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ABSTRACT

The two experiments reported are part of a series evaluating effects of display parameters, task variables, and operator perceptual limitations on ability of Night Vision Device operators to process visual information quickly and accurately. For untrained observers, target brightness requirements were higher for identification than for detection, but were about equal for both responses with target exposure times greater than a critical time of 0.10 to 0.17 second. With shorter exposure times, the target brightness needed for detection or identification increased as exposure time decreased. Increasing information load and randomizing target location raised brightness requirements for identification. The results suggest that operator performance might be improved significantly by special training to increase the observer's area of attention and his capacity to process visual information. (Author)

Technical Report 72-30

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Effects of Information Load, Location, and Mode of Observation on Detecting and Identifying Brief Targets

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HUMAN RESOURCES RESEARCH ORGANIZATION
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October 1972

Prepared for

Office of the Chief of Research and Development
Department of the Army
Washington, D.C. 20310

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HumRRO
Technical
Report
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HumRRO Division No. 2
Fort Knox, Kentucky

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The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development, and consultation. HumRRO's mission in work performed under contract with the Department of the Army is to conduct research in the fields of training, motivation, and leadership.

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FOREWORD

The purpose of the research performed by the Human Resources Research Organization under Work Unit NIGHTSIGHTS is to identify critical human factors problems in the use of new night operation devices and to develop effective techniques for training men to use the devices.

This document is a product of Work Sub-Unit VI, Experimental Studies of Visual Factors in Target Acquisition. The objective of this Work Sub-Unit is the experimental evaluation of selected perceptual factors that limit the efficiency of operators of Night Vision Devices in acquiring targets, and the development of effective training techniques to reduce these operator limitations.

Research under Work Unit NIGHTSIGHTS is being conducted by HumRRO Division No. 2, Fort Knox, Kentucky. The Division Director is Dr. Donald F. Haggard, and the Work Unit Leader during the conduct of this research was Dr. Harold P. Bishop. Military support is provided by the U.S. Army Armor Human Research Unit. LTC Joseph E. De Angelis was the Chief of the Unit during the earlier portions of the work; LTC Willis G. Pratt is the current Chief.

HumRRO research for the Department of the Army is conducted under Army Contract DAHC 19-73-C-0004. Army Training Research is performed under Army Project 2Q062107A745.

Meredith P. Crawford
President
Human Resources Research Organization

SUMMARY AND CONCLUSIONS

MILITARY PROBLEM

Continuing emphasis upon night operations and high mobility requires the use of Night Vision Devices in dynamic observation conditions. With these devices mounted on an air or land vehicle, both the mobility of the vehicle and the surveillance sector that can be covered are greatly increased. Under these conditions, the work load placed on the device operator will be extremely high, and the efficiency of the operator and the system will depend largely upon the effectiveness of the operator's training. At present, little is known about the limiting characteristics of the operator or the effects of display variables on his performance under these conditions. This information must be obtained before an effective training program can be developed.

RESEARCH PROBLEM

The performance of an operator observing with a Night Vision Device under dynamic conditions will be affected by many variables, including (a) display parameters, (b) task variables, and (c) operator characteristics, and the interactions of these elements. In order to develop an efficient training program to enhance the operator's ability to process visual information quickly and accurately, the critical variables in each of these classes must be identified and their effects on operator performance experimentally evaluated.

APPROACH

To minimize the effects of extraneous variables and to maximize control over the experimental variables, laboratory studies were chosen in preference to field studies.

Two experiments were conducted. In the first, the target brightness that observers needed in order to detect and to identify targets from a 2-target or 8-target set was determined with target exposure times that ranged from 0.032 to 4 seconds.

In the second experiment, the target brightness needed to detect and to identify targets from a 4-target set was determined with exposure times that ranged from 0.032 to 0.565 second. The targets appeared randomly at one of five locations in the field of view. One-half of the subjects were required to maintain fixation at the center of the field of view, and the other half were allowed to scan the field at will.

RESULTS

The results of Experiment I are as follows:

(1) The target brightness required for target detection and target identification increased significantly as target exposure times decreased below a critical time of 0.100 to 0.170 second. In general, for exposure times less than the critical time, the required target brightness was in an inverse relation to the exposure time.

(2) Minimum brightness required for discrimination among eight targets (a 3-bit problem in information theory terms) was significantly higher than for the two-target information load.

(3) Brightness needed for identification of targets was significantly higher than for detection.

The results of Experiment II are as follows:

(1) No differential effects upon target brightness required for target detection and identification were found for target location or mode of fixation.

(2) Target brightness required for detection and identification increased continuously with decreased target exposure time from the longest to the shortest times. With decreased exposure time the rate of brightness required for target detection and identification was much greater for exposure times less than a critical time of approximately 0.100 second than it was with exposure times longer than the critical time.

(3) Brightness needed for identification was significantly higher than for detection.

(4) All brightnesses were markedly higher than those obtained with the same exposure times in Experiment I.

CONCLUSIONS

(1) Significant decrements in performance on both target detection and target identification occur with target exposure times less than a critical time of approximately 0.170 second. This decrement is primarily the result of physiological limitations of the observer's visual system. Little or no improvement would be expected as a result of special training.

(2) A significant decrement in performance on target identification occurs with a small increase in the information load placed on an untrained observer. Since the difference between the brightness needed for detection and identification obtained under the eight-target (3-bit information) load is about three times the difference obtained under the two-target (1-bit) load, a significant improvement in performance might be expected as a result of special training.

(3) Lack of knowledge of where the target will appear in the field of view results in a marked decrement in performance for both target detection and target identification. A successful training program to increase the observer's area of attention would result in a very significant improvement in performance.

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Effects of Information Load, Location, and Mode of Observation on Detecting and Identifying Brief Targets

MILITARY PROBLEM

Night Vision Devices (NVDs) are now employed, most commonly, under static observation conditions with the operator and his device stationed as a fixed position suitable for surveillance of an assigned sector. Under these conditions, the utility of NVDs, and the increase they provide in the efficiency and safety of soldiers are unquestioned, although operator training is usually minimal[1] and the device efficiency is operator-limited (1).[2]

In accordance with continued emphasis on around-the-clock operations and high mobility, the present trend in the development and use of NVDs and systems reflects the need for their employment in more dynamic observation situations. With NVDs mounted on moving land or air platforms, both the mobility of the platform and the surveillance sector that can be covered in real time are greatly increased. Under these conditions and particularly in a combat environment, the work load placed upon a device operator will be extremely high. He will be required to detect and identify targets and to communicate critical target information under observation conditions that include a very high rate of information input and that change with minimal target dwell time.

The ability of the operator to respond to these demands—and, thus, the efficiency of the system—depends largely upon the capabilities of the operator and the effectiveness of his training. In order to develop a cost-effective training program that enhances the soldier's ability to process visual information quickly and accurately, research is needed to determine his perceptual limitations and the effects of display variables on his performance.

RESEARCH PROBLEM

The performance of an operator observing under dynamic conditions will be affected by many variables. For simplicity, considerations can be restricted to three classes of these variables:

(1) Display variables, such as target exposure time, contrast, and rate of movement.

(2) Task variables, such as the number of types of different targets that must be detected and identified.

(3) Operator variables, such as sensory and perceptual characteristics, knowledge, and motivation.

These variables, in particular, limit the observer's capacity to process and use information presented by the display.

In order to develop an efficient training program, therefore, the physiological limitations of the observer must be determined, along with the experimental evaluation of the effects of the display and task variables on his performance.

[1] As shown in research on the use of image intensifiers in Vietnam, performed by Richard A Kulp of HumRRO Division No. 2, September 1968.

[2] Also indicated in research comparing instructional approaches for training operators of a long-range night observation device, performed by John D. Engel, HumRRO Division No. 2, September 1970.

EXPERIMENT I: THE EFFECT OF INFORMATION LOAD AND EXPOSURE TIME ON TARGET DETECTION AND IDENTIFICATION

OBJECTIVE

Among the many variables that affect the observer's per . .. arget contrast and exposure time are of fundamental importance. The ta: ust have sufficient contrast and must remain in the field of view long enough for the observer to detect it, acquire and track it visually if it is moving, and identify it. Furthermore, the difficulty of the identification task will increase directly with the number of different targets to be identified. The first objective, then, is to determine the joint effects of exposure time and target brightness on detection and identification of targets from sets that include different numbers of targets. Throughout these experiments, exposure times were set and measurements were made of the brightness required for detection and identification by increasing brightness step-by-step from a level below threshold of perception.

METHOD

Subjects

The subjects were enlisted personnel obtained through military support channels and were trainees available at the U.S. Army Armor Training Center, Fort Knox, Kentucky. All men had normal vision and had a GT[3] score between 100 and 120. Of 10 subjects who began the experiment, five completed the series; only their scores are reported here. The five who dropped out did not return for the later sessions, apparently because of other commitments.

