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A SAN DIVER 3 SELECTION BATTERY

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NATIONAL INSTITUTE FOR PERSONNEL RESEARCH
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by

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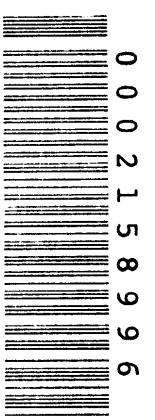

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SUMMARY

Three stages in the development of a selection battery for Divers 3 are described. In the first stage prediction was aimed at the broad range of activities in diver training; in the second stage prediction was focussed on underwater performance; and in the final stage previous findings were cross-validated and hypotheses concerning prediction of diver performance were tested.

In the course of the latter two studies, prediction exercises coincided with the application of different systems of diver training. Use was made of the opportunity to conduct prediction on courses which apparently had different criteria of success.

Entirely divergent constellations of predictive validities were obtained for the different courses. On the assumption that the more effective of these courses would be retained in future, a set of selection instruments was compiled into a battery for this course. Guidelines for the application of the battery are given in the text of the report.

OPSOMMING

Die studie in die ontwikkeling van 'n Duiker 3 keuringsbattery word beskryf. In die eerste stadium is voorspelling op die breë omvang van aktiwiteite in duikeropleiding gemik; in die tweede stadium is voorspelling op onderwater prestasie gekonsentreer; in die finale stadium is vorige bevindings gekruis-valideer en hipoteses aangaande voorspelling van duikprestasie is getoets.

In die verloop van laasgenoemde twee studies het voorspellingsoefeninge met die toepassing van verskillende opleidingsisteme saamgeval. Dié geleentheid is gebruik om voorspelling uit te voer op kursusse wat blykbaar verskillende kriteria ingehou het.

Heeltemal uiteenlopende konstellasies van voorspellings-geldighede is ten opsigte van die verskillende kursusse gevind. Met die aanname dat die meer doeltreffende kursus in die toekoms toegepas sal word, is 'n stel keurings-instrumente vir hierdie doel in 'n battery saamgevat. Riglyne vir die toepassing van dié battery word in die teks van die verslag aangebied.

INTRODUCTION

In 1965 the NIPR was commissioned by SAN to establish research needs in the SAN Diving Establishment. Results of the survey were duly reported (Deppe, 1966). A major recommendation - which was fully supported by Diving School staff - was the need for psychological selection at the Diver 3 level.

The development of a selection battery for Divers 3 commenced in 1966 and continued up to the present time. This period has been necessary to permit the accumulation of a sample of sufficient size to allow for meaningful psychometric analysis. In addition it was found necessary to conduct investigations in some detail into issues which were basic to the selection problem, viz. diving stress (Deppe, 1968) and training (Deppe, 1969, 1970a, 1970b).

This report deals with the results of research on Diver 3 selection. General factors underlying selection are discussed, followed by an overview of research procedure and results, discussion and recommendations.

CHAPTER 1 THE SELECTION PROBLEM

Diver selection involves more than the apparently straightforward prediction of success on the diving course. The term 'success' implies proficiency in respect of criteria which can take many forms. The term 'diving' covers a wide range of activities from academic learning, resistance to stress and exposure to high gas partial pressures. Furthermore, diving appears as a profession, as training and as immersion.

A separation of selection, training and performance appraisal is artificial and arbitrary. The interdependence and reciprocal influence of these functions is discussed in the present chapter.

1.1 Aims of diver selection

The purpose of selection is to permit identification of those individuals who are likely to cope with existing performance criteria. In the present context coping occurs in respect of training and not post-training performance; the two are by no means identical or even highly predictive of each other (Steyn, 1969), possibly as the former involves maximum performance and the latter relies on habitual performance. Prediction of on-course performance cannot therefore be expected to apply equally to future performance.

At present the Diver 3 trainee passes through three stages of selection. In the first place he volunteers, and therein differs from those who do not volunteer while having equal opportunities for doing so, even if only in his motivational preferences. Secondly he undergoes exacting medical screening; which he may fail on grounds of defects or weaknesses (e.g. physical deformities and short-sightedness) and medical pathology (e.g. a history of diabetes). Thirdly, the training course is in itself the ultimate selection device. The purpose of psychological selection is to provide an effective and economical substitute for on-course selection; if valid, it does so by either increasing mean trainee potential and thereby reducing the number of failures (if performance standards are held constant) or by increasing overall proficiency (if failure rate is held constant). Furthermore, psychological testing allows access to a large number of volunteers while selection by training is limited to the trainees that can be admitted to the course.

1.2 The interdependence of selection, training and appraisal

Basic to the three functions of selection, training and appraisal are performance criteria which comprise the aims of selection, the objectives of training and the factors and standards of appraisal.

It follows that criteria must be exactly defined in communicable terms and that the same criteria are applied to all three functions. There is some evidence that this principle has not been accurately applied to the Diver 3. The purpose of Diver 3 training, for example, is given as the inculcation of diving skills and knowledge. But does course failure occur on the basis of skill and knowledge? Later in this report evidence will be produced to show that failure is to some extent a function of training pace. The question arises as to whether selection must identify the trainee who can tolerate a high pace and physical training load or the person with a satisfactory capacity to learn skills and acquire knowledge. These problems indicate the importance of criterion research, the extent to which training is aligned to criteria and the nature of appraisal methods used, before a selection strategy can be devised.

1.3 Factors considered in selection

1.3.1 Predictor-criterion relationships

In a search for tools to predict performance, the usual procedure involves compiling a battery of predictors, applying it to a sample and comparing results with a criterion of performance. This method gives an indication of predictive or forecasting validity of the predictors.

