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MOONLIGHT I IDENTIFICATION OF STATIONARY HUMAN TARGETS

no

John E. Taylor

The George Washington University
Fort Benning, Georgia

December 1960

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RESEARCH MEMORANDUM type

MOONLIGHT I

IDENTIFICATION OF STATIONARY HUMAN TARGETS

by

John E. Taylor

December 1960

Approved:

Carl J. Lange

Carl J. Lange
Director of Research

U. S. Army Infantry
Human Research Unit
Fort Benning, Georgia

Number 21

Copy

COMPOSITION OF THE RESEARCH TEAM

This study was designed and supervised by John E. Taylor. Administrative details were the responsibility of John Sivy. Francis E. Jones was Director of Research and Lt Col Edgar S. Sanders was Chief at the Infantry Human Research Unit while this study was being conducted.

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BRIEF

The present studies were conducted to determine low visibility identification curves for human targets as a function of:

1. Level of illumination
2. Position of target
3. Position of observer
4. Night vision training of observer.

Based upon the findings of previous research, two experiments were conducted using four groups of basic trainees as subjects. The first experiment was conducted under no-moon illumination and the second, using the same subjects, was conducted under full moon. The variables in each experiment were (1) position of target (standing, kneeling, or prone), (2) position of observer (standing, kneeling, or prone), and (3) type of night vision training administered to each group (classroom training, field training, a combination of classroom and field training, or no training). Target identification data were collected in a large outdoor field laboratory. Curves were drawn showing percent correct responses plotted against range. Mean correct responses were analyzed statistically.

The data indicated that: (1) level of illumination had a strong practical effect on correctness of identification. (2) Full moon extended the range of observation approximately three times the range for no moon.

(3) Observer position had an inconsistent effect on correctness of identification. (4) Under no-moon, standing, kneeling, and prone observers did not differ appreciably. (5) Under full moon, standing observers could identify targets approximately 9 to 17 yards beyond kneeling observers, who, in turn, could identify targets approximately 20 to 30 yards beyond prone observers. (6) Position of target had a strong practical influence on correctness of identification. Under no-moon illumination, standing targets could be seen approximately 7 to 8 yards beyond kneeling targets, which, in turn, could be seen approximately 9 to 11 yards beyond prone. (7) Under full-moon illumination, standing targets could be seen approximately 13 to 20 yards beyond kneeling targets, which, in turn, could be seen approximately 12 to 25 yards beyond prone. (8) Night vision training had no effect on correctness of identification under the no-moon or full-moon conditions.

Generalizing to conditions similar to those under which the present study was conducted, it was concluded that the ability to identify human targets under low natural illumination is:

1. Directly related to level of illumination

2. Directly related to size of target being observed

3. Directly related to height of the observer's eyes above the ground under full-moon conditions, but not under no-moon conditions

4. Not related to the short periods of night vision training employed in these studies.

It was suggested that the findings of the present investigation be made available to those engaged in (1) developing tactical doctrine governing visual observation and the firing of individual weapons at night; (2) developing training courses for observation, target detection, and weapons firing at night; and (3) determining appropriate firer-to-target distances in the construction of night training facilities.

IDENTIFICATION OF STATIONARY HUMAN TARGETS

This report presents a discussion of an experiment conducted in Fall 1955 as part of Task MOONLIGHT research. The experiment addressed the problem of determining the relationships among a number of variables relevant to the detection and identification of infantry targets under low natural illumination. Specifically, the ability of stationary observers to correctly identify the positions of stationary human targets was investigated as a function of four variables: (1) level of illumination (no moon or full moon), (2) position of target (standing, kneeling, or prone), (3) position of observer (standing, kneeling, or prone), and (4) night vision training of observer (classroom training, field training, a combination of classroom and field training, or no training).

BACKGROUND

Proficiency in night operations depends heavily upon the ability to see effectively in semi-darkness and darkness. The increased emphasis on night fighting by the infantry makes important the need for information on the visibility of human targets at night. This is true because the infantryman's primary target is human regardless of whether the operation engaged in be offensive or defensive. Such information is particularly needed for (1) developing doctrine governing visual observation used to detect and engage personnel targets with individual weapons at night, (2) developing training courses for night target detection and night firing, and (3) determining appropriate firer-to-target distances for the construction of field training ranges.

Previous research oriented toward determining the individual soldier's ability to detect and identify targets at night has not been extensive. Studies by Rostenburg (2) and by Uhlaner (4) both concern validation of the Army Night Vision Tester (ANVT) against field criteria.

Since both of these studies involved detecting and recognizing materiel targets, the findings indicate little about the infantryman's ability to detect human targets. The study by Rostenburg was conducted at Fort Sill, Oklahoma, using targets which were primarily guns or vehicles. The study by Uhlaner was a continuation of the research initiated at Fort Sill and was conducted at Camp Blanding, Florida. Various pieces of equipment, such as guns, tanks, and other vehicles, were distributed over a field course. Each item served as a separate visual target to be detected and recognized under moonless illumination. Background against which the objects were viewed varied from very dark clumps of trees to white sand, and illumination did not remain constant because of occasional lightning and reflections of city lights from passing clouds. Because of the absence of human figures as targets, little can be concluded from the data as to the distances at which human targets might be visible on a moonless night.

Some research has been conducted to determine the effects of training on night vision ability. A report of the Working Group on Night Vision Training of the Armed Forces National Research Council Vision Committee (5) provided advice on the content and conduct of night vision training. Sharp, Gordon, and Reuder (3), reviewing the studies on the effects of training, found no evidence available on the effectiveness of a night vision training program as evaluated by performance in an actual field situation.

A study conducted jointly by Marks and Uhlaner of PRB, TAGO, and Jones and Ward of HumRRO, employed a field criterion course with live human targets to (1) obtain validation data for the ANVT and (2) determine the effects of various kinds of night vision training. Those aspects of the study pertinent to PRB have been published elsewhere (1). The data pertinent to the effects of training have not been previously published.[1] No definite conclusions as to the effects of differential night vision training on the ability to see at night could be drawn from the study. There seemed to be a consistent though slight tendency for soldiers who were given formal night vision training or who had night combat experience in Korea (on-the-job training) to be superior to recruits or inductees without training or experience. Jones and Ward warn, however, that this slight, consistent training effect must be viewed with caution in that the experimental procedures confounded training treatment with position on the observing line. It is possible that the apparent superiority of the trained groups may have been due as much to their having been assigned to favorable observation positions during data collection, as to the effects of training.

The present investigation was designed as a direct outgrowth of the joint study just described. Again it was a joint HumRRO-PRB investigation, with PRB reporting the ANVT findings separately.[2]

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[1] Curves derived from these data are included in Appendix A.

[2] It is the author's understanding that these data were to be published, but no specific references have been determined.

METHOD

Subjects

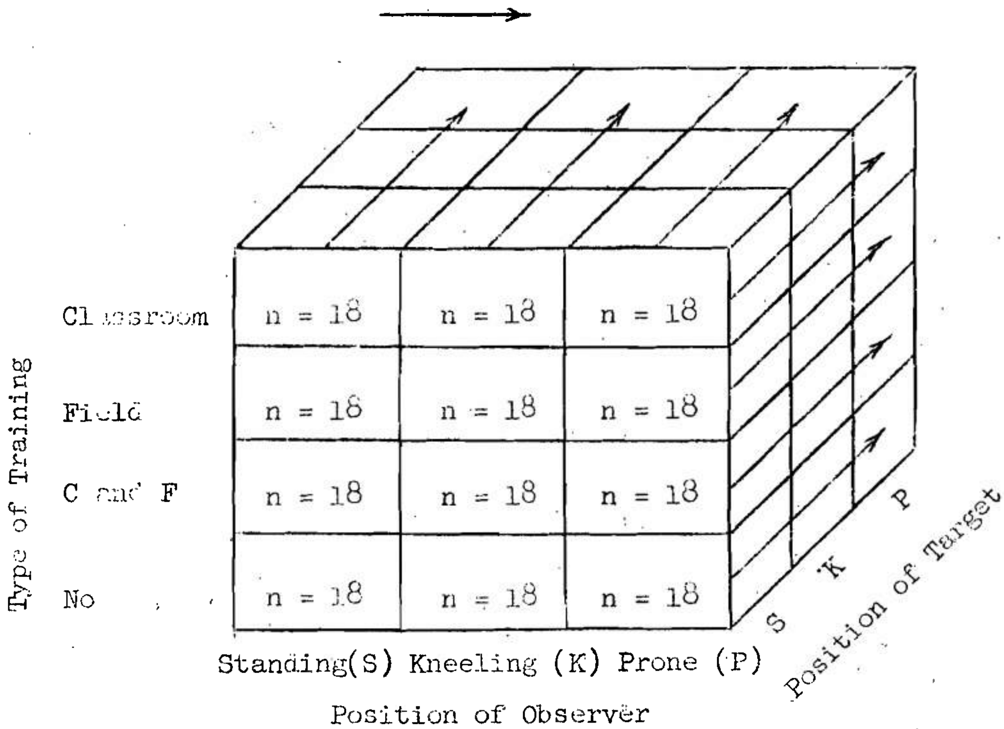
Subjects for the experiment were 216 of the basic trainees who had served as the experimental troops for the Fall 1955 administration of TRAINFIRE I (daytime training). Restrictions placed on the selection of these troops eliminated (1) individuals having prior military service, (2) conscientious objectors, and (3) assignments inconsistent with a ratio of six Caucasians to one Negro. Assignment to the MOONLIGHT groups was counterbalanced with assignment to the TRAINFIRE groups to control some of the contaminating effects of one program on the other.

Design

The effects of (1) target position during observation, (2) observer position during observation, and (3) night vision instruction administered prior to observation, upon detection and identification of human targets were investigated in a 3x3x4 experimental design. A diagram of the experimental design employed is given in Figure 1. The experiment was conducted first under no moon and then under full-moon conditions.

Each of the four groups of 54 subjects received a different type of night vision instruction before observing the targets. The four training conditions were classroom training, field training, a combination of classroom and field training, and no training.

During observation of targets, one-third of each group of subjects (N = 18) observed from the standing position, one-third from the kneeling position, and one-third from the prone position. This consisted of a total



N = 216

Figure 1. Diagrammatic Presentation of Experimental Design.

of 12 subgroups of 18 subjects each. All subjects were required to observe an equal number of standing, kneeling, and prone targets.

Training

Classroom Training. Group I received classroom training (CT) which consisted essentially of a two-hour lecture-demonstration covering the history of night warfare, research in night vision, and techniques for improving vision at night. It was the same instruction presented to beginning officer classes and NCO classes at the US Army Infantry School (USAIS), Fort Benning. The lecture covered these topics: (1) history of night warfare, (2) results of research on night vision, (3) the physiology of the human eye, (4) the effects of dark adaptation, (5) the necessity for off-center vision, (6) the technique of scanning, and (7) the importance of confidence. For approximately forty minutes of this two-hour period, the special lecture room was almost completely darkened. The subjects, by viewing very dimly-lit objects (utilizing shadow boxes), practiced the principles which they had learned. The classroom was the one used by the USAIS for the night vision phase of individual night firing instruction prescribed by TC 23-1. Also during this period, the independence of night vision in the right and the left eyes was shown; and the effects of red goggles, red light, and a brief dazzling light on dark adaptation were demonstrated. At the conclusion of the period the trainees returned to the barracks.

Field Training. Group II received field training (FT) which consisted essentially of two hours of practice at night under no moon in making discriminations about human figures. It was thought that, if any kind of practice would result in a lowered identification threshold, direct practice in making judgments about human figures might be the best technique.

The trainees were brought to an outdoor training area and divided into three subgroups of 18 trainees each. Each subgroup was assigned to one of three lanes. The lanes were 20 yards wide with 20 yards between them. The target, that is the human figure to be observed, took a given position at a given distance from the observation line according to a prearranged schedule. One target was assigned to each lane, and the positions which he assumed depended upon the lane in which he was working. In Lane One, the target faced either forward, left, or right, in a kneeling stance. In Lane Two, the target held a gray cardboard rectangle, approximately 1-1/2 feet by 3 feet, in either a vertical or horizontal position. Being dressed in fatigues, and holding the lighter, gray rectangle in front of him, he was almost invisible. In Lane Three, the target either appeared in standing position or did not appear at all.

Prior to training, all subjects were given an explanation of what the night's training was all about. They were all given an answer sheet with three columns of 30 answer spaces each, one column for each of the three lanes. The subjects were split into three groups and each group was taken to a lane. At the lane, each group was read the instructions appropriate to the lane. On Lane One, they were told to write L, R, or F to indicate whether the kneeling man was facing left, right, or forward. On Lane Two, they were told to write H or V to indicate whether the rectangle was horizontal or vertical. On Lane Three, they were told to write T or NT to indicate whether they saw a target or no target.

Training began with the trainees on the observation line facing away from the lanes while the targets took up their positions. When all three targets were in position, the trainees did an about face and observed the target in their lane. After 15 seconds they were again ordered to do an about face and were instructed to write what they had seen. After all the trainees had written, the instructor announced the correct response for that trial. Thus, the trainees received knowledge of results after making each response. While the trainees were writing, the target assumed the proper position and the proper distance for the next trial. Thirty trials were administered in this manner.

The trainees changed lanes after every 30 trials. Each subject received 30 trials on Lane One (kneeling target), 30 more on Lane Two (cardboard rectangle), and 30 more on Lane Three (standing or no-target) for a total of 90 trials. The three sets of 30 trials lasted two hours. At the end of this training, the trainees returned to the barracks.

Classroom and Field Training. Group III received a combination of classroom training and field training (CFT). This group received one hour of the lecture-demonstration and one hour of the outdoor field training described above. In order to shorten the classroom material to one hour, those parts of it which seemed most essential to perception at night were retained while the rest were omitted. Thus, the instruction covered (1) the effects of dark adaptation, (2) the necessity for off-center vision, (3) the technique of scanning, and (4) the importance of confidence. Also, the trainees spent approximately thirty minutes in the dark practicing the application of these principles with the shadow boxes. At the end of this time, the effect of a brief dazzling light on night vision and the independence of dark adaptation in the right and the left eyes were demonstrated. This concluded one hour of the training.

The second hour of training for this group was conducted in the same manner and using the same facilities as for Group II. The procedure was exactly the same as it was for Group II, except that Group III received only 15 trials at each lane. This second hour concluded the training for Group III after which time they returned to their barracks.

No Training. Group IV received no training (NT). This group served as a control group to provide information on the effects of spending two hours in the dark without any special training. It was intended that they would provide a baseline score against which the effectiveness of any of the three training procedures could be measured. This group simply went on a night march for two hours in an unlit part of the reservation. Following the march they returned to their barracks.

Target Observation Area

A rectangular area approximately 350-yards wide and 150-yards deep was selected for observation of the targets. The area was mowed and raked, providing a smooth, even surface with grass approximately one-to two-inches high. A dense, high, even tree line ran approximately parallel to the long axis of the field along the southwest side, approximately 100 yards from the observation field. On the opposite edge of the field (northeast) and running parallel with the long axis and the tree line, an observation line was constructed. The observation line was thus approximately 250 yards from the tree line with homogeneous and even terrain separating them.

The observation line faced away from a faint sky glow from the Main Post area, and the moon moved from right to left along the observation line and slightly behind the observers. The surroundings of the area contained no artificial lights that could be viewed from the observation line. Thus, during data collection, the subjects faced a dark tree line away from sky glow and the moon, and viewed no artificial lights.

