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EFFECTS OF CONTINUOUS MILITARY OPERATIONS ON SELECTED MILITARY TASKS

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BEHAVIOR AND SYSTEMS RESEARCH LABORATORY

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FOREWORD

The Night Operations Program within the Behavior and Systems Research Laboratory is concerned with problems in optimizing human performance in relation to night vision devices and related sensors. Specific aspects deal with determining: performance effectiveness of sensor systems; factors which affect performance; and means of improving effectiveness. The entire research program is responsive to requirements of the Combat Developments Command and is conducted under RDT&E Project 2Q062106A723, Human Performance in Military Systems, FY 1971 Work Program.

To further the research, a BESRL field unit was established at Fort Ord, California, where in conjunction with and with the support of the Combat Developments Command Experimentation Command (CDCEC), experimentation is currently being conducted with passive night vision devices. Personnel of the Behavior and Systems Research Laboratory are deeply appreciative of the excellent support given the research program by CDCEC, both in personnel and materiel. Special acknowledgment is made of the efforts of the Commander, Brigadier General T. W. Brown, and of Project Team III, which, under the command of Lieutenant Colonel J. Fulton, directly supported the research activity.

The new devices and sensors have increased the capability for continuous day and night operations and hence the likelihood that soldiers will be used for extended periods of time without scheduled rest. The present publication reports on research to determine the impact of such continuous operations on soldier effectiveness.

BESRL research in this area is conducted as an in-house research effort augmented by research contracts with organizations selected as having unique capabilities for research in this area. The present study was conducted under the program direction of Mr. Jack J. Sternberg, Behavior and Systems Research Laboratory, assisted by personnel of Manned Systems Sciences, Northridge, California, under the supervision of Mr. Douglass R. Nicklas.



J. E. UHLANER, Director
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EFFECTS OF CONTINUOUS MILITARY OPERATIONS ON SELECTED MILITARY TASKS

BRIEF

Requirement:

1. New devices and sensors for night seeing and target acquisition have increased the capability of the U. S. Army for continuous operation extending through day and night. Although the soldier can continue to function under such conditions, his performance on critical tasks may be so degraded that his effectiveness is severely impaired. The present research was undertaken to determine the extent to which soldier performance is degraded on combat-related tasks, with the goal of developing techniques, work methods, and procedures for reducing such degradation if it occurs.

2. Individual soldiers differ greatly in their ability to see and detect targets when using passive night vision devices. If high performers could be identified by means of a simple test, the assignment of men to use the devices could be greatly improved. Also, determination of factors related to high performance would give guidance for the development of techniques which could, at least in part, correct any deficiencies identified.

Procedures:

A group of nine players was tested each week on the following schedule: Day 1 (Friday)--orientation and training; Days 2 and 3 (Monday and Tuesday)--continuous operations testing; Day 4 (Wednesday)--controlled rest; Day 5 (Thursday)--recovery testing. Seven groups were tested on this schedule. The basic tests on the effects of continuous military operations were obtained during Days 2 and 3. These tests were: target acquisition with the Starlight Scope; rifle shooting; grenade-throwing accuracy. Players were kept continuously active on these and other (non-scorable) military activities for nearly 48 hours with no scheduled sleep. Perceptual and cognitive tests, primarily from Army test batteries, were also administered during this time to provide information on the second requirement. After a 24-hour rest on Day 4, players were again tested on Day 5 to provide information on a corollary question: if performance is impaired by continuous operations, is a 24-hour rest sufficient to allow for recovery?

Findings:

Players showed no degradation in performance on any of the tests given. Despite clear evidence of fatigue on the second day of continuous operations, the soldiers performed at the same level as on the first day. Morale also remained high.

The cognitive and perceptual tests given were not predictive of search performance on the night vision devices.

Utilization of Findings:

Troops can be tactically employed for at least 44 hours without suffering any loss in performance in their use of Starlight Scopes or in other military tasks such as rifle firing and grenade throwing, if their motivation is high.

The soldier's effectiveness in using the Starlight Scope appears to be more related to his training and to the work methods, procedures, and search techniques employed than to his ability to see and/or recognize targets.

EFFECTS OF CONTINUOUS MILITARY OPERATIONS ON SELECTED MILITARY TASKS

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EFFECTS OF CONTINUOUS MILITARY OPERATIONS ON SELECTED MILITARY TASKS

BACKGROUND

The development of sensors for night seeing and target acquisition has greatly increased the capability of the U. S. Army for continuous day and night combat operations. As a consequence, soldiers may frequently be required to operate for sustained periods with little reduction in level of activity during the night. Under such conditions, the effectiveness of a unit may be greatly impaired by degradation in the performance of the individual soldier.

The present report presents the findings of an experiment on the effects of continuous military operations. The experiment is part of an ongoing research program designed to improve the effectiveness of the soldier during night operations and, in particular, his effectiveness with night vision devices and sensors. The effects of continuous military operations on soldiers' search performance with devices was therefore of particular interest, but the effects on two other combat related tasks (live rifle fire and grenade throwing accuracy) were also measured.