Predictors incorporated into a battery are usually chosen so as to measure different and non-overlapping traits; this has certain psychometric advantages apart from avoiding needless repetition. Such separate dimensions as age, intellectual ability and emotional maturity may predict the criterion singly or in conjunction. If a single predictor accounts for a given portion or variance of the criterion then other predictors not correlated with the first-mentioned can, at best, only account for residual variance after suitable allowance has been made for some inevitable lack of reliability in the measuring instruments. What this means in practice is that it is unrealistic to expect an array of single predictor

dimensions to each correlate highly with the criterion. To take an example, if, as asserted by Miles (1962b), breathing patterns accurately predict success in diving, then intelligence and emotional maturity will show no relation to diving success unless they too are highly correlated with features of breathing patterns. The importance of physical properties for diving have repeatedly been stressed, though not researched as means of selection, so that the amount of performance variance that remains to be accounted for by psychological techniques is an unknown quantity.

1.3.2 The selection ratio

There is no question of selection when the number of candidates accepted for a course equals the number of candidates available. The efficiency of selection is largely dependent on the selection ratio; a low ratio is preferred, i.e. many more candidates than are accepted on the course. Assuming valid selection techniques, a decrease in the selection ratio will lead to an increase in diver potential in a group of a fixed size. However a point will be reached where potential - which may not be unique to diving - exceeds typical demands of diving to such an extent that the individual is likely to become dissatisfied and gravitate to other careers. Strictly this applies to professional diving after the course and not to selection for the course itself; however, the person who does not continue diving is just as big a loss to economy and training efforts as is the person who fails on the course.

An appropriate selection strategy would involve a careful choice of an optimal level of diver potential, a slice out of the diver potential distribution, to select those who will both cope with the demands of diving and also find them stimulating and rewarding enough to continue with diving as a career.

1.3.3 Criterion stability

Predictive validity is established in respect of a particular criterion. Fluctuations in the criterion will affect the validity of predictors.

It is generally agreed that diving involves unusual exposure to hazards, consequently such methods of training are applied as are calculated to produce a diver who will deliver satisfactory performance in spite of stressors. Such methods

involve the imposition of stress in the form of extreme physical effort and a high pace of activities (e.g. 'awkwards'*). Stress training is not conducted according to laid-down specifications and consequently varies markedly from one trainer to another. The effect of this variation is to produce differences in criteria which may range from stress-resistence per se to more subtle personality configurations involved in the learning to dive process. Fluctuation in formal and informal criteria can alter predictor-criterion relationships to a point where predictors will be appropriate to one situation and not the other.

1.3.4 The sample

As pointed out previously, by the time subjects are available for psychological selection they have been preselected by volunteering and by medical screening. The end result is a group which is homogeneous in some respects. If homogeneity extends to the dimensions covered by predictors, validity and reliability in the predictor-criterion relationships are adversely affected. This may be explained in the following example: Consider validity to lie in the extent to which the order of merit of individuals ranked according to diving skill coincides with the order of merit according to scores on an intelligence test. Each score of the intelligence test has a small error and may lie slightly higher or lower when the subject is retested on the same test. If the group is homogeneous with respect to intelligence and the scores are closely bunched then the mentioned errors can cause a restructuring in the order of merit; if the group is heterogeneous the scores will spread out and small error shifts of the individual scores will not affect the order. The same principle applies when a test is applied twice to the same group of subjects, that is, when test-retest reliability is measured.

Homogeneity will result from medical screening in that all trainees will be physically healthy and reasonably fit before the course. It is unlikely that this will affect psychological predictor dimensions. On the other hand volunteering

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* "Awkward" is the term used for an exercise carried out at a high pace.

springs from motivations which cannot be separated from other aspects of the trainee's personality structure.

A second characteristic of the sample lies in test-taking attitudes which differ in the research context in which the tests are originally applied from those in selection in which the trainee is keen to present a picture which he thinks will gain him acceptance to the course. Test faking is a widespread problem not confined to the present research and tests incorporate devices to overcome it, nevertheless faking can be expected to influence validities which were obtained in a pure research context.

The points raised regarding selection in this chapter are given in order to provide the reader with a framework to evaluate the research and follow the reasons for the choice of a particular selection strategy in the remainder of the report.

CHAPTER 2 RESEARCH PROCEDURE

The Diver 3 selection battery was developed in three stages. In the first, a global approach was adopted in which training demands were studied and used as the basis for choice of predictors and the development of a criterion. This is called the first tier study.

The second stage involved a study of diving as immersion and underwater work. In the second tier study predictors were chosen in accordance with a behaviour model of critical factors determining success and failure in immersion.

Finally, promising predictors were re-applied to a new sample in a cross-validation study. This stage is referred to as the 'follow-up' study.

2.1 First tier prediction

2.1.1 Job description and analysis

Description and analysis of training demands was conducted according to a system developed by the NIPR. The system is based on the 'critical incident' technique of Flanagan which, in the words of Siegel (1969) ".... emphasises the specific factors to job success or failure". The method requires that relevant data concerning the job (i.e. training) functions are grouped and described in terms of the human activities, psychological and physical, necessary to carry them out. Examples are extensively used to typify the activities involved and to fix the mean and range of complexity of functions.

Job data may be obtained through participation, interviews with incumbents, questionnaires and observation of activities. In the present study the author participated in the course and recorded the experiences of self and fellow trainees. A job description and analysis compiled with this information is reported elsewhere (Deppe, 1966) and repeated in the present report in a slightly modified form.

2.1.2 Development of a criterion

The first step in the development of a criterion involved inferring critical behaviours from job data. Information given in the job description was surveyed and combined

into groups of similar behaviours (traits) which were then described.

Traits contained a number of components which were negatively and positively defined, qualified by examples and prepared in the form of a rating schedule.

The rating schedule (Appendix I) comprised 29 pairs of statements, each pair accompanied by a scale from 1 (negative definition) through 4 (average) to 7 (positive definition). A list of course trainees was written below each pair of statements with the order of names randomized to avoid bias in ratings which may have accrued from ordinal position in the list.