The area was divided into 9 parallel lanes perpendicular to the observation line, each of which was 16-yards wide, with 20 yards between lanes. Along the observation line each lane was in turn subdivided into 24 equally spaced observation positions, each equipped with a flat-topped wooden stake. Starting with Lane One, the first stake was 5-feet high (on which a standing observer was to place his chin),[1] the next stake in

[1] For those men assigned a stake too high while standing on the ground, an ammo box was provided.

line was 30-inches high (on which a kneeling observer was to place his chin), the next stake in line was 6-inches high (on which a prone observer was to place his chin). The fourth stake along the line began the sequence over again. This sequence of stakes was repeated all along the observation line. Such an arrangement permitted observation by all subjects simultaneously, one-third standing, one-third kneeling, and one-third prone.[1] The stakes were numbered consecutively to facilitate administrative assignment and control of the subjects along the line.

Down the center of each lane, lying flat on the ground and in the grass (invisible to the observers), were luminous yard-markers upon which the personnel serving as targets would stand, kneel, or lie when in position to be observed. In the no-moon experiment these markers were placed 5-yards apart to a distance of 50 yards. In the full-moon experiment they were placed 10-yards apart from a distance of 20 yards to a distance of 120 yards.

Down the center of each 20-yard corridor separating the lanes, burlap screens were erected behind which the target personnel stayed when reading their sequence sheets or when procedure called for a no-target trial. In the no-moon experiment, one such screen was erected for each lane, 30 yards

[1] Since the targets were positioned in the center of each lane, the observers in the center observation positions were favored. The flank observers were farther from the targets. Only at the shortest (5-yard) range would this make any appreciable difference.

from the observation line, to be used by the one man serving as target in the lane. In the full-moon experiment, two other screens were erected at 60 and 90 yards, each to be used by one of the three men serving as targets in the lane.

A central control point was set up about the middle of the observation line and approximately 10 yards behind it. Loud speakers were distributed at frequent intervals along the observation line so that all subjects and target personnel could clearly hear the instructions for each trial.

Procedure

Assignment and Training. As stated earlier, the subjects were assigned to the MOONLIGHT treatment conditions in a counterbalanced order to control for some of the differential effects accruing from the TRAINFIRE treatment. In addition, all subjects were assigned to specific numbered stakes along the observation line in a counterbalanced order so as to have all treatment conditions equally represented along all segments of the observation line.

Upon assignment, the four training groups immediately underwent the two-hour period of night vision training simultaneously. While Group I was receiving CT, Group II was receiving FT, Group III was receiving CFT, and Group IV was on a two-hour night march receiving NT. Immediately following training all groups returned to their barracks.

No-Moon Experiment

1. Administration

The night following training all four groups were taken to the observation area where they spent approximately three hours (2030-2400 hours) in making target observations under no-moon illumination.

The subjects assumed their previously designated positions along the observation line. A central control officer, using a microphone, directed a total of 27 umpires (three per lane or one per every eight men) as they positioned the subjects along the line. Each umpire had a roster for checking that each subject was in the proper place and assuming the proper position. When the assignment to positions and checking were completed, the control officer and umpires briefed the subjects on the task at hand, explained the purpose of the experiment, and distributed materials. Each subject was given a 3x5-inch tablet and a pencil. They were instructed that each trial was to be recorded on a separate sheet. Two practice trials were provided to insure that all subjects, control umpires, and target personnel understood the procedure. Administrative details consumed approximately 1/2 hour, thus allowing the observers to become dark adapted.

Eighteen US Army enlisted personnel of average height served as target personnel. Nine of them, one per lane, worked the first 50 trials and the other nine worked the next 50. All were clad in green fatigue uniforms and wore soft caps.

2. Data Collection

One hundred trials were administered with the subjects recording their observations after each trial. Thirty trials presented the targets standing, 30 presented the targets kneeling, 30 presented the targets prone, and 10 presented no targets at all, with all distances being represented, according to a controlled random sequence. Thus, on a given trial, the target might have been standing, kneeling, or prone at any distance from 5 to 50 yards, or not present at all.

The sequence of activities for the 100 trials was as follows. Prior to the beginning of the first trial, all observers were in position (one-third standing, one-third kneeling, and one-third prone) looking down range; all umpires were in position behind the observation line; and each lane target was invisible behind his screen down range. Upon a signal by the control officer, all observers faced away from the field, toward their control umpires. The targets emerged from behind their screens, took up the prescribed position at the prescribed distance for the trial, and remained motionless facing the observation line. Upon instruction from the control officer, each observer placed the number of the trial in the upper left corner and his own code number in the upper right corner of the top sheet of his tablet. When all targets were in position and all observers were ready, the signal was given for the observers to face down range and observe with chin on stake. At the end of 15 seconds of observation, they were again instructed to face toward their umpires (away from the targets) and to write a large S, P, K, or N on the top sheet indicating whether they saw a soldier standing, kneeling, prone, or not at all. They were instructed to guess if not sure of what they saw. After recording his response, each observer removed the top sheet and held it at arm's length. The umpires then moved from left to right collecting the sheets and stringing them in bundles. During the recording of the data and collection of the sheets, the targets were taking up the proper positions down range for the next trial.

The observers were then instructed to indicate Trial 2 in the upper left and their code number in the upper right of the next sheet on their tablets. When all observers and all targets were ready, the signal was given for the observers to again face down range and observe with chin on stake for the second trial.

This procedure was repeated for 100 trials with the umpires providing close supervision of the observation line to see that all observers complied with instructions on all trials. Ten-minute breaks occurred after the 33d and 66th trials. At the completion of the 100th trial, all materials were collected and the troops returned to their barracks.

During data collection, on every 10th trial, photometric readings were taken with a radium button photometer. Inspection of these readings indicated that no appreciable fluctuations in level of illumination occurred over the 100 trials.

Throughout the experiment, red filtered flashlights and lanterns were used for control and signaling to preserve dark adaptation.

Full-Moon Experiment

1. Administration

Two weeks later, from 2030 to 2400 hours, all personnel returned to the observation area. The observers were again assigned to their numbered stakes, and given a brief review of the purpose of the experiment and procedures to be followed. Again, administrative details lasted one-half hour allowing the observers to become dark adapted prior to the first trial.

Nine additional men served as targets during this experiment, bringing the total number of targets for each lane to three. Only one target per lane was exposed on any one trial.

2. Data Collection

All procedures were identical with those of the no-moon experiment except that target distances were extended to 120 yards at intervals of 10 yards.

Again photometric readings were made every 10 trials. During the 100 trials the moon was approximately overhead, and there were no appreciable fluctuations in illumination.

FINDINGS AND INTERPRETATION

The data of the two experiments are not directly comparable in that the ranges to the targets were not the same. Thus, the data for the no-moon were handled separately from the full-moon data, both in statistical analyses and graphical analyses.[1]

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[1] Missing data and the need to equalize the number of subjects in each cell reduced the total number of subjects to 192 for the data analyses. There were 48 subjects in each group; of these 16 were standing observers, 16 kneeling observers, and 16 prone observers.

Curves for No-Moon Observations

Figures 2 to 8 present the results of the no-moon experiment in terms of per cent correct responses plotted against range to the target. Figure 2 shows the effects of training, Figures 3 to 5 show the effects of observer positions for each target position, and Figures 6 to 8 show the same data another way; that is, effects of target position for each observer position.

Under the no-moon condition, 100 per cent correct responses were not achieved even at the extremely close range of five yards. It was suspected that this may have been an artifact of the experimental situation because the extreme flank observers on each lane were actually about 9 yards from the target rather than 5 yards from the target. However, when all conditions of all variables were combined, the observers on the 6 inner points of the lanes (actual target range from 5 to 5.3 yards) only achieved approximately 95 per cent correct responses, while the observers on the 3 outer points on both sides (actual target range from 7.6 to 9.2 yards) achieved approximately 88 per cent correct responses.[1] Since these two percentages were not significantly different ($.10>p>.05$) the 5-yard range data were reanalyzed. It is more appropriate, however, to consider the percentages shown for the 5-yard range as being in the range of 5 to 9 yards.

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[1] This was considered the most extreme case. When the 12 inner points were compared to the 6 outer points on both sides, the difference in percentage of correct responses was also, as expected, non-significant.

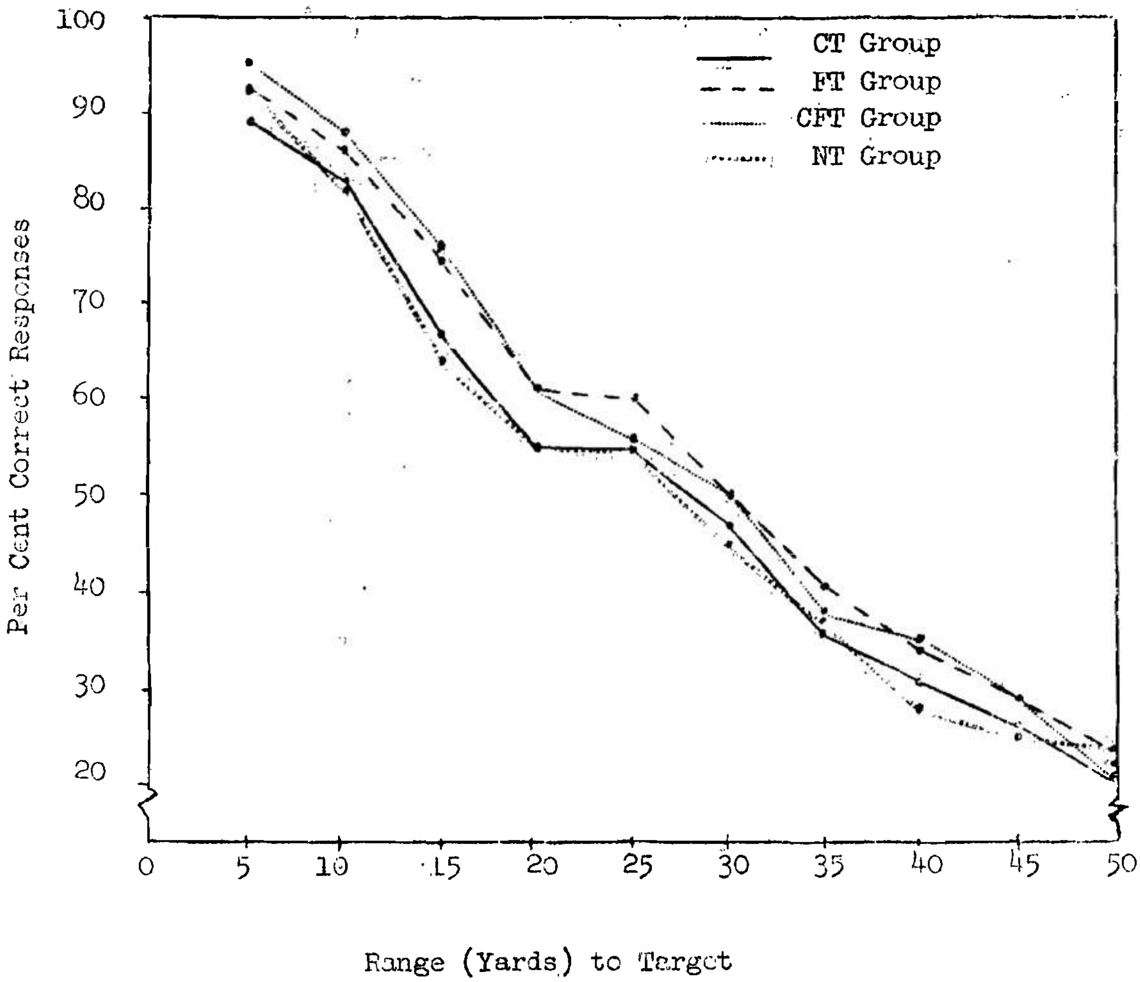

Figure 2. Effects of Training for Combined Observer and Target Positions (No-Moon Experiment)

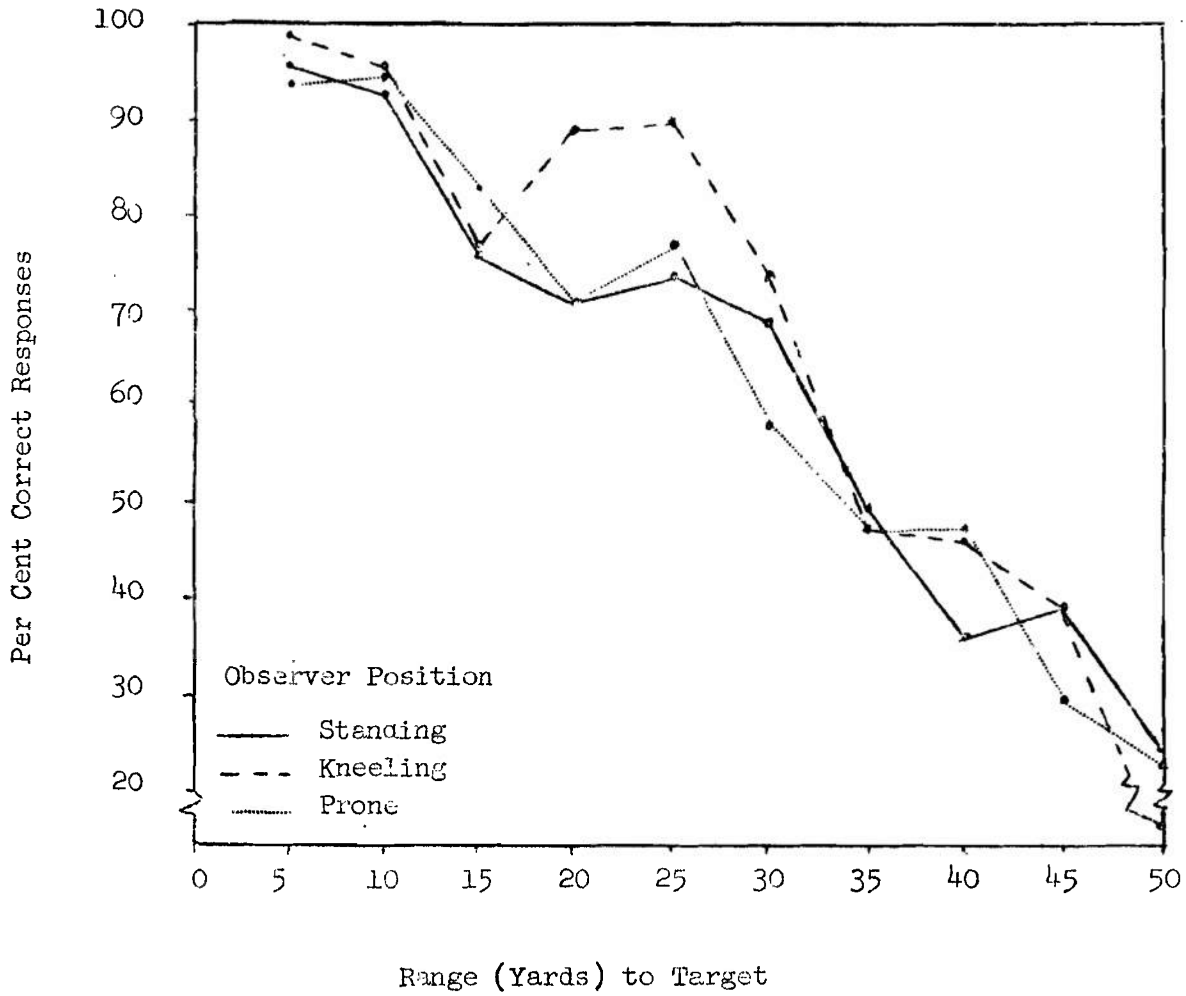

Figure 3. Effects of Observer Position for Standing Targets (No-Moon Experiment)

