PUBLICATIONS BRANCH
SUBMARINE MEDICAL CENTER
FILE COPY NO. 1

U. S. NAVAL SUBMARINE MEDICAL CENTER

Submarine Base, Groton, Conn.

REPORT NUMBER 616

CHARACTERISTICS OF THE SUBMARINE LINE OFFICER
I. A Factor Analytical Study of the Officer Candidate for the Submarine Service

By

Benjamin B. Weybrew

Bureau of Medicine and Surgery, Navy Department
Research Work Unit MF12.524.002-9004.05

Approved and Released by:

J. E. STARK, CAPT MC USN
COMMANDING OFFICER
Naval Submarine Medical Center

12 March 1970

This document has been approved for public release and sale; its distribution is unlimited.

CHARACTERISTICS OF THE SUBMARINE LINE OFFICER

I. A Factor Analytical Study of the Officer Candidate for the Submarine Service

by

Benjamin B. Weybrew, Ph. D.

SUBMARINE MEDICAL RESEARCH LABORATORY
NAVAL SUBMARINE MEDICAL CENTER REPORT NO. 616

Bureau of Medicine and Surgery, Navy Department
Research Work Unit MF12.524.002-9004.05

Reviewed and Approved by:

Charles F. Gell

Charles F. Gell, M.D., D.Sc. (Med.)
Scientific Director
SubMedResLab

Reviewed and Approved by:

Joseph D Bloom.

J. D. Bloom, CDR MC USN
Director
SubMedResLab

Approved and Released by:

J. E. Stark

J. E. Stark, CAPT MC USN
COMMANDING OFFICER
Naval Submarine Medical Center

This document has been approved for public release and sale; its distribution is unlimited.

SUMMARY PAGE

THE PROBLEM

To delineate the major characteristics of officer candidates for the Submarine Service and relate these characteristics to individual differences in performance in the Naval Submarine School.

FINDINGS

Application of factor analytical techniques to data obtained from a battery of thirty-five measures produced five factor dimensions labeled for purpose of discussion: (1) Factor I (F_1), Trait Configuration of an Ideal Submarine Officer Candidate; (2) Factor II (F_2), General Temperament Dimension; (3) Factor III (F_3), Special Aptitudes; (4) Factor IV (F_4), Politico-Economic Interests, and (5) Factor V (F_5), Focused Theoretical Interests. Out of the 150 officers sampled, only those receiving high scores in F_1 and F_3 tend to earn correspondingly high grades in Submarine School and high marks in underway training.

APPLICATIONS

This study identifies different types of officers and relates these groups to individual differences in performance in Basic Submarine Officers School, thus providing some tentative guidelines for officer selection for the Submarine Service.

ABSTRACT

The goals of this study were twofold: (1) to identify the trait configurations characterizing the different types of officers who volunteer for the Submarine Service; and (2) to investigate differences in performance of the officers making up each group identified in this manner.

Thirty-five items of data, including aptitude and personality tests, section leader ratings and grades in Submarine School were obtained from a sample of 150 officers. A centroid factor analysis delineated five factors, labeled: F_1 - Trait Configuration of an Ideal Submarine Officer Candidate; F_2 - General Temperament Dimension; F_3 - Special Aptitudes; F_4 - Politico-Economic Interests, and F_5 - Focused Theoretical Interests. Only those officers who obtain high scores in F_1 and F_3 receive comparably high grades in Basic Submarine School. A detailed discussion of the structure of each factor is presented.

TABLE OF CONTENTS

SUMMARY PAGE ii

ABSTRACT iii

INTRODUCTION 1

METHOD AND PROCEDURE 1

Measurement Techniques 1

Officer Candidate Battery (OCB) 1

Self-Reported Motivation Questionnaire (SMQ). 1

Personal Inventory Barometer (PIB). 2

Allport-Vernon-Lindzey Study of Values (AV) 2

Paired Comparison Trait Ratings (PCTR) 2

Performance Criteria 2

Subjects 2

Statistical Methodology 3

RESULTS 3

SUMMARY. 8

REFERENCES. 9

APPENDIX A 10

CHARACTERISTICS OF THE SUBMARINE LINE OFFICER
I. A Factor Analytical Study of the Officer Candidate for the Submarine Service

INTRODUCTION

This study was initiated about the time the first Fleet Ballistic Missile Submarine (SSBN598) was commissioned. At that time, the overall plan of the study called first for an empirical examination of the interrelationships of a variety of measurements with performance criteria obtained from a sizeable officer sample during Basic Submarine School. The methodology for this part of the study involved an extension of the correlation approach called factor analysis, the goal of the study being to delineate some of the major personality and aptitude dimensions (Factors) identified within the officer sample. The present paper is devoted to presenting the results of this factor analysis. Another paper will extend the present one by focusing upon the predictive problem pertaining to which type of officer (identified by the factor analysis in the first study) demonstrates the best performance record in the Submarine Service, which "drops out," which has been disqualified, and so on. The time span elapsed between the data collection and the accumulation of "follow-up" criteria data will have been approximately eight years. The data for the predictive study are currently in the analysis phase, the results to be presented in the second paper of this series.

