—				
Tracked or wheeled?	50	1,855	52.4	4.2
If tracked— tank or APC?	50	697	49.2	17.3
If wheeled— truck or jeep?	50	1,120	50.0	11.1
Correct mph	25	3,855	38.0	8.5
Correct number	50	3,855	61.1	7.6
If Troops—				
Marching or running?	50	639	69.5	19.9
Correct number	33	639	45.9	16.6

[a] Percentage of correct responses that would be expected on basis of guessing.

[b] Each computation is based on number of correct responses to the preceding more general question (e.g., the calculation for "Tank or APC" was based on the number (697) of correct responses ("Tracked") on the preceding question, "Tracked or Wheeled Vehicle").

[c] Of the 5,160 possible responses, only 4,880 were available for analysis. Some items or parts of items were omitted or mismarked by operators taking the test, and one operator made no response in three categories throughout the test.

The low over-all performance of the group was not anticipated, especially since the quality of the signals in the test was far superior to that which radar operators would encounter under most field conditions. There were only small differences in performance between operators trained on the job and those trained at Fort Huachuca (see Appendix A).

The answers of the operators indicated that, as a group, they thought they were not guessing. It can be seen in Figure 2 that they felt "very sure" or "pretty sure" of the majority of their responses. The more specific the category, the less confident the operators tended to be.

Further evidence that the operators were not guessing in making their choices is to be found in an analysis of the responses to each signal. Had the operators been guessing, there should have been no consistent pattern of responses. Generally, however, regardless of vehicle type, signals of vehicles traveling at the slowest speed were most frequently identified as those of tracked vehicles, and signals of vehicles traveling at the fastest speed were most frequently identified as those of wheeled vehicles. For example, signals produced by a tank moving at 5 miles per hour were correctly identified in 40 responses (31%); there were only 10 situations (7%) in which these signals were considered to be those of a jeep. The signal of a tank moving at 20 miles per hour, on the other hand, was identified as that of a tank in only 5 responses (4%) and as a jeep in 57 responses (46%).

The effects of speed of movement upon correct identification are summarized for tracked and wheeled vehicles in Figure 3. The detailed data on frequency of responses for all types of targets are presented in Appendix B.

It appears that the operators were basing their vehicle identification solely on signal characteristics due to the vehicle's speed. They retained this association between speed and vehicle identification despite the fact that for all types of vehicles the dominant pitch of the signal rises as speed increases. There are, however, other characteristics of the target signal for each type of vehicle that remain unique and unchanged regardless of speed. Familiarity with these characteristics presumably would help operators to make more reliable identifications of tracked and wheeled vehicles. The patterns of response choices suggested that the poor performance might have been due, at least in part, to the misconception, acquired during training, that the dominant pitch of signals for wheeled vehicles is always higher than the dominant pitch of signals for tracked vehicles, regardless of vehicle speed.

Measurement of the proficiency of AN/TPS-33 radar operators not only showed that their average level of performance in distinguishing between tracked and wheeled vehicles was about the percentage that would have resulted from guessing, but also provided indications of some sources of operator weaknesses in interpreting signals. Exploratory work toward possible methods of improving training in interpretation therefore was undertaken