A second purpose of the experiment was to determine whether performance with night vision devices could be predicted by scores from a number of tests. Prior BESRL research has shown that individual operators differ greatly in their ability to see and to detect targets during search. These differences may be due to perceptual-cognitive differences among individuals. It is possible that individuals differ in their ability to see targets or in their ability to recognize and discriminate a target from other target-like objects in a varied, cluttered terrain. If such perceptual-cognitive factors can be identified by a simple test and related to effective utilization of a night vision device, the test will have considerable value as a selection device. In addition, determination of factors related to high performance would give guidance for the development of techniques which could, at least in part, correct the deficiencies identified and increase the effectiveness of the soldier who is performing poorly. A battery of tests measuring various aptitudes and abilities was, therefore, administered during the experiment.

METHODOLOGY

A narrative description of the procedures is given here. Details of the methodology are given in the Technical Supplement.

Nine players were tested each week on the following schedule: Day 1 (Friday)--orientation and training; Days 2 and 3 (Monday and Tuesday)--continuous operations testing; Day 4 (Wednesday)--controlled rest; Day 5 (Thursday)--recovery testing. The basic tests on the effects of continuous military operations were given during Days 2 and 3.

Preliminary training and practice on two of the tests (rifle firing and grenade throwing) were given on Day 1. This training brought the players up to a stable level of performance and thereby prevented contamination of the primary test results by controlling learning which may have occurred during the actual conduct of the test. The final two days were included to provide information on a corollary question: If performance on the various tasks is impaired by continuous operations, is a 24-hour rest sufficient to allow for recovery? After a controlled rest on Day 4, the basic tests were given again on Day 5. Seven groups were tested, giving a total of 34 players tested under starlight illumination and 27 players under moonlight illumination (two men were dropped for administrative reasons).

The period of continuous operations began when the players assembled at 0600 hours on Monday at Camp Roberts, California. Immediately after breakfast, they were taken to a rifle range where they fired a total of 60 record rounds each at distances of 100, 200, and 300 meters. Firing was in a prone, unsupported position. The players then moved to a dummy grenade range where they threw 30 hand grenades (ten each from distances of 15, 20, and 25 meters) at a circular target marked on the ground. Upon completion of this test, players were given their noon meal, after which they were taken 30 miles by truck to a "base camp" at Hunter Liggett Military Reservation. During the afternoon, a battery of tests was administered and a hot meal was given in the field. From approximately 1900-2100 hours, the players were trained to use the Starlight Scope. (Based upon prior BESRL studies, this period of time was sufficient to bring the soldiers to a stable level of performance.) From 2100 hours Monday to 0130 hours Tuesday, they were on "perimeter defense" at the camp. During this time they searched almost continuously for targets, using tripod-mounted Starlight Scopes. Search behavior and target acquisition were recorded electronically. At 0130 hours, after coffee and sandwiches, the players were taken by truck to a point several miles from the base camp where they dismounted and moved on foot, using appropriate tactical procedures, to an observation post which commanded two road junctions, a stream, and considerable surrounding terrain. There they occupied fox-holes, two men working as a team. The two men worked on a 30 minutes on--30 minutes off cycle, the man on watch searching for targets using a handheld Starlight Scope. After two hours, the players made a tactical withdrawal to a rendezvous point with the truck. They were then taken by truck to Camp Roberts where they had breakfast, were again tested on the rifle and grenade ranges, had lunch, and were returned by truck to their base camp at Hunter Liggett Military Reservation, arriving there at about 1300 hours Tuesday. Operations continued with a four-hour tactical patrol which covered approximately six miles of rough and varied terrain. During the patrol, the players were ambushed by aggressors (firing blanks), deployed, and returned fire, captured one of the aggressors, and continued tactically until they returned to the base camp at approximately 1700 hours. The purpose of the patrol was to provide tactical realism as well as strenuous physical activity such as might be expected in an actual combat situation. After a hot meal at the base camp and administration of the test battery, the players again were put on perimeter defense and searched for targets using the tripod-mounted Starlight Scope, just as on the previous night.

Testing was completed at approximately 0130 hours Wednesday. At this time, the players had gone for nearly 44 hours without scheduled sleep. During this time, they did have opportunity for short catnaps--for example, when they were being transported by truck. However, the experiment was concerned not with the effects of sleep deprivation but rather with the effects of continuous military operations. Similar opportunities for rest and sleep exist even in combat and soldiers take advantage of them. In the experiment, therefore, no attempt was made to prevent the players from taking such natural rest breaks. Indeed, it was felt that any such interference would have impaired the validity of the test results.

Upon completion of the second night's testing at 0130 hours Wednesday, the players were returned by truck to Camp Roberts where they began a 24-hour controlled rest. The final day of activity (Thursday) replicated all the operations described for the Monday schedule, ending at 0130 hours Friday with the completion of testing of performance with the night vision devices. At this time, the players were debriefed and returned to Camp Roberts.