With the advent of the SSBN Program, the two-crew concept was introduced as a personnel management technique whereby the quality of men comprising the FBM crews could be optimized while, at the same time, maintaining the duration of submerged cruises within realistic tolerance limits. Obviously, with the introduction of the two-crew concept, the nature of, and quite possibly the severity of, the personnel problems may have changed as compared to those occurring during the era of the diesel submarine. There have been at least two summaries of the now quite substantial literature focused upon various aspects of the problems of recruitment, training, qualification and career retention of enlisted submariners (Bartlett, 1950; Weybrew, 1963). In contrast, the studies dealing with Submarine Line Officers have been both few in number and limited in content. For example, Campbell (1953), in a correlational study, delineated some of the factors characterizing the Submarine Officer as an effective leader, and more than a decade later, Hester and Auwood (1966) demonstrated the predictability of Submarine School grades from peer ratings. About midway in this time span--1959--a survey paper was published and contained an evaluation of several approaches to the complex problem of measuring individual differences in officer candidates for the Submarine Service (Weybrew & Molish, 1959). The present study is an extension of this last mentioned paper in the direction of providing suggestions as to the trait configurations characterizing the officer volunteer for the Submarine Service.

In the interest of clarifying the setting for the present study, it may be well to review those findings reported in the 1959 publication that are related to the present study. First, while none of the six Allport-Vernon (AV) Values Test Scores correlated with the Submarine School grades, there were sufficient subgroup differences; for example, between Naval Academy and non-Academy graduates, and between non-Academy engineering and non-engineering majors to suggest different population samples with respect to the AV scores. The custom-tailored SMQ (Self-reported Motivation Questionnaire), while it had no linear relationship to Submarine School grades, did discriminate between the officers who graduated from Submarine School and those who failed to graduate. Finally, the fact that the OCB (Officer Candidate Battery) scores correlated both with Basic Submarine School grades and the attrition criterion, attests to the repeatedly documented findings in the literature indicating that aptitude tests consistently correlate with training criteria.

METHOD AND PROCEDURE

Measurement Techniques

The measurement battery consists of aptitude and personality tests, ratings by section leaders and by instructors during simulation and underway training and, finally, grades in Basic Officer Submarine School. A statement regarding each measurement follows.

Officers' Candidate Battery (OCB)[1]. This aptitude test battery consisted of four subtests, namely; (1) Verbal, a measure of word fluency and comprehension; (2) Mechanical, sets of problems involving mechanical principles; (3) Mathematical, college level algebraic and trigonometric problems; and (4) Spatial, relative motion and spatial transposition problems. All subtest scores were standardized to McCall or T-scores, based upon Navy-wide normative data. For Submarine Officer samples, the subtest means ranged between 54-60 and the standard deviations from 8-9 score units (Weybrew & Molish, 1959).

The Self-reported Motivational Questionnaire (SMQ). This questionnaire, published by Weybrew & Molish (1959) consisted of fifty items, the contents of which were aimed at "tapping" goals or expectancies associated with volunteering for the submarines, e.g., "I volunteered for submarines because it is the

[1] In 1965, the OCB was replaced by DORE (Defense Officers' Record Examination), an aptitude battery similar to the Graduate Record Examination and currently in use by all Branches of the Armed Forces.

best way to learn nuclear engineering," and at value strength, e.g., "I believe that submariners are the most highly respected men in the Navy," and at the potency of the social motivation associated with being a member of a high status group, e.g., "I feel that one of the most important advantages of being a submariner is to be looked up to by the other men in the Navy." Fifty of these test items were responded to by means of a nine-point multicategory response format extending from "Not at all like me" to "Exactly like me." The score in use at the time of this study consisted of the sum of twenty-five (out of fifty) items keyed only on the basis of high item - total score correlation determined by an internal consistency analysis.

Personal Inventory Barometer (PIB). The second experimental questionnaire in use at the time the data for this study were collected was the Personal Inventory Barometer (PIB) (Weybrew & Youniss, 1957). The same multicategory response technique was used to obtain the PIB Score consisting of the summed responses to fifty-two (out of 100 total) neurotic symptoms validated against Submarine School attrition criterion. Examples of the type of items making up the PIB Score are: "I am more nervous than most people," "My sleep is restless and disturbed," etc.

Allport-Vernon-Lindzey Study of Values (AV). Since this questionnaire was used in a recently published Laboratory report involving Medical Officer candidates for the Submarine Service (Hester & Weybrew, 1969), one can do no better than to cite the descriptive material pertaining to this measure as presented in that report:

"Values may be defined as culturally-relative preferences. Closely akin to attitudes, the concept of "value" as a descriptive aspect of personality places culturally defined goals or behaviors on a good/bad, relevant/irrelevant, approval/disapproval continuum.

Since values imply choice, the construction of a measurement technique becomes rather straightforward as may be seen by an examination of the Allport-Vernon-Lindzey Scale used in the present study (Allport, Vernon, Lindzey, 1951). Accordingly, the Study of Values (AV) allows the respondent to choose in a multiple choice manner, the alternative most consistent with his value system. An example of one of the items is: If you were a university professor, which would you prefer to teach? (a) Poetry, or (b) Chemistry and Physics.

The AV consists of six, 20-item subtests, each purported to measure one of six classes of values corresponding to Spranger's personality types. A brief statement regarding the content of each of the six value subtests follows:

"The Theoretical value scale is aimed at 'tapping' motivation to seek out empirical knowledge in pursuit of a goal to discover the 'truth' about the phenomena in the environment. In a sense, the scale gets at scientific attitudes. The Economic value scale taps interest in business, production, marketing, and so on. It might be said that this scale 'gets at' attitudes consistent with the average American business man. The Aesthetic value scale attempts to determine the strength of the motivation to seek out beauty in form and harmony in the environment. In a sense, this scale attempts to dimension the intensity of artistic interests. The Social value scale attempts to dimension humanitarian motives, particularly with respect to altruistic or philanthropic components. The Political value scale attempts to dimension what has been called the 'power' motive, that is, motivation to seek environmental situations in which the opportunities for personal power, influence, and renown are maximized. Finally, the Religious value scale attempts to dimension certain philosophical interests (values), in particular, the intensity of the personal motivation to comprehend the cosmos as a whole and to relate himself to this totality. Obviously, the need-goal relationships from which the intensity of the religious motivation is inferred is quite abstract and may well 'tap' the more general profound need for intellectual stimulation of most any kind. The scale does not, as the title may indicate, attempt to tap attitudes toward organized religion."