Design

The experimental paradigm was a 2 x 2 x 9 factorial design with repeated measurements on all variables. Each subject was required to give both detection and identification responses to targets from sets that presented two targets (a 1-bit problem in information theory terms) or eight targets (a 3-bit problem in information theory terms), and that were exposed for times ranging from 0.032 to 4.000 seconds.

Each observer was tested under every condition in order to provide a control on differences between observers. The tests were conducted during three-hour experimental sessions on four successive days.

The order of presentation of test conditions was counterbalanced for days and information load with use of an ABBA design. Three of the subjects began the experimental series with observation under a two-target load on the first day and terminated the series with observations under the two-target load on the fourth day. The remaining two subjects began and terminated the experimental series with observations under the eight-target load. Within these constraints, targets and exposure times were presented in a random sequence.

Targets

Targets were simple geometric forms. These were chosen to avoid the problems of differences in previous knowledge on the part of the subjects and the effects of the peculiar characteristics of military targets. Results obtained with targets of simple geometric forms should more closely reflect the perceptual limits of the subjects.

[3]This is the General Technical (GT) Aptitude Area score, part of the Army Classification Battery.

information load of a set of targets was defined as the number of binary de ... required to determine which of the targets was presented. The eight targets that formed the basic eight-target (3-bit) set included a square, triangle, diamond, truncated pyramid, rhomboid, five-sided and six-sided polygon, and a circle. Two of these targets, the square and the triangle, were used as the two-target (1-bit) set.

The targets were presented to the subject with the use of negative slides projected ont a rear projection screen with a carousel type of projector. Target exposure time and interstimulus times were controlled with a Uniblitz[4] electric shutter driven with a configuration of Hunter timers. Target luminance was controlled with crossed polaroids driven by a DC motor used as a stepping motor and controlled by Hunter timers. A second projector was used to present a circular constant luminance adaptation field on which the targets were presented.

From the subject's position, the targets were slightly greenish-white forms that subtended a visual angle of approximately 1.25 degrees horizontally, seen on a slightly greenish-white field with a diameter that subtended a visual angle of approximately eight degrees. The adaptation field was illuminated to a low photopic level of 0.15 millilumen as measured with a gamma log-linear photometer. These conditions were chosen to approximate simplified visual requirements for observation of a tank-sized target at one kilometer through a Starlight scope with low environmental illumination.

Procedure

Prior to beginning each experimental session, subjects were allowed 15 to 20 minutes to adapt to the dark. On the first day, at the end of this "adapting" period, the experimenter read the instructions (given in Appendix A) to the subjects and answered any questions that were asked. Subjects then were given 10 practice trials at two exposure times to assure the experimenter that the subjects understood their task and could respond appropriately.

The subjects were seated 10 feet in front of the projection screen, which they observed monocularly. A modified one-way method of limits was used to determine the target luminances required first to detect and then to identify the target. At the beginining of a test series, the target luminance was set randomly to a point below the level required for detection. The target was then flashed onto the center of the adaptation field at two-second intervals with the luminance increased by approximately 0.03 log unit for each successive exposure.

The subject's task was to respond with a verbal "No" when he saw no target, with "Flash" when he detected but could not identify a target, and with the name of the form when he could identify it. The experimenter recorded the polaroid scale setting at each positive detection response of the subject until the subject had made two successive positive responses and for each identification response until the subject had made two correct identifications; this terminated the series. The subject's target brightness requirements for detection and identification were defined as the level recorded for the first of the two criteria responses in each category.

After completion of the exposure series with a given target, the carousel was advanced to the next target, the luminance was reset to a sub-threshold level and the next series commenced. Targets were used in random sequence and five sets of measurements obtained with each target at a given target exposure time before proceeding to the next. Each target exposure time was used twice in a repeated random sequence to give a total of 10 sets of measurements for each target-time combination.

[4]Commercial designations are used only for precision in describing the experiment. Their use does not constitute endorsement by the Army or by the Human Resources Research Organization.

On the first day of the experiment, after the practice period, the test series was divided into three sets of 40 or 50 targets and the subjects were given a five-minute rest period between sets. On succeeding days, the series was similarly divided into six sets, with a five-minute break between Sets 1, 2, 4, and 5, and a longer break of 15 minutes between Sets 3 and 4.

RESULTS

Preliminary examination of the data indicated that, with some differences in detail, the effects of exposure time on the observer's responses were, in general, similar for all targets and observers. Accordingly, mean combined measurements for observers and targets were calculated for each experimental condition. These are plotted in Figures 1 and 2, which show the mean log relative brightness required for detection and identification of the targets presented at the different exposure times.

To test for overall significance of the effects of the experimental variables, an analysis of variance was performed on the obtained measurements. The results of this analysis are shown in Table 1.

To avoid Type II errors, preliminary tests of the interactions of the variables were conducted at the .20 confidence level (2). The interaction between information load and response (AB) and between response and exposure time (BC) were both found to be

Relative Target Brightness Required to Detect and Identify Targets With a Two-Target Set Information Load

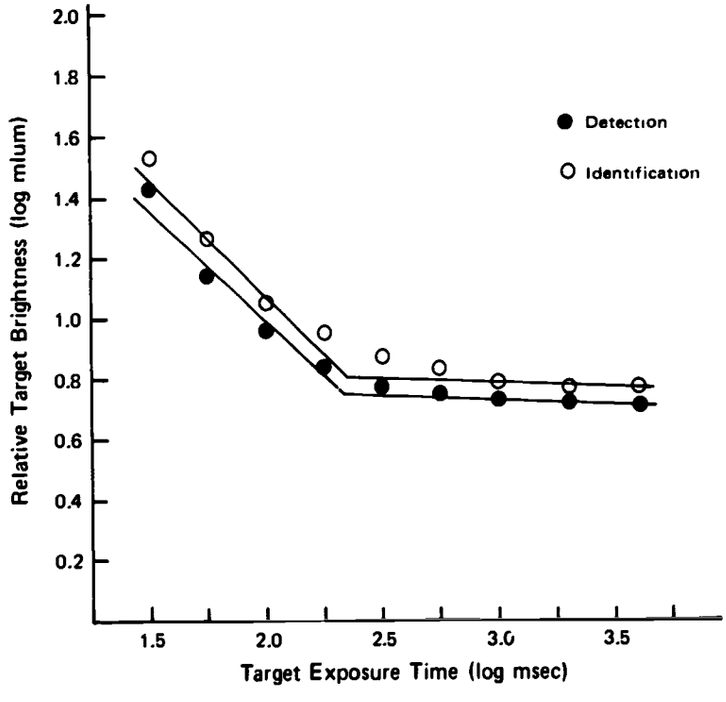

Figure 1

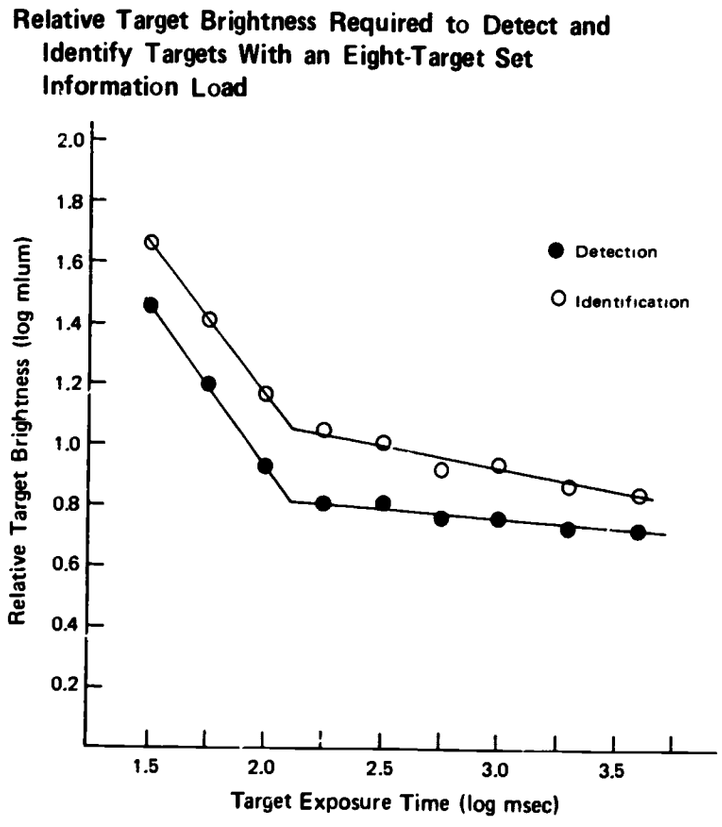

Figure 2

significant. The main effects of the variables were tested at the .05 level and the effects of exposure time and response were found to be significant.

