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TECHNICAL RESEARCH NOTE 120

Human Factors Studies
in Image Interpretation:

Vertical and Oblique Photos

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6 HUMAN FACTORS STUDIES IN IMAGE INTERPRETATION:
VERTICAL AND OBLIQUE PHOTOS

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USAPRO Technical Research Reports and Technical Research Notes are intended for sponsors of R&D tasks and other research and military agencies. Reports, unlike Notes, contain a management section. Any findings ready for implementation at the time of publication are presented in the latter part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

PREFACE

The present publication reports on a portion of Subtask b, "Identification of Basic Factors in Image Interpretation," of the IMAGE INTERPRETATION Task, FY 62 Work Program of the U. S. Army Personnel Research Office. The entire research task is responsive to special requirements of the Assistant Chief of Staff, Intelligence, the Deputy Chief of Staff for Logistics, and the U. S. Continental Army Command, and furthers the U. S. Army Military Personnel Management (DCSPER) objective of developing, and making available for operational use, research products to optimize the selection, classification, assignment, and utilization of Army personnel.

In tactical situations likely to occur in the future, the military requirement for timely and relevant intelligence information will be greater than ever before. Imagery obtained from photographic, infrared, radar, and other sensor devices will constitute a major source of this information. The ultimate usefulness to the tactical commander of these sensor devices and the imagery they produce will rest upon the ability of image interpreters to extract accurate and complete intelligence information rapidly from these media.

The primary objective of the IMAGE INTERPRETATION Task is to maximize intelligence extraction from imagery by selecting potentially better interpreters and by improved utilization of interpreter abilities. The psychological processes and techniques interpreters use in extracting information from different types of imagery will be identified. These processes and techniques, and the aptitudes, interests, and knowledge possessed by interpreters, will be related to effectiveness of performance. Image interpreter performance will be studied under varied normal and tactical conditions to determine effects of stress, fatigue, and time pressures on output. The optimal composition of image interpreter units in terms of number of interpreters and distribution of skills will be determined.

Other reports and papers dealing with image interpretation research are listed at the conclusion of the present report.

BRIEF

HUMAN FACTORS STUDIES IN IMAGE INTERPRETATION: VERTICAL AND OBLIQUE PHOTOS

~~Requirement:~~

Development of techniques to improve the performance of image interpreters is a continuing ~~ACIP~~ research requirement in the area of selection and utilization of personnel within aerial surveillance systems. The principal objective of the present study was to explore the value to image interpreters of examining both vertical and oblique views of a target area rather than views of either type alone.

~~Procedure:~~

One hundred and nine
109 recent graduates of the Image Interpretation Course, U. S. Army Intelligence School, were divided into five groups matched on general aptitude and final course grades. Tasks required of the several groups were varied so as to provide a basis for comparing performance when either vertical or oblique photos were used alone, and when the two types of photograph were used in combination.

Results:

1. Interpreters in the various groups did not differ significantly in number of correct identifications made, whether working from vertical photos, from oblique photos, or from the two types in some combination.
2. Giving interpreters a second type of photo after they had examined a single type tended to result in their reporting erroneous identifications.
3. The order in which interpreters were given the vertical and oblique photos did not appear to affect performance.

~~Conclusion:~~

The results, while limited in applicability because of the exploratory nature of the study, serve to indicate that having both vertical and oblique photos of a target area does not necessarily make for improved interpreter performance, and may in some circumstances encourage inaccuracy.

Recommendations:

1. A comprehensive study should be undertaken to determine the relative value of vertical and oblique cover alone and in combination, varying systematically such factors as the scale, quality, and content of photos, and the obliqueness of viewing angle. Optimal procedures for examining vertical and oblique imagery combinations should also be determined.
2. Similar human factors studies should be undertaken to determine effective input combination from a variety of sensors, and effective procedures for extracting intelligence information from all available imagery.