Paired Comparison Trait Ratings (PCTR). Ratings, with respect to twenty trait dimensions, were obtained from section leaders. A paired-comparison rating format was used whereby the rater could compare each of the thirty officers in a section each with all others singly for each trait. (See Appendix A for an example of the scale and also Weybrew & Alves (1959) for an example of its usage.) The trait titles for each rating scale were as follows: Adaptable to Change, Emotional Stability Anxiety Muscular Tension, Acceptance of Authority, Excitability, Maturity, Self-Confidence, Motivation, Likability, Alertness, Leadership, Industry, Problem-sharing, Aggression, Mood, Frustration Tolerance, Attitudes Toward Navy, and Overall Officer Potential. The ratings for each trait were converted to standard scores (T-scores) based upon the rating distributions for each section. This score transformation was necessary in order to combine the trait-rating distributions provided by the six section leaders into a single distribution for each rating scale.

Performance Criteria

Three varieties of data were available, namely; (1) ratings by the Submarine School instructors during underway training exercises aboard fleet-type submarines, (2) ratings while undergoing simulator training on the Attack Trainer, and (3) overall grades in Submarine School. The last mentioned score was in stanine form while the former two scores were in raw score form based upon a four-point grading scale.

Subjects

The subject sample consisted of one Submarine School Class[2] of which 49% were Naval Academy Graduates and 51% were graduates of various universities and colleges. Of the non-academy graduates,

[2] The total class numbered 184: however, complete score profiles for the thirty-five measures were available for only 150 officers.

35% had engineering degrees and 65% had degrees in other fields of specialization.

Statistical Methodology

The test scores, ratings and performance criteria were combined into a first order correlation matrix, the correlational technique involving the Pearson Product Moment statistic. In turn, the Thurstone Group Centroid Method of Factor Analysis was applied to this 35 x 35 correlation matrix in order to identify the underlying factors accounting for the variable interactions. The decision that all of the relevant common factors had been extracted and the analysis could be terminated was based upon the analytical criterion called Tucker's Phi described in Cattell (1953).

RESULTS

The 35 x 35 correlation matrix is presented in Table I.

A cursory examination of the matrix in Table I reveals the following two salient features: first, that the Basic Submarine School grades are predicted by aptitude tests, by the majority of the twenty-section leader trait ratings, and by the simulator and underway ratings. And, secondly, the "custom-tailored" psychiatric screening test (Personal Inventory Barometer - PIB), the motivation test (Self-reported Motivation Questionnaire - SMQ), and the published Value Test (Allport-Vernon-Lindzey - AV) do not bear any systematic relationship to any of the criteria included in this study.

Factor analysis, a logical extension of the correlational approach, provides insight into the possible processes underlying or accounting for the variable interrelationships depicted in Table I. Of the several analytical techniques of factor analysis available, the one of choice for the purpose of this study was the Thurstone Group Centroid Method with communalities estimated from the highest column entry (Thurstone, 1945). The factor loading matrix obtained from the application of this method to the correlation matrix in Table I is presented in Table II.

At the outset, it is to be noted that the factor loading matrix in Table II is unrotated. In most circumstances, Thurstone (1945) recommends that orthogonal reference axes located by centroid techniques be rotated according to some acceptable criterion (simple structure generally), if the resultant factors are to be meaningful. However, the Group Centroid Method used in this study involves the estimation of each centroid from a few (say 10% or less) of the variates with the highest communalities. In effect, therefore, this method makes the reference axes co-extensive with the "tightest" variable cluster thus reducing (or eliminating) the need for axis rotation to obtain an approximate orthogonal solution.

However, a series of single-plane, graphic rotations of the factor matrix (Table II) were made graphically, the resultant matrix being only slightly improved in the direction of simple structure. The decision, therefore was made to interpret the unrotated matrix presented in Table II.

In general, there are two kinds of questions to be answered from the data in Table II; one having to do with the structure or nature of the extracted factors, and the other related to the factor patterning of each of the tests or measures. In brief, factor structure is inferred from the nature of the five columns in Table II and the factor patterning of each of the thirty-five tests or measures from the loading patterns of the row data in the same matrix.

To be noted in Table II at the outset is the fact that the lowest communalities (h^2) are found for the Motivational Test (SMQ, Variable No. 1), the PIB Test (Variable No. 3) and one for the Trait Rating of Frustration Tolerance (Variable No. 27). Recalling that Multiple Factor Theory states that the communality of a measure differs from its "reliability" only by the amount of specific factor variance (Thurstone, 1945), it is a reasonable assumption that these tests were unique (i.e., have large specific factor variance) to the battery since the reliability of these measures has been reported to be substantial (Weybrew & Youniss, 1957; Weybrew & Molish, 1959; and Weybrew, 1962). On the other hand, the measures with the highest communalities were with one notable exception (Variable No. 20), the section leader ratings (Variables, Nos. 10-29). The loading pattern of the three criteria variables, namely; grades in Submarine School, performance evaluations underway and in the attack trainer (Variables, Nos. 1, 31 and 30 in that order) were accounted for by their loadings in Factor I (F_1) and Factor III (F_3), quite probably the two most meaningful of the five factors.

In order to clarify the structure of each of the five factors, the measures with the highest loadings were ranked and presented in Table III.