Operators' Degrees of Confidence in Making Responses

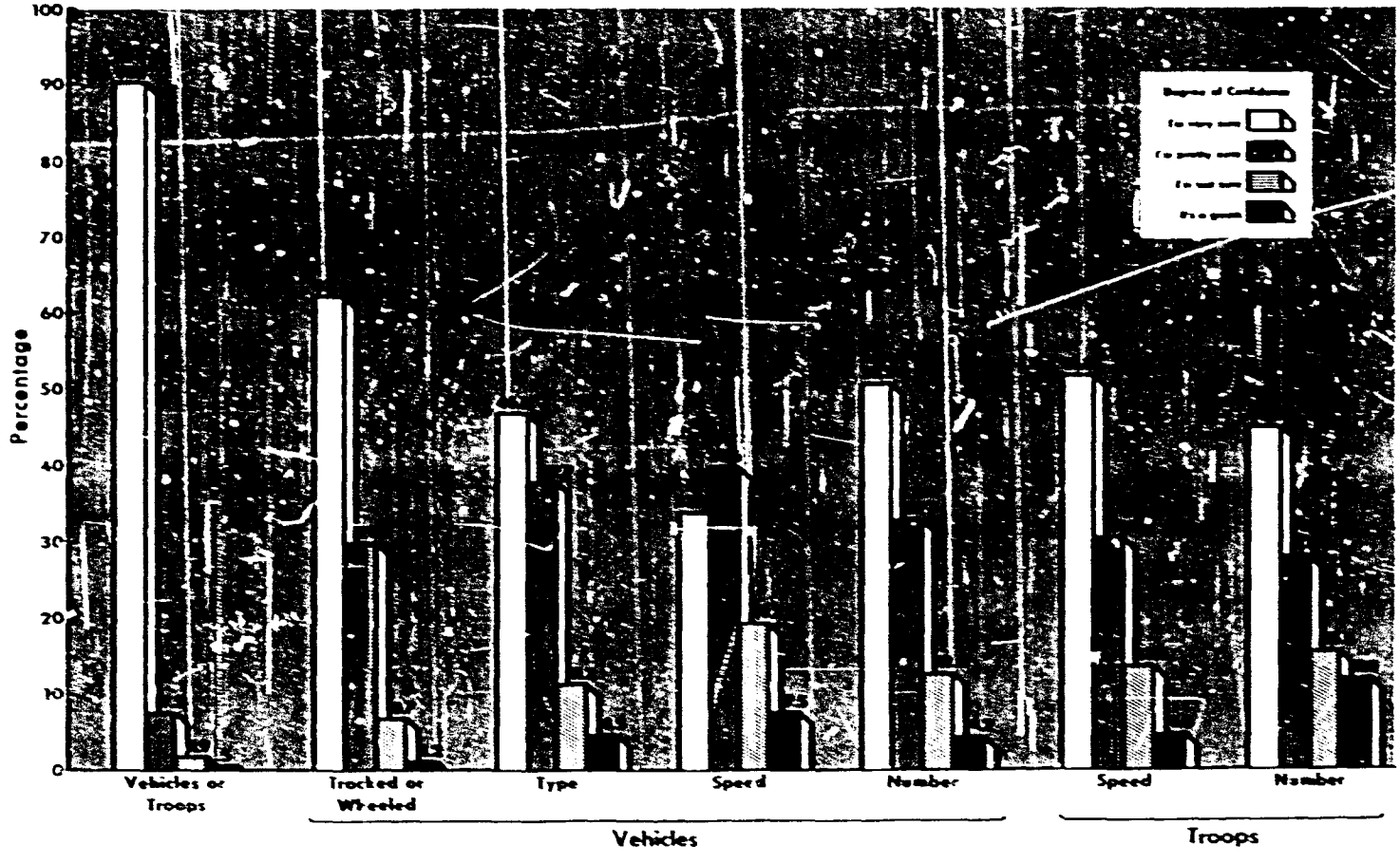

Figure 2

Effects of Speed of Movement Upon Correct Identification of Tracked and Wheeled Vehicles

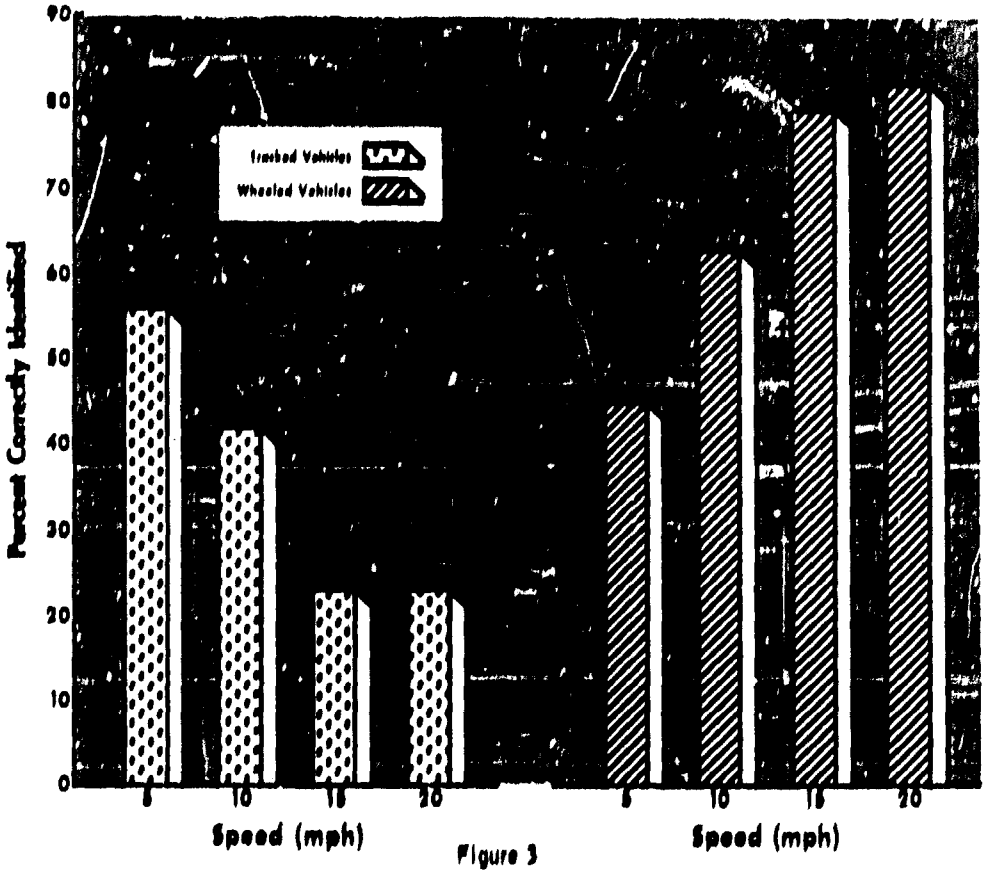

Figure 3

EXPLORATORY STUDY IN SIGNAL INTERPRETATION TRAINING

As a first step in developing improved training for ground surveillance radar operators, an exploratory study was conducted to determine whether naive operators can be taught to base their identifications of vehicle type on the characteristics of the signal that remain unique and unchanged regardless of vehicle speed.