RESULTS

The primary purpose of the experiments was to determine the effects of continuous military operations on soldiers' effectiveness and, if degradation occurred, to determine if 24 hours' rest was sufficient to return performance to its original level. A second purpose was to determine whether any of the cognitive-perceptual tests which were administered, or scores from the players' records, had any value as predictors of search performance with the night vision devices. Effects of continuous military operations are presented in terms of performance with night vision devices, rifle shooting, and grenade tossing. The results pertaining to the second question are in terms of correlation between test scores and night vision device performance.

Effects of Continuous Military Operations

Performance on none of the tasks was degraded by continuous military operations. Despite clear evidence of fatigue on the second day (e.g., verbalizations of fatigue, catnaps snatched during transport and during short breaks in activity), morale and performance remained high. Complaints and griping were frequent but good-humored. During debriefings after the second night's test with night vision devices--after almost 48 hours of continuous activity--most players reported that they were very tired but could keep going if they had to. When they were asked what they would do if they had a pass--go to bed or go to town--a large number said they would go to town and sleep could wait.

Night Vision Device Performance. The percentage of targets detected on the first night and second night of testing are shown in Table 1. Obviously, no degradation in performance occurred. The increase in percent detections on Night 2 of full-moon illumination is attributable to an increase on one of the three weeks of full-moon test. In this week, the first night of testing was somewhat overcast and the second night extremely bright. With this week eliminated, the mean detections were 56 percent and 56 percent for Nights 1 and 2, respectively.

Table 1

PERCENT TARGET DETECTION WITH STARLIGHT SCOPE		
Illumination Condition	Night 1	Night 2
Starlight	20	20
Full Moon	54	61

Table 2 shows mean target detection time. Again, no decrease in performance was found and, indeed, target acquisition was somewhat more rapid on the second night. Evidence from prior experiments suggests that this improvement in time taken for target acquisition was probably due to increasing familiarity with the terrain. Thus, familiarization with a terrain probably results in a reduction in the time required for target detection but no increase in the percentage of targets detected.

Table 2

MEAN TARGET DETECTION TIME
(Based only on targets detected)

Illumination Condition	Night 1	Night 2
Starlight	56	44
Full Moon	50	43

Rifle Performance. Rifle scores are given in Table 3. In this task, 20 rounds were fired at each distance (100, 200, 300 meters) on each day. Hits were scored according to the standard system, the center ring (bull's eye) having a value of 5 and surrounding rings values of 4 and 3. The stability of the performance is obvious. The lack of degradation is noteworthy in view of the high degree of perceptual and motor coordination required for accurate shooting, particularly at the greater distance.

Table 3

RIFLE PERFORMANCE

Distance (Meters)	Day 1	Day 2
100	83	83
200	54	55
300	36	39
Overall	173	177

Grenade Performance. Whereas rifle shooting requires fine hand-arm motor responses, the motor responses required in tossing a grenade are gross, involving large movements of the arm as well as compensatory adjustments of the entire body. The physical requirements, therefore, are quite different from those of rifle shooting. In this task, the players were required to throw 30 dummy hand grenades (ten each from distances of 15, 20, and 25 meters) at a circular target marked on the ground. This target was 24 feet in diameter and marked with concentric interior rings every one and one-half feet, giving a total of eight rings. The center ring (bull's eye) was three feet in diameter and was assigned a value of 8 for scoring purposes. The scoring value of each ring decreased with increasing distance from the center, with the outermost ring having a value of 1. Thus, the maximum score that could be made at any given distance was 80 (ten grenades, each hitting the bull's eye) and the maximum total score was 240. The results are shown in Table 4. The finding of primary importance was, again, no degradation in performance on Day 2 although a considerable amount of physical strength, as well as good control, was required to throw 30 grenades, especially at distances of 25 meters.

Table 4

GRENADE PERFORMANCE

Distance (Meters)	Day 1	Day 2
15	37	37
20	34	34
25	30	31
Total	101	102

Recovery Testing

The purpose of the "recovery" testing was to provide information on a corollary question: If performance is impaired by continuous operations, is a 24-hour rest sufficient to allow for recovery? As no degradation in performance occurred as a result of continuous military operations, test performance on the presumed "recovery" day was not analyzed.

Prediction of Performance with Night Vision Devices

In previous research by BESRL on performance with night vision devices, a great deal of difference among individuals has been found in the ability to see and to detect targets during search. These differences may be due to perceptual-cognitive differences among individuals. It is possible that individuals differ in their ability to see targets or in their ability to recognize and discriminate a target from other target-like objects in a varied, complex, and cluttered terrain. If the hypothesized perceptual-cognitive factors can be identified by a simple test and related to effective utilization of a night vision device, the test will have considerable value as a selection device, as well as providing guidance for techniques which could correct the deficiencies of the poor-performing soldier.

A variety of test scores were correlated with search performance scores from the first night's testing with the Starlight Scope. These tests were the Verbal (VE), Arithmetic Reasoning (AR), and Army Clerical Speed (ACS) from the Army Classification Battery (ACB), and the Attention to Detail (ATD) test from the Motor Vehicle Drivers Selection Battery - 1. In addition, a number of Army Classification Battery test scores and aptitude area composites were taken from the players' records.