It should be obvious that the manner in which the data in Table III are presented assumes that the structure of a given factor extracted from a matrix of correlation coefficients by factor analytical techniques can be inferred from the properties of the highest loading tests or measures. Stated another way, an examination of the content of the tests with the highest loadings on Factor I, for example, should provide suggestions as to the processes underlying this factor. One should point out also, that an examination of factor structure must also include a study of what measures do not load the factor, i.e., what processes are unrelated to the factor under surveillance.

Accordingly, Factor I (F_1) delineates those traits most predictive of high level performance in Submarine School. This statement is based on the fact that most of the variance of the three criteria measures (Nos. 2, 30 and 31) is accounted for by their loadings on F_1. It may be said, therefore, that F_1 serves to group the traits which characterize a Submarine Officer candidate whose overall grades in Submarine

Table I - Correlation Matrix of Aptitude and Personality Tests, Trait Ratings and Performance Criteria for One Class in Basic Submariner Officer School (N=150)

Variables	1	2	3	4	5	6	7	8	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	28	27	28	29	30	31	32	33	34	35
1. Self-rptd. Motivational Questionnaire (SMQ)	-	-03[c]	-32	19	06	-23	-13	14	03	08	-15	-06	02	05	-14	04	-11	-11	-10	-05	-20	-06	-13	16	-01	-06	03	-05	-06	-08	-07	03	00	-14	-11
2. Final Grades (Stanine)	..	-	-01	10	02	-01	-14	-08	07	-49	56	45	-24	-17	28	-19	42	50	58	27	60	39	46	21	55	46	14	50	38	57	45	32	48	32	50
3. Personal Inventory Barometer (PIB)	..	..	-	-15	-08	09	03	07	02	-01	-02	-13	-04	-09	05	-03	-02	06	-04	-10	-02	-09	00	-05	-07	-11	02	-09	-06	-04	-02	-01	12	15	09
4. Theoretical (A-V)[a]	..	..	..	-	-01	-01	-31	-27	-27	10	-15	-16	13	02	-10	11	-07	-13	02	-02	-17	-12	-04	07	-04	00	03	02	-10	-06	02	00	17	-01	08
5. Economical (A-V)[a]	..	..	..	..	-	-42	-22	16	-48	-14	03	14	-03	-12	01	-02	-08	07	04	08	06	06	-03	01	01	09	04	-02	04	09	08	-30	06	12	08
8. Aesthetic (A-V)[a]	..	..	..	..	..	-	-22	-33	-21	15	-11	-13	-01	06	-09	-10	-16	-03	-16	-22	-15	-23	-11	-02	-14	-05	-06	-12	-06	-12	-03	34	06	-01	00
7. Social (A-V)[a]	..	..	..	..	..	..	-	-12	06	13	-13	-11	01	11	04	05	13	-10	-06	-03	-07	-01	01	04	-12	-11	-15	-06	-07	-11	-08	-02	-19	-20	-10
8. Political (A-V)[a]	..	..	..	..	..	..	..	-	-28	-08	05	11	-04	-04	07	01	-12	11	-10	16	03	08	-04	-06	09	03	05	-05	01	-04	03	-14	-13	12	-23
9. Religious (A-V)[a]	..	..	..	..	..	..	..	..	-	-12	23	11	-03	-01	07	00	27	04	22	07	23	20	19	-01	19	02	06	21	14	18	-02	06	-01	-04	10
10. Overall Officer Potential (Rating)[b]	..	..	..	..	..	..	..	..	..	-	-75	-65	30	28	-51	26	-56	-53	-59	-66	-70	-75	-58	-18	-60	-62	-10	-68	-56	-71	-67	-07	-13	-16	-23
11. Adaptable to Change (Rating)[b]	..	..	..	..	..	..	..	..	..	..	-	75	-44	-39	46	-41	57	65	56	63	77	70	53	11	63	67	01	59	49	82	64	13	22	25	27
12. Emotional Stability (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	-	-44	-41	36	-51	51	58	48	54	67	66	41	-02	47	49	-01	47	38	66	56	18	19	15	20
13. Anxiety (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	-	58	-32	69	-35	-54	-02	-31	-32	-39	-08	11	-15	-28	32	-08	-19	-32	-35	-05	-14	00	-18
14. Muscular Tension (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	-	-20	63	-26	-44	-11	-20	-23	-34	-06	01	-22	-35	10	-14	-06	-35	-22	03	-04	-06	-13
15. Acceptance of Authority (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	-28	44	33	41	55	49	45	43	06	29	39	-20	43	51	40	36	06	05	02	18
16. Excitability (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	-41	-49	-08	-27	-33	-37	-11	23	-12	-21	22	-09	-13	-35	-34	-06	-13	-04	-14
17. Maturity (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	39	51	48	60	61	51	-09	46	33	03	53	48	55	40	09	17	-03	26
18. Self-Confidence (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	38	38	57	52	36	02	45	55	-06	40	31	56	57	12	23	25	29
19. Motivation (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	39	68	54	70	34	59	55	26	80	61	57	45	24	22	10	31
20. Likability (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	45	66	37	12	45	63	-11	48	41	54	49	02	-05	05	09
21. Alertness (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	66	71	15	62	56	15	65	57	72	81	18	27	18	36
22. Leadership (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	59	18	67	63	07	67	61	59	59	05	09	06	18
23. Industry (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	38	65	50	18	71	55	52	44	20	18	11	34
24. Problem Sharing (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	38	44	21	37	18	17	18	08	-11	00	13
25. Aggression (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	62	30	71	52	60	42	20	13	11	22
26. Mood (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	15	62	44	60	56	15	02	12	16
27. Frustration Tolerance (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	20	08	05	01	11	00	06	-08
28. Motivation for Submarines (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	66	62	52	21	17	08	22
29. Attitudes Toward Navy (Rating)[b]	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	48	43	22	19	09	16
30. Performance: Attack Trainer	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	68	09	21	12	22
31. Performance: Underway	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	12	15	08	20
32. OCB - Verbal	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	35	21	17
33. OCB - Mechanical	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	45	56
34. OCB - Mathematical	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	41
35. OCB - Spatial	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-

[a]A-V, Allport-Vernon Scale of Values
[b]Section Leader ratings. See Appendix A for example of rating format
[c]Decimals are omitted.