Method

There were two steps in the experiment. First, exercises to be used in training operators to discriminate between tracked and wheeled vehicles were constructed from the signals that had been used in the proficiency measurement study. Second, naive subjects were trained by means of these exercises and were then given a criterion test to determine the level of their performance in making the discrimination.

Training Exercises

Tapes were developed to give the student practice in discriminating between signals for tracked and for wheeled vehicles. The tapes provided a pause for student response followed by announcement of the correct identity of the signal.

To facilitate learning the signal characteristics peculiar to each vehicle type, two schemes were employed in constructing the training exercises: (1) Signals for tracked and wheeled vehicles were presented in pairs, so that the characteristics of the two types of signals could be readily compared. (2) Because vehicle speed and number of vehicles, as well as the type of vehicle, determine the characteristics of the audio signal, the exercises were ordered so as to bring in these additional characteristics gradually. Initial exercises presented signals with only those differences that are due to vehicle type; later exercises added the characteristics attributable to vehicle speed and number of vehicles (see Table 2).

Table 2

Paired-Signal Exercises, Showing Gradual Increase in Complexity of Signals Presented on Tapes

Paired Signal Exercise*	Number of Vehicles Compared in Each Item of Each Exercise	Speeds (mph)	Speeds Being Compared Within a Given Item
1	1 with 1	10	Same mph
2	2 with 2	15	Same mph
3	1 with 1	5 to 20	Same mph
4	1 with 1	5 to 20	Different mph
5	1 with 1 or 2 with 2	10	Same mph
6	1 with 2	15	Same mph
7	1 with 1 or 2 with 2	5 to 20	Same mph
8	1 with 1 or 2 with 2	5 to 20	Different mph
9	1 with 2	5 to 20	Same mph
10	1 with 2	5 to 20	Different mph

*Each item in an exercise contains a signal from a tracked vehicle and a signal from a wheeled vehicle for comparison of signal characteristics. Appendix C lists the exact signals used in each item of each exercise.

Twenty training-exercise tapes were constructed, each consisting of a series of 20 recorded audio signals produced by vehicle targets. In addition, an orientation tape, consisting of 24 signals, was constructed to familiarize the subjects with the variety of vehicle signals on which they were to be trained and tested.

On 10 of the exercise tapes the audio signals were presented singly; on the other 10 tapes the signals were presented in pairs. For the signal pairs, one signal was produced by a tracked vehicle and the other by a wheeled vehicle. Single-Signal Exercise 1 consisted of the same 20 signals used in Paired-Signal Exercise 1; Single-Signal Exercise 2 contained the 20 signals used in Paired-Signal Exercise 2; and so on. The signals used in the exercises are shown in Appendix C.

Signals for all 32 vehicle items from the proficiency measurement phase were used. Because of background conditions and siting during the recording of the master tapes, the clearest signals had been obtained for vehicles run at the location farthest from the radar (14,500 m.). Therefore, most of the signals selected for the training experiment were from the more distant locations.

On each tape every item was assigned a number and a voice announcement of the number was made at the beginning of each item. After the target signal or pair of signals, there was a short interval of silence during which the student could identify the signal on an answer sheet; then the signal or signals were identified by voice announcement on the tape. In the orientation tape, the identity of the signal was announced before the signal was heard by the subject.

Criterion Test

Two forms of a criterion test were constructed, each containing 32 signals. Since several recordings of each signal had been made for the proficiency study, it was possible to use similar but not identical signals of the same targets and thus to construct two nearly equivalent forms of the test. Insofar as possible, the signals used in the test were not identical with those used for the training exercises. The format and the method of recording the test were the same as they were for the exercises, except that no identification was recorded on the criterion test tapes. The signals used for the test are listed in Appendix D.

Subjects

Although ground surveillance radar operators are enlisted men, officers were used as subjects in the exploratory study. At that time no formal training program for the operators was being conducted and it was difficult to find enlisted men eligible for such training to serve as subjects for the experiment. However, because the purpose of this particular experiment was simply to discover whether it is possible to teach signal discrimination to naive subjects, it was not deemed necessary to use potential trainees as subjects. Also, it appeared that the time invested would yield the greatest return if a comparatively small number of junior-grade Army officers were used as subjects, as it has frequently been observed that they are in general, more highly motivated in performing experimental tasks than are randomly selected enlisted men.

Ten junior-grade Army officers, therefore, served as subjects for the experiment. They had no known auditory defects and no previous experience in listening to radar signals.

Apparatus

Both training and testing were conducted in a quiet room. The tapes were played on the Ampex Model 601-2 tape recorder. The signal from the recorder was fed through the Knight Model KN-400 amplifier to the headsets. Six subjects used the Knight Model KN-840 hi-fi headsets, and four subjects used the AN/TPS-33 headsets. A volume-control box was provided for each headset.

Procedure

Subjects were trained and tested two at a time. They were first briefed on the radar system and the nature of the task, but were not verbally instructed on signal characteristics. The orientation tape was then played, after which the experimenter discussed the subjects' impressions of the signals and answered their questions.