The effects of the variables and their interactions are clearly shown in the figures. Figure 1, which gives the measurements obtained with the two-target (1-bit) information load, shows that the observers required about 25% greater target brightness to identify than to detect the targets, but the trends of the measurements were similar for both responses. In general, for exposure times greater than a critical time of about 0.170 second, the required brightness was relatively constant. With exposure times less than the critical time, however, the required brightness increased abruptly and was in an inverse relation to the decrease in exposure time.

The trends of the measurements obtained with the eight-target (3-bit) information load (Figure 2) are similar overall to those obtained with the two-target (1-bit) information load. However, two differences may be noted: In Figure 2, the differences between the target brightness required for detection and identification measurements were greater (about 60%), and the identification measurements showed a definite steady decrease rather than a constant measurement at exposure times greater than the critical time. These differences reflect the effects of the interaction between the mode of response and the information load.

Since this interaction would affect the test of significance of the effects of information load, a secondary test of this variable was performed with only the identification

Table 1

Analysis of Variance: Effects of Information Load and Target Exposure Time on Relative Target Brightness Required for Detection and Identification

Source of Variation	*df*	*MS*	*F*	*p*
Between Subjects (S)	4	3,782.5		
Within Subjects				
A (Information Load)	1	2,053.7	6.4	.10
Error AS	4	322.3		
B (Response)	1	8,309.6	11.1	.05
Error BS	4	748.9		
C (Exposure Time)	8	13,390.4	195.2	.01
Error CS	32	68.6		
AB	1	1,145.1	6.3	.10
Error ABS	4	182.2		
AC	8	39.0	<1	NS
Error ACS	32	45.6		
BC	8	46.4	19.6	.01
Error BCS	32	3.2		
ABC	8	10.6	<1	NS
Error ABCS	32	30.7		

measurements included. The obtained F ratio of 26.0 indicated that the target brightness required for the identification of the targets was significantly greater under the eight-target (3-bit) than under the two-target (1-bit) load.

The straight line segments, drawn by inspection, in Figures 1 and 2 fit the data quite well, except for data points in the immediate neighborhood of the critical time. This is a result of averaging the scores of the different subjects in response to the different targets. This is exemplified in Figure 3, which shows the identification measurements for a difficult and an easy target for two subjects. These data were chosen for illustration only, and the individual curves are separated vertically by arbitrary amounts. The main points to be noted are that the critical times at which the slope of the lines changed abruptly vary between subjects for the same target, and the relative increase in required target brightness with decreased exposure times greater than the critical time is higher for difficult targets than it is for easy targets.

DISCUSSION

The results of this experiment indicate that both reduced target exposure time and increased information load result in a marked deterioration of target acquisition performance. Generally, the performance decrement due to shortened target exposure time was found with exposure times less than a critical time of 0.100 to 0.170 second. Overall, the trends of the measurements shown in Figures 1 and 2 are similar to the trends of the

Relative Target Brightness Required to Identify an Easy and a Difficult Target by Two Subjects (Eight-Target Set)

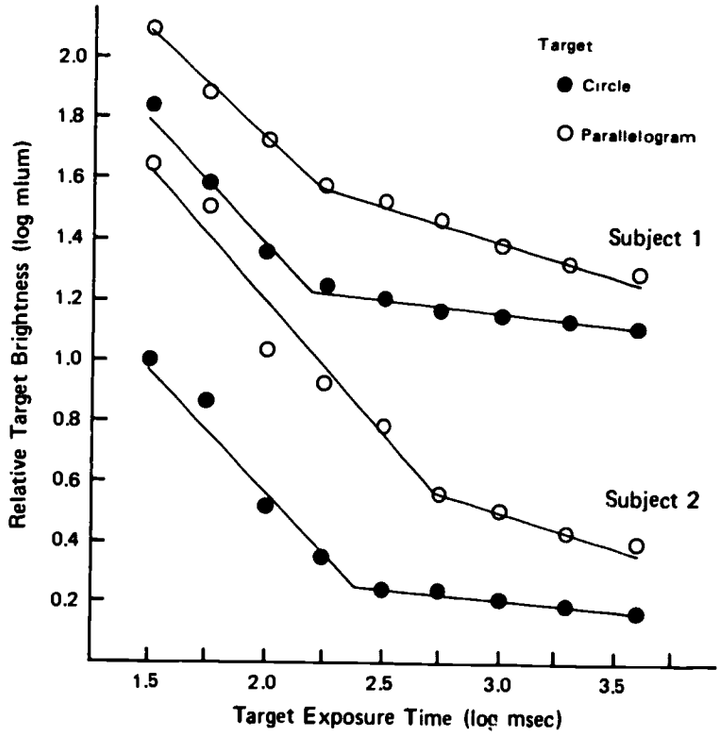

Figure 3

measurements obtained by other researchers in their studies of Bloch's Law[5] (3, 4). At present, there is no completely satisfactory theoretical explanation of this relationship between intensity and time for visual responses, but it is commonly assumed to reflect neural behavior and limitations (3). The detection measurements obtained in this experiment, then, may be interpreted as a description of the physiological limits for target acquisition by an untrained observer.

It should be noted that the differences between the critical times obtained under the two-target and eight-target (1-bit and 3-bit) information loads appear to be the result of averaging a larger number of measures obtained after more practice in the calculation of the measurements for the eight-target (3-bit) condition. In general, the absolute levels of obtained measurements and the value of the critical time will vary with the observer, his state of adaptation and amount of practice (5), and the specific responses he is asked to make (6, 7). The shape of the curve fitted to the measurements obtained under simple observation conditions, however, remains relatively invariant (2, 4).

[5] Bloch's Law states that with target exposure times less than a critical time, *tc*, the energy required to elicit a constant visual response is a constant given by the product of the target intensity and exposure time, (i.e., $I \times t = K$). With exposure times greater than *tc*, the required energy is independent of time and $I = C$.

The increased difficulty of the identification task under the eight-target (3-bit) load is shown by the difference in level, and particularly by the difference in slope, between the identification measurements obtained under the two-target (1-bit) and eight-target (3-bit) load conditions. In part, the differences between these measurements may be explained as a result of the observer's need for increased target brightness to resolve sufficient detail for discrimination between the larger number of targets in the eight-target set.

As is indicated by the significant interaction between information load and response (detection vs. identification), the identification measurements obtained under the eight-target load also must reflect limitations set by more complex perceptual processes, because if resolution requirements were the only reason for the differences between the measurements obtained under the two-target and eight-target conditions, one would expect the trends of the identification measurements obtained under the two conditions to be parallel. However, the trends of the brightness obtained by Kahneman (8) with acuity targets requiring differing degrees of resolution were essentially parallel. Moreover, the trends of the detection and identification brightnesses obtained under the two-target load in this experiment are parallel.

In summary, from the results of this experiment it may be concluded that as a result of physiological limitations of the observer's visual system, target detection and identification performance deteriorates significantly and rapidly with reduction of the target exposure time below 0.100 to 0.170 second. Furthermore, the information processing capacity of the untrained observer is limited, and a significant decrement in target identification performance occurs with a small increment in formation load from a minimal two-target (1-bit) load.

EXPERIMENT II: EFFECTS OF RANDOM TARGET LOCATION AND MODE OF FIXATION ON TARGET DETECTION AND IDENTIFICATION

OBJECTIVE

In Experiment I, the observers knew that the targets would always appear in the center of the field of view, thus, they could focus their attention on a small area in the field. In an operational situation, a target may appear anywhere in the field of view and the observer will have to attend to the whole field rather than to a small part of it. Therefore, one objective was to determine the relative performance decrement that might result from an observer's lack of knowledge of where the target would appear. A second, related objective was to determine whether the mode of fixation had a differential effect on performance.

METHOD

Subjects

The subjects were enlisted men obtained through military support channels and were trainees available at the Armor Training Center. All had normal vision and a GT score between 100 and 120. Of the 10 men who began the experiment, eight completed the series (only their scores are reported here); two did not return for the second experimental session of the day.

Design

The experimental paradigm was a 5 x 2 x 6 factorial design with repeated measurements. All subjects were required to give both detection and identification responses to targets presented at five locations in the stimulus field and exposed for durations of 0.032 to 0.585 second. One-half the subjects were instructed to fixate at the center of the screen and one-half were allowed to search the stimulus field at will.

In Experiment I, it had been found that the subjects' reliability in reporting back for experimental sessions on successive days was very poor. Therefore, in Experiment II all observations for a given subject were obtained on the same day. After preliminary training, the subjects made observations on the targets in blocks of 80 with rest intervals of five minutes between blocks. They were also given a break of one hour for lunch. Subjects were assigned alternately to each fixation group in order of their appearance on successive days. The order of targets, times, and locations used during the day was randomized.

Targets

Four of the targets used in Experiment I were combined into a set to present a 2-bit information load to the observers. These were the square, rhomboid, five-sided polygon, and the circle. The targets were displayed at the top center, center, bottom center, left center, and right center of the field of view. The projection apparatus and the general observation conditions were the same as those in Experiment I.