Table II - Unrotated Loading Matrix Resulting From The Factor Analysis of the Submarine Officer Battery

Title of Measure	Factors F_1	F_2	F_3	F_4	F_5	h^2
1. Self-rptd. Motivational Questionnaire (SMQ)	-12[a]	04	-12	13	34	16
2. Final Grades (Stanine)	64	14	41	08	01	60
3. Personal Inventory Barometer (PIB)	-03	-07	11	02	-43	20
4. Theoretical (Allport-Vernon)	-09	11	27	18	42	30
5. Economical (A-V)	07	-07	-13	80	-16	69
6. Aesthetic (A-V)	-13	-09	37	-30	10	26
7. Social (A-V)	-10	01	-31	-37	-34	36
8. Political (A-V)	02	-08	-33	51	-31	47
9. Religious (A-V)	18	12	-01	-48	-28	36
10. Overall Officer Potential (Rating)	83	10	-11	12	00	72
11. Adaptable to Change (Rating)	88	-10	-02	03	-06	79
12. Emotional Stability (Rating)	76	-24	-02	06	01	64
13. Anxiety (Rating)	49	63	06	12	-06	66
14. Muscular Tension (Rating)	-43	50	10	-06	-05	45
15. Acceptance of Authority (Rating)	58	-02	-13	-07	-05	36
16. Excitability (Rating)	-48	65	-05	14	-07	68
17. Maturity (Rating)	68	-03	04	-28	-07	50
18. Self-Confidence (Rating)	70	-29	07	13	-10	61
19. Motivation (Rating)	72	46	11	-04	-02	74
20. Likability (Rating)	66	-04	-32	05	15	56
21. Alertness (Rating)	85	12	10	01	-18	78
22. Leadership (Rating)	82	06	-24	-03	03	74
23. Industry (Rating)	69	43	02	-08	-14	69
24. Problem Sharing (Rating)	21	47	-14	05	17	32
25. Aggression (Rating)	72	34	-08	03	04	64
26. Mood (Rating)	73	15	-20	08	19	64
27. Frustration Tolerance (Rating)	04	43	04	12	-05	20
28. Motivation for Submarines (Rating)	76	46	-02	-07	08	80
29. Attitudes Toward Navy (Rating)	64	31	02	-02	00	51
30. Performance: Attack Trainer	82	00	00	02	03	67
31. Performance: Underway	71	-05	-04	06	09	52
32. OCB - Verbal	19	14	41	-24	09	29
33. OCB - Mechanical	26	-04	74	20	-11	65
34. OCB - Mathematical	18	-02	41	39	-25	41
35. OCB - Spatial	36	00	52	12	-17	44

[a]Decimals are omitted.

School, as well as his graded performance on the Attack Trainer and during underway training all tend to fall in the upper end of the distributions for this sample of officers. However, the fact that, without exception, all of the trait dimensions loading this factor are based upon section leader ratings suggest the influence of what has been called "halo effect," that is, the tendency for ratings of socially-desirable traits to be highly intercorrelated.[3]

It is to be noted also that the OCB scores (Variables Nos. 32 - 35) do not load F_1 significantly, thus suggesting that aptitude as measured by these tests is not an important component of this factor. Glancing at the loading patterns for OCB in Table II however, discloses the possibility that these test indices are part of another essentially independent pattern of traits associated also with the individual difference in Submarine School performance but loading Factor III -the structure of which will be discussed later. Similarly, none of the values, motivation or neurotic-symptom test scores load F_1, the variance of these measures being accounted for by the structure of the remaining four factors.

Factor II (F_2) was labeled, "General Temperament Dimension" largely on the basis that an officer receiving a high score in this factor also is rated by his section leader as excitable, tense and anxious. In addition, he is rated as having high affiliative needs and to be well-motivated and industrious. Like F_1, the structure of F_2 is based largely upon ratings.

[3] It should be understood that the officers making the trait ratings did not in any case assign the grades with respect to the three criteria.

Table III - Structure of the Five Factors Extracted From the Submarine Officer Candidate Battery

Measurement Number	Factor Loadings[a]	Rank Order of Loadings	Factorial Content[b]
Factor I - Trait Configuration of an Ideal Submarine Officer Candidate			
11	88[c]	1	Highly adaptable to change (rating)
21	85	2	Alert (rating)
10	83	3	High overall officer potential (rank order)
22	82	4.5	Good leadership capabilities (rating)
30	82	4.5	Good performance on Attack Trainer (Grades)
12	76	6.5	Emotionally stable (rating)
28	76	6.5	Strong motivation for submarines (rating)
26	73	8	Tends to be happy (rating)
19	72	9.5	Highly motivated in general (rating)
25	72	9.5	Tends to be aggressive (rating)
31	71	11	Good performance in underway training (Grades)
18	70	12	Self-confident (rating)
23	69	13	Industrious (rating)
17	68	14	Mature (rating)
2	64	15.5	Good grades in Submarine School
29	64	15.5	Favorable attitudes toward Navy (rating)
Factor II - General Temperament Dimension			
16	65	1	Tends to be excitable (rating)
13	63	2	Tends to be anxious (rating)
14	50	3	Tends to be tense (rating)
24	47	4	Tends to be affiliative (rating)
28	46	5.5	High motivation for submarines (rating)
19	46	5.5	High overall motivation (rating)
23	43	7	Tends to be industrious (rating)
Factor III - Special Aptitudes			
33	74	1	High mechanical aptitude (test)
35	52	2	High spatial aptitude (test)
32	41	4	High verbal aptitude (test)
34	41	4	High mathematical aptitude (test)
2	41	4	Tends toward good grades (Submarine School)
6	37	6	Tends toward high aesthetic values (A-V)[c]
8	-33	7	Low interest in political matters (A-V)
20	-32	8	Rated towards "not likeable end of scale"
7	-31	9	Low in social interests (A-V)
Factor IV - Politico-Economic Interests			
5	80	1	Interested in the field of Economics (A-V)
8	51	2	Interested in Political matters (A-V)
9	-48	3	Low interest in Philosophy of Religion (A-V)
34	39	4	High in Mathematics aptitude (test)
7	-37	5	Social values less important (A-V)
6	-30	6	Low in aesthetic interests (A-V)