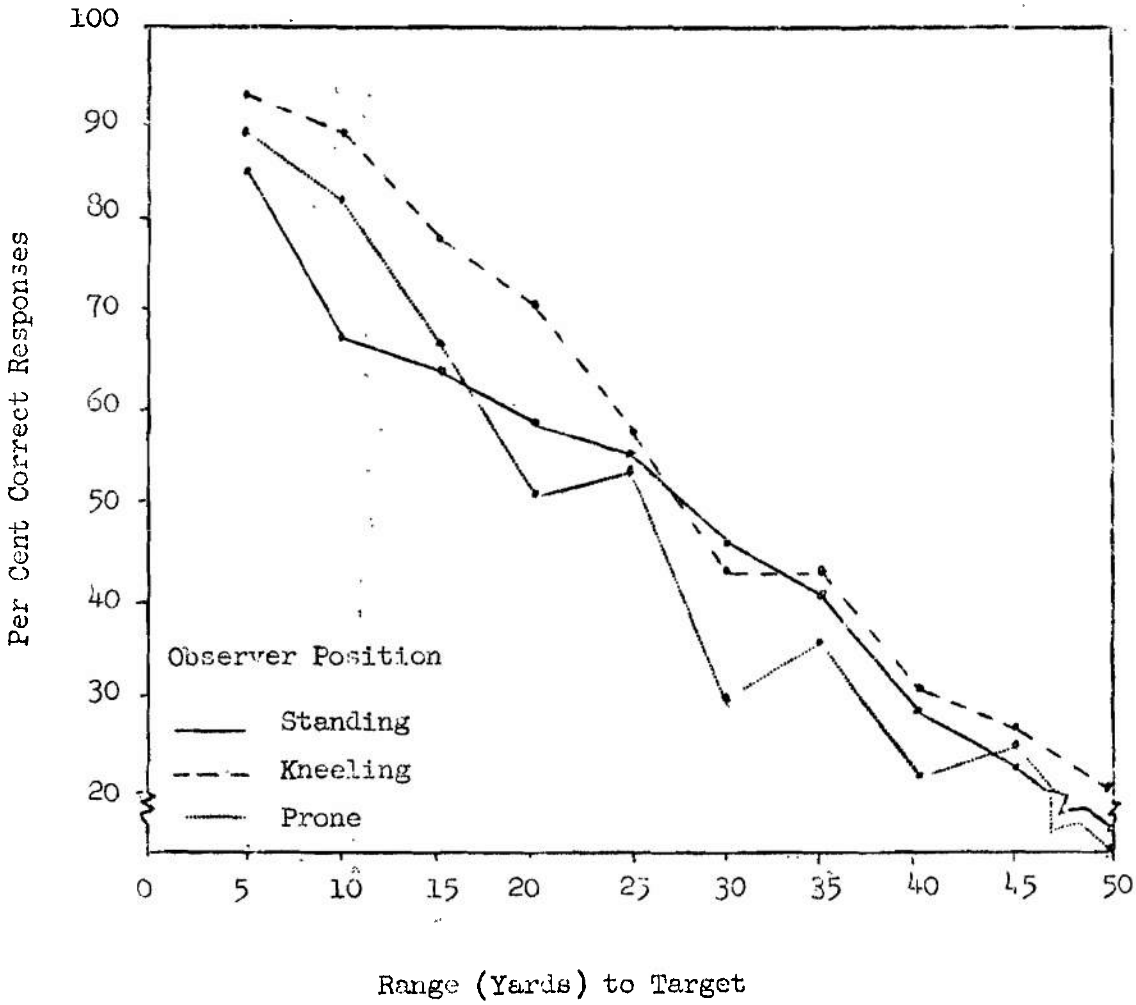

Figure 4. Effects of Observer Position for Kneeling Targets (No-Moon Experiment)

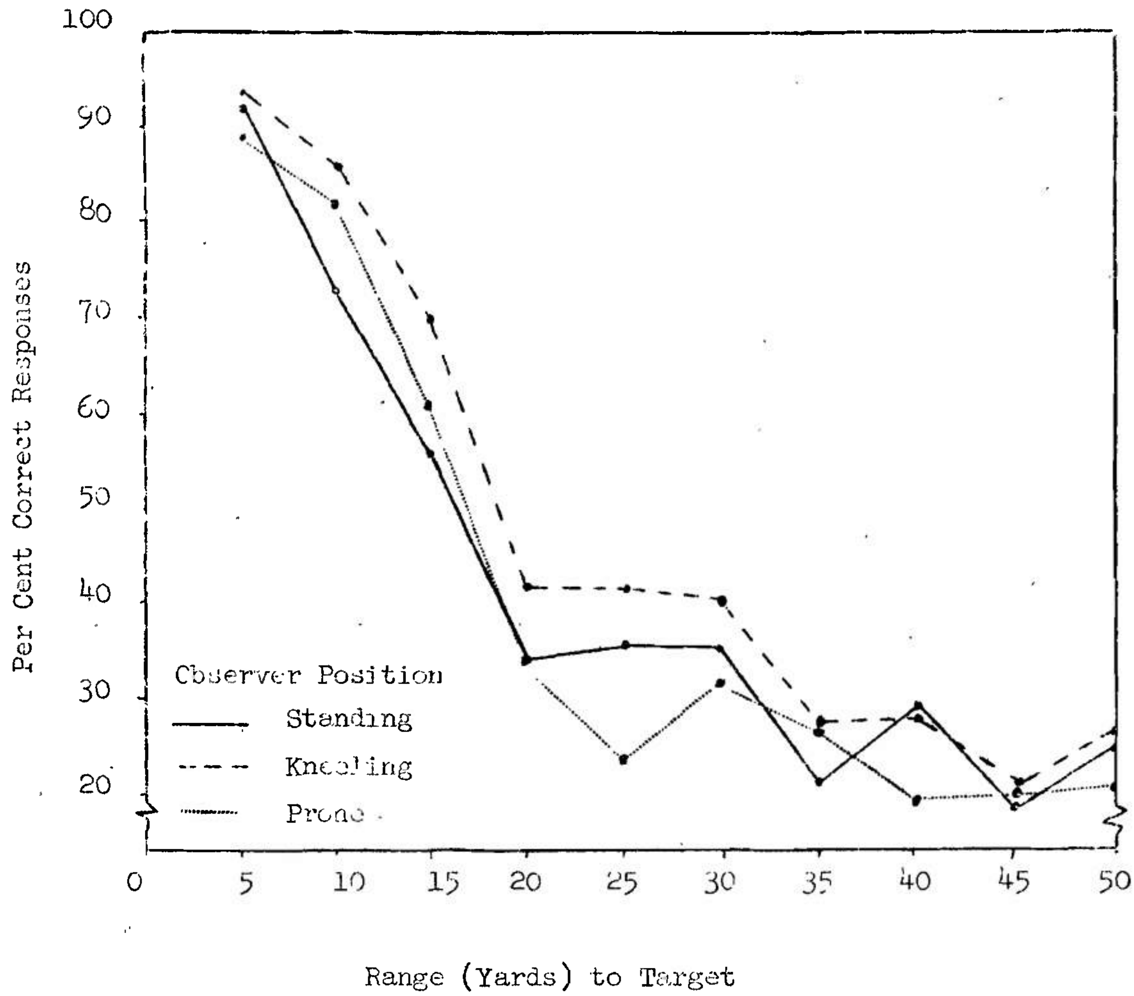

Figure 5. Effects of Observer Position for Prone Targets (No-Moon Experiment)

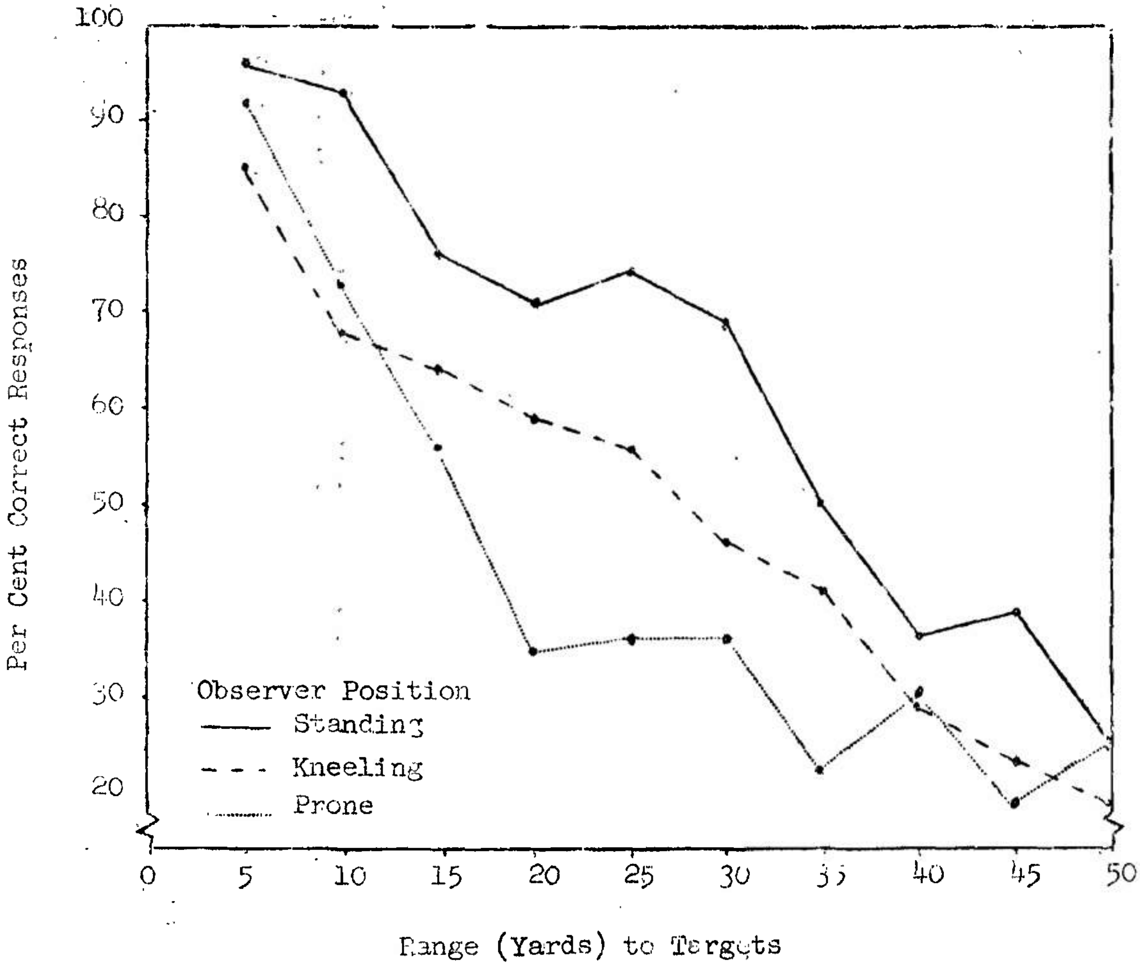

Figure 6. Effects of Target Position for Standing Observers (No-Moon Experiment)

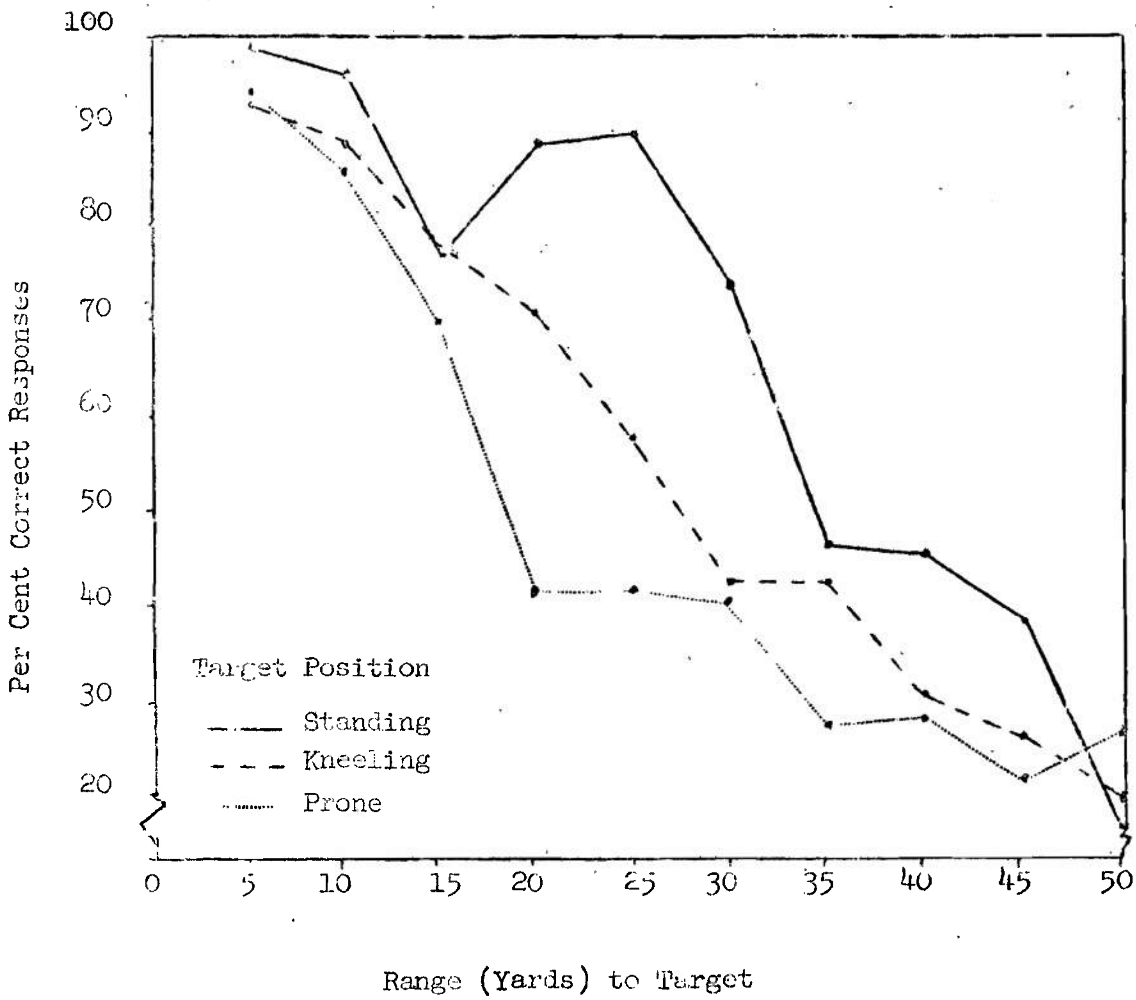

Figure 7. Effects of Target Position for Kneeling Observers (No-Moon Experiment).