The two-day schedule of training and testing is shown in Table 3. Two sequences for presenting the exercises were employed, with half the subjects assigned to each training sequence. In Sequence A, the single-signal exercise was presented before the corresponding

Table 3

Sequence of Administering Exercise Tapes and Criterion Test

Sequence	Sequence A		Sequence B	
	First Day	Second Day	First Day	Second Day
Morning	Orientation Tape	Exercise Tapes Paired 1	Orientation Tape	Exercise Tapes Paired 1
	Exercise Tapes	Paired 2	Exercise Tapes	Paired 2
	Single 1	Paired 3	Paired 1	Paired 3
	Paired 1	Paired 4	Single 1	Paired 4
	Single 2	Paired 5	Paired 2	Paired 5
	Paired 2	Single 6	Single 2	Paired 6
	Single 3	Paired 6	Paired 3	Single 6
	Paired 3	Single 7	Single 3	Paired 7
		Paired 7		Single 7
Afternoon	Exercise Tapes	Exercise Tapes	Exercise Tapes	Exercise Tapes
	Single 3	Paired 7	Single 3	Paired 7
	Single 1	Single 8	Single 1	Paired 8
	Single 4	Paired 8	Paired 4	Single 8
	Paired 4	Single 9	Single 4	Paired 9
	Single 5	Paired 9	Paired 5	Single 9
	Paired 5	Single 10	Single 5	Paired 10
		Paired 10		Single 10
	Criterion Test*	Criterion Test	Criterion Test	Criterion Test

*Forms A and B of the Criterion Test were each given to half of the students on the first days, and were alternated on the second days

paired-signal exercise. In Sequence B, the paired-signal exercises were presented first. For both sequences, reviews were given at the beginning of the afternoon sessions and at the beginning of the second day. Rest periods of from 5 to 15 minutes were given between exercises.

The subjects were tested at the end of each day. One member of each pair was given one of the test forms on the first day, and the other form on the second day; the sequence was reversed for the other subject in each pair.

Results and Discussion

The mean criterion test scores for the entire group were 61% for the first day and 70% for the second day. The group's performance on the first day's test was significantly better than chance ($t = 3.01$, $p < .02$). Thus, the results show that it is possible to teach naive subjects the characteristics by which signals of tracked and wheeled vehicles may be distinguished. (See Appendix E.)

After analysis showed that differences in performance due to type of headset used were negligible, data were grouped without regard to the type of headset used. The test scores made by the group trained in Sequence A (which averaged 66% on the first day and 76% on the second day) were consistently higher than those made by the group trained in Sequence B (which averaged 56% on the first day and 64% on the second day). This consistency seems worth noting even though, because of the small size of the two samples, differences cannot be assigned any statistical significance.

Inspection of the scores made by individual subjects during the training exercises provided information on the pattern of individual performances. The range of individual scores made by the subjects on the various training exercises is shown, with the group means, in Appendix F. As might be expected, subjects who did well on the exercises also did well on the criterion tests. Wide differences in performance between subjects were evident during both training and testing. These differences were consistent, in that subjects whose average performance was poor tended to be consistently poor—that is, they scored poorly whenever scores were recorded—and those whose average performance was good were consistently good. The correlation of .71 between the criterion test scores for the first and second days gives further indication of individual consistency of performance.

In summary, it has been found that, with training, it is possible to obtain an average performance in target discrimination that is significantly better than chance. However, the wide, consistent differences in performance observed between individual subjects suggest that obtaining a high level of performance may be much more a problem of selection than of training. An effective combination of selection and training procedures should produce AN/TPS-33 operators who can discriminate between the signals of tracked vehicles and those of wheeled vehicles.

APPENDICES

Appendix A

PERCENTAGE OF CORRECT RESPONSES BY TYPE OF OPERATOR TRAINING

Item	Chance Score[a]	Operators Trained at Fort Huachuca (N = 28)			Operators Trained on Job (N = 15)		
		Number of Responses[b]	Actual Score	Standard Deviation	Number of Responses[b]	Actual Score	Standard Deviation
	%		%			%	
Vehicle(s) or Troops?	50	3,120	92.6	5.9	1,760	90.7	5.2
If Vehicle(s)–							
Tracked or wheeled?	50	2,468	52.4	3.8	1,387	52.4	4.9
If tracked– tank or APC?	50	434	50.6	19.4	263	46.7	12.9
If wheeled– truck or jeep?	50	857	47.9	10.7	463	54.0	11.1
Correct mph	25	2,468	38.2	8.0	1,387	37.7	9.6
Correct number	50	2,468	61.9	7.9	1,387	59.7	7.0
If Troops–							
Marching or running?	50	428	65.9	20.8	211	75.9	17.0
Correct number	33	428	45.9	18.2	211	45.8	13.8

[a]Percentage of correct responses that would be expected on the basis of guessing.
[b]Each calculation is based on number of correct responses to the preceding *more general* question