Procedure

The general procedure was identical to the procedure followed in Experiment I The instructions were modified, as shown in Appendix A, to indicate to the observer whether he was to fixate at the center of the field of view or could scan the field at will.

RESULTS

Preliminary examination of the data showed no discernible differences in the obtained measurements associated with individual targets or their location in the field for either group of observers. The measurements, were, therefore, combined over all targets, locations, and subjects. The values plotted in Figures 4 and 5, showing the mean log relative brightness required for detection and identification of the targets, are based on 320 measurements. Figure 4 shows the measurements of the group that observed with fixation at the center of the field of view, and Figure 5 shows the measurements of the group that scanned the field of view at will.

An analysis of variance was performed on the combined data and the results, summarized in Table 2, show that only the effects of target exposure time and type of response were significant.

Figures 4 and 5 show that the identification measurements average about 40% higher than the detection measurements and that both detection and identification measurements increased regularly with decreased exposure time. For both groups of observers, the rate of increase of the measurements increased abruptly at a critical time of approximately 0.100 second.

Relative Target Brightness Required to Detect and Identify Targets That Appeared at Random Locations by Subjects Instructed to Fixate at the Center of the Field of View (Four-Target Set)

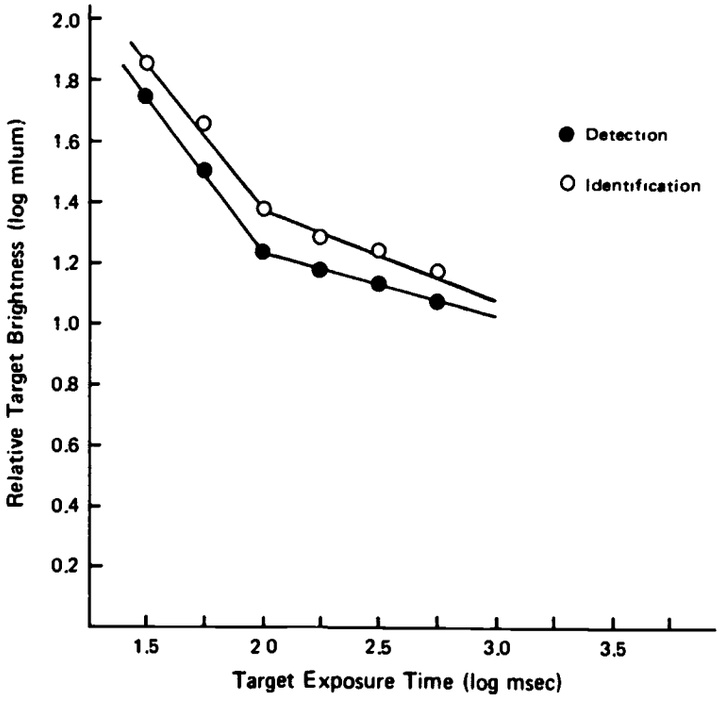

Figure 4

DISCUSSION

Overall, the trends of the measurements obtained in this experiment are similar to the trends of those obtained in Experiment I. However, the clearly larger measurements obtained in this experiment indicate the greatly increased difficulty of the detection and identification tasks, when the observers do not know where the target will appear. Because there were no differences in measurements caused by the effects of mode of fixation or target location, one may tentatively conclude that the requirement to distribute attention over all parts of the field effectively results in a general increase in perceptual threshold.

CONCLUSIONS

(1) Significant decrements in performance on both target detection and target identification occur with target exposure times less than a critical time of approximately 0.170 second. This decrement is primarily the result of physiological limitations of the observer's visual system. Little or no improvement in the measurements would be expected as a result of special training.

(2) A significant decrement in performance on target identification occurs with a small increase in the information load placed on an untrained observer. Because the

Relative Target Brightness Required to Detect and Identify Targets That Appeared at Random Locations by Subjects Allowed to Scan the Field at Will (Four-Target Set)

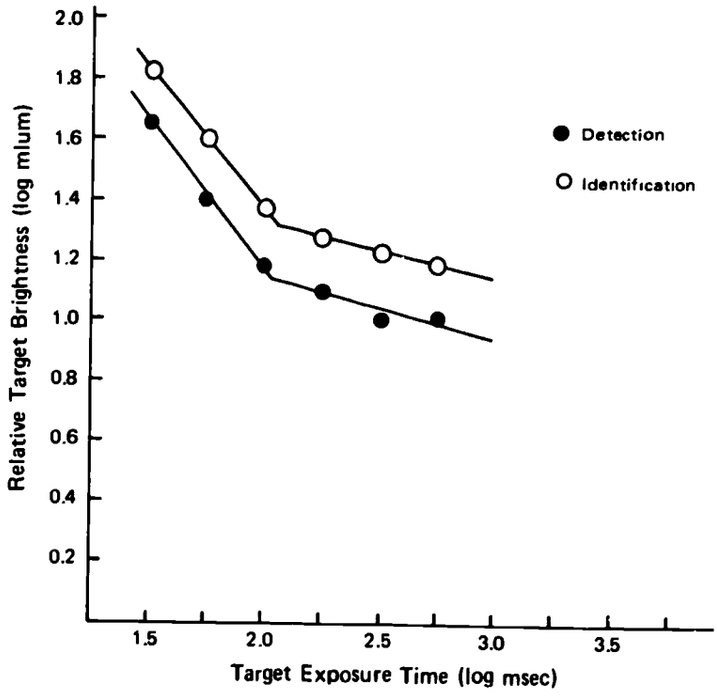

Figure 5

Table 2

Analysis of Variance: Effects of Method of Observation and Target Exposure Time on Relative Target Brightness Required for Detection and Identification

Source of Variation	*df*	*MS*	*F*	*p*
Between Subjects (S)	7			
A (Fixation)	1	213.0	<1	NS
Error AS	6	765.5		
Within Subjects	88			
B (Response)	1	3,914.3	32.0	.01
AB	1	44.0	<1	NS
Error ABS	6	124.7		
C (Time)	5	9,815.8	56.0	.01
AC	5	135.4	<1	NS
Error ACS	30	175.3		
BC	5	147.4	1.4	NS
ABC	5	114.9	1.1	NS
Error ABCS	30	108.7		

difference between the detection and identification measurements obtained under the eight-target (3-bit) information load is about three times the difference obtained under the two-target (1-bit) load, a significant improvement in performance might be expected as a result of special training on target identification.

(3) Lack of knowledge of where the target will appear in the field of view results in a marked decrement in both target detection and target identification performance. A successful training program to increase the observer's effective area of attention would result in a very considerable improvement in performance.

LITERATURE CITED
AND APPENDIX

LITERATURE CITED

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Appendix A

INSTRUCTIONS TO SUBJECTS

"The purpose of this experiment is to determine how bright a form must be in order for it to be seen on a white background. To determine this, I am going to show you a series of slides. Each slide will be exposed several times in a very short time interval.

"At first, the form on the screen will be too dim for you to see. I will gradually make the form brighter until you can see it clearly.

"As the form becomes brighter, the first thing you will notice is a small flash of light on the screen. You will probably not be able to recognize the form. When this happens. I want you to say "flash" to indicate that you have seen the flash. (Experiment involving different positions, subjects also indicated location of the flash.) As the form becomes brighter, you will be able to make out the form. When you recognize a form, simply tell me what you saw. For example, if you see a square, simply say "square." Do not attempt to name a form if you are not sure what it is.

"Before we start the experiment, I will show you the forms (and positions) that will be used and then give you a few practice trials so you will become familiar with the procedures.

"We will stop for short rests during the session, so you will not become too tired."

Subjects in Experiment I were told that the flashes and forms would appear in the center of the dimly lit area.

Subjects in Experiment II were told the flashes and forms would appear in any one of five positions: center, right, left, top or bottom.

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13 ABSTRACT

The two experiments reported are part of a series evaluating effects of display parameters, task variables, and operator perceptual limitations on ability of Night Vision Device operators to process visual information quickly and accurately. For untrained observers, target brightness requirements were higher for identification than for detection, but were about equal for both responses with target exposure times greater than a critical time of 0.10 to 0.17 second. With shorter exposure times, the target brightness needed for detection or identification increased as exposure time decreased. Increasing information load and randomizing target location raised brightness requirements for identification. The results suggest that operator performance might be improved significantly by special training to increase the observer's area of attention and his capacity to process visual information.