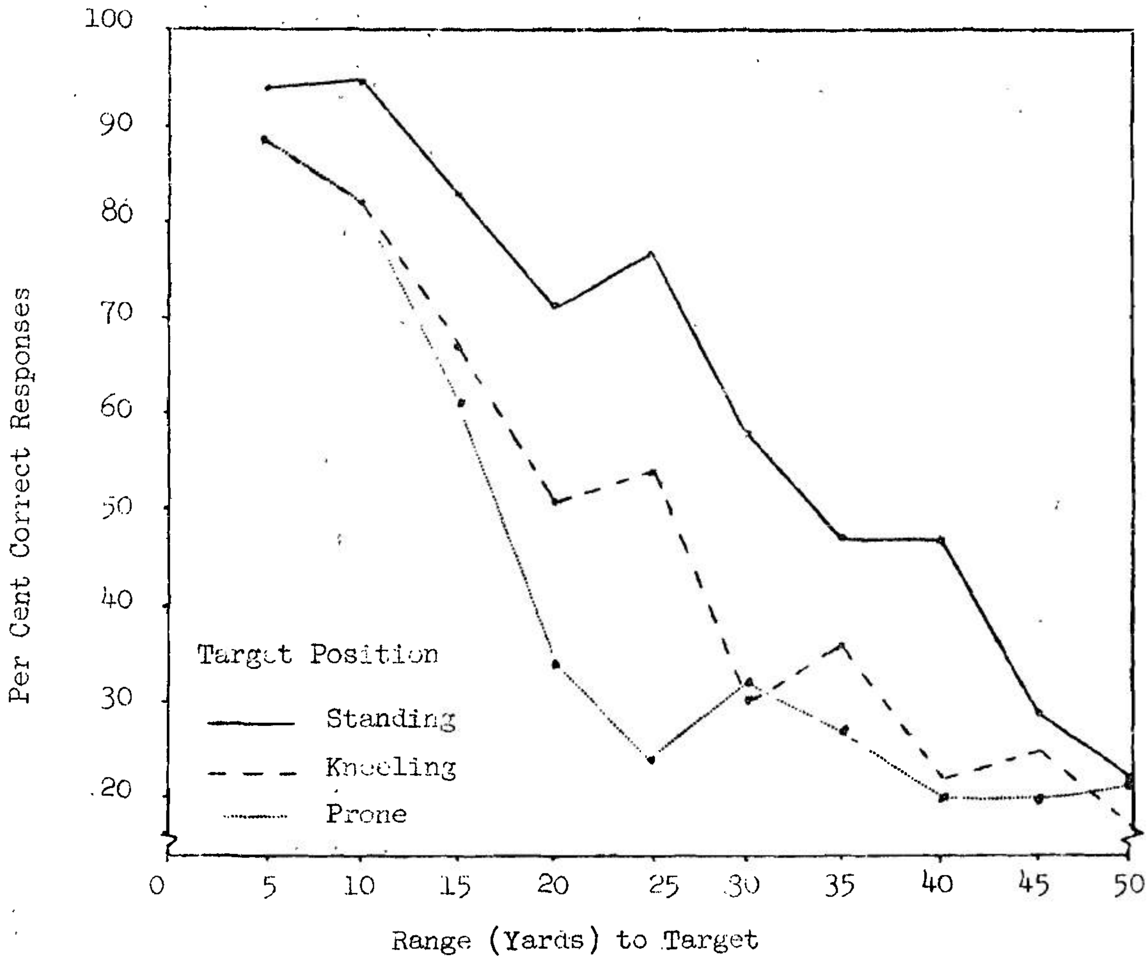

Figure 3. Effects of Target Position
for Prone Observers (No-Moon Experiment)

The amount of difference from the observers to the target over the points on the lane is greatest at this close range.[1] Heterogeneity of target background may possibly account for the fact that even the observers at the close range of 5 to 5.3 yards were unable to achieve 100 per cent correct responses.

Effects of Night Vision Training

The curves in Figure 2 are seen to be slightly different in that the percentages of correct responses for the CT and NT groups fall slightly below the respective points for the CFT and FT groups under the no-moon conditions. The range of this difference over the curve is approximately 3 to 8 yards. The point at which 50 per cent of the responses were correct and 50 per cent were incorrect is in the range of 27 to 30 yards for all groups with the CFT and FT groups being better by approximately 3 yards than the CT and NT groups. However, this slight, though fairly consistent superiority of the field training groups, was shown to be non-significant with further analysis.

Effects of Observer Position

Figures 3, 4, and 5 indicate that position of observer had little effect under no moon. There was a tendency, however, for the kneeling observer to be superior to both standing and prone observers, especially when observing prone targets. Looking specifically at the 50 per cent points, no consistent observer-position effect is apparent.

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[1] At the 10-yard target range, the flank observers are 12.6 yards from the target; at the 20-yard target range, the flank observers are 21.4 yards from the target.

Effects of Target Position

Figures 6, 7, and 8 indicate that position of target had considerable effect under no moon. Over-all differences are apparent with the standing target being easier identified than the kneeling, and the kneeling being easier identified than the prone. The 50 per cent point for kneeling targets was approximately 9 to 11 yards beyond that for prone, and that point for standing targets was approximately 7 to 8 yards beyond that for kneeling.

Shape of Curves

Figures 2 to 8 indicate that under no moon the per cent of correct response curves seemed to be either linear or negatively accelerated depending upon the positions of the observers and the targets. The curves for standing, kneeling, and prone observers looking at prone targets tended to be negatively accelerated. The curves for the standing, kneeling, and prone observers looking at the standing and kneeling targets tended to be linear. It is probable that, if extended far enough (to 0 per cent performance), these curves would also have been negatively accelerated.[1]

Statistical Analysis of No-Moon Observations

Tables 1 and 2 present mean correct responses derived from the no-moon study according to type of training, observer position, and target position.

---

[1] The curves generated under the conditions of the similar study by Jones and Ward indicated that performance approaching 0 per cent correct responses could be expected at 50 yards. The conditions of the present investigation produced approximately 20 per cent performance at 50 yards.

Table 1

Mean Correct Responses, No-Moon Condition

Groups	Observer Position	Target Position: Standing	Kneeling	Prone
CT	Standing	18.5	13.0	12.6
	Kneeling	20.4	15.4	14.4
	Prone	18.5	12.9	11.5
FT	Standing	19.1	16.6	12.5
	Kneeling	20.3	17.5	15.0
	Prone	19.4	15.2	13.1
CFT	Standing	18.8	15.8	14.9
	Kneeling	20.4	17.6	13.6
	Prone	19.5	14.8	12.6
NT	Standing	19.1	13.6	11.0
	Kneeling	19.7	15.8	14.7
	Prone	17.3	13.6	12.1

Table 2

Total Means and Grand Mean, No-Moon Condition

Training Group			
CT	FT	CFT	NT
15.3	16.5	16.4	15.2

Target Position		
Standing	Kneeling	Prone
19.3	15.2	13.2

Observer Position		
Standing	Kneeling	Prone
15.5	17.1	15.1

Grand Mean
15.9

Analysis of variance of the no-moon scores showed that at the .05 level of significance:

1. None of the variables interacted. That is, differences which did occur were consistent ones.

2. All target positions differed from one another with standing targets being identified more often than kneeling targets, and kneeling targets being identified more often than prone.

3. Not all observer positions differed. Kneeling observers were somewhat superior to both standing and prone observers, but standing and prone observers did not differ from each other.

4. The three groups that received CT, FT, and CFT did not differ among themselves, nor were they superior to the control group which received NT.

Tables B-1 to B-3 in Appendix B summarize these analyses of the no-moon data.

Curves for Full-Moon Observations

Figures 9 through 15 present the results of the full-moon experiment in terms of per cent correct responses plotted against range to the target. Figure 9 shows the effects of training, Figures 10 to 12 show the effects of observer position for each target position, and Figures 13 to 15 show the same data another way, that is, effects of target position for each observer position.

It is to be seen that, just as in the no-moon experiment, 100 per cent correct responses were not achieved even at the close ranges.

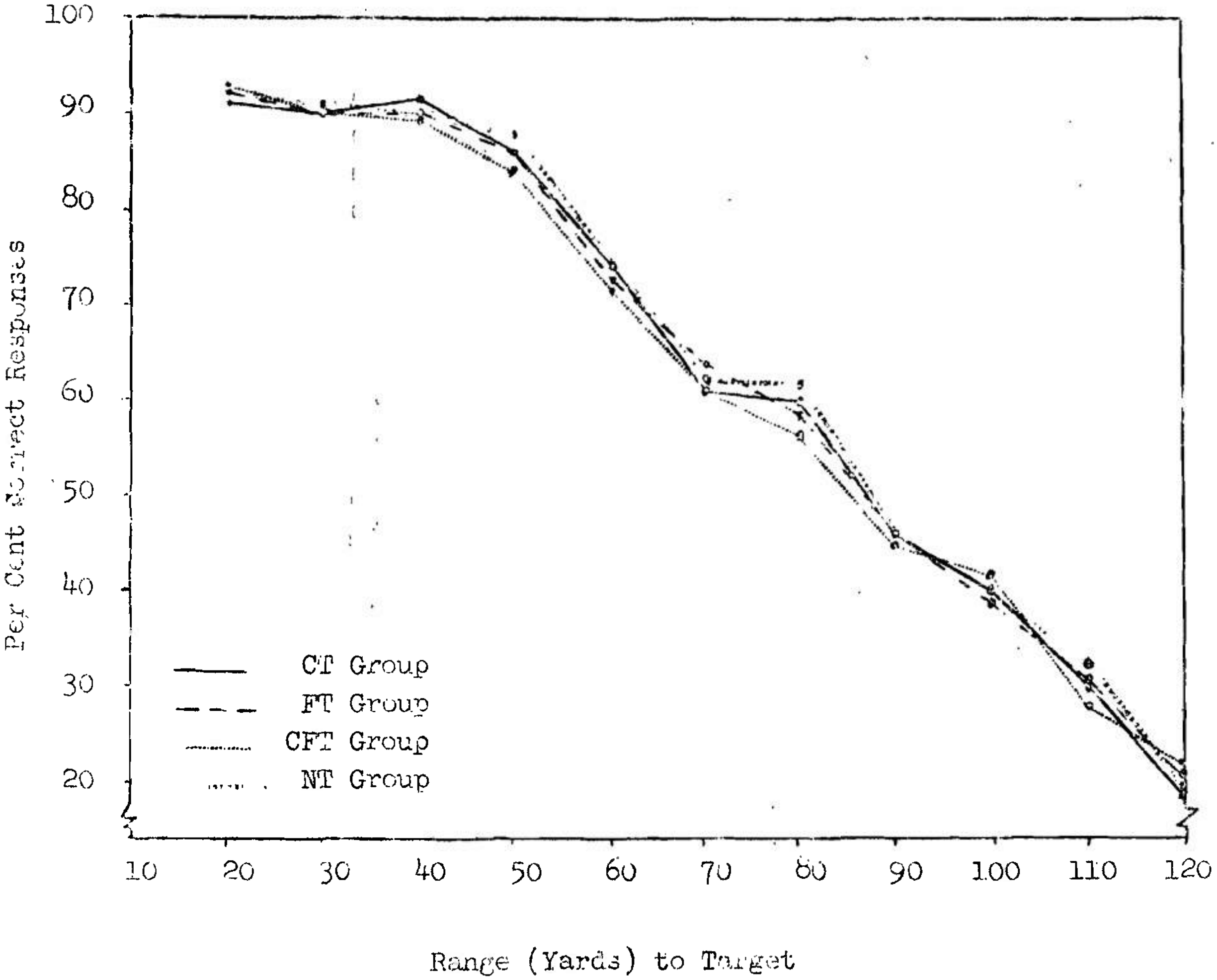

Figure 9. Effects of Training for Combined Observer and Target Positions (Full-Moon Experiment)

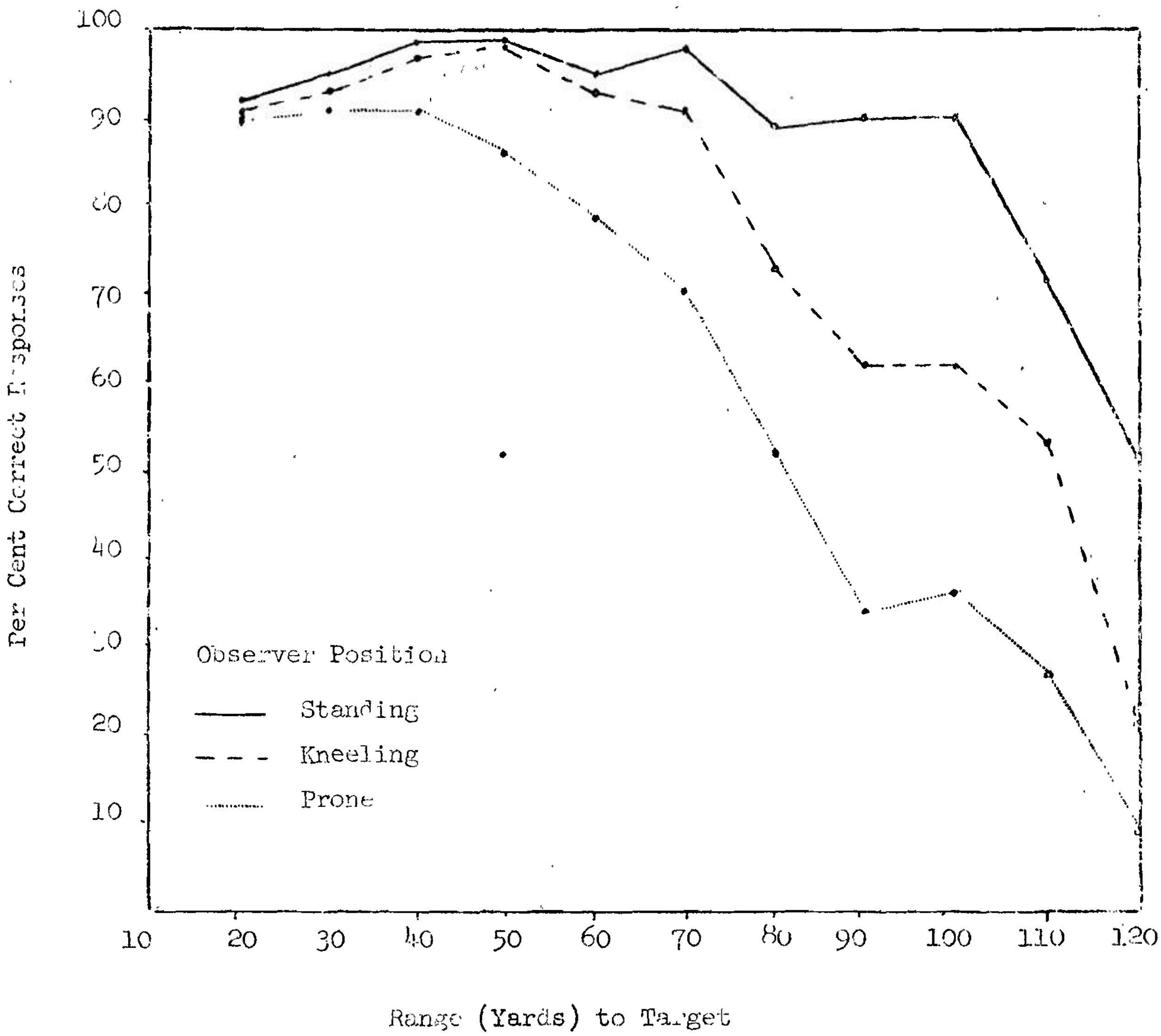

Figure 10. Effects of Observer Position for Standing Targets (Full-Moon Experiment)

