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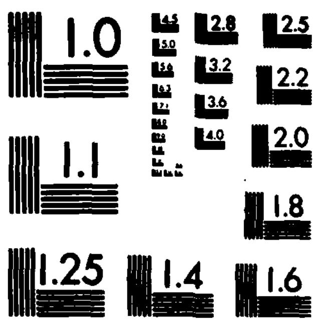

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EFFECTS OF DISPLAY FORMAT ON SONAR OPERATOR PERFORMANCE

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EFFECTS OF DISPLAY FORMAT ON SONAR OPERATOR PERFORMANCE

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The objective of this research was to determine whether the test currently used to measure proficiency in acoustic analysis, which differs substantially from the OL-82 sonar system used in the fleet, provides an accurate estimate of operator on-the-job performance. Subjects (22 AWs enrolled in the Air Anti-Submarine Squadron Forty-one (VS-41) operator course) were administered six single target grams to analyze and classify on the OL-82 sonar system simulator; and six, using static lofargrams. Measures of acoustic analysis (identification of sound source, predominant spectrum, and propeller mode), and → over

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) classification (accurate identification of the target) decisions were obtained under both testing situations.

Subject performance on the analysis variables differed significantly for the two display formats. Subjects more accurately identified predominant spectrum, sound source, and propeller mode on the OL-82 sonar system simulator than they did on the static linear lofargrams. Subjects' performance on the classification task was not significantly different for the two display formats. It was concluded that operator proficiency on the OL-82 sonar system simulator, at least for AWs in the training pipeline, cannot be estimated accurately using static linear lofargrams.

FOREWORD

This research and development was performed in response to recognized Navy needs for an investigation of the effects of initial training and job conditions on skill retention under subproject ZF63-522-001-010 (Computer-aided and Classroom Training), work unit 03.07 (Skill and Knowledge Retention). In previous work conducted to investigate relationships, problems were observed in the consistency between different performance measures.

The objectives of the subproject are to (1) derive ways of detecting potential problems existing in the Navy and (2) recommend means to minimize performance deterioration by restructuring training and job conditions. The objective of this effort was to examine the relationship between the assessment of operator performance in a high-fidelity simulator and the use of proficiency tests that are of relatively low fidelity to the actual performance situation to estimate operational readiness. Results are intended primarily for the Anti-Submarine Warfare Wing, Pacific, and for other agencies concerned with aviation sonar operator training and testing. This report should also be of interest to agencies responsible for the development of skill maintenance programs and proficiency tests for personnel in technical ratings.

Appreciation is expressed to members of the instructor staff at the Air Anti-Submarine Squadron Forty-one (VS-41), Naval Air Station, North Island, who were instrumental in facilitating the gathering of data and who provided advice on technical matters. Particular appreciation is expressed to AWCS Sather for his support throughout the research project.

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SUMMARY

Problem

Aviation antisubmarine warfare operators (AWs) in the S-3A community are tasked with classifying targets using acoustic analysis techniques. The task is accomplished onboard the aircraft using dynamic, computer-based, passive acoustic sonar equipment (OL-82 sonar system). Acoustic information is presented on logarithmically-scaled lofargrams using multiple-display formats on a CRT screen. Multiple job aids are available for problem solution.

In contrast, the operational readiness of these operators is estimated based on results of a test using static lofargrams to present acoustic information. Job aids available to the operators in these tests are limited to mechanical dividers and hand-held calculators.

Objective

The objective of this research was to determine whether the currently used proficiency test, which differs substantially from the OL-82 sonar system, both in the form of presentation and in support for the analysis procedures, provides an accurate estimate of operator on-the-job performance.

Approach

Subjects were 22 students enrolled in the Air Anti-Submarine Squadron Forty-one (VS-41) operator course. The subjects were administered six single target grams to analyze and classify on the OL-82 sonar system simulator and six, using static lofargrams. The grams used for the two test administrations were equated for level of difficulty by subject matter experts using the lofargram difficulty index. Measures of acoustic analysis (identification of sound source, predominant spectrum, and propeller mode), and classification (accurate identification of the target) decisions were obtained under both testing situations.

Findings

Subject performance on the analysis variables differed significantly for the two display formats. Subjects more accurately identified predominant spectrum, sound source, and propeller mode on the OL-82 sonar system simulator than they did on the static linear lofargrams. Subjects' performance on the classification task was not significantly different for the two display formats. Correlations between the two display formats for analysis and classification scores were uniformly low. Analysis significantly correlated with classification scores for performance on the OL-82 sonar system simulator but not for performance on static lofargrams.