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14 KEY WORDS	LINK A		LINK B		LINK C	
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1 CINC USA PACIFIC ATTN G3 DOC APO SAN FRAN 96610
1 CG US ARMY JAPAN APO 96343 SAN FRAN ATTN G3
10 CG USA FORCES SOUTHERN COMD ATTN SCARCD CZ
1 CG USA ALASKA ATTN ARACD APO 98749 SEATTLE
2 CG US ARMY EUROPE APO 09403 NY ATTN OPNS DIV
1 CO ARMY TRANS RES COMD FT EUSTIS ATTN TECH LIB
1 CG USA AD COMD ENT AFB ATTN ADGPA COL()
6 CG 1ST ARMY ATTN DCSDT FT MEADE MD
3 CG 3RD ARMY ATTN DCSDT FT MCPHERSON
4 CG SIXTH ARMY PRES OF SAN FRAN ATTN AMOPS-T2
1 CG EUSA ATTN AG-AC APO 96301 SAN FRAN
2 CG EUSA ATTN G-3 APO 96301 SAN FRAN
1 DIR HEL APG MD
1 CG USA CDC EXPERIMENTATION COMD FT ORD
2 ENGNR PSYCHOL LAB PIONEERING RES DIV ARMY NATICK LABS NATICK MASS
1 TECH LIB ARMY NATICK LABS NATICK MASS
2 INST OF LAND CAT ATTN TECH LIB FT BELVOIR VA
1 CO USA CDC C&R AGCY ALA
1 REDSTONE SCIENTIFIC INFO CTR US ARMY MSL COMD ATTN CHF DOC SEC ALA
1 CO FT HUACHUCA SPT CMND USA ATTN TECH REF LIB
2 CG US ARMY CDC EXPERIMENTATION COMD FT ORD
1 SIXTH USA LIB DEPOT BLDG M 13 14 PRES OF SAN FRAN
1 CHF DEPT OF CLIN & SOC PSYCH WALTER REED ARMY INST OF RES WASH D C
1 PLNS OFCR PSYCH HDQTRFS USACDCEC FT ORD
5 CG FT ORD ATTN G3 TNG DIV
2 DIR WRAIR WALTER REED ARMY MED CTR ATTN NEUROPSYCHIAT DIV
1 CO HQ ARMY ENLISTED EVAL CTR FT BENJ HARRISON
1 TECH LIB BOX 22 USACDC EXPERIMENTATION COMD FT ORD
1 HUMAN FACTORS TEST DIV (ADHZ) USAF HOSP EGLIN AFB
1 CO USA MOBILITY EQUIP R&D CTR ATTN TECH DOC CTR FT. BELVOIR
1 CO FRANKFORD ARSNL ATTN SMUFA-N64DD/2D2-4 PA
3 6TH RGN USARADCOM FT BAKER
1 4TH ARMY MSL COMD AIR TRANSPORTABLE SAN FRAN
2 CO PICATINNY ARSNL DOVER N J ATTN SUMPA VCI
1 LIB DEF SUPPLY AGCY CAMERON STA VA
2 CO USA CDC AG AGCY FT BENJ HARRISON IND
1 REF M MS IS NASA ALA
1 CO USA CBT DEVEL COMD TRANS AGCY FT EUSTIS
1 CO ARMY CDC INF AGY FT BENNING
1 CO ARMY CDC ARMOR AGY FT KNOX
8 USA CDC SPEC WARFARE AGENCY FT BRAGG
1 CO US ARMY CDC AVN AGCY FT RUCKER
1 DIR OF INTERN TNG USA LOG MGT CTR FT LEE
3 CO USA CDC CBT SUPPORT GP FT BELVOIR
3 CO USA TNG CTR (FA) ATTN AKPSITC-TT FT SILL
1 CG USA TNG CTR & FT LEONARD WOOD ATTN ACOFS G3
1 CG USA INF CTR ATTN AJIGT-T FT BENNING
1 CG USA TNG CTR INF ATTN ACOFS G3 FT DIX
1 CG USA TNG CTR ATTN ACOFS G3 FT JACKSON
1 CG USA TNG CTR INF ATTN ACOFS G3 FT LEWIS
1 CG USA TNG CTR INF & FT ORD ATTN ACOFS G3
61 CG USA TNG CTR INF ATTN ACOFS G3 FT POLK
3 CO USA MED TNG CTR ATTN DIR OF TNG FT SAM HOUSTON
10 CG USA AD CTR ATTN G3 FT BLISS
1 CG USA TNG CTR INF ATTN ACOFS G3 FT CAMPBELL
3 LIB ARMY WAR COLL CARLISLE BKS
1 CO USA INTELL SCH ATTN AHBH-S-AO FT HUACHUCA
1 DIR OF MILIT PSYCHOL & LDRSHP US MILIT ACAD WEST POINT
1 US MILIT ACAD WEST POINT ATTN LIB
1 CDMDT ARMY AVN SCH ATTN DIR OF INSTR FT RUCKER
2 CDMDT ARMY SECUR AGY TNG CTR & SCH FT DEVENS ATTN LIB
1 STIMSON LIB MED FLD SERV SCH BROOKE ARMY MED CTR FT SAM HOUSTON
10 CDMDT THE ARMOR SCH ATTN DDI FT KNOX
1 CDMDT ARMY ARMOR SCH FT KNOX ATTN WEAPONS DEPT
1 LIB USA ARMOR SCH FT KNOX
1 CDMDT USA CHAPLAIN SCH ATTN DDI FT HAMILTON
1 CDMDT ARMY CHEM CORPS SCH FT MCCLELLAN ATTN EDUC ADV
4 CDMDT ADJ GEN SCH FT BENJ HARRISON ATTN EDUC ADV
1 CDMDT USAIS ATTN EDUC ADV FT BENNING
1 CDMDT USAIS ATTN AJIIS-D-EPRD FT BENNING
1 LIB ARMY QM SCH FT LEE
1 CDMDT ARMY TRANS SCH FT EUSTIS ATTN EDUC ADV
1 CDMDT USA MIL POLICE SCH ATTN PLNS GPHUG DDDI FT GORDON
2 CDMDT US ARMY SOUTHEASTERN SIG SCH ATTN EDUC ADV FT GORDON
1 CDMDT USA AD SCH ATTN DDI FT BLISS
5 ASST CDMDT ARMY AIR DEF SCH FT BLISS ATTN CLASSF TECH LIB
3 CG USA FLD ARTY CTR & FT SILL ATTN AVN DFCR
1 CDMDT DEF INTELL SCH ATTN SI&A DEPT
1 CDMDT ARMED FORCES STAFF COLL NORFOLK
1 CDMDT JUDGE ADVOCATE GENERALS SCH U OF VA
1 DPTY CDMDT USA AVN SCH ELEMENT GA
1 DPTY ASST CDMDT USA AVN SCH ELEMENT GA
1 USA AVN SCH ELEMENT DFC OF DIR OF INSTR ATTN EDUC ADV GA
1 EDUC CONSLT ARMY MILIT POLICE SCH FT GORDON
6 CDMDT USA ENGR SCH ATTN EDUC ADV AHBBES-EA FT BELVOIR
2 CDMDT USA SCH EUROPE ATTN EDUC ADV APO 09172 NY
1 DFC OF DOCTRINE DEV LIT & PLNS USA ARMOR SCH ATTN AHBAAS-DM
1 DIR OF INSTR US MIL ACAD WEST POINT NY
1 DIR OF MILIT INSTR US MILIT ACAD WEST POINT
1 USA INST FOR MIL ASSIST ATTN LIB BLDG 1512808 FT BRAGG
4 USA INST FOR MIL ASSIST ATTN COUNTERINSURGENCY DEPT FT BRAGG
1 COMDT DEF MGT SCH FT BELVOIR
2 CDMDT USA MSL & MUN CTR & SCH ATTN CHF OFC OF OPS REDSTONE ARSNL
2 CDMDT US WAC SCH US WAC CTR ATTN AJMCT FT MCCLELLAN
2 HQ ABERDEEN PG ATTN TECH LIB
1 CO USA INTELL CTR & SCH ATTN DIR OF ACADEMIC OPS FT HUACHUCA
1 CO USA INTELL CTR & SCH ATTN DIR OF DOC & LIT FT HUACHUCA
1 COMDT USA C&GSC DFC OF CHF OF RESIDENT INSTR FT LEAVENWORTH
1 CDMDT USA CA SCH ATTN DFC OF DOCTRINE DEVEL LIT & PLNS FT BRAGG
1 CDMDT USA CA SCH ATTN DDI FT BRAGG
1 CDMDT USA CA SCH ATTN EDUC ADV FT BRAGG
1 CDMDT USA CA SCH ATTN LIB FT BRAGG
1 CDMDT USA SCH & TNG CTR ATTN ACOFS G3 TNG DIV FT MCCLELLAN
1 CDMDT USA SCH & TNG CTR ATTN ACOFS G3 PLNS & OPS DIV FT MCCLELLAN
10 CDMDT USA INST FOR MIL ASSIST ATTN DDI FT BRAGG
1 LIBN USAIS FT BENNING
8 CDMDT USA FLD ARTY SCH ATTN DDI FT SILL
1 CDMDT USA ARTY SCH ATTN EDUC SERVICES DIV FT SILL
1 CDMDT USA ARTY SCH ATTN EDUC ADV FT SILL
1 CDMDT USA TRANS SCH ATTN DIR OF DOC & LIT FT EUSTIS
1 CDMDT USA TRANS SCH ATTN LIB FT EUSTIS
1 USA INST FOR MIL ASST ATTN EDUC ADV FT BRAGG
1 CDMDT ARMY QM SCH OFC DIR OF NONRESID ACTVY ATTN TNG MEDIA DIV VA
1 CDMDT USA ARTY SCH ATTN LIB FT SILL
1 CG USA SCH & TNG CTR ATTN ACOFS G3 FT GORDON
1 DIR OF GRAD STUD & RSCH ATTN BEHAV SCI REP USA&GSC
1 CDMDT USA AD SCH ATTN AKBAAS-OL-EA FT BLISS
2 DIR BRGD & BN OPNS DEPT USAIS FT BENNING
1 DIR COMM ELEC USAIS FT BENNING
1 DIR ABN-AIR MOBILITY DEPT USAIS FT BENNING
2 DIR COMPANY TACTICS DEPT USAIS FT BENNING
1 CG USA SIG CTR & SCH ATTN ATSSC-DP-COB FT MONMOUTH
1 SECY OF ARMY, PENTAGON
1 DCS-PERS DA ATTN CHF C&S DIV
1 DIR OF PERS STUDIES & RSCH DDCSPER DA WASH DC
2 ACSFOR DA ATTN CHF TNG DIV WASH DC
1 HQ ARMY MAT COMD R&D DRCTE ATTN AMCRD-RC
2 CG ARMY MED R&D CMND ATTN BEHAV SCI RES BR
1 US ARMY BEHAVIOR & SYS RSCH LAB ATTNCRD-AR ARL VA
1 OPD PERS MGT DEV OFC ATTN MOS SEC (NEW EQUIP) DPDMO
1 PROVOST MARSHAL GEN DA
1 DIR CIVIL AFFAIRS DRCTE DDCSOPS
1 OFC RESERVE COMPON DA
2 CG USA SEC AGCY ARL HALL STA ATTN AC OF S GI VA
12 AUMIN DDC ATTN: TCA (MEALY) CAMERON STA ALEX., VA. 22314
1 CO US ARMY MED RES LAB FT KNOX
1 CG ARMY ELECT COMD FT MONMOUTH ATTN AMSEL CB
1 CHF OF R&D DA ATTN CHF TECH & INDSTR LIAISON OFC
1 CO USA CDC MED SERV AGCY FT SAM HOUSTON
1 USA BEHAVIOR & SYS RSCH LAB ATTN CRD-AIC ARL VA
1 CDMDT USA CBT SURVEIL SCH & TNG CTR ATT ED ADV FT HUACHUCA
1 CDMDT USA CBT SURVEIL SCH & TNG CTR ATTN ORG DOC & NEW EQUIP ARIZ
2 TNG & DEVEL DIV DUCSPERS
1 CDMDT USA CBT SURVEIL SCH & TNG CTR ATTN 1ST CBT TNG BDE ARIZ
1 CAREER MGT BR ATTN R CETIENNE CAMERON STA ALEX VA
1 USA LIB DIV-TAGO ATTN ASDIRS
2 PRES ARMY ARMOR BD FT KNOX
1 PRES ARMY INF BD FT BENNING ATTN FE&SP DIV
1 PRES ARMY MAINT BD FT KNOX
2 PRES ARMY ARTY BD FT SILL
1 CG CONARC ATTN COL E M HUDAK ATIT-SA FT MONROE
15 CG CONARC ATTN ATIT-STM FT MONROE
2 CG CONARC ATTN LIB FT MONROE
1 CO ARMY CBT DEVEL COMD MILIT POLICE AGY FT GORDON
1 USA ARCTIC TEST CTR CHF INSTR & TEST METH DIV SEATTLE
1 CHF USA AD HRU FT BLISS
1 CHF USA ARMOR HRU FT KNOX
1 CHF USA AVN HRU FT RUCKER
1 CHF USA INF HRU FT BENNING
1 CHF USA TNG CTR HRU PRES OF MONTEREY
10 CG 4TH ARMORED DIV ATTN DCSUT APO NY 09326
2 CO 194TH ARMORED BDE FT KNOX
5 CO 2D ARMURED CAV REGT APO 09693 NY
1 CO 3D ARMURED CAV REGT FT LEWIS
4 CO 14TH ARMORED CAV REGT ATTN AVN OFCR APO 09146 NY
1 1ST ARMORED DIV HQ & HQ CO FT HOOD ATTN AC OF S G2
5 CO 1ST BN 63RD ARMOR 1ST INF DIV ATTN S3 FT RILEY
8 CO 1ST BN 64TH ARMOR 3RD INF DIV ATTN S3 APO NY 09031
5 CO 2ND BN 68TH ARMOR 8TH INF DIV ATTN S3 APO NY 09034
1 CO COMPANY A 3D BN 32D ARMOR 3D ARMORED DIV APO NY
1 CO 5TH BN 33D ARMOR ATTN S3 FT KNOX
1 CO 3RD BN 68TH ARMOR 8TH INF DIV ATTN S3 APO NY 09028
1 CO 3RD BN 37TH ARMOR 4TH ARMURED DIV ATTN S3 APO NY 09066
1 CALIF NG 40TH ARMORED DIV LOS ANGELES ATTN AC OF SG3
1 55TH COMD HQ DIV ARMY NG JACKSONVILLE FLA
1 CG HQ 27TH ARMORED DIV NY AIR NG SYRACUSE
1 TEXAS NG 49TH ARMORED DIV DALLAS
3 CG ARMY ARMOR CTR FT KNOX ATTN G3 AIBKGT
1 CG 3RD INF DIV ATTN ACOFS G3 APO NY 09036
1 CG 7TH INF DIV ATT ACOFS G2 APO SAN FRAN 96207
1 CG 8TH INF DIV ATTN ACOFS G2 APO NY 09111