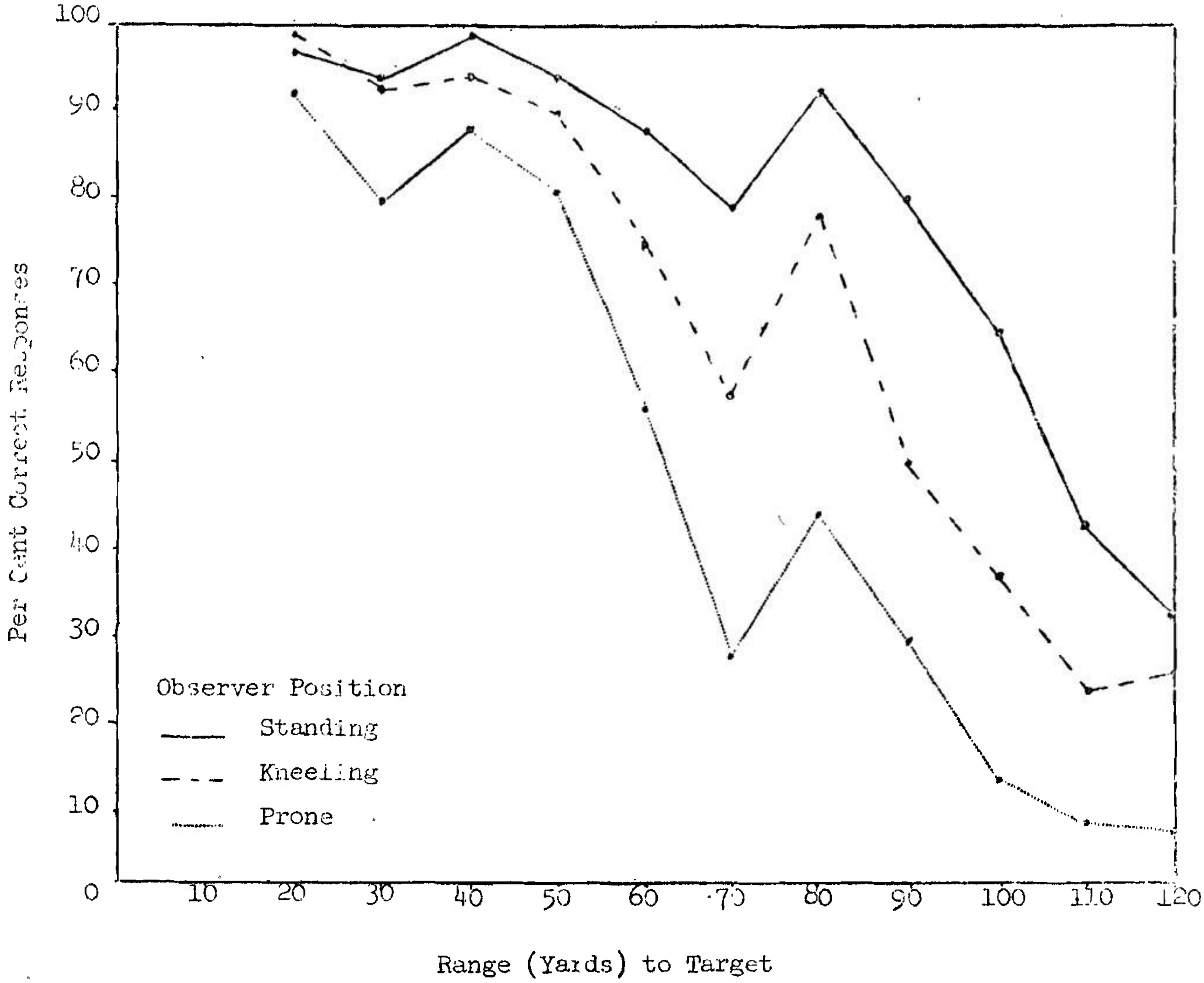

Figure 11. Effects of Observer Position for Kneeling Targets (Full-Moon Experiment)

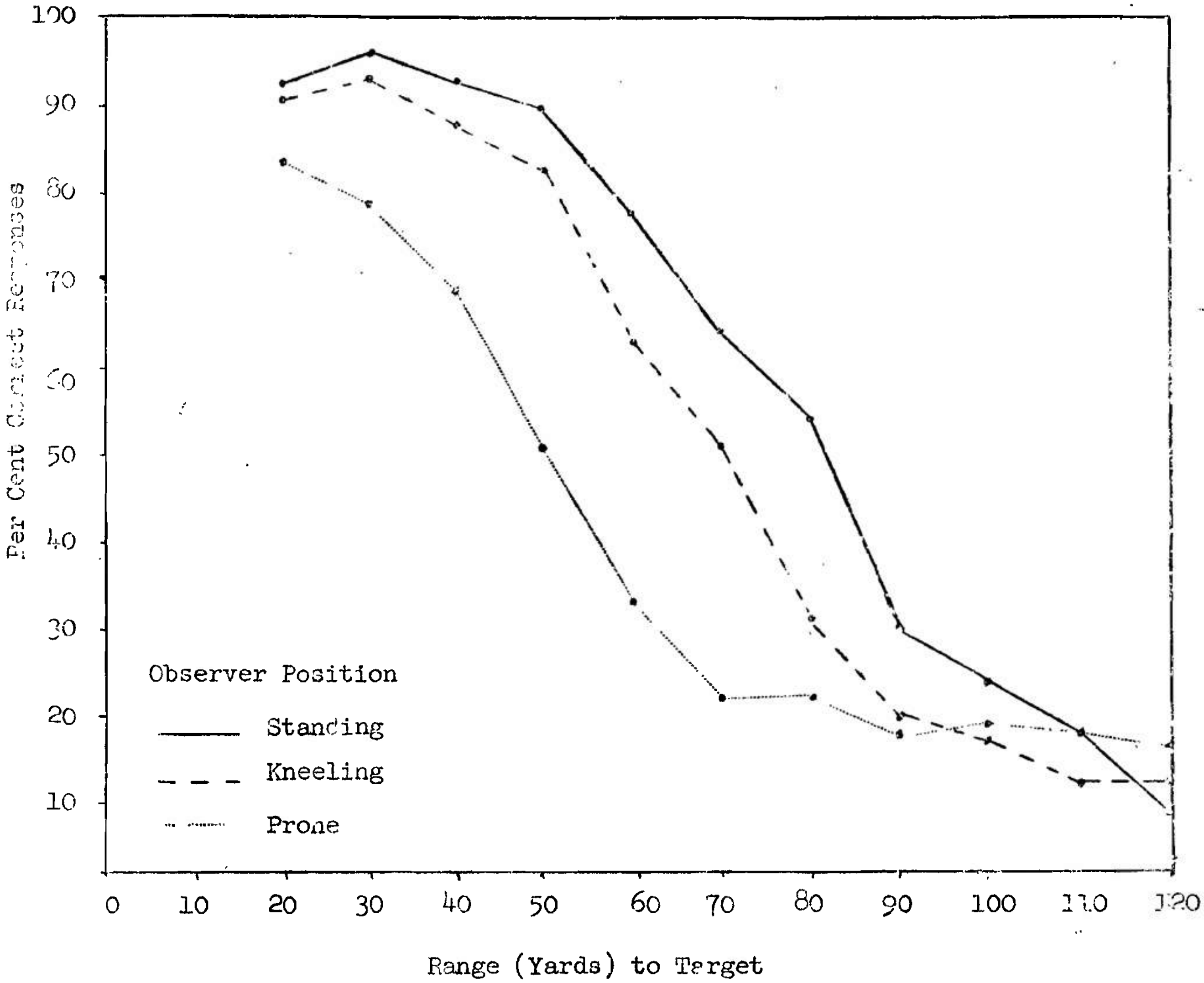

Figure 12. Effects of Observer Position for Prone Targets (Full-Moon Experiment)

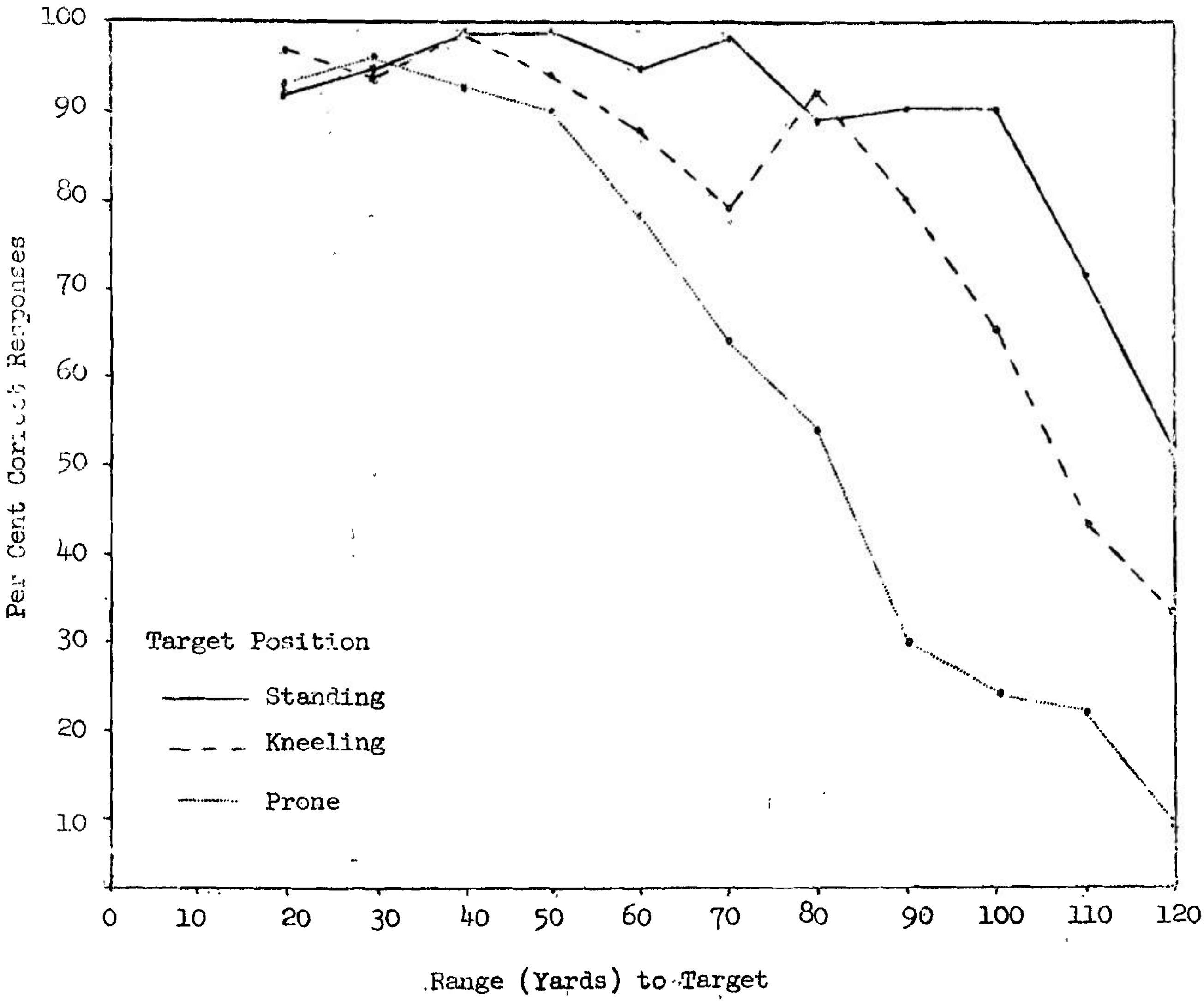

Figure 13. Effects of Target Position for Standing Observers (Full-Moon Experiment)

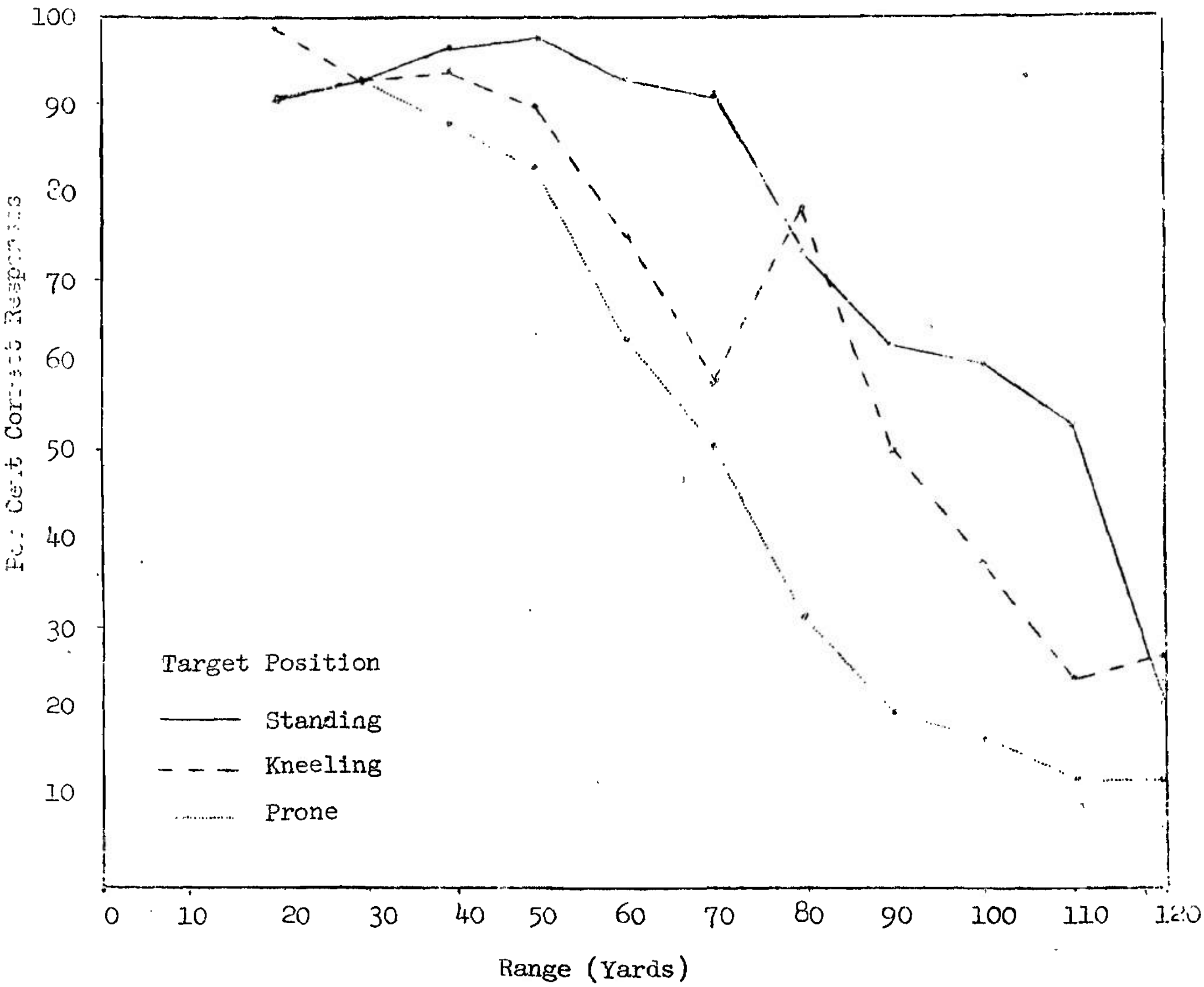

Figure 14. Effects of Target Position for Kneeling Observers (Full-Moon Experiment)