These were: Pattern Analysis (PA); Infantry-Combat (IN); Armor, Artillery and Engineers-Combat (AE); and General Technical (GT). Also, a "hidden figures" test was administered in which the task was to discriminate a geometric figure "hidden" in a more complex background. In addition, two visual acuity tests were given, one using a standard eye chart for daylight vision and one using the Army Night Seeing Tester (ANST) for night vision.

These tests covered a broad range of factors, but performance on none of the tests correlated significantly with performance on the night vision devices.

CONCLUSIONS

When properly motivated, soldiers can perform at a stable level with no loss in efficiency on important combat-related tasks during a 44-hour period of continuous military operations. No evidence of performance decrement was found in tasks requiring target detection with night vision devices, live rifle fire, and grenade tossing.

Cognitive and perceptual tests used in this experiment did not correlate with performance on the Starlight Scope and were therefore not predictive of search performance. As the tests given cover a wide range of skills and aptitudes, it appears that the soldier's efficiency in using these devices is related chiefly to the work methods, procedures, and search techniques employed rather than to perceptual-cognitive differences.

EFFECTS OF CONTINUOUS MILITARY OPERATIONS ON SELECTED MILITARY TASKS

TECHNICAL SUPPLEMENT

TECHNICAL SUPPLEMENT

METHODOLOGY

Subjects

Sixty-three (63) enlisted men from the Experimentation Battalion (Armor), Camp Roberts, California, were used as subjects (players).

Equipment

The apparatus employed can be classified into three categories: Night vision devices (NVDs), the data acquisition system, and ancillary equipment.

Night Vision Devices. The night vision device used was the Starlight Scope, AN/PVS-2 (SS).

Data Acquisition System. As a detailed description of the data acquisition system used in the testing of performance with the night vision devices is contained in other reports^{1, 2}, only a brief description is given here. The data acquisition system has three components: 1) the tripods which support the Universal Device Platforms and the night vision devices; 2) the Universal Device Platforms (UDPs); and 3) the electronic control and data recording console. Nine heavy-duty tripods are used in line, each tripod being set into concrete for stability. Each UDP consists of a metal casing attached to the tripod head, the NVDs being attached to the UDP. The UDP rotates with respect to a fixed base and is adjustable for elevation. Each UDP contains two shaft encoders, one for azimuth and one for elevation, which measure the azimuth and elevation of the device with accuracy to within one-tenth of a degree. Each UDP also contains a "trigger" microswitch which the player presses when he acquires a target. These microswitches are designed and located so that their use does not interrupt searching or disturb orientation of the device. Output from the microswitch and shaft encoders is transmitted by cable to the data recording console.

¹ Sternberg, J. J. and J. H. Banks. Search effectiveness with passive night vision devices. BESRL Technical Research Report 1163. June 1970.

² Hyman, A., J. J. Sternberg, and J. H. Banks. Human performance experimentation in night operations: Technology and instrumentation for field research. BESRL Technical Research Note 223. June 1970.

The electronic control and data recording console is van-mounted and contains a monitoring-control panel and a recorder panel. On the monitoring-control panel are a magnetic tape unit, numerical displays (NIXIE³ tubes) for visual presentation of azimuth and elevation of selected player stations on a real time basis, and a number of selection buttons. Information recorded on the magnetic tape includes: beginning and end of target presentation; player number and azimuth and elevation of the device used (sampled four times per second); and any responses by a player. A time base is provided by tape speed. Thus, both target acquisition responses and fine-grain recording of search behavior are on the tape and extractable by computer. The recorder panel contains a digital recorder which provides a graphic hard-copy display of the search behavior, target coordinates, and responses of any selected player, on a near-real time basis.

Photometric readings were obtained with a Gamma Scientific Corporation model 2020 photometer⁴, equipped with an S-11 photocathode and a cosine-filter which gave an integrated reading, in footcandles, of illumination from the upper hemisphere. Readings were taken at regular intervals throughout the experiment.

Terrain

The terrain used for the primary test with the night vision devices was part of the Hunter Liggett Military Reservation. The terrain selected permitted the use of a search area 75° wide and more than 1500 meters deep. The land was flat to hilly, bisected by a road, traversed by ravines and streams, with some large open grassy areas and some areas heavily cluttered with trees, brush, and rocks. The test area was surrounded by mountains. The nearest town of any size (though small) was some 30 miles away. Skyglow was therefore effectively eliminated. Additionally, the terrain had a general north-south orientation, so that the moon passed over the terrain roughly from right to left. Thus, when testing was conducted under moonlight, targets were not generally front-lighted during one portion of the session and backlighted during a later portion. (Previous research has shown that the probability of detection is considerably different under these two conditions.)

³ Commercial designations are used only for precision in describing the experiment. Their use does not constitute indorsement by the Army or by the Behavior and Systems Research Laboratory.

⁴ See footnote 3.