Conclusions

1. Accurate estimates of operator proficiency on the OL-82 sonar system simulator, at least for AWs in the training pipeline, were not obtained using tests that measured operator performance on static linear lofargrams.

2. Since it is likely that subjects' ability to classify targets on the static lofargram was due, at least in part, to familiarity with target patterns studied in previous training, their performance may not reflect their actual classification capabilities on the OL-82 system. This points up the need for extensive libraries of taped signals so that [illegible] be tested using unfamiliar grams.

[illegible]

1. Research should be conducted to determine the validity of [illegible] [illegible] analysis and classification skills [illegible]

2. Research should be conducted to determine whether on-the-job performance of acoustic analysts of computer-based sonar systems is degraded by use of static grams in training, in promoting skill maintenance, and in estimating proficiency on tests.

3. Tests of operator proficiency should measure analysis and classification skills using lofargrams not previously encountered by the operator in the training environment.

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INTRODUCTION

Problem and Background

Operation of complex systems in the modern Navy requires that technical personnel maintain a high level of skill. Proficiency tests are administered to personnel to assess their level of technical competence and to make estimates of operational readiness. However, constraints or limitations on resources for testing, such as cost, administrative difficulties, and unavailability of operational equipment at test sites, may necessitate compromises in testing that reduce the accuracy of the proficiency tests in determining operational readiness in fleet operators/technicians. In addition, because of these testing constraints, the skills tested by the proficiency tests may be significantly different than those performed on the job. As a result, personnel may have to practice and maintain skills specifically for the test, which would actually distract their attention from maintaining the skills used on the job.

There is considerable recognition of the problems associated with accurate measurement of job performance. Vineberg and Joyner (1982) point out that the development and administration of job sample performance tests are difficult, time consuming, and often do not yield objective and meaningful measures of performance. Osborn and Ford (1976) and Ellis, Wulfeck, and Fredericks (1979) stress the requirement for a high degree of similarity between the actual task and how it is measured. Ellis et al. (1979) developed procedures for assessing the adequacy of performance tests, emphasizing the need for consistency between the test standards, conditions, and actual task performance on the job.

Aviation antisubmarine warfare operators (AWs) in the Navy's S-3A community are tasked with classifying targets using computer-based, passive acoustic sonar equipment (OL-82 sonar system). Acoustic information is presented on logarithmically-scaled lofargrams on a CRT screen using multiple-display formats. Several job aids, including computational programs and electronic dividers, are available for problem solution.

In contrast, for skill maintenance training and proficiency testing in the fleet, a quite different form of the task is used. For example, in the S-3A squadrons at Naval Air Station, North Island, AWs practice on static lofargrams to maintain their acoustic analysis and classification skills. These skills are tested on a quarterly proficiency exam that requires the operator to analyze and classify static lofargrams. The Wing Command then interprets the scores obtained to estimate the proficiency of those AWs on the OL-82 sonar system used in the S-3A aircraft. However, operators in those squadrons reported that they spent about twice as much time per week studying static lofargrams for the quarterly wing exam than they spent performing the task in the aircraft (Konoske, Wetzel, & Montague, 1983).

Currently, the proficiency tests must present acoustic information on single-display, static, linear-scaled lofargrams because neither the OL-82 sonar system in the aircraft nor the OL-82 simulator used in the operator training course is available for proficiency testing. Additionally, the lofargram display on the OL-82 sonar system is produced with a logarithmic measurement scale. At this time, mechanical logarithmic dividers do not exist. Since the lines on the gram cannot be measured without such a device, analysis procedures cannot be accomplished on printed copies of OL-82 displays. The only job aids available to the operator in the test conditions are linear-scaled mechanical dividers and hand-held calculators, neither of which are used by the operator while performing the job under operational conditions.

Although it appears that the knowledge and skills required to analyze acoustic data on-the-job and from printed lofargrams are similar, the two tasks are not "the same" because the AW using the OL-82 sonar system has a greater number and types of job aids available to help perform acoustic analysis than does the AW using the printed lofargram proficiency test. The accuracy of using operator performance on static, linear scale lofargrams to estimate operational readiness on a logarithmically scaled, computer-based sonar system needs to be assessed.