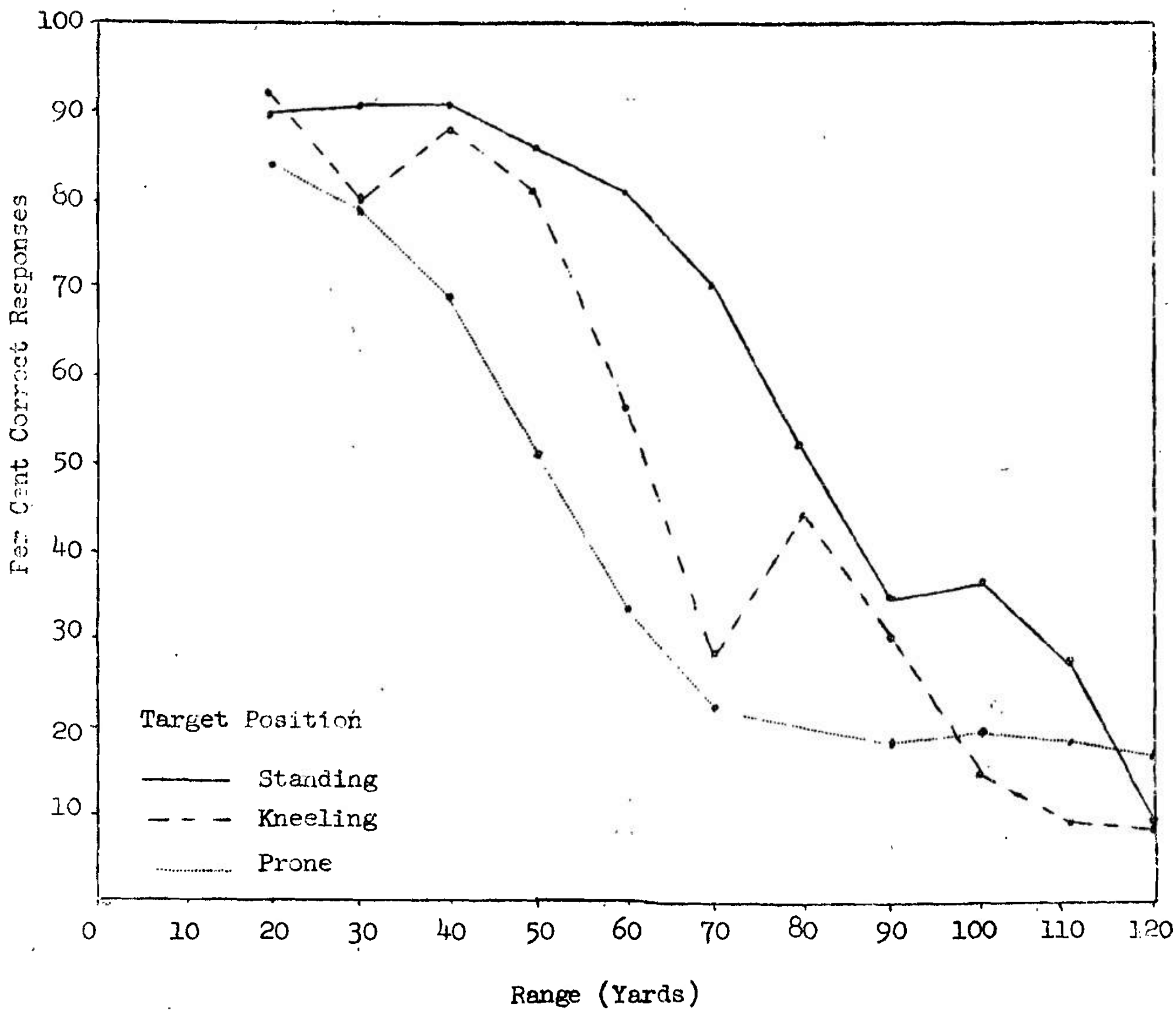

Figure 15. Effects of Target Position for
Prone Observers (Full-Moon Experiment)

Again, the targets may have been difficult to identify because of heterogeneity of background.

Effects of Night Vision Training

Figure 9 indicates that no consistent difference was produced under full moon by the night vision training. The curves are practically superimposed. Looking specifically at the 50 per cent points, it is seen that these were practically identical for all four groups.

Effects of Observer Position

Figures 10, 11, and 12 indicate that position of the observer had a large and rather consistent effect under full moon. The standing observer was superior to the kneeling observer who, in turn, was superior to the prone observer. This superiority held for all target positions. The 50 per cent point for kneeling observers exceeded those for prone observers by approximately 20 to 30 yards, and those respective points for standing observers exceeded those of kneeling observers by approximately 9 to 17 yards.

Effects of Target Position

Figures 13, 14, and 15 indicate that position of target also had considerable effect under full moon. Over-all differences are apparent with the standing target being easier identified than the kneeling target, and the kneeling target being easier identified than the prone. Looking again at the 50 per cent points, it is seen that these points for kneeling targets exceeded those for prone targets by approximately 12 to 25 yards, and those for standing targets exceeded those of the kneeling targets by approximately 13 to 20 yards.

Shape of Curves

Figures 9 to 15 indicate that under full moon the per cent correct response curves seemed to be positively accelerated or sigmoid depending upon position of observer and target. The curves for all observers looking at the prone targets, and for prone observers looking at the kneeling targets, tended to be sigmoid. The curves for all observers looking at standing targets, and for standing and kneeling observers looking at kneeling targets, tended to be positively accelerated. It is probable that, if extended far enough (to 0 per cent performance), these curves would also have been sigmoid.[1]

Figure 11 shows a peculiar reversal occurring between 70 and 80 yards for the kneeling targets. There was approximately a 15 per cent increase in accurate response for 80-yard over 70-yard kneeling targets. This is presumed to reflect a situational artifact.

Statistical Analyses of Full-Moon Observations

Tables 3 and 4 present mean correct responses derived from the full-moon study according to type of training, observer position, and target position.

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[1] An informal tryout run on the target observation area prior to mowing and raking indicated that 0 per cent correct responses could be expected at 120 yards. This proved to be a serious underestimate with the actual range of correct responses being approximately 10 to 50 per cent at 120 yards.

Table 3

Mean Correct Responses, Full-Moon Condition

Groups	Observer Position	Target Position: Standing	Kneeling	Prone
CT	Standing	29.4	25.4	18.7
	Kneeling	24.8	22.0	16.9
	Prone	20.8	15.2	13.4
FT	Standing	29.2	27.0	19.7
	Kneeling	24.6	21.4	16.4
	Prone	20.6	16.1	12.4
CFT	Standing	28.8	25.4	19.4
	Kneeling	26.3	23.4	17.5
	Prone	18.4	14.9	11.3
NT	Standing	28.9	26.0	20.1
	Kneeling	24.4	20.1	16.7
	Prone	19.8	17.5	14.4

Table 4

Total Means and Grand Mean, Full-Moon Condition

Training Group			
CT	FT	CFT	NT
20.7	20.8	20.6	20.9

Target Position		
Standing	Kneeling	Prone
24.7	21.2	16.4

Observer Position		
Standing	Kneeling	Prone
24.8	21.2	16.2

Grand Mean
20.8

Analysis of variance of the full-moon scores showed that at the .05 level of significance:

1. Position of target and position of observer interacted with the difference between standing and kneeling targets being largest for the prone observers, and the differences between kneeling and prone targets being least for the prone observers and largest for the standing observers. Simple effect analyses for target and observer were made.

2. The simple effects analyses of target position for each observer position showed that all target positions differed from one another with standing targets being identified more often than kneeling targets, and kneeling targets being identified more often than prone.

3. The simple effects analyses of observer position for each target position showed that all observer positions differed from one another with standing observers being superior to kneeling observers, and kneeling observers being superior to prone.

4. The three groups that received CT, FT, and CFT prior to the experiment did not differ among themselves, nor were they superior to the control group which received NT.

Tables B-4 to B-6 summarize these analyses of the full-moon data.

Comparison of No-Moon Curves with Full-Moon Curves

An over-all comparison of Figures 2 to 8 with Figures 9 to 15 indicates that the superiority of full-moon over no-moon observations is large and consistent. Depending upon both the position of the observer and position of the target, correct identifications could be made at distances ranging from two to five time greater under full-moon than under no-moon. Ignoring observer position and target position, comparing the 50 per cent points of Figure 2 with those of Figure 9 indicates that this point for all groups occurred at approximately 27 to 30 yards under no-moon and occurred at about 87 yards under full-moon.

As stated previously, no statistical comparison could be made of the two sets of data.

Interpretation of Graphs and Statistics

Effect of Training

The curves and statistics considered together for the no-moon data are taken to indicate that the night vision training had a slight but negligible effect on the identification of targets. The curves and statistics considered together for the full-moon data also indicate that the night vision training had no effect whatever on the full-moon observations. The failure of the training to affect identification of targets indicates the need of more extensive training to effect improvement.

Effect of Target Position

The curves and statistics considered together for the no-moon data indicate that the standing targets were more easily identified than the kneeling, and the kneeling targets were more easily identified than the prone. The curves and statistics for the full-moon data taken together indicate the same effect during the full-moon observations. All the data, then, are considered to indicate that target position had a strong practical influence on correctness of identification.

Effect of Observer Position

The curves and statistics considered together for the no-moon data are taken to indicate that a slight but negligible practical superiority was enjoyed by the kneeling observers over both standing and prone observers. No explanation for this is offered other than that some peculiarity of contrast between figure and background may have been present at the 30-inch level used for the kneeling position on this piece of terrain. The curves and statistics considered together for the full-moon data are taken to indicate that standing observers were much superior to kneeling, and that kneeling observers were much superior to prone observers. The data, then, are considered to indicate that observer position had a strong practical effect on full-moon, but not on no-moon, observations.

Effect of Level of Illumination

In the absence of statistical analyses, but considering the large and consistent superiority of the full-moon observations over the no-moon observations, the data are considered to indicate that level of illumination had a strong practical effect on correctness of identification.

SUMMARY AND CONCLUSIONS

The present studies were conducted to determine low visibility identification curves for human targets as a function of:

1. Level of illumination
2. Position of target
3. Position of observer
4. Night vision training of observer.

Based upon the findings of previous research, two experiments were conducted using four groups of basic trainees as subjects. The first experiment was conducted under no-moon illumination and the second, using the same subjects, was conducted under full moon. The variables in each experiment were (1) position of target (standing, kneeling, or prone), (2) position of observer (standing, kneeling, or prone), and (3) type of night vision training administered to each group (classroom training, field training, a combination of classroom and field training, or no training). Target identification data were collected in a large outdoor field laboratory. Curves were drawn showing per cent correct responses plotted against range. Mean correct responses were analyzed statistically. The data indicated that level of illumination had a strong practical effect on correctness of identification. Full moon extended the range of observation approximately three times the range for no moon. Observer position had an inconsistent effect on correctness of identification. Under no moon, standing, kneeling, and prone observers did not differ appreciably. Under full moon, standing observers could identify targets approximately

next p.

9 to 17 yards beyond kneeling observers, who, in turn, could identify targets approximately 20 to 30 yards beyond prone observers. Position of target had a strong practical influence on correctness of identification. Under no-moon illumination, standing targets could be seen approximately 7 to 8 yards beyond kneeling targets, which, in turn, could be seen approximately 9 to 11 yards beyond prone targets. Under full-moon illumination, standing targets could be seen approximately 13 to 20 yards beyond kneeling targets, which, in turn, could be seen approximately 12 to 25 yards beyond prone targets.

Night vision training had no effect on correctness of identification under the no-moon or full-moon conditions.

Generalizing to conditions similar to those under which the present study was conducted, it is concluded that the ability to identify human targets under low, natural illumination is:

1. Directly related to level of illumination.

2. Directly related to size of target being observed.

3. Directly related to height of the observer's eyes above the ground under full-moon conditions, but not under no-moon conditions.

4. Not related to the short periods of night vision training employed in these studies.

The findings of the present investigation should be made available to those engaged in (1) developing tactical doctrine governing visual observation and the firing of individual weapons at night; (2) developing training courses for observation, target detection, and weapons firing at night; and (3) determining appropriate firer-to-target distances in the construction of night training facilities.

end

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2. Rostenberg, Lee O. Night Vision Studies. Department of Gunnery, The Field Artillery School, Fort Sill, Oklahoma, February 17, 1944.

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4. Henry, E. R., and Uhlaner, J. E. Validation of Army Night Vision Tester. (PRS Report 816). Personnel Research Section, The Adjutant General's Office, Department of the Army, Washington, D. C., January 30, 1950.

5. Verplanck, W. S., Ch., Johnson, E. Parker, MacDonald, P. Robb, and Riesen, Austin H. Report of the Working Group on Night Vision Training. Minutes and Proceedings of the Armed Forces - NRC Vision Committee, 29th Meeting, November 1951.

APPENDICES

APPENDIX A

Curves Drawn From Data Collected by

Jones and Ward at Fort Rucker in 1953.

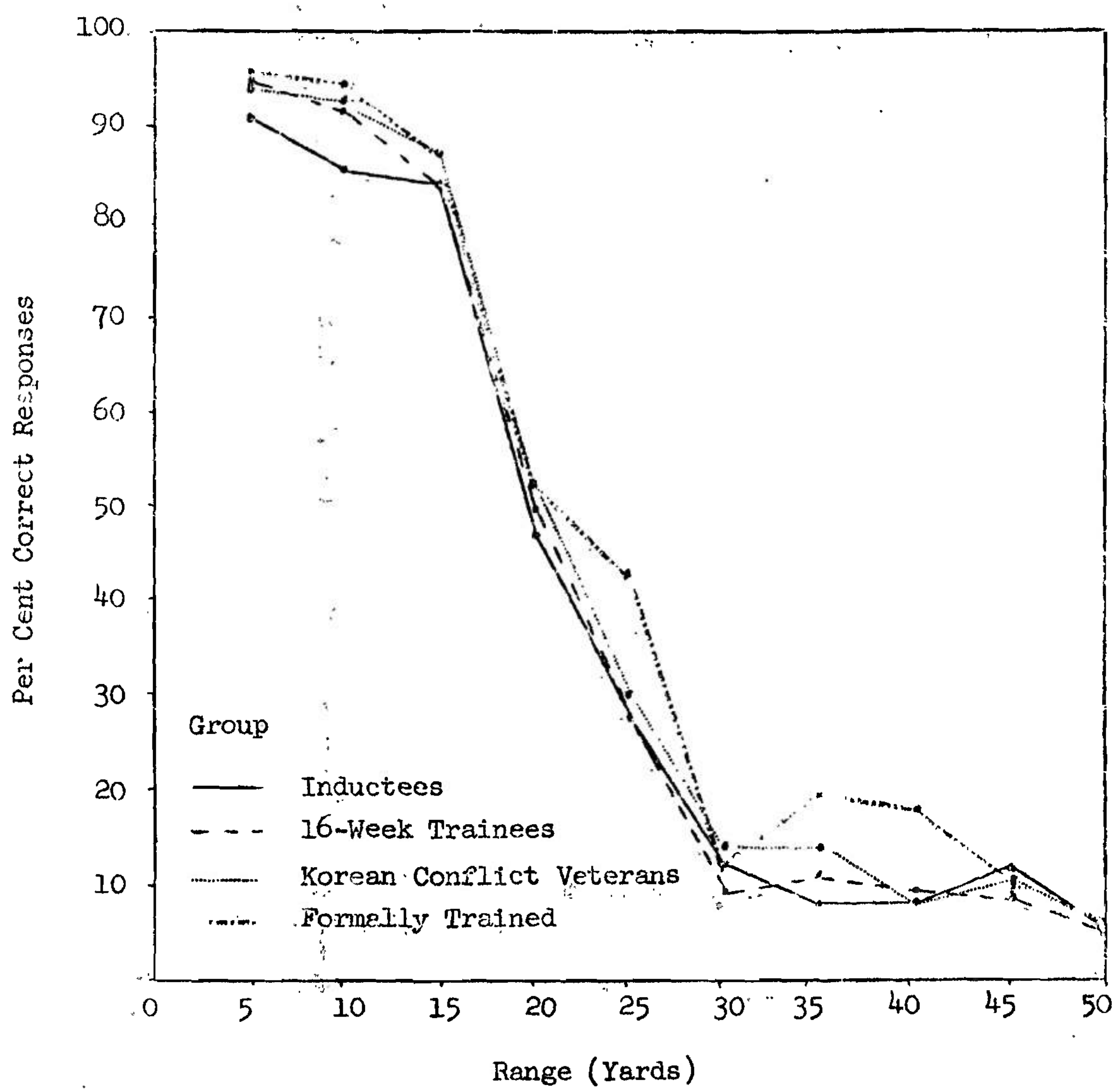

Figure A-1. Effects of Training Tested Under No-Moon Conditions; Standing Target, Observer Prone (Fort Rucker Data)