HUMAN FACTORS STUDIES IN IMAGE INTERPRETATION: VERTICAL AND OBLIQUE PHOTOS

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HUMAN FACTORS STUDIES IN IMAGE INTERPRETATION: VERTICAL AND OBLIQUE PHOTOS^{1/}

STATEMENT OF THE PROBLEM

Technological innovation of recent years have led to the development of a variety of sensor devices designed for use in aerial reconnaissance systems. The image interpreter may be called upon to extract intelligence information from any one of several types of images or from a combination of images provided by more than one sensor. A combination of vertical and oblique photographs of the target area is commonly employed by Army tactical image interpreters. The different views are obtained by photographing a given area from different angles during separate time periods or simultaneously using multiple camera mounts in the aerial platform. Both vertical and oblique cover of the same tactical area were frequently available to image interpreters during World War II and the Korean War, and are often obtained for intelligence and training purposes today.

The present study was undertaken to explore the usefulness to the image interpreter of vertical and oblique photographs, used both singly and in combination, and to obtain indications of ways in which one or both views of a target area could be exploited to greater advantage in an image interpreter system. The following questions, having operational implications with respect to the use of vertical and oblique photography, were formulated as a basis for a human factors research approach to the problem.

1. Are ^{there} ~~these~~ differences in quantity and quality of identifications made as a function of using both vertical and oblique photographs of a target area as compared to using one or the other type?
2. When both vertical and oblique photos are provided, does the order in which interpreters examine the two types affect the amount and accuracy of the information reported?
3. If only one type of photograph is provided the interpreter, which type--vertical or oblique--is most useful?

Definitive answers to questions such as those formulated can normally be provided only by extensive research in which the effect of such variables as image content, scale, quality, format, and oblique viewing angle are systematically observed. The present study, while limited in scope,

^{1/} A fuller description of the research program in image interpretation currently being conducted by the Army Personnel Research Office may be found in Technical Research Note 114, Human factors studies in image interpretation: The value of stereoscopic viewing.

was designed to explore circumstances in which differences in performance are associated with use of vertical and oblique imagery so as to facilitate greater precision and economy of design in a comprehensive program of research on the problem.

METHOD

Sample

The study was conducted at the U. S. Army Intelligence School, Fort Holabird, Maryland, using as subjects 109 recent graduates (36 officers and 73 enlisted men) from the Image Interpretation Course. The majority of these interpreters had had no on-the-job experience. The men were divided into five groups, each consisting of 21 or 22 interpreters. The groups were matched on final grade averages and on a composite of aptitude test scores. The five groups had about equal numbers of officers and enlisted men.

Design of the Study

Type--or types--of photographs provided and pattern of presentation were varied by group and viewing period according to the following plan:

- Group 1. Vertical photos the first 15 minutes (V), then vertical plus oblique (V + O).
- Group 2. Oblique photos first 15 minutes (O), then oblique plus vertical (O + V).
- Group 3. Both vertical and oblique photos, both time periods (V and O).
- Group 4. Only oblique photos both time periods (O).
- Group 5. Only vertical photos both time periods (V).

Initially, all groups were given the impression that they had only 15 minutes in which to work. At the beginning of the second 15 minutes, whether or not interpreters were furnished additional photos, they were told to check their original identifications and to make any further identifications they could during the additional period. During periods when interpreters had both types of photographs to work from, they were free to decide for themselves the relative amount of time to spend examining each type.

Performance Measures

The vertical and oblique photographs used in this experiment were obtained from an aerial reconnaissance sortie flown early in the Korean

War during the Fall of 1950. During this sortie, trimetrogon^{2/} coverage was obtained of North Korean military positions. Six photos, three vertical (scale 1:8,500) and three left oblique taken at approximately 1300 hours, were selected for the performance measures. The photographs show an area in which an enemy convoy of 14 trucks^{3/} appears and can be viewed stereoscopically in both the vertical and oblique cover. The interpreters' task was to detect and identify all vehicles on or near a tree-lined road along which the convoy was traveling.