Objective

The objective of this research is to obtain data on operator performance of acoustic analysis and classification skills on the OL-82 sonar system simulator and the lofargram proficiency tests. Such data will be used to determine whether scores on the static lofargram are accurate estimates of performance on the OL-82 sonar system.

APPROACH

Subjects

Subjects were 22 students enrolled in the Air Anti-Submarine Squadron Forty-one (VS-41) operator course. All had attended the Common Core Acoustic Analysis School, Fleet Aviation Specialized Training Group, prior to attending the VS-41 operator course.

Test Materials/Procedures

In all cases, subjects were administered the OL-82 exam prior to the static lofargram test. The order of the tests was a condition required by the VS-41 instructors.

OL-82 Sonar System Simulator

The final exam for unit four (lofargram analysis) of the VS-41 operator course was used for the computer-based sonar system performance test. Six single-target grams were presented serially to subjects seated in the OL-82 positional trainer. Job aids, such as aural cues (presented through earphones worn by subjects), electronic dividers, track ball, and computational programs, were available for subject use. Display options included Broadband, Vernier, Translate, ALI, and Demon presentations.

Subjects reported analysis and classification decisions over a communications phone to an instructor positioned outside. The instructor evaluated the subject's performance on the variables of interest using a predetermined scoring checklist.

Static Linear Lofargram

Six single-target grams were presented on static linear lofargrams to subjects seated at tables in a classroom setting. These grams, which were photocopies of grams produced on the fast analyzer system (FAS), had been judged by subject matter experts to be of equal difficulty to those used in the OL-82 sonar system simulator test. Job aids available to the subjects were limited to mechanical dividers and hand-held calculators. Subjects wrote analysis and classification decisions on an answer sheet provided for the test.

Test Scores

1. Gram analysis performance scores were accurate identification of predominant spectrum (PS), sound source (SS), and propeller mode (PM) of the target presented on the grams on both displays.

2. The classification score was accurate identification of targets for grams (A) presented on both displays.

Analyses

1. An analysis of covariance was performed on the analysis and classification scores for the two display modes, using subject's armed forces qualification test (AFQT) score as the covariate.

2. Mean percentage scores and standard deviations (SDs) for gram analysis and classification on the two display types were computed.

3. Correlations were computed for and between gram analyses and classification scores obtained using the two displays.

FINDINGS

Table 1, which presents results of the analysis of covariance performed on the scores obtained using the two display modes, shows that test performance due to display/system differences differed significantly for the analysis variables but not for classification accuracy.

Table 1

Analysis of Covariance Summary Table for the Effect of Display on Analysis and Classification Scores

Score	df	MS	F
Analysis:			
Sound source	1	22095.4	103.60**
Error	21	203.4	
Predominant spectrum	1	22230.0	59.20**
Error	21	375.1	
Propulsion mode	1	1276.6	4.16*
Error	21	306.8	
Classification:			
Accuracy	1	56.8	.18
Error	21	315.1	

*$p < .05$.
**$p < .01$.

Table 2, which presents mean percentage scores and SDs for scores obtained on the two display types, shows that the SS and PS analysis scores obtained by subjects on the static lofargram test were about half those obtained on the OL-82 sonar system test. However, on the classification score, subjects scored somewhat higher on the static lofargram test than on the OL-82 test.

Table 2

Mean Percentages and Standard Deviations for Gram Analysis and Classification Scores Using Both Types of Displays

Score	Type of Display			
	OL-82 Simulator		Static Lofargram	
	Mean	SD	Mean	SD
Analysis				
Sound source (SS)	93.04	10.03	48.22	19.80
Predominant spectrum (PS)	93.81	9.87	48.86	24.83
Propulsion mode (PM)	80.77	18.18	70.00	22.88
Classification				
Accuracy (A)	80.81	19.56	83.09	17.21

Table 3 presents analysis and classification score intercorrelations for both types of display. As shown, analysis scores were significantly correlated with classification scores for targets displayed on the OL-82 sonar system simulator, but not for targets displayed on the printed lofargrams. Finally, Table 4 shows that correlations between scores obtained using the two displays were uniformly low and nonsignificant.