Table III - Structure of the Five Factors Extracted From the Submarine Officer Candidate Battery (cont)

Measurement Number	Factor Loadings[a]	Rank Order of Loadings	Factorial Content[b]
		Factor V - Focused Theoretical Interests	
3	-43	1	Few neurotic symptoms (test)
4	42	2	Interest in Theoretical matters (A-V)
1	34	3.5	High motivation (test)
7	-34	3.5	Little interest in social issues (A-V)
8	-31	5	Little interest in Political matters (A-V)
9	-28	6	Low interest in Philosophy of Religion (A-V)
34	-25	7	Low Mathematical aptitude (test)

[a] Decimals are omitted.
[b] Statement about the measure takes into account the sign of the factor loading.
[c] A-V, Allport-Vernon-Lindzey--Study of Values

Neither the test scores nor criteria are identified with this factor. But, in contrast to F_1, the rating cluster defining F_2 contained ratings of traits considered both socially desirable and socially undesirable. Examples of the former are to be found in ratings of excitability, anxiety and tension (Nos. 16, 13, 14, in that order) and of the latter in the ratings of affiliation, motivation and industry (in sequence, Nos. 24, 28, 19 and 23). This finding suggests that F_2 is less obscured by the artifact of "halo" and may reflect a meaningful personality dimension yet essentially unrelated to the criteria. Further, in comparing the structure of F_1 and F_2 (Tables II and III), it is well to note that those officers who obtain high scores in F_1 are rated low in the socially undesirable traits (Nos. 14 and 16, for example) while those receiving high scores in F_2 are rated high on these same traits. In brief, the highly effective Submarine Officer student fits what might be called a stereotype of a Submarine Officer, as adaptable, alert, emotionally stable, confident, mature and so on, but not including temperamental traits such as excitability, tension and the like.

Factor III (F_3) is clearly an aptitude factor since it is identified largely by the four OCB test scores. Like F_1, but unlike F_2, a person obtaining a high score in this factor also tends to fall in the upper part of the distribution of Submarine School grades. However, in contrast to F_1, this factor is loaded negatively by two of the Allport-Vernon Value scores, Aesthetic and Political, suggesting low interests in these areas (see p. 2) for an explanation of these test scores). Of interest is the loading pattern for the section leader's rating of "likability" (No. 20) on F_1 and F_3 (Table III). While admittedly a broad extrapolation from the data, apparently there are two types of officers (as defined by this measurement battery) who perform well in Basic Submarine School, namely, the "F_1 type" who are rated as alert (but are not necessarily high aptitude candidates), likable, adaptable, and confident submariner candidates who more or less fit the prevailing stereotype of the Submarine Officer. On the other hand, the "F_3 types" are high aptitude candidates who tend to earn good grades in Submarine School, but at the same time tend to be rated as unlikable by the section leaders. It is important to note at this point that the performance scores obtained underway (No. 31) and in the Attack Simulator (No. 30) load F_1 but not F_3. This finding is interpreted to be a reflection of the fact that these two performance scores are based largely on observer judgements and, as a result, fit the stereotype depicted in F_1. On the other hand, Submarine School grades which load both F_1 and F_3 are presumably based more upon objective achievement test scores and less upon instructor impressions. Of particular interest, of course, is the answer to the question overriding all of the descriptive sketches of the structure of the five factors extracted from the measurement matrix, namely, which type of officer becomes the high-quality, full-retirement career Submarine Officer? As stated earlier, this question will be faced in the second paper of this series.

Factor IV (F_4), like F_2 preceding and F_5 to follow (see Table III), delineates a trait cluster unrelated to the performance criteria used in this study (Variables 2, 30, and 31). Unlike F_1 and F_2 however, F_4 is not associated with trait ratings except for a low negative loading for the rating labeled, "Maturity" (no. 17), suggesting a slight tendency for the officers with high scores in this factor to be rated as less mature. As is seen in Table III, the structure of F_4 is based entirely upon test scores. Thus, virtually all of the variance of the Economics Subtest of the Allport-Vernon Test falls in the hyperplane of F_4 suggesting that the major component of this factor is a value and interest pattern, hypothetically at least, similar to those found in a typical businessman.

Moreover, predispositions to seek out the kind of environmental situations and circumstances in which the person can exercise control and achieve recognition is suggested by the theoretical basis for the Allport-Vernon-Lindzey Political Subtest (No. 8). It is well to note however, that this last mentioned Subtest overlays both F_3 and F_5, but in the opposite directions (see Table II). While speculative, this loading pattern suggests that one strong component of F_3 and F_5 is attitudinal in nature. Since the loading is negative on F_3, the assumption is that these officers view the power motive as defined by the Political Subtest as irrelevant. Conversely, this motive is apparently most important for those obtaining high scores in F_4. In contrast to the two positively-loading Values Subtests on F_4, three other categories of values tend to be negatively related to this factor. Stated in words, this loading pattern indicates that an officer obtains a high score in F_4 who has low interests in philosophy and theology, and who tends to consider social and aesthetic interests and values as less important.