Appendix B

FREQUENCY OF RESPONSES FOR RADAR SIGNALS

Signal		Number of Responses					
		Tracked Vehicle		Wheeled Vehicle		Troop(s)	Total*
		Tank	APC	Truck	Jeep		
Vehicle	Speed (mph)						
One Tank	5	40	35	35	19	7	127
	10	20	30	54	7	2	113
	15	6	22	58	43	0	129
	20	5	13	49	57	0	124
Two Tanks	5	43	25	35	7	1	111
	10	27	29	42	15	0	113
	15	13	24	43	45	1	126
	20	10	20	25	69	1	125
One APC	5	43	26	35	8	15	127
	10	14	18	61	19	1	113
	15	3	9	38	62	0	112
	20	8	15	44	59	0	126
Two APCs	5	33	24	33	14	8	112
	10	27	25	51	9	0	112
	15	12	21	52	24	0	109
	20	17	28	53	31	0	129
One Truck	5	47	14	38	6	6	111
	10	8	19	79	21	1	128
	15	10	17	51	35	0	113
	20	2	9	33	85	0	129
Two Trucks	5	28	34	44	16	1	123
	10	24	32	45	11	0	112
	15	10	21	35	47	0	113
	20	8	17	29	73	0	127
One Jeep	5	17	28	47	21	2	115
	10	16	20	61	28	2	127
	15	2	8	34	69	1	114
	20	6	20	37	62	1	126
Two Jeeps	5	54	27	41	1	2	125
	10	24	29	40	19	2	114
	15	12	16	52	45	0	125
	20	8	14	38	62	4	126
Personnel	Movement						
One Man	Marching	10	2	0	2	130	144
	Running	63	33	9	2	93	200
Four Men	Marching	23	19	8	4	117	171
	Running	40	24	5	2	57	128
Squad	Marching	31	11	1	1	126	170
	Running	16	7	3	2	115	143

*Each vehicle item was used three times in the test; thus, 129 responses was the maximum number possible for each vehicle at each speed if all subjects made responses. For the personnel targets, 129 responses were possible for those used three times, 172 for those used four times, and 215 for those used five times.

Appendix C

SIGNALS USED FOR TRAINING EXERCISES

Orientation Tape

Item	Single Signals	
	Vehicle	mph
1	One Jeep	20
2	One Jeep	5
3	One Jeep	10
4	One Jeep	15
5	One Jeep	20
6	One Tank	20
7	One Tank	5
8	One Tank	10
9	One Tank	15
10	One Tank	20
11	One Truck	20
12	One Truck	5
13	One Truck	10
14	One Truck	15
15	One Truck	20
16	One APC	20
17	One APC	5
18	One APC	10
19	One APC	15
20	One APC	20

	Paired Signals			
	Vehicle	mph	Vehicle	mph
21	Wheeled	20	Tracked	20
22	Wheeled	15	Tracked	15
23	Wheeled	10	Tracked	10
24	Wheeled	5	Tracked	5

Paired-Signal Exercises*

Paired-Signal Exercise 1				
1	One Tank	10	One Jeep	10
2	One Tank	10	One Jeep	10
3	One Jeep	10	One APC	10
4	One Jeep	10	One APC	10
5	One Truck	10	One APC	10
6	One Truck	10	One Tank	10
7	One Truck	10	One APC	10
8	One Tank	10	One Jeep	10
9	One APC	10	One Truck	10
10	One Tank	10	One Truck	10

(Continued)

*The 20 signals used in Paired-Signal Exercise 1 were presented separately in Single-Signal Exercise 1; those used in Paired-Signal Exercise 2 were presented separately in Single-Signal Exercise 2, and so on.

Paired-Signal Exercises[a] *(Continued)*

Item	Paired Signals			
	Vehicle	mph	Vehicle	mph
Paired-Signal Exercise 2				
1	Two Trucks	15	Two Tanks	15
2	Two APCs	15	Two Trucks	15
3	Two Jeeps	15	Two Tanks	15
4	Two Jeeps	15	Two APCs	15
5	Two Tanks	15	Two Trucks	15
6	Two Tanks	15	Two Trucks	15
7	Two Trucks	15	Two APCs	15
8	Two Trucks	15	Two APCs	15
9	Two Jeeps	15	Two Tanks	15
10	Two Jeeps	15	Two APCs	15
Paired-Signal Exercise 3				
1	One APC	20	One Jeep	20
2	One Truck	5	One Tank	5
3	One Truck	10	One APC	10
4	One Tank	15	One Jeep	15
5	One Truck	20	One Tank	20
6	One APC	15	One Jeep	15
7	One APC	5	One Truck	5
8	One Tank	10	One Jeep	10
9	One Truck	20	One Tank	20
10	One APC	5	One Jeep	5
Paired-Signal Exercise 4				
1	One APC	20	One Jeep	5
2	One Jeep	20	One APC	5
3	One Jeep	5	One Tank	20
4	One Truck	10	One APC	20
5	One Truck	15	One Tank	5
6	One Truck	5	One Tank	15
7	One Truck	10	One APC	15
8	One Tank	20	One Jeep	15
9	One Jeep	20	One Tank	15
10	One APC	10	One Truck	5
Paired-Signal Exercise 5				
1	One Truck	10	One Tank	10
2	Two Tanks	10	Two Jeeps	10
3	One APC	10	One Truck	10
4	Two Jeeps	10	Two APCs	10
5	One Tank	10	One Jeep	10
6	Two APCs	10	Two Trucks	10
7	One Jeep	10	One APC	10
8	One Jeep	10	One Truck	10
9	Two Tanks	10	Two Trucks	10
10	One Jeep	10	One Tank	10

(Continued)

[a]The 20 signals used in Paired-Signal Exercise 1 were presented separately in Single-Signal Exercise 1; those used in Paired-Signal Exercise 2 were presented separately in Single-Signal Exercise 2, and so on.