Instructors rated the trainees in their own courses with instructions to spread ratings around the group mean (rather than on a recalled norm of previous groups).

For subsequent analysis, ratings on the 29 statements were converted to standard scores based on the mean and scatter of each group separately after which further distinction between groups was dropped and the total group was treated as a single sample.

Finally, standard scores were subjected to analysis by the Principal Factor Analysis method followed by Varimax rotation to simple structure. Highly loaded items or statements emerging under factors were combined into job indices and labelled according to the nature of the criterion dimension.

2.1.3 Choice of predictors

Predictors consisted of psychological tests chosen to represent the traits inferred from the description and analysis of the training course.

2.1.4 Analysis of the data

Predictor-criterion relationships are examined by means of Product-Moment intercorrelations, followed by multiple regression of selected predictors on single criterion job-indices.

Weight validities as estimates of multiple correlations in future testing are interpreted in terms of forecasting efficacy by means of the Taylor-Russell tables.

2.1.5 Sample

The first tier study employed 71 male subjects aged 17 to 27 years (Mean, 19 years). Subjects comprise the total from eight Diver 3 courses. Table 1 shows the number of subjects per course.

TABLE 1: Subjects in diving courses A...H

Group	n
A	5
B	7
C	8
D	8
E	9
F	10
G	8
H	16
Total	71

2.1.6 Task sequence

Predictors were applied before training or during the first two weeks. Rating schedules were completed by instructors at the end of each course.

2.2 Second tier prediction

This section deals with prediction of success of adaptation to immersion. The term 'adaptation' is introduced to describe subjects scoring above the mean on criterion scores; similarly 'maladaptation' refers to those scoring below the mean. The terms are therefore used in a relative and not an absolute sense.

2.2.1 Development of criteria

On the basis of previous research in diving it was concluded that critical determinants of underwater adaptation comprise manifest arousal and rate of information

processing. Full reasons for these conclusions are described elsewhere (Deppe, 1971).

It is argued that low levels of arousal have a stimulating effect on performance and that this principle applies until optimal arousal is reached whereafter performance deteriorates. As diver training induces arousal of sufficient magnitude to place stress experiences in the upper reaches of the arousal continuum - for which evidence will be produced later in this report - high levels of arousal in diving will accompany low performance. The highly aroused diver is therefore seen as a poorer performer than the person who is calm and free from anxiety underwater. In the same way the person who can usefully process information underwater in making decisions and carrying out purposive activity is considered to be adapted. He delivers optimum performance underwater on the task assigned to him, which after all is the intention of diver training.

With these hypotheses in mind, measures were obtained of anxiety (high arousal) in diving and of change in task performance resulting from immersion. Finally overall measures of diving success were obtained in the form of ratings of underwater performance by peers and instructors.

2.2.1.1 Criterion of anxiety

In situ measures of anxiety are difficult to obtain with presently available techniques. Subjective measures such as self-reports are fakable and apparently objective psychophysiological measures can hardly be applied in water and under pressure.

The final choice consisted of heart rate measures as increases from a control to the pre-dive condition. This measure reflects the increase in heart rate and thereby the anxiety the individual experiences in anticipation of the coming experimental dive*. While it may have been preferable to measure heart rates underwater instead of before the dive, this is rendered impossible by an oxygen-conserving dive reflex (Wolf, 1970) which overrides excitation effects.

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* The experimental dive involved immersion to 3 metres in clear, calm water with the subject carrying out tests.

Control values were obtained with subjects seated, at the end of a day and before a long weekend. Pre-dive values were obtained with subjects dressed in basic gear, standing and approximately five minutes before the dive. Each subject's score was determined as control divided by pre-dive values.

2.2.1.2 Criterion of underwater performance

Basic performance testing is the presumption that the score derived on an ability measure is a true reflection of maximum capability in the dimension measured. If then the same test is applied underwater, a change in performance, apart from practice effects, presumably measures the extent of change in the individual's ability to make use of his innate resources as reflected against surface performance. In short, if the individual scores 50% poorer underwater than on the surface, then his ability to use his resources has dropped by that amount. A decrement score may be obtained in this way by contrasting an individual's underwater performance against his own surface performance.

Furthermore, as studies involving performance decrement in conditions of hypoxia and nitrogen narcosis - both common diving phenomena - have shown that the higher-order faculties used in complex tasks was most sensitive to disturbing influences, a cognitive test was chosen to obtain the necessary sensitivity to immersion effects. A verbal reasoning test designed by Baddeley (1968) was chosen for this purpose.

Examples of items are given below.

	True	False
A follows B - AB		X
B precedes A - BA	X	

The subject is presented with 60 items similar to those in the example and is given three minutes in which to do as many as possible. The test is therefore an accurate reflection of the capacity for information processing. Test - retest reliabilities in the order of .80 have been obtained (Baddeley, 1968).

In order to reduce practice effects which are reported to be small after the first trial (Baddeley, 1968), the test was applied three times on the surface (S1....S3)

and then underwater (U/W). An adaptation score was calculated as S3 divided by U/W.

2.2.1.3 Ratings of underwater adaptation

As the second tier study came after the first tier study, it was possible to make use of the results of the first tier study here. Thus in the statistically derived criterion of the latter, a factor called 'Diving skill' emerged with its particular set of statements relating to it. These statements were used in the present study in the form of a rating schedule of underwater performance. Separate schedules were devised for, and applied by, peers and instructors. Although 'underwater proficiency' and 'resistance to stress' originally loaded on the same factor they are conceptually distinct and were separately rated here to allow for re-assessment of the relationship between them.

The rating schedules are given below.

IA UNDERWATER PROFICIENCY

(Positive)

Highly proficient in all diving skills and in handling and operating diving equipment, tools, etc.