Finally, it is to be noted (Table II) that a considerable amount of the variance of the Mathematics Aptitude Test (Variable 34) is explained by its loading on F_4. One plausible explanation may be related to the fact that comprehension of modern Economics is based upon an understanding of a relatively new field called Econometrics, which, in a sense is an amalgamation of the two fields. It is well to reiterate however, in passing, that none of these value indices load F_1 and F_3, the factors containing most of the variance of the three performance criteria. The fact that the structure of F_2, F_4 and F_5 -the latter to be discussed next-is unrelated to the three training criteria, raises the very interesting possibility that the factor analysis has unearthed some personality dimensions which, while unrelated to training criteria, may be related to individual differences in the performance of the officer prior to and following submariner qualification. Data are currently being analyzed with a view of examining this possibility.

It is noted at the outset, that Factor V (F_5) overlaps F_4 to the extent that four of the factor marker[4] tests are common to both factors. Accordingly, F_5 is like F_4 in that officers with high scores in both tend to have low interest in social matters (No. 7) and to have low interest in philosophy of religion (No. 9). Loading both F_4 and F_5, but with opposite signs, are Variables Nos. 8 and 34, suggesting that one component of F_5 is low mathematics aptitude and low interest in political matters. It is to be noted also that the component of F_5 related to social and political values has an identical component in F_3 (see Table II). The argument that F_5 is a factor separate from F_3 and F_4 hinges upon the fact that virtually all of the variance of the Motivation Test (SMQ, No. 1) and the Neuroticism Test (PIB, No. 3) is accounted for in terms of their loadings on F_5. Thus, an officer obtaining a high score in this factor does so as a result of his high score in the Theoretical Values Test (No. 4), his high motivation score (No. 1) and his low score on the Neuroticism Test (No. 3). The use of the term "focused" in the label for F_5 is, of course, hypothetical, but is based upon the fact that the SMQ (No. 1) Test is constructed so as to ascertain the degree of clarity a submariner candidate can structure his immediate goals at the time he was tested. Too, the low loading of the PIB Test Score (No. 3) suggests that some trait like emotional stability characterizes the officer obtaining a high score in this factor. However, as was the case in the structure of F_1, there is a distinct possibility that a significant component of this factor is artifactual. In F_1, the possible artifact was the halo bias of the raters. In the case of F_5, since three test scores are unique to this factor, there is the distinct possibility that a response bias like social desirability[5] may account for at least some of the structure of this factor. Regardless of the details of its structure, the utility of the factor dimension labeled F_5-and the same thing can be said for all of the factors-depends upon its relationship with criteria of the effectiveness of the officers later on in their careers.

SUMMARY

This study was designed to provide at least some tentative answers to two broad questions: What aptitude and personality dimensions characterize the line officer volunteer for the Submarine Service, and how are these dimensions related to existing training criteria? A second related question, equally broad, may be stated as follows: Having classified a sizable sample of Submarine Officer candidates in terms of a variety of test scores, ratings and criteria, how do these various officer groupings fare as Submarine Officers eight years later? This paper presents data bearing on the first question, while data pertinent to the second question is to be summarized in the second paper of this series.

The analytical approach for this study was factor analysis applied to a 35 x 35 matrix of correlation coefficients obtained from a battery of personality and aptitude tests, trait ratings by section leaders, Basic Submarine School grades, and grades earned during underway and simulator exercises. The subject population consisted of 150 officer volunteers for the Submarine Service. The data were collected prior to their admittance to Basic Submarine Officers School.

The factor analysis resulted in five orthogonal factors, tentatively labeled: F_1 - Trait Configuration of an Ideal Submarine Officer Candidate; F_2 - General Temperament Dimension; F_3 - Special Aptitudes; F_4 - Politico-Economic Interests; and F_5 - Focused Theoretical Interests.

[4] Factor-marker tests, i.e. those tests that have high loadings on a factor and, as a result, are used to describe its structure.

[5] Social desirability is a term used in psychometrics to refer to the tendency for respondents to the personality test items to give the response that they think the test administrator wants them to give, rather than the valid or true response.

There are several aspects of the structure of the five factors that should be emphasized. First, most of the variance of the three performance criteria is accounted for by the structure of F_1, which is not loaded by any of the psychometric tests (except OCB spatial), but instead, is identified by a cluster of section leader ratings, indicating that the good Submarine School performer is rated as Adaptable, self-confident, highly motivated, not tense and excitable and is adjudged to have favorable attitudes toward the Navy and to have optimal leadership potential. Since most of the trait ratings associated with F_1 are assumed to be socially desirable, it cannot be gainsaid that a significant component of F_1 results from the effects of the halo bias of the section leaders providing the trait ratings. Stated differently, F_1 presumably represents a stereotype of the Submarine Officer which, quite significantly perhaps, does not include aptitudes, values, or other personality traits as measured by tests constructed for these purposes.

Secondly, F_3 like F_1, contains one of the criteria-grades in Submarine School-and, as such, accounts for most of the contribution of the aptitude tests. F_3 differs from F_1 in that it is loaded by several values tests indicating that this type of officer tends to be low in social and political interests and high in aesthetic interests. Interestingly, even though this type of officer tends to obtain high Submarine School grades, he nonetheless tends to be rated as not likable. Moreover, although the loadings are small (Table II), there is some tendency for him to be rated as being characteristically unhappy (Variable No. 26) and to be rated low in leadership potential (No. 22). In brief then, two somewhat contrasting types of good performers in Submarine School have been identified by the structure of F_1 and F_3.