Paired-Signal Exercises* *(Continued)*

Item	Paired Signals			
	Vehicle	mph	Vehicle	mph
Paired-Signal Exercise 6				
1	One Truck	15	Two APCs	15
2	One Jeep	15	Two APCs	15
3	One Truck	15	Two Tanks	15
4	Two Trucks	15	One APC	15
5	One Jeep	15	Two Tanks	15
6	Two APCs	15	One Jeep	15
7	Two Tanks	15	One Truck	15
8	One Jeep	15	Two Tanks	15
9	One Tank	15	Two Jeeps	15
10	One Truck	15	Two APCs	15
Paired-Signal Exercise 7				
1	One Tank	20	One Truck	20
2	One Jeep	5	One APC	5
3	Two Tanks	15	Two Jeeps	15
4	Two Trucks	15	Two Tanks	15
5	One Truck	5	One APC	5
6	Two Jeeps	20	Two APCs	20
7	One APC	20	One Jeep	20
8	Two Tanks	5	Two Jeeps	5
9	One Tank	10	One Truck	10
10	Two APCs	20	Two Trucks	20
Paired-Signal Exercise 8				
1	One Truck	20	One Tank	15
2	Two Jeeps	10	Two Tanks	5
3	Two APCs	5	Two Jeeps	15
4	Two Trucks	5	Two APCs	20
5	One Truck	5	One APC	20
6	One Tank	10	One Jeep	5
7	Two Jeeps	5	Two Tanks	10
8	One APC	15	One Truck	20
9	One APC	15	One Jeep	20
10	Two Tanks	5	Two Trucks	20
Paired-Signal Exercise 9				
1	One APC	10	Two Trucks	10
2	Two APCs	20	One Jeep	20
3	Two APCs	5	One Truck	5
4	One Jeep	20	Two Tanks	20
5	Two Jeeps	20	One Tank	20
6	One Truck	10	Two Tanks	10
7	Two Jeeps	15	One APC	15
8	Two Trucks	20	One APC	20
9	Two Jeeps	10	One Tank	10
10	Two Trucks	5	One Tank	5

(Continued)

Paired-Signal Exercises* *(Continued)*

Item	Paired Signals			
	Vehicle	mph	Vehicle	mph
Paired-Signal Exercise 10				
1	Two Jeeps	5	One APC	10
2	One Jeep	10	Two APCs	5
3	One Tank	20	Two Trucks	15
4	Two Tanks	15	One Truck	20
5	Two Jeeps	20	One Tank	5
6	Two Trucks	5	One APC	20
7	Two Tanks	15	One Truck	5
8	One APC	10	Two Jeeps	20
9	Two Jeeps	10	One APC	20
10	One Tank	5	Two Trucks	15

*The 20 signals used in Paired-Signal Exercise 1 were presented separately in Single-Signal Exercise 1, those used in Paired-Signal Exercise 2 were presented separately in Single-Signal Exercise 2, and so on.

Appendix D

SIGNALS USED IN CRITERION TEST

Test Form A			Test Form B		
Item	Signal		Item	Signal	
	Vehicle	mph		Vehicle	mph
1	One Truck	20	1	One Jeep	15
2	Two Trucks	5	2	Two Trucks	5
3	One Tank	5	3	Two APCs	10
4	One Jeep	10	4	Two Trucks	15
5	Two Tanks	15	5	One Tank	10
6	Two Tanks	20	6	One Truck	5
7	One Jeep	20	7	Two Tanks	15
8	Two Jeeps	5	8	One Jeep	5
9	One Truck	10	9	One Truck	20
10	One Tank	15	10	One Truck	15
11	Two APCs	20	11	One Tank	5
12	Two Jeeps	15	12	One APC	5
13	One APC	20	13	One APC	10
14	One Tank	20	14	Two Jeeps	15
15	One APC	5	15	Two Tanks	10
16	Two Trucks	20	16	Two APCs	5
17	Two Jeeps	20	17	Two Trucks	10
18	Two Tanks	10	18	One Jeep	10
19	One APC	10	19	Two Jeeps	20
20	Two Trucks	15	20	Two Trucks	20
21	Two APCs	10	21	Two Jeeps	5
22	One Jeep	15	22	One APC	20
23	One Jeep	5	23	One Truck	10
24	One Tank	10	24	Two APCs	20
25	One APC	15	25	Two Jeeps	10
26	Two Tanks	5	26	One APC	15
27	Two Jeeps	10	27	One Jeep	20
28	One Truck	15	28	One Tank	20
29	Two APCs	15	29	Two Tanks	20
30	Two APCs	5	30	Two APCs	15
31	Two Trucks	10	31	One Tank	15
32	One Truck	5	32	Two Tanks	5

Appendix E

CRITERION TEST SCORES

Table E-1

Group Scores on Criterion Test

Group	N	Test Score	
		First Day	Second Day
		%	%
Total	10	61.0	70.0
Sequence A	5	65.6	75.6
Sequence B	5	56.3	63.7
Hi-fi headsets	6	57.0	70.3
AN/TPS-53 headsets	4	63.6	69.3