3 CG 4TH INF DIV (MECH) & FT CARSON ATTN ACOFS G3
1 DA HQS FT CARSON & HQS 4TH INF DIV (MECH) ATT MAJ HARRIS
1 CG HDQTRS USA HAWAII ATTN ACOFS G2 SAN FRAN 96557
3 CG 82ND ABN INF DIV ATTN ACOFS G3 FT BRAGG
1 CG XVIII ABN CORPS ATTN ACOFS G3 FT BRAGG
1 CO 197TH INF BRGD FT BENNING ATTN S3
1 CO 1ST BN (REINF) ATTN S3 FT MYER
1 CO HDQTRS 2ND BN 6TH US INF REGT ATTN S3 APO NY 09742
7 CO 3RD BN 6TH INF REGT ATTN S3 APO NY 09742
1 CO 171ST INF BDE ATTN S3 APO SEATTLE 98731
1 CO 1ST BN 39TH INF 8TH INF DIV ATTN S3 APO NY 09034
1 CO 2ND BN 15TH INF 3RD INF DIV ATTN S3 APO NY 09026
5 CG 1ST INF DIV ATTN ACOFS G3 FT RILEY
5 CO 1ST BN (MECH) 52ND INF 198TH INF BDE ATTN S3 APO SAN FRAN 96219
1 CO 4TH BN (MECH) 54TH INF ATTN S3 FT KNOX
1 CO USA PARTIC GP USA TNG DEVICE CTR FLA
2 CONSOL RES GP 7TH PSYOP GP APO 96248 SAN FRAN
2 DA OFC OF ASST CHF OF STAFF FOR COMM-ELCT ATTN CETS-6 WASH
1 CHF MED RES PROJ ARMY HOSP US MILIT ACAD WEST POINT
1 CG MILIT DIST OF WASHINGTON
1 USA RECRUITING COMD HAMPTON VA
1 SYS RES GP ENGNR EXPRM STA COLUMBUS O
1 DIR ARMY LIB PENTAGON
1 CHF OF MILIT HIST DA ATTN GEN REF BR
1 CO USA 10TH SPEC FORCES GP FT DEVENS
1 CG 31ST ARTY BDE AD ATTN S3 PA
1 CO 28TH ARTY GP AD ATTN S3 SELFRIDGE AFB
1 HQS 45TH ARTY BDE AD ATTN S3 ARL HTS ILL
1 CO 35TH ARTY BDE AD ATTN S3 FT MEADE MD
1 CG 101ST ABN DIV (AIRMOBILE) ATTN ACOFS G3 APO SAN FRAN 96383
1 CG 1ST CAV (AIRMOBILE) ATTN ACOFS G3 APO SAN FRAN 96383
1 US ARMY GEN EQUIP ATTN TECH L & FT LEE
1 US ARMY TROPIC TEST CTR PO DRAWER 942 ATTN BEHAV SCIEN CZ
1 CO 525TH MIL INTELL GP ATTN [illegible] APO SAN FRAN 96307
1 CO USAFAAC ATTN S3 FT SILL
10 CG III CORPS & FT HOOD ATTN G3 SEC FT HOOD
30 CO 1ST ARMORED DIV ATTN G3 SEC FT HOOD
3 CG 2D ARMORED DIV ATTN G3 SEC FT HOOD
25 CO 13TH SUPT BDDE ATTN S3 SEC FT HOOD
1 CG USAFAC & FT SILL ATTN AKPSIGT-INTN
5 CO III CORPS ARTY ATTN G3 SEC FT SILL
15 CO 1ST AIT BDDE ATTN G3 SEC FT BLISS
8 CG USATCI & FT POLK ATTN AKPPO-DCOT
1 RSCH CONTRACTS & GRANTS BR ARO
1 BESO ARO OFC CHF OF R&D WASH DC
1 CHF OF R&D DA ATTN SCI INFO BR RSCH SPT DIV WASH DC
1 CO HQS BN USAFAC & FT SILL ATTN S3
4 CO III CORPS APTY ATTN S3 FORT SILL
1 CO USRAH ATTN S3 FT SILL
1 CG USAFACFS ATTN AKPSIAC-AS FT SILL
1 CINC US ATLANTIC FLT CODE 312A USN BASE NORFOLK
1 CINC PACIFIC SCIEN ADV GP (J305) BOX 13 FPO 96610
1 COR TNG COMMAND US PACIFIC FLT SAN DIEGO
1 CHF RES DIV BUR OF MED + SURG DN
5 TECH LIB PERS 110 BUR OF NAV PERS ARL ANNEX
3 DIR PERS RES DIV BUR OF NAV PERS
1 TECH LIB BUR OF SHIPS CODE 210L NAVY DEPT
1 ENGNR PSYCHOL BR ONR CODE 455 ATTN ASST HEAD WASH DC
3 CO + DIR NAV TNG DEVICE CTR ORLANDO ATTN TECH LIB
1 CO FLT ANTI-AIR WARFARE TNG SAN DIEGO
1 CO NUCLEAR WPNS TNG CTR PACIFIC US NAV AIR STA SAN DIEGO
1 CO FLEET TNG CTR US NAV STA SAN DIEGO
1 PRES NAV WAR COLL NEWPORT ATTN MAHAN LIB
1 CO FLT ANTI-SUB WARFARE SCH SAN DIEGO
1 CHF OF NAVL RSCH PERS & TNG BR (CODE 458) ARL VA
1 CHF OF NAV RES ATTN DIR PSYCHOL SCI DIV CODE 450
1 CHF OF NAV RES ATTN HEAD GP PSYCHOL BR CODE 452
1 DIR US NAV RES LAB ATTN CODE 5120
1 DIR NAVAL RSCH LAB ATTN LIB CODE 2029 WASH DC
1 CO MED FLD RES LAB CAMP LEJEUNE
1 COR NAV MSL CTR POINT MUGU CALIF ATTN TECH LIB CODE 3022
1 DIR AEROSPACE CREW EQUIP LAB NAV AIR ENGNR CTR PA
1 OIC NAV PERS RES ACTVY SAN DIEGO
1 NAV NEUROPSYCHIAT RES UNIT SAN DIEGO
1 OIC PERS RES LAB NAV PERS PROGRAM SUPPORT ACTIVITY WASH NAV YD
3 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AO-18
1 HQ MARINE CORPS ATTN AX
1 DIR MARINE CORPS EDUC CTR MARINE CORPS SCH QUANTICO
1 DIR MARINE CORPS INST ATTN EVAL UNIT
1 US MARINE CORPS HQS HIST REF LIB ATTN MRS JADOT
1 CHF OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
1 DIR OPS EVAL GRP OFF OF CHF OF NAV OPS OPO3EG
2 COMDT PTP COAST GUARD HQ
1 CHF OFCR PERS RES + REVIEW BR COAST GUARD HQ
1 CO US COAST GUARD TNG CTR GOVERNORS ISLAND NY
1 CO US COAST GUARD TNG CTR CAPE MAY NJ
1 CO US COAST GUARD TNG CTR & SUP CTR ALAMEDA CALIF
1 CO US COAST GUARD INST OKLA CITY OKLA
1 CO US COAST GUARD RES TNG CTR YORKTOWN VA
1 SUPT US COAST GUARD ACAD NEW LONDON CONN
1 TECH DIR TECH TNG DIV(HRD) AFHRL LOWRY AFB COLO
1 DEPT OF THE AF HQS USAF ATTN AFCIN-301 PENTAGON
1 CHF SCI DIV ORCTE SCI + TECH DCS R+D HQ AIR FORCE AFRSTA
1 RADC RASH GRIFFISS AFB NY
2 COR ELEC SYS DIV LG HANSCOM FLD ATTN ESMDA/STOP 36 MASS
2 SMAMA (SMACU-PERS RSCH) MCCLELLAN AFB
1 ATC ATXRQ RANDOLPH AFB
1 AFHRL/IT ATTN CAPT W S SELLMAN LOWRY AFB
1 HQ SAMSO (SMSIR) AF UNIT POST OFC LA AFS CALIF
1 MILIT TNG CTR OPE LACKLAND AFB