All interpreters were provided with a map of the relevant area, a sortie plot overlay, and information about the location and disposition of friendly and enemy forces. A general list of vehicles, both tracked and wheeled, was provided to all interpreters. Only gross identification was required, i.e., "truck", "car", "tank", etc. Interpreters numbered directly on the photographs the objects they had detected, and then recorded identifications on special answer sheets. In addition, at the end of every five-minute period, the interpreters marked their answer sheets to indicate which identifications they had made during the period. Answer sheets could thus be scored for separate time periods.

The performance scores obtained for evaluation of group differences were right scores (number of correct identifications), wrong scores (number of erroneous identifications), and accuracy scores (number of correct identifications divided by sum of correct and erroneous identifications). Each of these scores was computed for the first 15 minutes, for the second 15 minutes, and for the total 30-minute period.

^{2/} Trimetrogon photography is a method of aerial photography whereby three photographs, one vertical and two obliques, are taken simultaneously in a direction at right angles to the line of flight. The obliques, taken at an angle of 60 degrees from the vertical, side lap the vertical photograph. Further information on this type of cover may be found in Army Technical Manual TM 30-245, Photographic Interpretation Handbook.

^{3/} To establish the actual content (ground truth) of the tactical imagery, relevant historical records of the Korean action were studied and related to the photographs. Using the records, several experienced interpreters of a Military Intelligence Group interpreted the photographs. Their interpretations were checked by two experienced interpreters assigned to the Army Personnel Research Office. A third check was made by instructors at the U. S. Army Intelligence School. Further details of key development are provided in AFRO Technical Research Note 114, Human factors studies in tactical image interpretation: The value of stereoscopic viewing, by J. Zeidner, R. Sadacca, and A. I. Schwartz, May, 1961.

Statistical Analysis

Significance of differences among the five groups in mean performance as measured by the three indices of performance was assessed by analysis of variance. Statistical tests were conducted separately for right, wrong, and accuracy scores for each 15-minute viewing period and for the total 30-minute period. In addition, predetermined orthogonal comparisons were made to test for the significance of mean differences between specified groups of interpreters. Table 1 lists the specific groups compared and the hypotheses tested in each of the orthogonal comparisons.

RESULTS

Correct Identifications

Whether interpreters worked only with vertical photographs, only with oblique photographs, or with vertical and oblique photographs in some combination, performance with respect to number of correct identifications was practically the same. The various groups did not differ significantly in average number of vehicles identified in either time period or in the total viewing time. The slight variations in group means presented in Table 2 are considered to have occurred by chance. Interpreters in all groups made most of their correct identifications during the first 15 minutes, the average being 7.5 or about 60 percent of the vehicles appearing in the photos. In the second 15 minutes, the average number of correct identifications was .9.

None of the comparisons of specific groups or combinations of groups listed in Table 1 yielded statistically significant mean differences in number of correct identifications.

Wrong Identifications

Table 3 presents the mean number of wrong identifications made by the interpreters in each group during each time period. Differences among the groups for the first 15-minute period were not statistically significant. During the second 15-minute period, however, those groups given additional imagery (Groups 1 and 2) made almost twice the number of wrong identifications as the other groups. Differences in mean wrong scores were significant at the .05 level. The additional imagery apparently encouraged the interpreters to make additional identifications on the basis of doubtful cues.

The order in which interpreters received the vertical and oblique photographs evidently did not affect performance, inasmuch as Groups 1 and 2 did not differ significantly in mean number of wrong identifications made during the total time period.