Examples

(1) Expertly maneuvers
(2) Skillful in sharing air
(3) Quick in assembling equipment
(4) Does not get in buddies' way.

(Negative)

Clumsy and makes mistakes in diving and in handling equipment.

Examples

(1) Swims into other divers and obstacles
(2) Bungles diving skills
(3) Slow in assembling equipment
(4) Clumsy in maneuvering.

IB RESISTANCE TO STRESS

(Positive)

Maintains high performance and acts calmly and rationally in the face of dangers and stresses.

Examples

Does not seem to be negatively affected by:

(1) Dirty water

(2) Cold

(3) Nitrogen narcosis

(4) Any emergency.

(Negative)

Becomes agitated and confused and makes mistakes when faced with dangers and stresses.

Examples

(1) Does not respond to signals

(2) Swims excessively fast

(3) Fumbles and drops things underwater

(4) Tends to panic easily.

Instructors were required to rate subjects on a seven-point scale, as in the previous study, and peers were given a three-point rating scale (+1, 0 and -1) to match anticipated capabilities to discriminate.

2.2.2 Choice of predictors

Predictors were chosen on the basis of hypotheses concerning the roles of arousal (as anxiety and stress experience) and information processing rate in success of adaptation to immersion. Furthermore, in view of the emphasis placed on motivation in respect of diving by authors (e.g. Miles, 1962) a measure of resistance to stress as a function of willingness to persevere was included as a predictor. Predictors are described in the following section.

2.2.2.1 Susceptibility to arousal

In view of the hypothesized role of high arousal in immersion as a debilitating influence on performance, the present concern is with differences among individuals in terms of excitation following on standard stimulus conditions.

The measure used was the Galvanic Skin Response (GSR) measured by the Tarchanoff method, i.e. the electric potential generated by sweat gland activity. According to Stevens (1951) the measure reflects "... an arousal aspect of a new and unexpected stimulus ..... like the situation involved in a startle reaction" (p. 497). Skin potential was amplified and continuously recorded, both on the left and the right side of the subject's body, and sporadic sound signals were given.

Derived scores consisted of the GSR total score and the ratio of left versus right body side reactivity. The total score, that is the sum of deviations from baseline after five consecutive sound stimuli, assessed susceptibility to arousal. The left versus right reactivity ratio which, according to Fisher et al. (1959) reflects body image vulnerability, was employed to sample what appears to be a mediating variable between the stimulus and the amount of arousal experienced in the diving situation as immersion largely involves an assault on the body perimeter (Deppe, 1970). According to Fisher et al. (1959) the left dominant person has a more adequate body image.

2.2.2.2 Rate of information processing

For present purposes rate of information processing may be defined as the quantity of information which is received and processed in a given unit of time. Rate of information processing (RIP) is dependent on a number of other factors, for example the individual's RIP capacity, familiarity with the information presented, complexity and difficulty of material, etc.

RIP applies to sensory, perceptual and conceptual levels. Any activity carried out loads on each of the levels in shifting proportions. For example, in learning to clear the mask the diver initially recalls instructions on the technique and makes sequential judgements on the effectiveness of his performance; at this stage mask-clearing requires extensive conceptual, perceptual and sensory

commitment. At a later stage the exercise is carried out reflexively and without conscious attention to the minor stimulus of water around the nostril, at this stage there is little sensory and no conceptual involvement. The demands of the activity have shifted from a creative to a maintenance function. Immersion requires extensive adaptatory behaviour by the diver because of the vast range and number of changes that immersion impose (Deppe, 1970) and it is hypothesized that the capacity for speeded information processing determines residual cognitive capacity (Deppe, 1970s) and thereby the underwater performance of the subject.

While the relation between arousal and information processing has not been intensively explored, there is some evidence, as noted by Delius (1970), that the two closely interact. Both arousal and information processing have 'attention-filling' properties so that the aroused person who fixates on the threat cannot attend to complex tasks at the same time. Whether the fixed capacity for awareness is devoted to one task or another doubtless depends on the individual's priorities assigned to the tasks. If he is highly aroused he will attend to the threat and if arousal is at a minimum his residual capacity is at a maximum, qualified by his capacity for attending or for processing information.

Predictors were matched to the three levels of cognitive activity on which information processing occurs, viz. the sensory, perceptual and conceptual levels. Corresponding measures were Critical Flicker Fusion (CFF), Embedded Figures (EF) and the reasoning test developed by Baddeley (1968).

(i) Critical Flicker Fusion

Subjects viewed the screen of a variable stroboscope through a 13 mm opening. In two increasing and two decreasing rate trials subjects adjusted the rate until flicker disappeared into a steady light.

The score, in cycles per second, was calculated as the mean of four trials.

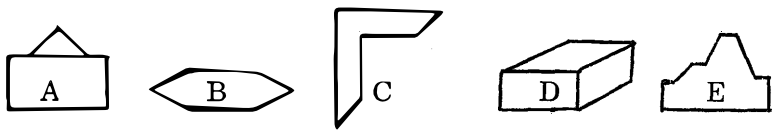
(ii) Embedded Figures

A Gottschaldt Figures version of the Embedded Figures Test was used. Forty-five complex geometric figures in the test are accompanied by

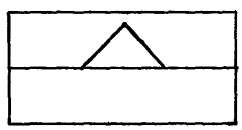
five simpler key figures which are contained in certain of the former. The subject decides which key figures are contained in each item.

Example

Key figures



Test item



The score consists of the number of items correctly responded to within a set time.

(iii) Reasoning Test

The reasoning test has been described earlier (Section 2.2.1.2).

In the present context the final surface score (S3) was used as a measure of the speed at which statements regarding the order of a pair of letters could be resolved.

As one of the criteria of underwater adaptation made use of this test, the predictor/criterion relationship involving the reasoning test on both occasions was not examined.