2 AFHRL (HRT) WRIGHT-PATTERSON AFB
1 AMD AMRH BROOKS AFB TEXAS
1 HQS ATC DCS/TECH TNG (ATTMS) RANDOLPH AFB
1 USAFA DIR OF THE LIB USAF ACAD COLO
2 CO HUMAN RESOURCES LAB BROOKS AFB
1 COMDT USAF SPEC OP SCH (TAC) EGLIN AFB
1 AFHRL (FT) WILLIAMS AFB ARIZ
1 PSYCHOBIOLOGY PROG NATL SCI FOUND
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN IOL
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN DIR OF TNG
3 CIA ATTN CRS/ADD STANDARD DIST
1 SYS EVAL DIV RES DIRECTORATE DOD-DCO PENTAGON
1 DEPT OF STATE BUR OF INTEL + RES EXTERNAL RES STAFF
1 SCI INFO EXCH WASHINGTON
2 CHF MGT & GEN TNG DIV TR 200 FAA WASH DC
1 BUR OF RES & ENGR US POST OFC DEPT ATTN CHF HUMAN FACTORS BR
1 EDUC MEDIA BR OE HEW ATTN T D CLEMENS
1 OFC OF INTERNATL TNG PLANNING & [illegible]AL BR AID WASH DC
1 DEPT OF TRANS FAA ACD SEC HQ 610A WASH DC
2 ERIC OE WASH DC
1 SYS DEVEL CORP SANTA MONICA ATTN LIB
1 DUNLAP + ASSOC INC DARIEN ATTN LIB
2 RAC ATTN LIB MCLEAN VA
1 RAND CORP WASHINGTON ATTN LIB
1 GP EFFECTIVENESS RSCH LAB U OF ILL DEPT OF PSYCHOL
1 ELECT PERS RSCH GP U OF SOUTHERN CALIF
1 COLUMBIA U ELEC RES LABS ATTN TECH EDITOR
1 MITRE CORP BEDFORD MASS ATTN LIB
2 LEARNING R&D CTR U OF PITTS ATTN DIR
1 HUMAN SCI RES INC MCLEAN VA
2 TECH INFO CTR ENGNR DATA SERV N AMER AVN INC COLUMBUS O
1 CHRYSLER CORP MSL DIV DETROIT ATTN TECH INFO CTR
1 CTR FOR RSCH IN SOCIAL SYS ATTN LIBN MD
1 GEN DYNAMICS POMONA DIV ATTN LIB DIV CALIF
2 OTIS ELEVATOR CO DIV ATTN LIB STAMFORD CONN
1 MGR BIOTECHNOLOGY AEROSPACE SYS DIV MS BH-25 BOEING CO SEATTLE
1 IDA RSCH & ENG SUPT DIV ARL VA
1 SCI & TECH DIV IDA ARL VA
1 HUGHES AIRCRAFT COMPANY CULVER CITY CALIF
1 DIR CTR FOR RES ON LEARNING + TEACHING U OF MICH
1 EDITOR TNG RES ABSTR AMER SOC OF TNG DIRS U OF TENN
1 U OF CHICAGO DEPT OF SOC
1 DIR CTR FOR RSCH IN SOCIAL SYS KENSINGTON MD
3 CANADIAN JOINT STAFF OFC OF DEF RES MEMBER WASHINGTON
3 CANADIAN ARMY STAFF WASHINGTON ATTN GSO2 TNG
2 CANADIAN LIAISON OFCR ARMY ARMOR BD FT KNOX
2 OFC OF ARMED FORCES ATTACHE ROYAL SWEDISH EMBSY DC
3 AUSTRALIAN NAV ATTACHE EMBSY OF AUSTRALIA WASH DC
1 FRENCH ARMY LIAISON OFCR USAAVNC & FT RUCKER
1 OFC OF AIR ATTACHE AUSTRALIAN EMBSY ATTN: T.A. NAVGN WASH. D.C.
2 AUSTRALIAN ARMY ATTACHE EMBSY OF AUSTRALIA ATTN TECH CLK
2 OR B T DOUD LANING SYS LTD SURREY ENGLAND
1 MENNINGER FOUNDATION TOPEKA
1 AMER INSTS FOR RSCH SILVER SPRING
1 AMER INSTS FOR RSCH ATTN LIBN PA
1 DIR PRIMATE LAB UNIV OF WIS MADISON
1 DR E GINZBERG COLUMBIA UNIV SCH OF BUS
3 MATRIX RSCH CO FALLS CHURCH VA
1 EDUC & TNG CONSLT CO LA CALIF
1 OBERLIN COLL DEPT OF PSYCHOL
1 DR GEORGE T HAUTY CHMN DEPT OF PSYCHOL U OF DEL
1 GEN ELECTRIC CO SANTA BARBARA ATTN LIB
1 HEAD DEPT OF PSYCHOL UNIV OF SC COLUMBIA
1 U OF GEORGIA DEPT OF PSYCHOL
1 SE CO WASH D C
1 AMER INST FOR RSCH ATTN LIB PALO ALTO CALIF
1 COLL OF ARTS & SCI U OF MIAMI ATTN L L MCQUITTY
1 ROWLAND + CO HADDONFIELD NJ ATTN PRES
1 NORTRONICS DIV OF NORTHROP CORP ANAHEIM CALIF
1 OHIO STATE U SCH OF AVN
2 AIRCRAFT ARMAMENTS INC COCKEYSVILLE MD
1 DR J B CULLEN DEPT OF SOC & ANTHROP UNIV OF RI
2 OREGON STATE U DEPT OF MILIT SCI ATTN ADJ
1 AMER PSYCHOL ASSOC WASHINGTON ATTN PSYCHOL ABSTR
1 NO ILL U HEAD DEPT OF PSYCHOL
1 GEORGIA INST OF TECH DIR SCH OF PSYCHOL
1 LIFE SCI INC HURST TEXAS ATTN W G MATHENY
1 AMER BEHAV SCI CALIF
2 DIR INSTR RESOURCES STATE COLL ST CLOUD MINN
1 COLL OF WM + MARY SCH OF EDUC
1 SO ILLINOIS U DEPT OF PSYCHOL
1 WASH MILITARY SYS TECH LIB DIV BETHESDA MD
1 NORTHWESTERN U DEPT OF INDSTR ENGNR
1 DR L TWYFORD NY STATE EDUC DEPT ABSTRACT EDITOR AVCR
1 AEROSPACE SAFETY DIV U OF SOUTHERN CALIF LA
1 MR BRANDON B SMITH RES ASSOC U OF MINN
1 DR V ZACHERT RT 1 GOOD HOPE GA
1 J P LYDON DIR JR ROTC SAN ANTONIO TEXAS
2 CHRYSLER CORP DEF ENGR ATTN DR H BERMAN DETROIT
1 DR S ROSCOE ASSOC DIR FOR RSCH INST OF AVN U OF ILL
1 DR C HELM DEPT EDUC PSYCH CITY U OF NY
1 GEN H P HARRIS (USA RET) PRES THE CITADEL SC
1 DR H SHOEMAKER DIR TNG RSCH GP NY
1 VOC-TECH EDUC PROG PLNNG DEV ATTN W STOCK ST PAUL
1 CHF PROCESSING DIV DUKE U LIB
1 U OF CALIF GEN LIB DOCU DEPT
1 FLORIDA STATE U LIB GIFTS + EXCH
1 PSYCHOL LIB HARVARD UNIV CAMBRIDGE
1 U OF ILL LIB SER DEPT
2 U OF KANSAS LIB PERIODICAL DEPT
1 U OF NEBRASKA LIBS ACQ DEPT
1 OHIO STATE U LIBS GIFT + EXCH DIV
1 PENNA STATE U PATTEE LIB DOCU DESK
1 PURDUE U LIBS PERIODICALS CHECKING FILES
1 STANFORD U LIBS DOCU LIB
1 LIBN U OF TEXAS
1 SYRACUSE U LIB SER DIV
1 SERIALS REC UNIV OF MINN MINNEAPOLIS
1 STATE U OF IOWA LIBS SER ACQ
1 NO CAROLINA STATE COLL DH HILL LIB