Table 1

SPECIFIC GROUP COMPARISONS FOR SIGNIFICANCE OF DIFFERENCES
IN MEAN PERFORMANCE SCORES

Groups Compared	Hypotheses Tested
<u>First 15 minutes</u>	
Group (1) vs Group (5)	Two matched groups receiving only vertical performed equivalently.
Group (2) vs Group (4)	Two matched groups receiving only oblique performed equivalently.
Groups (1) and (5) vs Group (3)	Two groups receiving only vertical performed equivalently to group receiving both vertical and oblique.
Groups (1) (3) and (5) vs Groups (2) and (4)	Three groups receiving vertical performed equivalently to two groups receiving only oblique imagery.
<u>Second 15 minutes</u>	
Group (1) vs Group (2)	Groups receiving vertical and oblique imagery in different orders performed equivalently.
Group (4) vs Group (5)	Group receiving only vertical performed equivalently to group receiving only oblique.
Groups (4) and (5) vs Group (3)	Groups having only vertical or oblique performed equivalently to group having both throughout.
Groups (1) and (2) vs Groups (3) (4) and (5)	Groups receiving additional imagery performed equivalent to groups not receiving additional imagery.
<u>Total 30 minutes</u>	
Group (1) vs Group (2)	Groups receiving vertical and oblique in different orders performed equivalently.
Groups (1) and (2) vs Group (3)	Groups later receiving additional imagery performed equivalently to group having both throughout.
Groups (1) (2) and (3) vs Group (5)	Groups receiving vertical and oblique performed equivalently to group receiving only vertical.
Groups (1) (2) (3) and (5) vs Group (4)	Groups receiving vertical performed equivalently to group receiving only oblique.

Table 2

MEAN RIGHT SCORES OF EXPERIMENTAL GROUPS BY TIME PERIOD

Group	First 15 Minutes	Second 15 Minutes	Total 30 Minutes
1	(V) 7.9	(V + O) .9	8.8
2	(O) 6.5	(O + V) 1.1	7.6
3	(V and O) 8.4	(V and O) 1.0	9.4
4	(O) 7.3	(O) .8	8.1
5	(V) 7.3	(V) .7	8.0
Average of Groups:		7.5	.9 8.4

Table 3

MEAN WRONG SCORES OF EXPERIMENTAL GROUPS BY TIME PERIOD

Group	First 15 Minutes	Second 15 Minutes	Total 30 Minutes
1	(V) 6.5	(V + O) 2.0	8.6
2	(O) 6.7	(O + V) 2.8	9.5
3	(V and O) 7.5	(V and O) 1.6*	9.2
4	(O) 5.1	(O) 1.2*	6.3**
5	(V) 6.7	(V) 1.5*	8.0
Average of Groups:		6.5	1.8 8.3

*The group made significantly fewer misidentifications on the average than Groups 1 and 2. ($P < .05$ in statistical orthogonal comparison.)

**This group made significantly fewer misidentifications on the average than Groups 1, 2, 3, and 4.

Interpreters in Group 4, who worked only with the oblique photos, made significantly fewer wrong identifications than did interpreters in any of the other four groups, who received vertical cover during one or both 15-minute viewing periods. The result cannot be taken as strong evidence of the general superiority of oblique photography for image interpretation, since the experiment was limited to a single set of photographs. In the oblique photos provided in the present study, the vehicles were clearly outlined below the tops of trees, whereas in the vertical photos vehicles and tree shadows were blended. There were no significant mean differences in number of wrong identifications among the four groups who received the vertical photos alone or in combination with oblique photos.

During the 30-minute period, the mean number of wrong identifications made by all the interpreters in the sample was 8.3. One interpreter made as many as 31 wrong identifications.

Accuracy of Identifications

Comparisons of accuracy scores revealed no statistically significant differences in mean scores among the five groups during any time period (Table 4). Mean accuracy during the second 15-minute period dropped considerably from the first 15-minute period for all groups of interpreters, regardless of the type of imagery provided. Mean accuracy scores across all groups was 54% during the first 15-minute period as compared to 34% during the second period. Apparently, additional time and/or imagery do not necessarily result in improved interpreter performance.