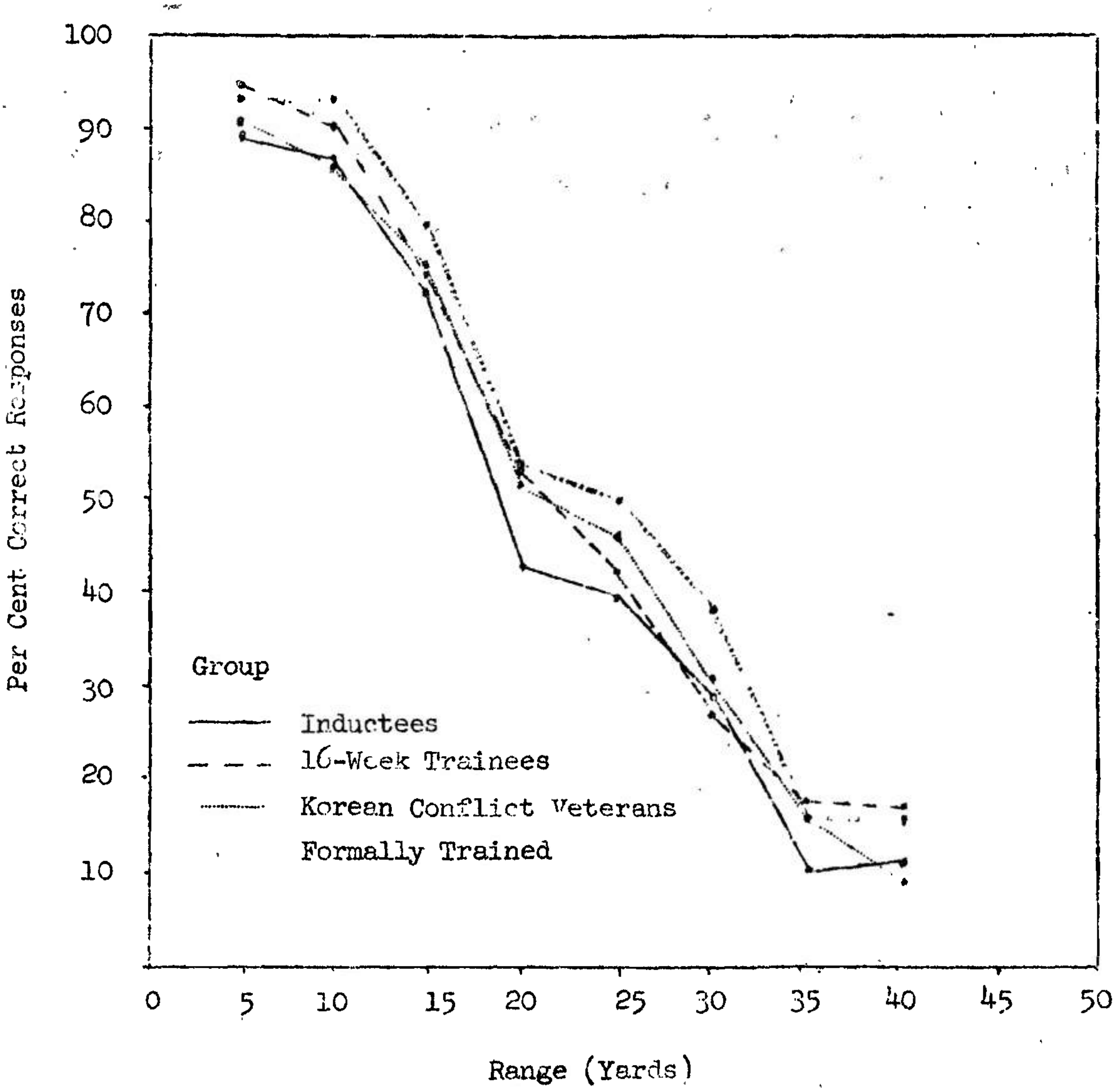

Figure A-2. Effects of Training Tested Under No-Moon Conditions; Kneeling Target Observer Prone (Fort Rucker Data)

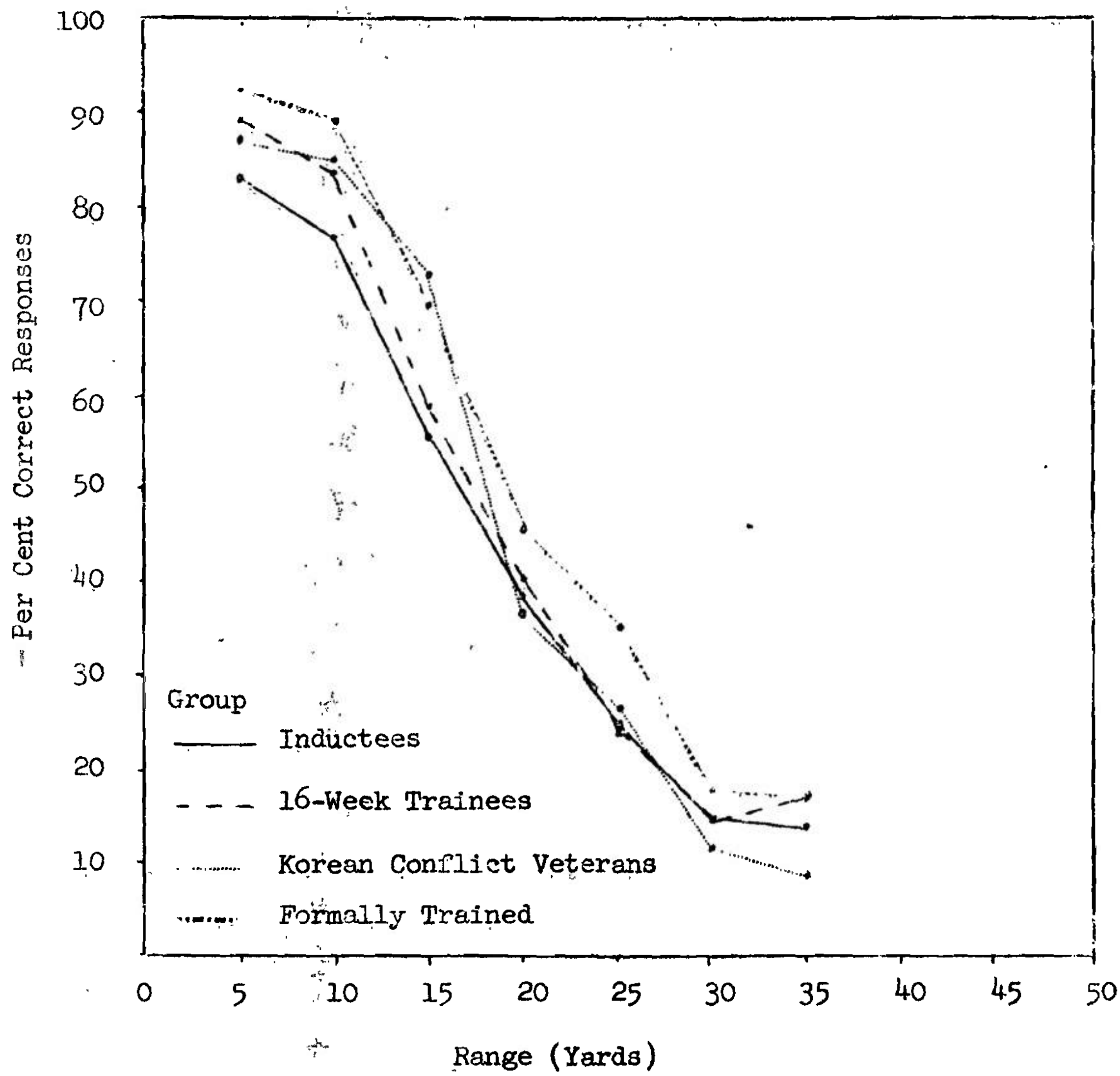

Figure A-3. Effects of Training Tested Under No-Moon Conditions; Prone Target, Observer Prone (Fort Rucker Data)

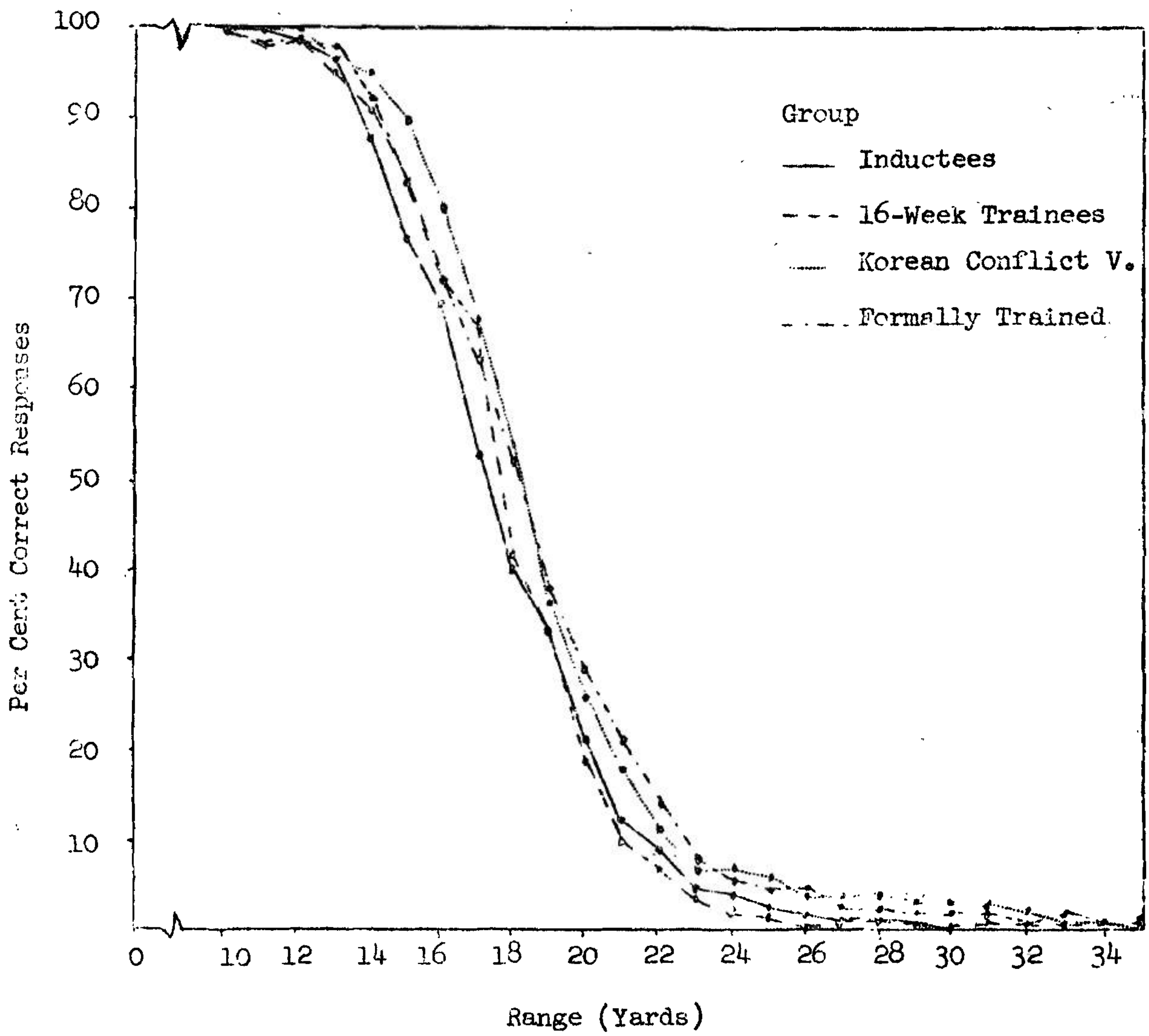

Figure A-4. Effects of Training Tested Under No-Moon Conditions; Walking Target, Observer Prone (Fort Rucker Data)

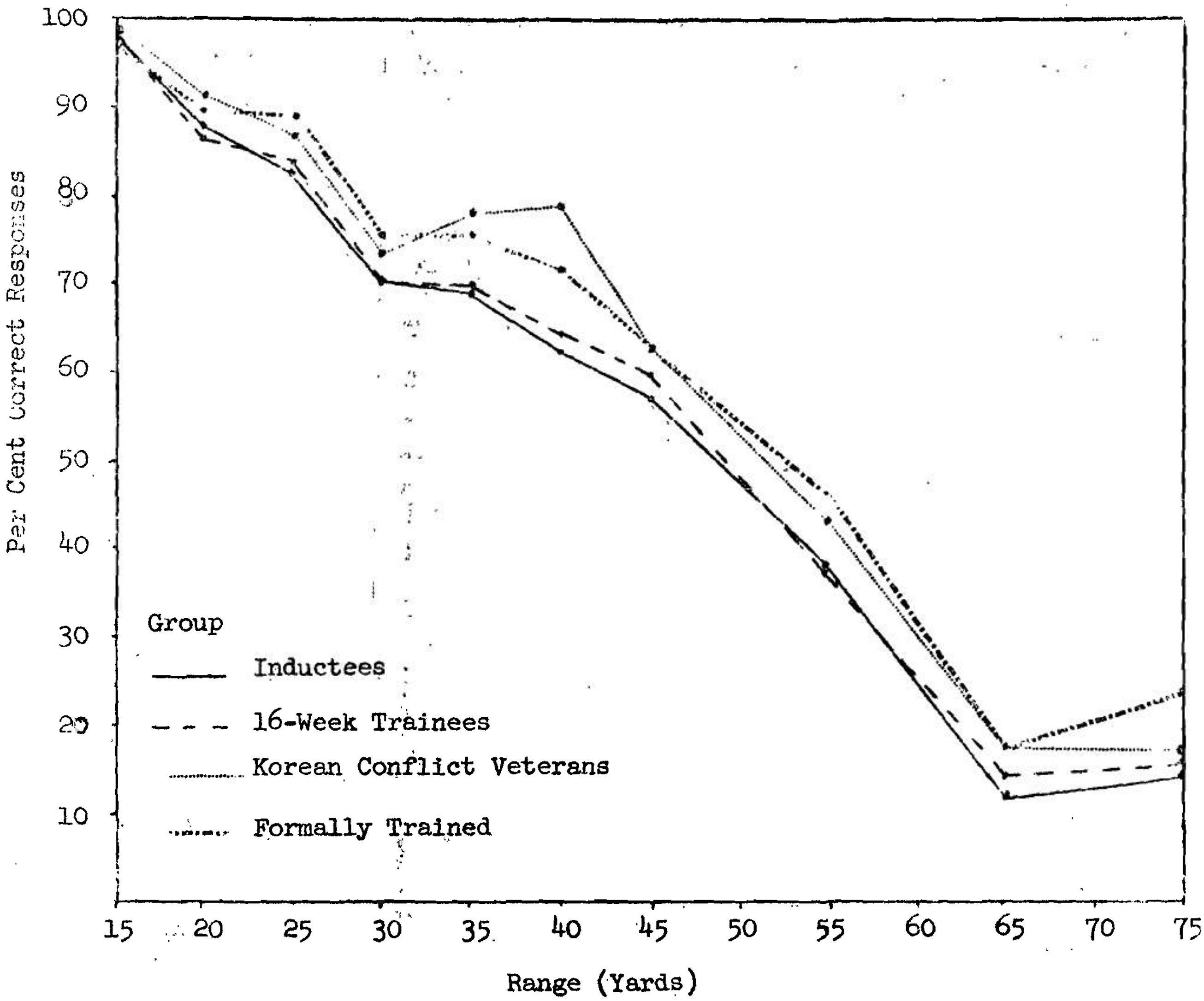

Figure A-5. Effects of Training Tested Under Quarter-Moon Conditions; Standing Target, Observer Prone (Fort Rucker Data)