Targets

A total of 48 targets were presented in the night vision device testing session. The 48 targets were of two types: 32 personnel and 16 vehicular. Half the targets were presented moving and half stationary. Vehicles of three types were used: 1/4-ton truck, 5-ton truck, and armored personnel carrier (M-113). The personnel targets were soldiers dressed in fatigues, appearing either singly or in groups of two. The targets were of varying difficulty, and were distributed throughout the terrain at distances of 100-1200 meters. Targets were located in three bands: 100-350 (near), 350-800 (mid), and 800-1200 (far). Contrast was manipulated by placing targets against suitable backgrounds--target silhouetted against a tree line (low contrast) or against an open grassy area (high contrast)--but no attempt was made to rigorously define or measure target-background contrast. All targets could be seen by the unaided eye during daylight. Placement of targets was carefully controlled so that target visibility remained constant for a given evening, e.g., changes in moon angle did not throw a shadow on a target during only one part of a night's run.

Ambient Illumination Conditions

Testing was conducted under two ambient illumination conditions: starlight and three-quarter to full-moon. (Previous BESRL research has indicated little performance change with increases in illumination from half-moon to three-quarter or full-moon levels.) The range and mean of the photometric readings (in footcandles) obtained are given below:

Starlight: mean = 1.2×10^{-4} ; range = 6.0×10^{-5} to 1.3×10^{-4}

Full Moon: mean = 4.8×10^{-3} ; range = 3.4×10^{-3} to 6.5×10^{-3}

Procedure

A group of nine players was tested each week on the following schedule: Day 1 (Friday)--orientation and training; Days 2 and 3 (Monday and Tuesday)--continuous operations testing; Day 4 (Wednesday)--controlled rest; Day 5 (Thursday)--recovery testing. The basic tests on the effects of continuous military operations were obtained during Days 2 and 3. Preliminary training and practice on two of the tests were given on Day 1 in order to prevent contamination of the primary test results by learning during the actual conduct of the test. The final two days were included to provide information on a corollary question: if performance on the various tasks is impaired by continuous operations, is a 24-hour rest sufficient to allow for recovery? After a controlled rest on Day 4, therefore, the basic tests were given on Day 5.

A total of seven groups was tested, four under starlight and three under full-moon conditions. Two players were deleted for military and administrative reasons, giving a total of 34 and 27 players tested under starlight and full-moon illumination conditions, respectively. Also, recovery testing (Day 5) was given only to three starlight groups and one full-moon group, because of changes in illumination condition after Day 3.

The actual program of events and time schedule are shown in Table 1.

Table 1

PROGRAM OF EVENTS

Day	Time	Place	Event	Hours of Continuous Military Operations
Friday	0730-0930	Camp Roberts	Players assemble in briefing room to fill out administrative forms and receive military and BESRL civilian briefings on the experiment.	
	1000-1200	Camp Roberts	Players zero weapons. Go through practice on the rifle and grenade ranges. Weapons cleaned and turned in.	
Monday	0600-0730	Camp Roberts	Players mess; weapons issued, and equipment loaded on trucks.	0000
	0730-0800	Camp Roberts	Players moved to rifle range by truck.	0130
	0800-0930	Camp Roberts	Players fire 60 rd for record at 100, 200, 300 meters.	0200
	0930-1030	Camp Roberts	Players at grenade course throw for record at 15, 20, 25 meters. Clean rifles.	0330
	1030-1130	Camp Roberts	Players return weapons. Draw another weapon for use at HLMR. Mess.	0430
	1130-1300	Camp Roberts to HLMR	Players moved by truck to BESRL site at HLMR.	0530
	1300-1500	BESRL Site HLMR	Players given selected Army Classification Battery and psychological tests. Landolt "C" eye test given.	0700
	1500-1700	BESRL Site	Rest period and mess	0900
1700-1900	BESRL Site	Players take hidden figures test and ANST. Briefed on night's schedule and use of Starlight Scope.	1100	

Table 1 (Continued)

Day	Time	Place	Event	Hours of Continuous Military Operations
	1900-2100	BESRL Site	Players trained on use of Starlight Scope; go through a practice session.	1300
Monday	2100-0130	BESRL Site	Players tested on performance with Starlight Scope.	1500
Tuesday	0130-0230	HLMR OP Site	Players move to OP site by truck and on foot.	1930
	0230-0430	OP Site	Players use handheld Starlight Scopes to detect targets.	2030
	0430-0500		Move on foot from OP Site to truck for transportation to Camp Roberts.	2230
	0500-0630	HLMR to Camp Roberts	Players moved by truck to Camp Roberts.	2300
	0630-0730	Camp Roberts	Mess and draw weapons for rifle range.	2430
	0730-0800	Camp Roberts	Players march to rifle range.	2530
	0800-0930	Camp Roberts	Players fire for record at 100, 200, and 300 meters.	2600
	0930-1030	Camp Roberts	Players at grenade course throw for record at 15, 20, and 25 meters. Clean rifles.	2730
	1030-1130	Camp Roberts	Players return rifles. Draw another rifle for afternoon Patrol. Mess.	2830
	1130-1300	Camp Roberts to HLMR	Moved to HLMR BESRL Site by truck.	2930
	1300-1700	BESRL Site HLMR	Dismounted patrol performing basic infantry maneuvers, with aggressors.	3100
	1700-1800	BESRL Site	Mess.	3500
	1800-2000	BESRL Site	Players given selected Army Classification Battery and psychological tests. Landolt "C" eye test given.	3600
	2000-2100	BESRL Site	Players given warm-up session on Starlight Scope.	3800