Table 4

MEAN ACCURACY^a SCORES OF EXPERIMENTAL GROUPS BY TIME PERIOD

Group	First 15 Minutes	Second 15 Minutes	Total 30 Minutes
1	(V) 54%	(V + O) 35%	51%
2	(O) 51%	(O + V) 34%	49%
3	(V and O) 54%	(V and O) 41%	52%
4	(O) 57%	(O) 31%	56%
5	(V) 52%	(V) 28%	52%
Average of Groups:	54%	34%	52%

^aThese mean values were obtained by summing individual accuracy scores and dividing by the number of cases, and do not necessarily agree with overall mean accuracy scores derived by using the right and wrong scores in Tables 2 and 3.

SUMMARY OF RESULTS

1. No significant differences in number of vehicles correctly identified were found between interpreters having both vertical and oblique photos and those having only one view of the target area.
2. Significantly more misidentifications were made when additional photos of a different type were provided after an initial viewing period using a single type of photo.
3. The group using only oblique imagery produced fewer wrong identifications than did the groups receiving vertical imagery during one or both 15-minute periods. The difference was statistically significant for the total time period.
4. Changing the order of presentation of the imagery--vertical first or oblique first--yielded no significant differences in terms of right, wrong, or accuracy scores.

CONCLUSION

The view that the performance of image interpreters is improved by providing additional--and different--views of a target area was not supported by the present exploratory study. In fact, additional imagery may under some circumstances encourage interpreters to report objects erroneously. Whether this tendency to overreport was influenced by the particular performance measure used in the present study, or whether comparable results would be obtained with experienced image interpreters remains to be investigated. The effect of giving interpreters imagery from other types of sensor (radar and infrared, for example) in addition to conventional photography also remains to be investigated.

RECOMMENDATIONS

1. A comprehensive study should be undertaken to determine the relative value of vertical and oblique cover alone and in combination, varying systematically such factors as photo scale, quality, and content, and oblique viewing angle. Optimal procedures for examining vertical and oblique imagery combinations should also be determined.
2. Similar human factors studies should be undertaken to determine effective input combinations from a variety of sensors, and effective procedures for extracting intelligence information from all available imagery.

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HUMAN FACTORS STUDIES IN IMAGE INTERPRETATION: VERTICAL AND
OBLIQUE PHOTOS by R. Sadacca, J. E. Rames, and A. I. Schwartz.
December 1961. Rept on Image Interpretation b-00 Proj.--16 p.
Incl. tables, 13 Ref. (USAPRO Technical Research Note, No. 120)
(DA Project ZL-95-60-001) Unclassified Report

The value to image interpreters of examining both vertical and oblique views of a target area rather than views of either type alone was explored. 109 recent graduates from the Image Interpretation Course, Ft. Monmouth, were divided into five experimental groups matched on final course grades and on general aptitude test scores. Tasks required of the several groups were varied so as to provide a basis for comparing performance when either vertical or oblique photos were used alone and when the two types of photos were used in combination. No significant differences were found in number of correct identifications made when interpreters had both types of photos or either type alone. More misidentifications were made when a second type of photo was provided after an initial viewing period of a single type. Changing the order of presentation of the imagery did not appear to affect performance. Thus, results of this exploratory study indicated that having both vertical and oblique photos of a target area does not necessarily make for improved interpreter performance. More definitive results would be expected from a more comprehensive study in which such factors as scale, quality, and content of photos are systematically varied.

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The value to image interpreters of examining both vertical and oblique views of a target area rather than views of either type alone was explored. 109 recent graduates from the Image Interpretation Course, Ft. Holabird, were divided into five experimental groups matched on final course grades and on general aptitude test scores. Tasks required of the several groups were varied so as to provide a basis for comparing performance when either vertical or oblique photos were used alone and when the two types of photos were used in combination. No significant differences were found in number of correct identifications made when interpreters had both types of photos or either type alone. More misidentifications were made when a second type of photo was provided after an initial viewing period of a single type. Changing the order of presentation of the imagery did not appear to affect performance. Thus, results of this exploratory study indicated that having both vertical and oblique photos of a target area does not necessarily make for improved interpreter performance. More definitive results would be expected from a more comprehensive study in which such factors as scale, quality, and content of photos are systematically varied.

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