Table E-2

Individual Operator Scores on Criterion Test

Subject	Test Score	
	First Day	Second Day
	%	%
1	68.8	87.5
2	56.3	59.4
3	59.4	56.3
4	62.6	78.1
5	65.6	90.6
6	59.4	68.8
7	78.1	71.9
8	34.3	46.8
9	68.8	71.9
10	76.3	65.6

Appendix F

TRAINING SCORES

Mean and Range of Operator Scores on Training Exercises

(N = 10)

Exercise Tape	Mean Score	Standard Deviation	Range of Scores
	%		%
Paired-Signal			
1	82.0	12.3	60-100
2	74.0	12.7	50- 90
3	69.0	8.8	60- 80
4	56.0	22.7	30- 90
5	73.0	16.4	50-100
6	89.0	12.6	70-100
7	77.0	14.2	50- 90
8	84.0	16.5	50-100
9	79.0	15.2	60-100
10	79.0	15.2	50-100
Single-Signal			
1	69.0	15.8	45- 85
2	69.5	12.1	40- 80
3	68.0	5.9	60- 80
4	75.0	13.3	65- 95
5	63.5	14.5	40- 85
6	77.5	17.4	45- 95
7	72.0	8.6	60- 85
8	77.0	12.3	60- 95
9	78.0	13.4	50- 95
10	75.5	16.4	45-100

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2 CG US ARMY EUROPE APO 403 NY ATTN OPNS DIV
6 CG FIRST ARMY GOVERNORS ISL NY ATTN G3
6 CG SECOND ARMY FT GEO G MEADE ATTN DCSOT
1 CG THIRD ARMY FT MCPHERSON
7 CG FIFTH ARMY CHICAGO ATTN ALFGC TNG
1 DIR HUMAN ENGNR LABS ABERDEEN PG
2 ENGNR PSYCHOL LAB PIONEERING RES DIV ARMY NATICK LABS NATICK MASS
1 CO ARMY PICTORIAL CTR LONG ISL ATTN APPLICAT DEVEL BR TV DIV
1 SIXTH ARMY LIB DEPOT PRES OF SAN FRAN
1 DIR WALTER REED ARMY INST OF RES WALTER REED ARMY MED CTR ATTN NEUROPSYCHIAT DIV
1 CO HQ ARMY ENLISTED EVAL CTR FT BENJ HARRISON
1 CO FRANKFORD ARSNL ATTN SMUFA 1031/65-1
1 CBT OPNS RES GP ARMY CBT DEVEL COMD FT BELVOIR ATTN OPNS ANLS HUMAN FACTORS
1 CO ARMY CBT DEVEL COMD FT KNOX ATTN ARMOR AGY
3 ARMY WAR COLL CARLISLE BKS ATTN LIB
1 US MILIT ACAD WEST POINT ATTN LIB
2 COMDT ARMY SECUR AGY TNG CTR + SCH FT DEVENS ATTN LIB
10 DIR OF INSTR ARMOR SCH FT KNOX
1 COMDT ARMY CHEM CORPS SCH FT MCCLELLAN ATTN EDUC ADV
1 COMDT ARMY SOUTHEASTERN SIG SCH FT GORDON
10 CG ARMY ARTY + MSL CTR FT SILL ATTN AVN OFFR
1 COMDT ARMED FORCES STAFF COLL NORFOLK
1 COMDT JUDGE ADVOCATE GEN SCH U OF VA
1 EDUC CONSLT ARMY MILIT POLICE SCH FT GORDON
6 COMDT ARMY ENGNR SCH FT BELVOIR ATTN ASSRES-SY
1 SPEC WARFARE SCH FT BRAGG ATTN LIB
2 HQ ABERDEEN PG ATTN TECH LIB
1 SECY OF ARMY
1 DCS-PERS DA ATTN CHF C+S DIV
2 RES FOR FORCE DEVEL DA ATTN CHF TNG DIV
1 ARMY PERS RES OFC ATTN CRD-AR
2 OFC OF PERS OPNS DA ATTN OPCSS-A
1 ARMY PROVOST MARSHAL GEN
1 OFC RESERVE COMPON DA
20 CTR DEF DOCUMENTATION CTR CAMERON STA
1 CHF OF R+D DA ATTN CHF TECH + INDUSTR LIAISON OFC
1 PERS + TNG DIV TECHNC OFC OF CHF OF ORD DA