Table 1 (Continued)

Day	Time	Place	Event	Hours of Continuous Military Operations
Tuesday	2100-0130	BESRL Site	Players are tested on performance with Starlight Scope.	3900
Wednesday	0130-0300	BESRL Site Camp Roberts	Moved to Camp Roberts by truck.	4330
	0300-0330	Camp Roberts	Equipment turned in.	4500
Wednesday	0330-0600	Camp Roberts	Rest at barracks, supervised by NCO.	4530
Thursday	0600-0730	Camp Roberts	Players mess; weapons issued and equipment loaded on trucks.	
	0730-0800	Camp Roberts	Players moved to rifle range by truck.	
	0800-0930	Camp Roberts	Players fire 60 rd for record at 100, 200, 300 meters.	
	0930-1030	Camp Roberts	Players at grenade course throw for record at 15, 20, 25 meters. Rifles cleaned.	
	1030-1130	Camp Roberts	Players return weapons. Draw another weapon for use at HLMR. Mess.	
	1130-1300	Camp Roberts to HLMR	Players moved by truck to BESRL site at HLMR.	
	1300-1500	BESRL Site	Players given selected Army Classification Battery and psychological tests. Landolt "C" eye test given.	
	1500-1700	BESRL Site	Rest period and mess.	
	1700-1900	BESRL Site	Players given hidden figures test and ANST.	
	1900-2000	BESRL Site	Players practice and warm-up on Starlight Scope.	
Thursday	2000-0030	BESRL Site	Players tested on performance with Starlight Scope.	
Friday	0030-0100	BESRL Site	Players debriefed	
END OF EXPERIMENT				

A detailed description of the activities shown in Table 1 is given below.

Orientation and Training (Day 1)

On the Friday prior to the conduct of the weekly test period, the players were assembled at Camp Roberts, California, for orientation and completion of necessary forms. Military and civilian briefings were given to describe the experiment, explain its purpose, and answer any of the players' questions. These briefings had two purposes: first, to increase the players' interest and involvement in the experiment, and second, to explain how and why they would be evaluated on a number of different measures during the coming test week. This combination of approaches was effective in eliciting their cooperation and sustained participation.

Following orientation, the players were taken by truck to a rifle range where they zeroed the M-14 rifles which they would be using for record fire during the experiment. After zeroing his weapon, each player fired 10 rounds each at ranges of 100, 200, and 300 meters for familiarization with the weapon and the rifle range, and to provide practice so that his performance on the first day of testing would be representative of his true ability.

Upon completion of the rifle training, players moved to a range which had been prepared and tossed dummy hand grenades at a bull's-eye type target, from distances of 15, 20, and 25 meters. Training concluded on Friday with the cleaning of weapons.

Initiation of Continuous Military Operations (Day 2)

Rifle and Grenade Test

On the Monday following orientation and rifle and grenade training, players at Camp Roberts, California, departed at 0600, after breakfast, for the rifle range. After firing ten warm-up rounds at 100 meters, players fired two series of ten rounds each at ranges of 100, 200, and 300 meters, with the order counterbalanced. Thus, each player fired a total of 60 rounds of record fire for each player.

Following the record rifle fire, players moved to the grenade range and tossed two series of five dummy grenades each at ranges of 15, 20, and 25 meters in counterbalanced order. This activity resulted in 30 scores for each individual. The grenade and rifle tasks had two purposes: 1) to provide a base line measure of precision physical performance; and 2) to initiate activity in tasks in continuous military operations.

After completing the record rifle firing and grenade throwing, players cleaned and turned in their weapons. Each player was issued a substitute weapon (one not used for record fire) to be used in subsequent activities in continuous military operations. Players were messed at this time and moved by truck to Hunter Liggett Military Reservation, California (approximately 30 miles).

Written Test Battery

Upon arrival at the BESRL field site, players stowed their rifles and equipment and assembled in a classroom for administration of a written test battery. A number of the tests were from the Army Classification Battery (ACB) including Verbal (VE), Arithmetic Reasoning (AR), and Army Clerical Speed (ACS). The Attention to Detail (ATD) test from the Motor Vehicle Drivers Selection Battery - 1 was also given. An additional test was given in which the task was to discriminate a geometric figure "hidden" in a more complex figure--a task which is conceptually similar to the discrimination of a target "hidden" in a complex background. At the conclusion of the written tests, visual acuity was tested using a standard eye chart. After rest and evening mess, the players again assembled in the classroom for administration of the Army Night Seeing Test (ANST), a measure of night vision.