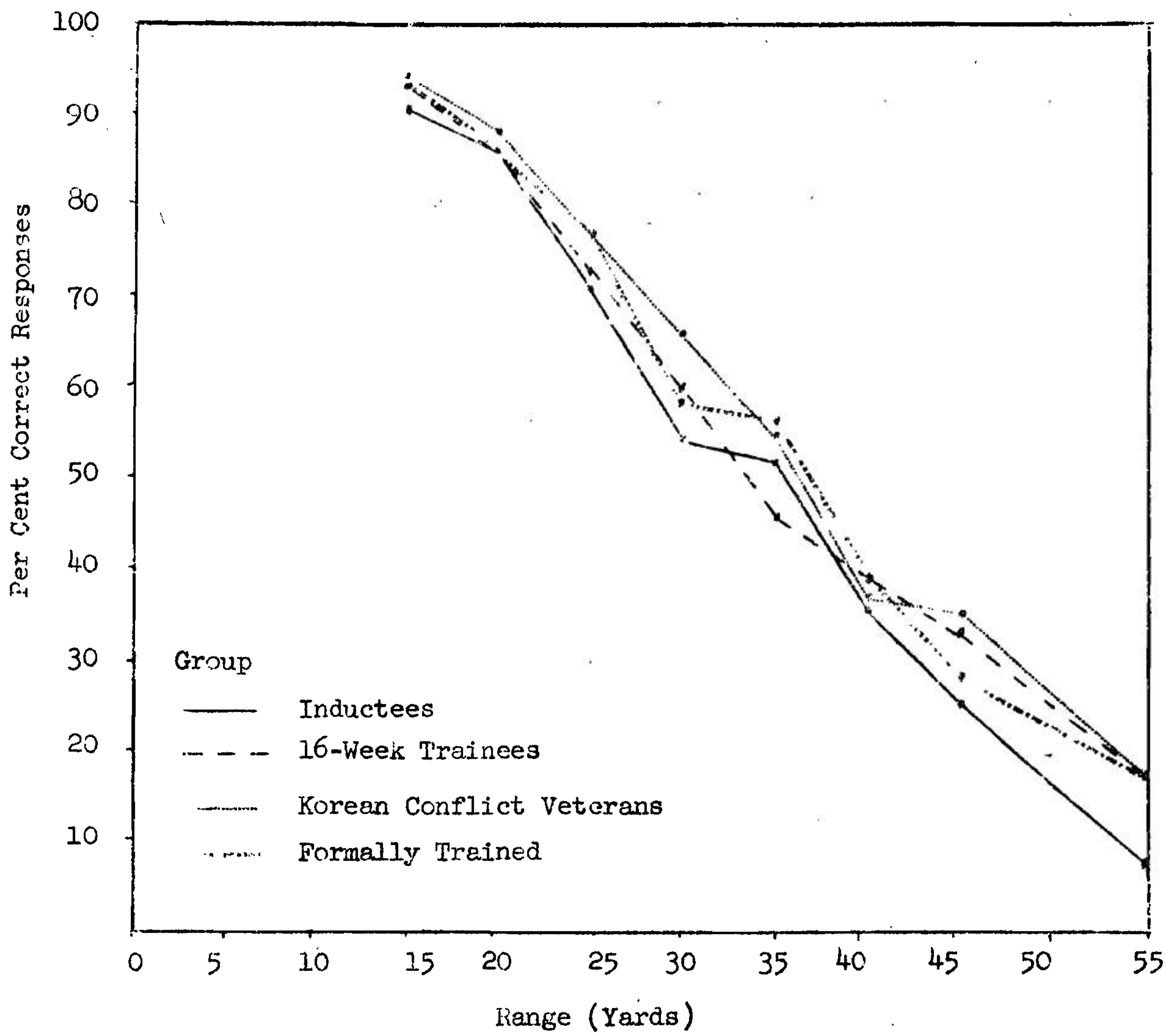

Figure A-6. Effects of Training Tested Under Quarter-Moon Conditions; Kneeling Target, Observer Prone (Fort Rucker Data)

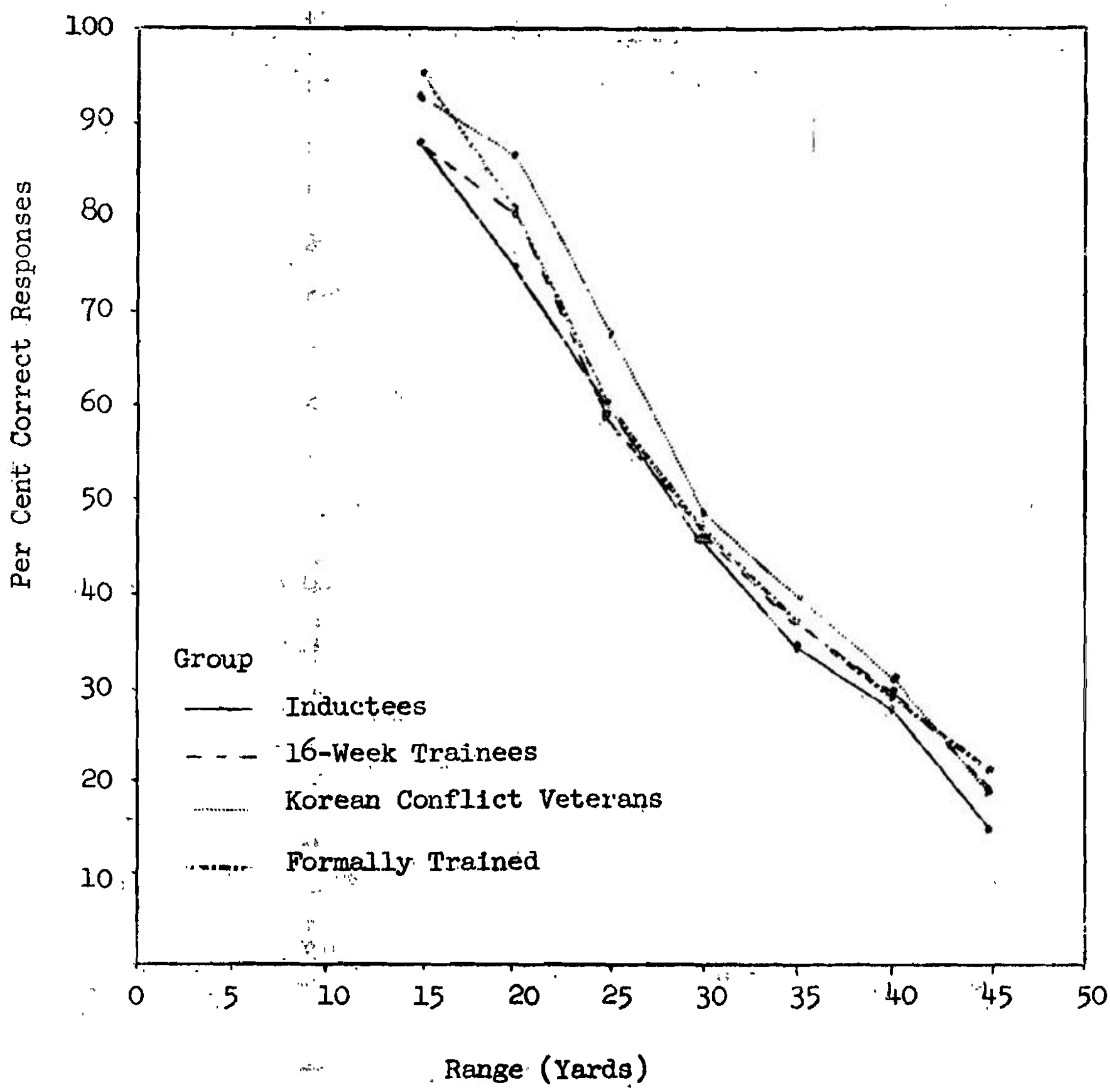

Figure A-7. Effects of Training Tested Under Quarter-Moon Conditions; Prone Target, Observer Prone, (Fort Rucker Data)

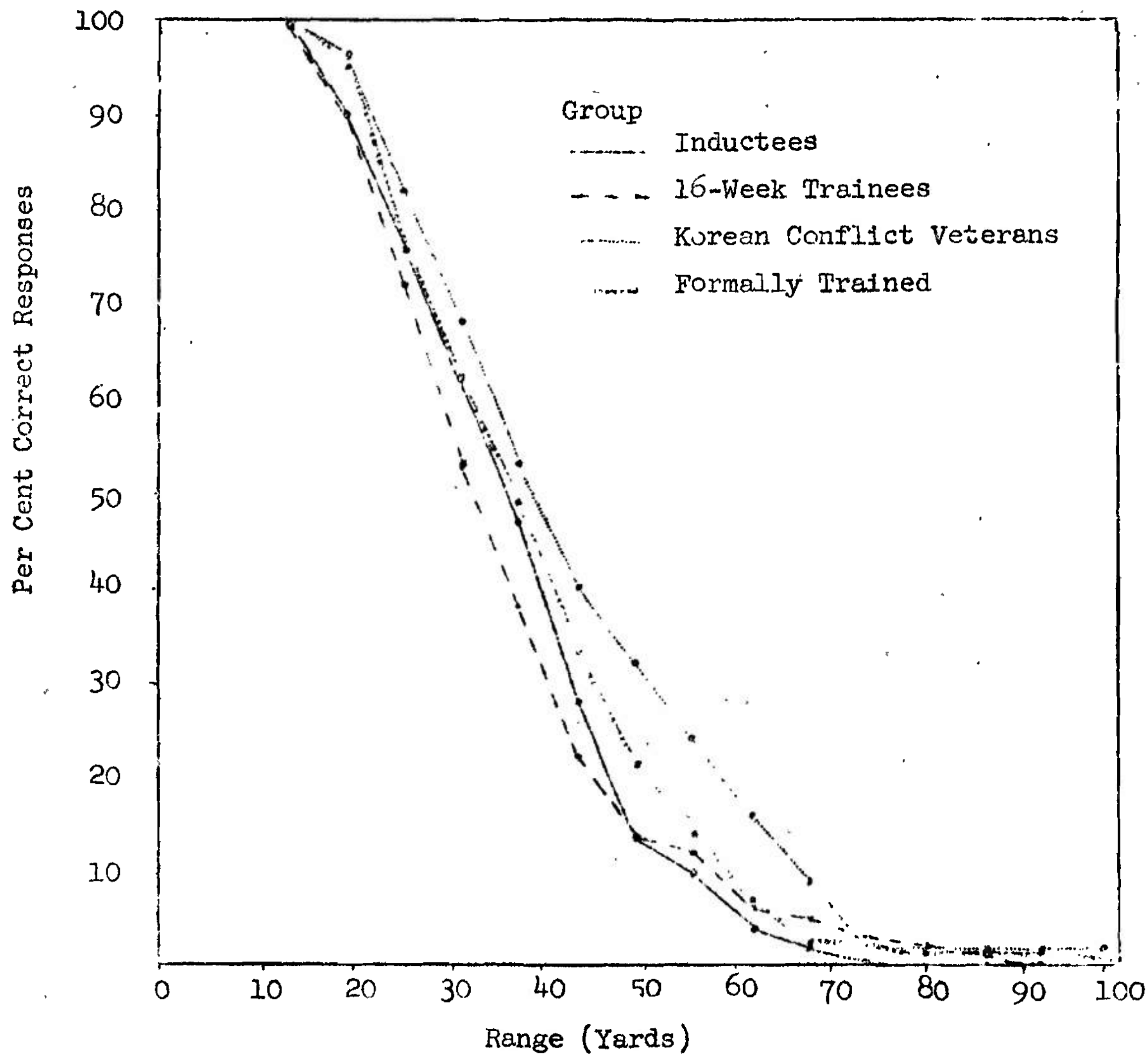

Figure A-8. Effects of Training Tested Under Quarter-Moon Conditions; Walking Target, Observer Prone (Fort Rucker Data)

APPENDIX B

Summary Tables of Analyses of Variance and Appropriate Tests of No-Moon Data and Full-Moon Data

Appendix B

Table B-1

Analysis of Variance, No-Moon Condition

Source	df	Mean Square	F	p
Between subjects	191			
Observer positions	2	217.77	3.86[a]	.025>p>.01
Training conditions	3	74.32	1.33[a]	p>.20
Observer positions x training conditions	6	6.44	.11	p>.20
Error (b)	180	58.05		
Within subjects	384			
Target positions	2	1850.57	154.64[a]	.001>p
Target positions x observer positions	4	3.29	.27[a]	p>.20
Target positions x training conditions	6	13.54	1.13[a]	p>.20
Target positions x observer positions x training conditions	12	11.23	.93	p>.20
Error (w)	360	12.06		
Total	575			

[a] Computed and tested by pooled non-significant error terms.

Table B-2

Tests of Differences Between Means of
Target Positions, No-Moon Condition

Target Position Means					
Standing	Kneeling	Prone	Comparison	t	p
19.3	15.2	13.2	S vs K	11.6	.001>p
			S vs P	17.2	.001>p
			K vs P	5.6	.001>p

Table B-3

Tests of Differences Between Means of
Observer Positions, No-Moon Condition

Observer Position Means					
Standing	Kneeling	Prone	Comparison	t	p
15.5	17.1	15.1	S vs K	2.1	.05>p>.02
			S vs P	.5	.70>p>.60
			K vs P	2.6	.02>p>.01

Appendix B

Table B-4

Analysis of Variance, Full-Moon Condition

Source	df	Mean Square	F	p
Between subjects	191			
Observer positions	2	3568.41	85.60[a]	.001>p
Training conditions	3	1.88	.05[a]	p>.20
Observer Positions x training conditions	6	44.54	1.07	p>.20
Error (b)	180	41.59		
Within subjects	384	26.52		
Target positions	2	3307.17		
Target positions x observer positions	4	51.95	5.82[a]	.001>p
Target positions x training conditions	6	7.28	.82[a]	p>.20
Target positions x observer positions x training conditions	12	6.59	.73	p>.20
Error (w)	360	9.00		
Total	575			

[a] Computed and tested by pooled non-significant error terms.

Table B-5

Tests of Differences Between Means of Target Positions, Full-Moon Condition

Observer Position	Target Position Means S	K	P	F	p	Comparison	t	p
Standing	29.1	26.0	19.5	214.8	.001>p	S vs K	6.6	.001>p
						S vs P	20.3	.001>p
						K vs P	13.7	.001>p
Kneeling	25.0	21.7	16.9	95.8	.001>p	S vs K	5.6	.001>p
						S vs P	13.8	.001>p
						K vs P	8.2	.001>p
Prone	19.9	15.9	12.9	96.1	.001>p	S vs K	7.9	.001>p
						S vs P	13.8	.001>p
						K vs P	6.0	.001>p

Table B-6

Tests of Differences Between Means of
Observer Positions, Full-Moon Condition

Target Position	Observer Position Means S	K	P	F	p	Comparison	t	p
Standing	29.1	25.0	19.9	80.6	.001>p	S vs K	5.6	.001>p
						S vs P	12.7	.001>p
						K vs P	7.1	.001>p
Kneeling	26.0	21.7	15.9	82.3	.001>p	S vs K	5.4	.001>p
						S vs P	12.8	.001>p
						K vs P	7.4	.001>p
Prone	19.5	16.9	12.9	31.3	.001>p	S vs K	3.1	.01>p>.001
						S vs P	7.9	.001>p
						K vs P	4.7	.001>p