2.2.2.3 Indirect measures of susceptibility to arousal and RIP

It has been suggested (Herbert et al., 1969) that particular personality traits accompany susceptibility to arousal, and concommitant with arousal a decrease in effective information processing. The authors contend that individuals may be graded in respect of 'central nervous system strength'. A strong nervous system leads to such personality traits as extraversion and primary functioning and is accompanied by tolerance for a high intensity of stimulation. On the other hand the weak nervous system with its concommitants of introversion and secondary

functioning leads to an intolerance for high levels of stimulation albeit greater sensitivity to low levels of stimulation.

In accordance with this model selected personality and temperament measures are included as predictors in the present study.

(i) NIPR Personality Questionnaire

The Personality Questionnaire contains 45 items consisting of pairs of statements, A and B, which describe behaviours typical of the extrovert and the introvert.

Example

8. A takes a long time to make friends.
B makes friends easily.

The subject is instructed to respond to statements which are typical of himself. A high score denotes extroversion.

(ii) NIPR Temperament Questionnaire

The Temperament Questionnaire is similarly constructed to the above but incorporates 27 items sampling the primary-secondary functioning dimension.

Example

7. A is radical.
B is more conventional.

A high score on this test denotes primary functioning.

2.2.2.4 Perseverence under stress

Apart from the ability to adapt, motivation to persevere must be given due recognition as a determinant of success on the diving course. When diver training is examined as a cost/reward situation, the likelihood of a trainee persisting on the course depends largely on the costs and rewards that the total situation provides. In the first place the trainee is a volunteer and one may conclude that the trainee is attracted to goals in the course which, when

achieved, constitute rewards. On the other hand costs are equally variable, trainees will differ in stress response to awkward conditions, for example trainees from rural areas are considered to be hardier than those from urban areas.

The test of perseverence used in this study measures the subject's willingness to persist with a task in spite of physical discomfort. Similarly, in the diving course, the costs consist of physical discomfort resulting from strenuous physical training, cold, etc. and the task consists of the training exercises set by the instructor.

Subjects were seated before a dynamometer, i.e. an instrument which registers handgrip strength, and exerted maximum grip with the non-preferred hand. After all subjects were tested for maximum grip in this way they underwent the second series in which each subject, again with the non-preferred hand, exerted two-thirds of his own maximum grip-strength for as long as possible. The score comprised the grip time of the second series.

2.2.3 The sample

The sample comprised two groups known as the experimental (E) and traditional (T) groups. The division was made as part of diver training research and groups were exposed to different training methods. Both groups involved an age range of 17 to 20 years with mean ages of 18.0 and 18.1 years for the T and E groups respectively.

2.2.4 Data analysis

Predictor/criterion relationships were examined by splitting criterion rankorders on the mean for each group to reconstruct "adapted" and "maladapted" groups by the method:

$$\frac{Me_+ + Me_+}{Me_- + Me_-} \quad \begin{matrix}\text{(groups E and T)} \\ \text{(groups E and T).}\end{matrix}$$

The procedure was followed for each of the three criterion dimensions. Means of predictor scores of the Me_+ and Me_- groups were compared by the Mann-Whitney U Test (Siegel, 1956).

2.2.5 Task sequence

Predictor scores were obtained before the course. Criterion measures, excluding ratings, were obtained at the end of two and seven weeks of training and ratings were obtained at the end of the course.

2.3 Follow-up study

This section deals with the follow-up study of diving success. The purpose of the study was to verify relationships discovered in the previous studies and to implement new directions in testing where this was considered feasable.

2.3.1 Development of the criterion

A rating schedule was constructed for completion by instructors. Four dimensions were included, namely those which emerged as criterion factors in the first tier study; diving skill, task-orientation, intellectual ability and emotional maturity. Statements within factors were summarized into trait descriptions, both positively and negatively defined, and a 9 point scale was stretched from the negative to positive descriptions. This fine scale was chosen as dimensions were now sufficiently defined and delineated to permit accurate interpolation by raters. (App. II).

Secondly, the instructor was guided as to the expected frequencies of scale points so that an approximately normal distribution of ratings was obtained for each group.

2.3.2 Predictors

Instruments which had previously shown predictive validity in either study were retained. In later chapters these are shown to be the Gordon Personal Profile, Bass Orientation Inventory, Mental Alertness Test, D-K Questionnaire and the interview.

Additional measures, for which justification is given in a discussion of the results of the second tier study or obtained from diving research publications, were biographical data, a mental health inventory (MMPI), a measure of the need for achievement, a selected electro-encephalographic variable, measures of risk-taking and of aggression.

2.3.2.1 Biographical data

In a study of performance in prolonged underwater habitation, American researchers Radloff et al. (1968) established that in their study personality variables were unsuccessful in predicting performance; they concluded, however, that age and birth order were useful predictors of diving success. Similarly in an earlier study by the NIPR age and Diver 3 performance were highly correlated in a small sample (Deppe, 1966). Accordingly it was decided to include selected demographic variables as predictors, viz. home language (English or Afrikaans); number of siblings; birth order (first-born, middle-born or last-born); domicile (city, town, burrough or rural); level of education; number of schools attended; number of sports in which the subject participated at school; average number of hours spent weekly on sport at school; smoking, whether severe (plus 20 daily), moderate (10 to 19) or mild (0 to 9); drinking, as frequent (daily) moderate (weekly) or mild (monthly or not at all), and whether or not there had been a split in the home through divorce, separation or death involving parents.

2.3.2.2 Minnesota Multiphasic Personality Inventory

Later in this report grounds will be given for the inclusion of a measure of mental health or general adjustment as a predictor. The instrument chosen for this purpose was the Minnesota Multiphasic Personality Inventory (MMPI).