Performance with Night Vision Devices

Training

Following a briefing and explanation of the nature of the task, players were assigned to the Starlight Scopes and training was begun. The training session had three purposes: 1) to instruct the player in the use of his device; 2) to teach him the appearance of targets when viewed through a night vision device; and 3) to allow him to develop facility in the rapid detection and simulated shooting of the targets. Training did not commence until at least the End of Evening Nautical Twilight (EENT), with the sun 12° or more below the horizon. The training session was conducted by the Test Director, with the engineer at the monitoring-control console and nine instructors who assisted the players individually. The Test Director first read a prepared script of general instructions. When the instructions became specific to the device, the individual instructors instructed the players, reading from a prepared script. The instructions included diopter adjustment, objective lens focussing, limits of the search area, tripod height adjustment, and procedures to be followed in "shooting" the targets. No instructions or training on search techniques were given, but the players were told that during testing each should use whatever technique was best for him.

When all adjustments were made and the players understood how to use the device, the second phase of training was begun. Five targets were presented, one at a time. Prior to presentation of each target, the players were told the type of target, its location, and that it would be lighted. The players were instructed to find the light and to "shoot" it. After all players had found and shot the target, the light was extinguished and the players were instructed to study and shoot the target again if they could see it. The engineer at the monitoring-control console compared player responses with a catalog of actual target locations and informed the Test Director which players were having difficulty in finding the targets and/or were not following proper procedures. When all players had successfully responded to each of these five targets, an additional eight targets were presented, one at a time. For these targets, the players were not told the target location, but the target again was lighted. After most players had found and shot the lighted target, the light was extinguished and the players were instructed to study and shoot the target again if they could see it. Players having difficulty were assisted by their instructors. This action completed the second part of the training session.

The purpose of the third phase of training was to provide practice in rapid acquisition of targets so that subsequent performance during testing would not be influenced by additional learning. Twelve targets were presented, following the same procedure as that during testing, and no assistance, either by lights or instruction, was given. At the conclusion of training, players were given a 15-minute rest prior to the beginning of testing.

Total training time was approximately 90 minutes (15, 30, and 45 for Parts 1, 2, and 3, respectively). This highly structured training session had been found, in previous research, to be necessary for adequate training in a reasonable amount of time. While training was performed on the same terrain used for testing, the practice target locations were different from the experimental target locations.

Night Vision Device Testing

Testing did not commence until after the End of Evening Astronomical Twilight (EEAT), when the sun is 18° or more below the horizon, and was terminated prior to the Beginning of Morning Astronomical Twilight (BMAT), before the sun approaches 18° below the horizon. Testing was scheduled so that ambient illumination on any given night remained relatively constant--for example, on a full-moon night, data were collected only when the full moon was exposed. When testing was conducted under moonlight conditions, data collection did not commence until the moon had ascended to 25° above the eastern horizon and was terminated before the moon descended beyond 25° above the western horizon. These procedures minimized the ambient illumination changes during any given evening.

The testing phase of the experiment was divided into two parts. The first part was to determine the ability of players to find targets through search. The second part was to determine the ability of each man-device combination to see targets without search.

Search

Players were required to search the terrain continuously for four periods of 30 minutes each. During each period, 12 targets were exposed for two minutes per target, with approximately 30 seconds between target presentations. At one-half hour intervals, players were given a 15-minute break in a rest tent. During these breaks the targets were re-located.

In each block of 12 targets, six targets were presented in a dynamic mode and six in a static mode. All dynamic targets moved parallel to the line of player cubicles, i.e., across the line of sight of the players as they searched the field. Personnel targets moved at a walking pace, and vehicular targets at approximately three or four miles per hour. The movement of each target was 1° of visual arc, the actual length traversed being adjusted according to the distance of the target from the players. Three basic sequences (scenarios) of target presentations were used, the fourth scenario being a replication of the first, resulting in a total of 48 target presentations per night. Each scenario contained targets of all types, distances, and contrasts. Order of scenarios and movement was systematically varied to counterbalance sequential effects. Basically, only one target was presented at a time (a multiple-man personnel target was defined as a single target), but three times in each scenario two targets (in different locations) were presented simultaneously to reduce the possibility that players would learn that only single targets were presented. However, only the primary target was scored. To prevent players from using vehicle engine noise as a cue, three times in each scenario one of the vehicular targets which was not exposed would run its engine for 30 seconds.

For the entire evening's run, targets were continuously observed by the Target Monitor on the test line. This Monitor was equipped with a NOD and was thoroughly familiar with all target locations and the order of the scenarios being used on a given night. His primary responsibility was to verify that targets were up and down at the correct times, in the correct locations, and in the correct movement modes. In most cases, a one-word verification from the Monitor immediately followed target report. This procedure was utilized to maintain discipline and responsiveness of target personnel. Additional responsibilities of the Monitor included reporting light security violations, improper concealment of targets, and changes in ambient illumination and weather conditions.

Player behavior was continuously monitored by the instructor assigned to each player, by the training NCO, and by a civilian scientist also on the test line. In addition, an engineer at the monitoring-control console continuously monitored visual displays showing real time azimuth and elevation of each instrument to insure that all players were searching and following correct procedures.

For purpose of analysis, a player response was defined as a "hit" when the azimuth and elevation of the instrument were within $\pm 3^\circ$ of the actual target location. The target detection data reported here are based on this definition.