1 ARMY PERS RES OFC ATTN CRD-AIC
1 PRES ARMY MAINT BD FT KNOX
2 CG 1ST INF DIV FT RILEY ATTN G3
2 CG 4TH INF DIV FT LEWIS ATTN G3
1 CG 5TH INF DIV (MECH) FT CARSON
3 CG 82D ABN INF DIV FT BRAGG ATTN G3
3 CG 25TH INF DIV APO 25 SAN FRAN
7 4TH BN (MECH) 54TH INF FT KNOX
2 CHF AUDIO VISUAL APPLICAT OFC ARMY PICTORIAL DIV OFC OF CHF SIG OFCR
2 HQ ARMY LIAISON GP PROJ MICH U OF MICH
1 DIR ARMY LIB
1 CHF OF MILIT HIST DA ATTN GEN REF BR
1 82D ABN DIV FT BRAGG
1 CG 31ST ARTY BRGD AIR DEF OAKDALE PENNA
1 CG 101ST ABN DIV FT CAMPBELL
1 CG 1ST CAV DIV APO 24 SAN FRAN
1 ARMY R+D OFC PANAMA FT CLAYTON CANAL ZONE ATTN BEHAV SCI COORD
3 DIR PERS RES DIV BUR OF NAV PERS
3 CHF OF NAV PERS
1 CHF OF NAV RES ATTN HEAD PERS + TNG BR CODE 458
1 OIC NAV PERS RES ACTVY NAV YD WASHINGTON
1 CO MED FLD RES LAB CAMP LEJEUNE
2 CONTROL NAV BASE NORFOLK
1 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AO-1B
1 HQ MARINE CORPS ATTN AX
1 DIR MARINE CORPS INST ATTN EVAL UNIT
1 CHF OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
3 DIR OF PERS PROCUR + RETENTION AIR FORCE MILIT PERS CTR RANDOLPH AFB
1 CHF SCI DIV DIRCTE SCI + TECH DCS R+D HQ AIR FORCE AFRSTA
2 HQ AIR FORCE STAFF COLL SCBR 3 ANDREWS AFB
1 AERO MED RES LAB 6570TH WRIGHT-PATTERSON AFB
1 AIR MOVEMENT DESIGNATOR 6570TH WRIGHT-PATTERSON AFB
1 HQ BALLISTICS SYS DIV PERS SUBSYS BR BSSSP NORTON AFB
2 6570TH AERO MED RES LAB WRIGHT-PATTERSON AFB
1 DIR AIR U LIB MAXWELL AFB ATTN AUL3T-63-253
3 CENTRAL INTEL AGY ATTN OCR MAIL RM
1 DEPT OF STATE BUR OF INTEL + RES EXTERNAL RES STAFF
1 SCI INFO EXCH WASHINGTON
2 CHF RERL TNG BR TNG DIV FED AVN AGY ATTN PT 30
1 DUNLAP + ASSOC INC DARIEN ATTN LIB
2 RES ANLS CORP BETHESDA
1 MITRE CORP BEDFORD MASS ATTN LIB
2 TECH INFO CTR ENGNR DATA SERV N AMER AVN INC COLUMBUS O
1 CHRYSLER CORP MSL DIV DETROIT ATTN TECH INFO CTR
1 GEN DYNAMICS POMONA CALIF ATTN LIB
1 MARQUARDT CORP POMONA CALIF ATTN DEPT 560
1 CHF PERS SUBSYS AIRPLANE DIV MS 74-93 RENTON WASH
1 SYLVANIA ELECTRIC PRODUCTS INC NEEDHAM HGTS MASS ATTN PERS SUBSYS MNGR
1 THIOKOL CHEM CORP NUMERICS DIV LOS ANGELES ATTN LIBR
1 INST FOR DEF ANLS RES + ENGNR SUPPORT DIV WASHINGTON
5 BRITISH EMBSY BRITISH DEF RES STAFF WASHINGTON
1 AMER INST FOR RES WASHINGTON
1 AMER INST FOR RES LOS ANGELES
1 ROWLAND + CO HADDONFIELD NJ ATTN PRES

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(Contract DA 44-188-ARO-2) (DA Proj. 2J024701A712) Report For Official Use Only

To measure operator proficiency in identifying audio signals from the AN/TPS-33 ground surveillance radar, a test of 120 tape-recorded signals generated by representative military targets was administered to 43 trained operators. It was found that they could discriminate between personnel and vehicle targets. An experiment was run to determine whether operators can be trained to identify vehicles on the basis of signal characteristics unique to each vehicle type. After two days' training, 10 naive officer subjects learned to discriminate reliably between tracked and wheeled vehicles, although there were marked differences in operator aptitude.

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1. Acoustic detectors—radar
2. Combat surveillance—defense
3. Detection—target recognition
4. Radar targets—vehicles
5. Sound ranging—detection
6. Surface targets—radar signals

I. Title: ARMORNITE XIII
II. Kraemer, Alfred J., Emley, David L., Miller, Arthur L., Stevenson, Paul H.
III. U.S. Army Armor Human Research Unit, Fort Knox, Kentucky
IV. Contract DA 44-188-ARO-2

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To measure operator proficiency in identifying audio signals from the AN/TPS-33 ground surveillance radar, a test of 120 tape-recorded signals generated by representative military targets was administered to 43 trained operators. It was found that they could discriminate between personnel and vehicle targets. An experiment was run to determine whether operators can be trained to identify vehicles on the basis of signal characteristics unique to each vehicle type. After two days' training, 10 naive officer subjects learned to discriminate reliably between tracked and wheeled vehicles, although there were marked differences in operator aptitude.

UNCLASSIFIED

1. Acoustic detectors—radar
2. Combat surveillance—defense
3. Detection—target recognition
4. Radar targets—vehicles
5. Sound ranging—detection
6. Surface targets—radar signals

I. Title: ARMORNITE XIII
II. Kraemer, Alfred J., Emley, David L., Miller, Arthur L., Stevenson, Paul H.
III. U.S. Army Armor Human Research Unit, Fort Knox, Kentucky
IV. Contract DA 44-188-ARO-2

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Human Resources Research Office, George Washington U., Alexandria, Va. 22314
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