The MMPI may be described as a personality measure adapted for clinical practice. Scores are presented in the form of clinical and psychopathologic syndromes. One of the scales, psychopathic deviation, has also been reported to serve as a succesful predictor of diving success in French military diver training (Caillé, 1969). The present study was seen as an opportunity for testing this finding in respect of South African Naval divers.

The MMPI contains 550 items to which the subject responds as "True", "False" or "Cannot Say" after deciding whether the described behaviour in the item is like his own or not.

The following items are typical:

"I believe I am being plotted against".

"It takes a lot of argument to convince some people of the truth".

"I wish I could be as happy as other people seem to be".

The scales of the instrument are Hypochondriasis (Hs), Depression (D), Hysteria (Hy), Psychopathic deviance (Pd), Masculinity-Femininity (Mf), Paranoia (Pa), Psychaesthenia (Pt), Schizophrenia (Sc) and Hypomania (Ma). In addition validity scales given an indication of the profile validity and permit correction of profile elevations.

2.3.2.3 Need-Achievement measure

McClellands Need-Achievement (N-Ach) measure, as the name suggests, is intended to assess the subject's drive to achieve towards an envisaged standard of excellence, i.e. a subjective standard of performance. The instrument was chosen as an appropriate measure of motivation in view of the emphasis placed on motivation in diver training by various authors (e.g. Miles, 1962).

Need-Achievement is measured by showing subjects three cards in succession and instructing him to write a story according to certain guides (e.g. What is happening ? Who are the persons ?). Stories are scored in terms of the nature of projection in respect of achievement in the stories written by the subject. As an extension of the test two additional pictures showing divers swimming underwater were included to introduce specific diving as well as general content.

2.3.2.4 Electroencephalogram

The electroencephalogram (EEG) had been applied to diver trainees as a matter of course throughout the selection project in order to identify individuals with clinical EEG abnormalities which might be expected to potentiate problems in diving with high gas partial pressures.

In the present context, however, EEG records were followed up to test the hypothesis proposed by Caillé (1969) that characteristics of the alpha rhythm differentiated between good and poor divers in his naval sample.

2.3.2.5 Risk-taking

In a recent study by Biersner et al. (1970) it was shown that a sample of 20 U.S. Naval divers had a significantly higher risk-taking preference than a comparable group of controls. The trend shows that divers show a preference for high risk/high reward situations and that such individuals either are more likely to volunteer for a diving course than their counterparts or that such preference may be engendered by diver training. Although no comparisons were made between diver performance and scores on a measure of risk-taking, it is tenable that such a relationship exists on the grounds that the high-risk trainee more easily adapts to the costs and rewards of diver training.

To test for such a relationship a risk-taking measure was devised and applied. The measure contained two types of items; the first assessed betting preferences as in the study by Biersner et al. (1970), e.g.

Which do you prefer ?

A. 50% chance of losing R5 and 50% chance of winning R5, or

B. 50% chance of losing R1 and 50% chance of winning R1.

The second emphasized physical costs and rewards, e.g.

Would you rather

A. Collect specimens for a zoo, or

B. Collect specimens of plants ?

2.3.2.6 Aggression

A measure of aggressive behaviour developed by the NIPR depicts a person in a situation in which he is the target for interpersonal aggression (Picture Situation Test: PST). The testee responds by projecting his answer into the situation, i.e. his method of coping with the situation.

In as much the individual is subjected to threat in the test, as well as in the diving situation, the manner of response may be transferred from one situation to the other. Furthermore, the scoring system of the PST, e.g. whether the response is constructive or destructive, of high or low aggression-intensity, is

patently relevant to success in handling underwater threat.

2.4 The sample

The follow-up study consisted of a series of separate investigations and made use of different samples. The study involving cross-validation of predictors was conducted on two samples trained by the two instructors who had previously trained the experimental and traditional groups. There was some justification in accepting that the instructors had carried over the methods of traditional and experimental training into the present situation and that this called for separate analysis of results. The instructor applying NDT methods now trained a group of 13 subjects (Mean age 19.6 years, range 18 to 24 years) designated group A. The instructor applying traditional methods trained a group of ten individuals (Mean age 19.5 years, range 18 to 22 years) designated group B.

A third group was made up of three separate training courses, designated groups C1, C2 and C3. Group C included 38 trainees with a mean age of 19.7 years, range 17 to 26 years.

2.5 Data analysis

Results were analysed for each of the groups separately by means of predictor/criterion correlations and frequency comparisons.

CHAPTER 3 SCUBA DIVER TRAINING: JOB DATA, CRITICAL BEHAVIOUR TRAITS AND PREDICTORS

The present chapter concerns the description and analysis of Diver 3 training, the inference of critical behaviour traits expected to determine success and failure from job data (i.e. course demands) and the choice of predictors to represent critical behaviours.

3.1 Job description and analysis

3.1.1 Job description

3.1.1.1 Diving

The trainee learns to dive in varied conditions (clear water, low to nil visibility, cold water, confined spaces, etc.) and under hurried conditions (e.g. in sharing air with a fellow diver) using Scuba and SDDE*.

Learns and applies diving theory practically (signals, decompression techniques, etc.) and as an aid to diving techniques, e.g. relates Boyle's Law to exhalation rate on ascent. Carries out basic diving skills (maneuvers underwater clears mask, pneumatizes, etc.). Is constantly vigilant to deviations from customary sensations from equipment (e.g. responds to an increase in breathing resistance by pulling air reserve rod) and meets adaptation needs (e.g. responds to pain in ears by pneumatizing), continually orientating and navigating (e.g. scans visual field for cues denoting the vertical, e.g. feels lie of life-line, slope of bottom, etc.

Co-ordinates movements with those of fellows (sends and receives line signals), shares air on request, keeps within visual range of diving team, etc.,

May dive experimentally with Standard Suit or Closed Circuit Breathing Apparatus,

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* Surface Demand Diving Equipment.

responding to specific equipment limitations (e.g. to stay above 33' on oxygen) and operating according to type (e.g. adjusts Standard Suit spindle valve).