Thirdly, F_2, F_4 and F_5 are alike in the fact that these dimensions are unrelated to the three criteria included in the study. F_2 appears to represent a temperamental dimension related to the general excitation level characterizing the officer, and while this dimension is unrelated to Submarine School performance, it may identify the kind of an officer who has more favorable attitudes toward a full-retirement career as a Submarine Officer than do the F_1 and F_3 types. Similarly, F_4 and F_5, which have four overlapping Values and Aptitudes Tests defining them, appear to represent a bipolar cluster of traits related to the officers' value, interest and preference patterns. There is evidence in the literature that measurements of this kind ordinarily do not predict excellence in performance, yet often predict persistence of vocational choice and hence, longevity in an occupational specialty (Strong, 1951). Thus, it is possible that this factor analytical study may have identified some of the traits characterizing the Submarine Officer with the most favorable career prospects.

In brief, five types of officers have been empirically identified by this analysis, each type, hypothetically at least, bearing different degrees of relationship to the quality of Submarine Officer that develops prior to and following qualification. Data are being analyzed to shed some light on the very relevant questions as to which of these officer types qualifies (and, for that matter, which doesn't), which excels in performance, and which "drops out" of submarines and most importantly, which type becomes a full-retirement, career officer.

REFERENCES

1. Bartlett, N. R. Review of Research and Development in Examination for Aptitude for Submarine Training, SMRL Report No. 153, 1950.

2. Campbell, D. T. A Study of Leadership Among Submarine Officers, ONR, N6 Ori-17, T.O., III NR 171 123, Columbus, Ohio: Ohio State Univ., Res. Foundation, 1953.

3. Cattell, R. B. Factor Analysis: An Introduction and Manual for the Psychologist and Social Scientist. New York: Harper and Brothers, 1953.

4. Hester, R. and Auwood, J. A. Exploratory Study of a Peer Nomination Technique with Officer Trainees in Basic Submarine School, SMRL Memo Report No. 66-12, 1966.

5. Hester, R. and Weybrew, B. B. Background and Motivational Characteristics of Medical Officer Candidates for the Submarine Service, SMRL Report No. 579, May 1969.

6. Strong, E. K. Permanence of Interest Scores Over Twenty-two Years. J. Appl. Psychol., 1951, 35: 89-92.

7. Thurstone, L. L. Multiple Factor Analysis. Chicago, University of Chicago Press, 1945.

8. Weybrew, B. B. and Youniss, R. P. Personal Inventory Barometer, I: Development of the Questionnaire, SMRL Report No. 290, 1957.

9. Weybrew, B. B. and Alves, D. J. Exploratory Study of the Relation of Autonomic Resiliency to Manifest Anxiety and Selected Personality Traits, SMRL Report No. 307, 1959.

10. Weybrew, B. B. and Molish, H. B. Approaches to the Study of Motivation of Officer Candidates for Submarine Service, SMRL Report No. 321, 1959.

11. (U) Weybrew, B. B. Prediction of Adjustment to Prolonged Submergence Aboard a Fleet Ballistic Missile Submarine. I: Interrelation of Adjustment Criteria. SMRL Report No. 383, 1962. (Contents CONFIDENTIAL)

APPENDIX A

EMOTIONAL STABILITY

How does he control his emotions? Think in terms of how this individual would act under pressure, in fearful situations, such as depth charging, etc.

		THE NAMES OF THE	OFFICERS TO BE	RATED ARE PLACED	ON THESE LINES.	- - - - - - - - ETC.	- - - - - - - - "
Extremely well controlled	9						
	8						
Moderately well controlled	7						
	6						
Minimally well controlled	5						
	4						
Slightly lacking in control	3						
	2						
Completely lacking in control	1						
	0						

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Naval Submarine Medical Center, Naval Submarine Medical Research Laboratory	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE
CHARACTERISTICS OF THE SUBMARINE LINE OFFICER I. A FACTOR ANALYTICAL STUDY OF THE OFFICER CANDIDATE FOR THE SUBMARINE SERVICE

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Interim Report

5. AUTHOR(S) *(First name, middle initial, last name)*
Benjamin B. WEYBREW

6. REPORT DATE 12 March 1970	7a. TOTAL NO. OF PAGES 10	7b. NO. OF REFS 11
8a. CONTRACT OR GRANT NO. b. PROJECT NO. MF12.524.002-9004.05 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) SMRL Report Number 616 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*	

10. DISTRIBUTION STATEMENT
This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Naval Submarine Medical Center Box 600, Naval Submarine Base New London Groton, Connecticut 06340

13. ABSTRACT

The goals of this study were twofold: (1) to identify the trait configurations characterizing the different types of officers who volunteer for the Submarine Service; and (2) to investigate differences in performance of the officers making up each group identified in this manner.

Thirty-five items of data, including aptitude and personality tests, section leader ratings and grades in Submarine School were obtained from a sample of 150 officers. A centroid factor analysis delineated five factors, labeled: F_1 - Trait Configuration of an Ideal Submarine Officer Candidate; F_2 - General Temperament Dimension; F_3 - Special Aptitudes; F_4 - Politico-Economic Interests, and F_5 - Focused Theoretical Interests. Only those officers who obtain high scores in F_1 and F_3 receive comparably high grades in Basic Submari ne School. A detailed discussion of the structure of each factor is presented.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

UNCLASSIFIED

Security Classification

3ND PPSO 13152

14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Submarine Officer Selection						
Factor Analysis						
Training Criteria						