2 BOSTON U LIBS ACQ DIV
1 U OF MICH LIBS SER DIV
1 BROWN U LIB
1 COLUMBIA U LIBS DOCU ACQ
1 DIR JOINT U LIBS NASHVILLE
1 U OF DENVER MARY REED LIB
2 LIB GEO WASH UNIV ATTN SPEC COLL DEPT WASH DC
2 LIB OF CONGRESS CHF OF EXCH + GIFT DIV
1 U OF PGH DOCU LIBN
1 CATHOLIC U LIB EDUC & PSYCHOL LIB WASH DC
1 U OF KY MARGARET I KING LIB
1 SO ILL U ATTN LIBN SER DEPT
1 BRIGHAM YOUNG U LIB SER SECT
1 U OF LOUISVILLE LIB BELKNAP CAMPUS
1 GEORGETOWN U LIB SER DEPT WASH DC
1 LIBS COLO STATE U ATTN DOC LIBN FT COLLINS
1 CG USACDC FT BELVOIR VA
1 CO USACDC AVN AGCY FT RUCKER ALA
1 CG USA ARMOR CTR FT KNOX
1 COMDT USA ARMOR SCH FT KNOX
1 CG EIGHTH USA APO SAN FRAN 96301
1 COMD IN CHF USA EUROPE & 7TH ARMY APO NY 09403
1 CG CONARC ATTN ATIT-RD-MO FT MONROE
1 PRES USA ARMOR & ENGR BD FT KNOX
1 CG US MIL ASSIST COMD VIETNAM APO SAN FRAN 96222
1 COMDT USA AVN SCH FT RUCKER ALA
1 COMDT USA PRIN HELICOPTER SCH FT WOLTERS
1 COMD USA VIETNAM US MIL ASSIST COMD VIETNAM APO SAN FRAN 06222
1 COMDT SEVENTH USA COMBINED ARMS SCH APO NY 09114
1 CG USA FORCES SOUTHERN CCMD CZ
1 CO USA LIMITED WARFARE LAB APG MD
1 PROJ MGR SEA NITEOPS PO BOX 9285 ATTN MR WALLACE ALEX VA
1 CO NOTTS DETACHMENT FT BELVOIR
1 COMD IN CHF USA PACIFIC ATTN GPOP-JST APO SAN FRAN 96558
1 CO ACTIV APO SAN FRAN 96384
1 CG USA TEST & EVAL COMD ATTN AMSTE-PO-S APG MD
1 CG USA ELECT COMD ATTN AMSEL-CR-GV FT MONMOUTH
1 DIR USA HEL ATTN AMXHE-SYS APG MD
1 OPT DIR NIGHT VISION LAB ATTN AMSEL-NV FT BELVOIR
1 CG USA ORD CTR & SCH ATTN AHAN-OM APG MD
1 CG USA SIG CTR & SCH ATTN SIGOJT-IB FT MONMOUTH
1 CO USA CBT SURVL & ELEC WARFARE SCH & TNG CTR ATTN AMCTC-CSS-NE-E
1 COMDT USA FLD ARTY SCH ATTN AKPSIAS-DI-P FT SILL
1 COMDT USA ENGR SCH ATTN AHBBES-DR FT BELVOIR
1 COMDT USAIS ATTN AJIIS-I FT BENNING
1 COMDT USA SE SIG SCH ATTN SESS-I-PR FT GORDON
1 CO APG ATTN STEAP-MT-TF
1 CG USACDC EXPERIMENTATION COMD ATTN G2 FT ORD
1 CG USACDC EXPERIMENTATION COMD ATTN G3
1 CO USACDC INF AGCY ATTN CAGIN-CM FT BENNING
1 CG USA CDC CBT ARMS GP ATTN LTC MARTIN FT LEAVENWORTH
1 CO USACDC MAINT AGCY MAT DIV ATTN CDC-MA-E APG
1 COMDT US MARINE CORPS CODE AO4C DC
1 CO USACDC INST OF SPEC STUDIES ATTN STAND STUDY DIRECT
1 CO USACDC ARMOR AGCY FT KNOX
1 PROJ MGR NIGHT VISION ATTN COL SURKAMP FT BELVOIR
1 CG USA MAT COMD ATTN AMCRD-O DC
1 CO USA MOBLT EQUIP RSCH & DEV CTR FT BELVOIR
1 CG MCDEC CHF C&E DIV QUANTICO VA
1 COMDT MCDEC DIR DEV CTR QUANTICO VA
1 DEPT OF AF HQ-USAF TAC AIR WARFARE CTR ATTN USAFTAWC EGLIN AFB
1 PROJ DIR MASSTER FT HOOD
1 COMD IN CHF USA KOREA APO SAN FRAN