See

Upon completion of the search phase of testing, the final 12 targets were presented again to determine the ability of each man-device combination to see targets when no search was involved. On each trial, the target turned a light on himself and the players were told the target location and type. Players were instructed--and assisted if necessary--to find the lighted target. After the light was extinguished, they were to continue to watch the target, if they could see it, and to fire on it as soon as it started to move into defilade. Targets moved into defilade at varying times (unknown to the players) after the light was extinguished: 20 seconds for near targets, 40 seconds for mid targets, and 60 seconds for far targets. The player was scored as having seen the target if he fired while the target was moving into defilade or within eight seconds of target disappearance.

Observation Post (Day 3)

The testing of performance with night vision devices concluded at approximately 0130 Tuesday morning. Players then received hot soup, coffee, and sandwiches and were taken by truck to a location several miles away. They then dismounted and moved a half mile on foot through a ravine, using appropriate tactical procedures, and took up positions in previously constructed bunkers at an Observation Post (OP) where they could observe two road interdiction points and the surrounding terrain. Two men and one Starlight Scope were assigned to each bunker. The players had previously been briefed on the tactical situation and told that targets might appear during the two hours they were to be in the positions. Players searched the field in half-hour shifts--one man on the device, the other resting.

A walking personnel target was exposed for two minutes during each half-hour shift. Thus, four target opportunities existed, separated by intervals of one half hour. The location of the target was changed for each presentation.

After completion of the OP site search test, the players withdrew from the position and returned to a rendezvous point with the truck (approximately 0500 Tuesday). They were then transported back to Camp Roberts for breakfast and repetition of the activities described above for Monday morning--rifle firing and grenade throwing. Finishing these activities, they returned by truck to Hunter Liggett Military Reservation after the noon meal Tuesday.

Operations continued at Hunter Liggett Military Reservation with a four-hour tactical patrol. The patrol was approximately six miles in length and covered highly varied terrain--hills, streams, open meadows, forested areas, and canyons. The patrol was ambushed twice by aggressors firing blanks. When attacked, the players deployed, returned fire, captured one of the aggressors, and continued tactically until they returned to the base camp (test site) at approximately 1700 hours. The purpose of the patrol was to provide tactical realism in continuous military operations, as well as strenuous physical activity such as might be expected in an actual combat situation. After an evening meal and a rest, the test battery (using alternate forms, when available) was re-administered as on Monday afternoon, and the players continued into the second night of search activity. Procedures were the same, but a short warm-up period was substituted for the training. The OP site activity, however, was not repeated.

Controlled Rest (Day 4)

Upon completion of the second night of testing (Wednesday, approximately 0200), the players were taken by truck to Camp Roberts to begin a 24-hour controlled rest period. At this point, the players had been involved in almost 48 hours of continuous operations, with no scheduled sleep. During the controlled rest period, the players occupied a separate barracks so that their sleep would not be disturbed. After their initial sleep, they were given the freedom of the post (PX, theater, etc.) but were under the supervision of an NCO who always knew their location and expected return-to-barracks time. All players were required to be in bed no later than 2300 Wednesday night (Day 4) to insure adequate rest before the next day's testing.

Recovery Testing (Day 5)

The purpose of the final day of testing was to answer the corollary question: If degradation of performance does occur as a consequence of continuous military operations, is a 24-hour rest sufficient for recovery to initial level? The final day of activity, Thursday, therefore replicated all the operations described for the Monday schedule. Following completion of the performance test with night vision devices, players were debriefed and returned to Camp Roberts.

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13. ABSTRACT New devices and sensors for night seeing and target acquisition have increased the capability of the U. S. Army for continuous operation extending through day and night. Although the soldier can continue to function under such conditions, his performance on critical tasks may be so degraded that his effectiveness is severely impaired. The present research was undertaken to determine the extent to which soldier performance is degraded on combat-related tasks, with the goal of developing techniques, work methods, and procedures for reducing such degradation if it occurs. / / A group of nine players was tested each week on the following schedule: Day 1 (Friday)--orientation and training; Days 2 and 3 (Monday and Tuesday)--continuous oper- ations testing; Day 4 (Wednesday)--controlled rest; Day 5 (Thursday)--recovery testing. Seven groups were tested on this schedule. The basic tests on the effects of continuous military operations were obtained during Days 2 and 3--target acquisition with the Starlight Scope; rifle shooting; grenade-throwing accuracy. Players were kept continu- ously active on these and other (non-scorable) military activities for nearly 48 hours with no scheduled sleep. Perceptual and cognitive tests, primarily from Army test batteries, were also administered during this time. After a 24-hour rest on Day 4, players were again tested on Day 5 to provide information on a corollary question: if performance is impaired by continuous operations, is a 24-hour rest sufficient to allow for recovery? Players showed no degradation in performance on any of the tests given. Despite clear evidence of fatigue on the second day of continuous operations, the soldiers per- formed at the same level as on the first day. Morale also remained high.		

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13. Abstract - continued

The cognitive and perceptual tests given were not predictive of search performance on the night vision devices.

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Research techniques - methodology						
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*Starlight scope						
Field experimentation methodology						
Military psychology						
Predictors - night vision device performance						
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