Table 3

Gram Analysis and Classification Score Intercorrelations for Both Types of Displays

	Analysis			Class.
Display/Score	SS	PS	PM	A
Static Lofargram				
Analysis				
Sound source (SS)	1.00	0.42*	0.18	0.04
Predominant spectrum (PS)		1.00	0.15	0.18
Propulsion mode (PM)			1.00	0.28
Classification				
Accuracy (A)				1.00
OL-82 Simulator:				
Analysis				
Sound source (SS)	1.00	0.52*	0.57**	0.60**
Predominant spectrum (PS)		1.00	0.30	0.41*
Propulsion mode (PM)			1.00	0.93**
Classification				
Accuracy (A)				1.00

*p < .05.
**p < .01.

Table 4

Correlations Between Display Types for Gram Analysis and Classification Scores

	Static Lofargram			
OL-82 Simulator	SS	PS	PM	A
Sound source (SS)	.21	.13	.24	-.08
Predominant spectrum (PS)	.09	-.07	.07	.07
Propulsion mode (PM)	.06	.28	.28	-.08
Classification accuracy (A)	.16	.21	.33	.07

DISCUSSION AND CONCLUSIONS

Subjects performed acoustic analysis procedures better on the OL-82 sonar system simulator than on the static lofargrams, probably because of the difference in the number and kinds of job aids available. The OL-82 simulator provides the subjects with numerous electronic job aids, computerized computational programs, and multiple display formats that are designed to make the operator's job of acoustic analysis easier and more accurate. With the lofargram test, subjects were limited to hand-held calculators and mechanical dividers.

Subjects' ability to classify targets did not significantly differ for the two display modes. On the OL-82 test, they were able to perform the analysis and classification tasks at about the same level of proficiency. However, on the static lofargram test, they performed relatively poorly on the analysis tasks, but were able to classify the targets with a relatively high degree of accuracy. It may be that they were able to classify targets on the static lofargrams that they had difficulty analyzing (i.e., they were unable to show how they analyzed the gram to reach the classification decision) because of their familiarity with the specific lofargrams selected for the test. These grams were obtained from the gram library provided by the Acoustic Analysis School, where subjects had received their basic acoustic analysis training and had studied most or all of these grams. In discussions following the static lofargram test, subjects reported recognizing the target patterns and making their classifications from memory. Thus, it appears that the classification scores obtained on this test may not be a good general indication of their ability to classify unfamiliar targets using the static lofargram.

It appears that tests that use static lofargrams to assess OL-82 sonar system operator performance may underestimate operator proficiency in acoustic analysis, at least for sonar operators in training. Apparently, it is easier to analyze acoustic information on the OL-82 sonar system than on static lofargrams because of the number and kinds of job aids available to the operator. Tests that measure performance using static grams may reflect the increased difficulty of that largely unaided format. In addition, because the skills required to perform in the testing situation do not accurately represent the skills required to perform the task on-the-job, the operators must spend time practicing skills only used in the testing condition. It may be that differences shown in the performance of acoustic analysis procedures on the two display formats decrease with increased experience level of the operators. However, it is also possible that time spent practicing test-oriented skills may interfere with the maintenance of job-oriented skills and could potentially degrade job performance on the OL-82 sonar system.

RECOMMENDATIONS

1. The validity of assessing the operational readiness of sonar operators in the fleet should be determined using tests that rely on static lofargrams to measure acoustic analysis and classificaiton skills that are operationally performed on computer-based sonar systems.

2. Research should be conducted to determine whether on-the-job performance of acoustic analysis on computer-based sonar systems is degraded by use of static grams in training, in promoting skill maintenance, and in estimating proficiency on tests.

3. Tests of operator proficiency that use static lofargrams should measure analysis and classification skills on lofargrams not previously encountered by the operator in the training environment.

REFERENCES

Ellis, J. A., Wulfeck, W. H., II, & Fredericks, P. The instructional quality inventory, Volume II: User's manual. (NPRDC Spec. Rep. 79-24). San Diego: Navy Personnel Research and Development Center, August 1979. (AD-A083 678)

Konoske, P. J., Wetzel, S. K., & Montague, W. E. Estimating skill degradation for aviation antisubmarine warfare operators (AWs): Assessment of job and training variables (NPRDC Spec. Rep. 83-28). San Diego: Navy Personnel Research and Development Center, April 1983.

Osborn, W. C., & Ford, J. D. Research methods of synthetic performance testing (HumRRO/FR-CD(L) 76-1). Carmel, CA: Human Resources Research Organization, April 1976.

Vineberg, R., & Joyner, J. N. Prediction of job performance: A review of military studies (NPRDC Tech. Rep. 82-37). San Diego: Navy Personnel Research and Development Center, March 1982. (AD-A113 208)

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