Occasionally carries out diving support roles as time-keeper, standby diver, attendant, look-out, etc., following laid-down task activities, e.g. as time-keeper he records times of submergence, exit, calculates air supply endurances, etc.

3.1.1.2 Searching

Conducts searches for targets (mines, lost objects, etc.) as quickly as possible, following fixed sequence of steps in any of eight standard searchplans, e.g. in a gridsearch he sequentially moves swimline for fixed distances after searching off swimline.

In searching, trainee scans search area visually or tactually by sweeping arms across search area, e.g. compromises height over sea bottom to cover maximum area but still identify target.

Searches in varied conditions (cold water, among obstacles, in nil visibility, etc.).

3.1.1.3 Academic learning

Attends classes, demonstrations (e.g. of parts of demand valve, compressor operation) and films (e.g. illustration of diving principles, search types) to learn principles of diving (e.g. learns equipment design and functions, time-keeper duties) basic physiological phenomena underlying diving (symptoms, causes, etc. of decompression illness, $C0_2$ poisoning, etc.), underlying physical laws (Laws of Boyle, Henry, Dalton, etc.). Learns diving-related subjects (harbour regulations, first aid, life-saving, diving gear design, etc.).

Writes weekly and end-course examinations.

3.1.1.4 Maintenance

Maintains satisfactory condition of equipment (washing, storing, repairing wetsuits, etc.). Adjust equipment (e.g. adds or removes weights to correct buoyancy), repairs equipment, etc.

Checks and maintains Scuba daily, e.g. fills cylinder, checks pressure reading with gauge.

3.1.1.5 Preparation for diving

Prepares for dive or diving operation by donning basic gear (wetsuit, etc.) and Scuba, and by recalling and collecting items needed for specific diving operation (flag, supervisor's box, etc.).

3.1.1.6 Physical training

Participates in physical training, as instructed, for one hour circuit training and at odd intervals, e.g. swims 1 mile, runs through knee-deep water.

3.1.1.7 Record-keeping

Recalls details of dive to record in diving log. Records activities (e.g. circular search) and relevant clock times (e.g. time of entry and surfacing).

3.1.1.8 Involvement in functions

The approximate time spent on the above functions is given below.

Diving	18%
Searching (included in 'diving')	7%
Academic learning	40%
Maintenance	15%
Preparation for diving	8%
Physical training	17%
Record-keeping	2%

3.1.2 Job analysis

3.1.2.1 Factor 1: Decisions

Summary

Continuously decides on following action in underwater adaptation, simultaneously integrating visual cues (relative positions of seafloor, shotrope, air bubble

movement, etc.), kinaesthetic cues (e.g. pressure on ears, vestibular signals regarding posture) to orientate himself, to adapt physically to water and changing pressure, to search, to carry out safety drills, etc. Interprets cues denoting deviation from the steady state, e.g. giddiness may signify $C0_2$ excess.

Decisions must be made quickly (e.g. in sharing air with fellow diver), in awkward circumstances, (e.g. in nil visibility) and frequently involves the lives of self and fellow divers.

Examples

-Decides how to cope with lack of air

On 90' dive incumbent swam fast, felt an increased resistance to breathing, lost mask and, on request for air from co-diver, received seawater in the mouth and lungs. Assessed three alternatives, viz. to stay down and repeat request for air, to attempt to satisfy air requirements from own supply or to surface quickly and disrupt the search operation. Decided to surface knowing that he would require air within one minute or he would lose consciousness, that surfacing would require approximately one minute but air expansion and turbulence would increase breath-hold time, that no air remained (deduced from breathing resistance, from the fact that reserve rod was pulled previously) and decided to make emergency ascent.

Incumbent was vigilant to practice safety drill, viz. to signal intention to surface, to drop weightbelt, to ascend up shot-rope and to exhale on ascent.

-Decides on position

While searching in nil visibility incumbent lost knowledge of position (compass orientation). Decided on steps in fixing position - recalled travelling directions on underwater guidelines, felt lie of lifeline to surface, felt slope of bottom, tactually assessed different rope thicknesses to identify them, etc.

-Decides on following steps in search

In any search, diver recalls own movement sequence and searchplan to decide on following procedures, e.g. locates bottom-line, secures swim-line, signals one pull, swims along swim-line, etc.

-Decides on special signal

Two divers carrying out a search in nil visibility decided to give four clasps on each other's wrists as an indication that the air supply was diminished. Based this procedure on the knowledge that in nil visibility the customary visual signal would not be seen, that the "lack of air" signal was too critical to be transmitted through pulls on the buddy-line on which it could be confused with other signals, that the duration of the search made an air shortage probable, etc.

-Decides on cause of poor equipment operation

On experiencing highly variable negative to positive pressures in the breathing supply, the diver decided to adjust cylinder harnesses by lowering and tightening cylinder straps. Relied on learned knowledge of equipment design principles (especially design and function of the demand valve) and of diving physics (ambient pressure gradient) to decide that varying demand valve/lung center distance caused pressure variation and that this could be alleviated by decreasing the distance between lung center and demand valve.

-Decides on means to orientate to the vertical

After descending to forty feet in nil visibility and cold with fellow-diver on buddy-line, diver experienced autokinetic illusion of rotation around longitudinal body axis. Decided on attempt to dispel illusion by countermeasures - pushed both hands into the mud, rotated self in opposite direction to the illusion, etc. eventually dispelled illusion by extending arm along lifeline to the surface. From experience the diver ascribed the illusion to a lack of visual orientating cues, incomplete pneumatising, etc. and realized it was necessary to compensate by finding other cues.

3.1.2.2 Factor 2: Controls and checks

Summary

In all facets of training directly and constantly controlled by instructor who observes and corrects incumbent's performance (e.g. checks his speed of exhalation on ascent, body position in searching, Also controlled by adherence to a standard procedure, e.g. the fixed sequence of movements in a searchplan, the meanings of signals and signalling procedure.

Examples

-Controlled by instructor in the following

Instructor supervises his diving by checking on his welfare (keeps track of the diver's route underwater, sends signals to the diver, appoints a standby diver for emergencies) and by ensuring that training exercises have been adequately performed (e.g. dives with trainee to appraise search technique).

The instructor ensures the trainee has adequate opportunities for acquiring the necessary knowledge by providing lessons in the classroom, by showing relevant slides and films and by giving practical demonstrations (e.g. how to don a wetsuit).

Instructor provides feedback by debriefing the trainee, by disciplining him and by setting weekly examinations on diving topics.

-Trainee is controlled in his actions by the narrowed safety parameters in diving

Operational efficiency of Scuba depends upon the efficacy of preparation (e.g. inadequate cylinder filling results in short diving duration, if the wetsuit is not in good repair the diver will be cold, the incorrect number of weights results in incorrect buoyancy, etc.).

Personal safety is dependent upon observance of diving rules, e.g. fast, continuous ascent after long duration at extreme depths will result in decompression illness, failing to exhale on ascent results on lung injury.

3.1.2.3 Factor 3: Pressure of work

Regular pressures comprise daily circuit training as well as sporadic exercises, e.g. running on the beach through foot-deep water.

Fluctuating pressures comprise exercises done at maximum speed ("awkwards"), e.g. in donning equipment or in searches. Number of "awkwards" increases from approximately one per day after three weeks of training to two or three per day during the last two weeks.

3.1.2.4 Factor 4: Language usage

Summary

Reads notes (in English and Afrikaans) on diving, physiology, seamanship, etc. which he recalls to write examinations and converse with the instructor and fellow divers. Must understand written diving concepts to utilize them in diving.

Examples of commonly used terms

Decompression, partial pressure, CO_2, ascent rate, timekeeper, nitrogen narcosis, barotrauma, gas diffusion, distance line, swimline, bottom line, jackstay, after free area, shotrope, marker buoys, tidal volume, respiratory centre, etc.

3.1.2.5 Factor 5: Numerical computations

Summary

Uses given formuale to make pre-dive calculations, e.g. of set endurance. Must recall limited number of formulae on demand (e.g. to convert water depth to pressure equivalent) and values usually associated with formula parts (e.g. air consumption in liters per minute). Reads off tables, e.g. stoppage depth and times against dive depth and duration in determining decompression procedures.

Examples

Recalls and applies formula for calculating set endurance.

$$\text{Endurance} = \frac{\text{Cyl. volume} \times (\text{filled pressure} - \text{reserve pressure})}{1 + \frac{\text{Depth}}{33} \times \text{consumption rate.}}$$

Recalls cylinder volume (e.g. 13.6 liters), reserve pressure (e.g. 20 ats.), etc.

Assesses results for probable correctness, relying on experience of range of results encountered, e.g. realises that endurance of 3 hours at 100' is impossible with standard diving cylinder.

3.1.3 Additional observations

Whereas the job description and analysis describe the activities carried out by trainees and the methods employed, the picture is perhaps not complete in respect of secondary demands of training.

The first week of training is particularly strenuous in terms of physical stress. Trainees carry out daily circuit training for approximately one hour and, between formal training exercises, they undertake mile swims in cold water, jump off a ship's bridge into the water (approximately 35' height) and run through knee-deep water. Standards have been set which, to the Diving Establishment's way of thinking, weed out those who "can't take it"*.

The pressure of physical training eases off slightly after the first week to be replaced by "awkwards" during the sixth and seventh weeks. An awkward is the term applied to any exercise carried out at maximum speed and may be applied to a part or complete diving exercise.

Transgressions are punished through additional physical training, e.g. fifty press-ups for not stowing equipment properly.

The unstated policy of the Diving Establishment, at the time of this investigation, has been to impose stress and train divers under stress on the assumption that this method would lead to a raised post-course diving stress resistance. In addition it was believed that diver trainees who failed under these conditions were poor diver potential on a criterion that applied to the Diver 3 course as well as to post-course diving performance. These points have been raised and discussed elsewhere (Deppe, 1969b, 1970c).

3.2 Behaviour characteristics and predictor choice

Behaviour traits selected to represent important determinants of success in the Diver 3 course are diving skill, social maturity, character, concern for others, resistance to stress and conceptualization. Each is described and accompanied

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* Personal communication: Head of Diving Establishment.

by predictors chosen to represent that trait.

3.2.1 Diving skill

The person high on diving skill has mastered all the basic diving techniques (clearing mask, pneumatizing, etc.) and feels 'at home' underwater. He swims equally well in any position and operates diving equipment efficiently, making few mistakes. Emergencies that arise are effectively handled (e.g. in sharing air with a buddy-diver). The sense of direction is maintained at all times, even in low or nil visibility. Specific diving and search tasks are carried out quickly and correctly (e.g. the swimline is kept at the correct tension and height during a circular search).

The diver who is low on diving skills is awkward, clumsy swims erratically, bumps into his buddy or objects in the environment, loses the sense of direction, gets tangled up in lines, makes mistakes in operating equipment, etc.

The description embodies at least three separate components, viz. physical skills as psychomotor proficiency, underwater effectivity in being able to mobilize energies toward carrying out the task rather than maintaining homeostasis, and those qualities which promote co-operation with fellow divers and concern for rules. The last component is incorporated in other behaviour traits (concern for others, etc.), the second is the topic of second-tier prediction in this report.

To assess the contribution of psychomotor skills towards prediction of success, a visual-motor assembly task (Tripod test) was chosen as predictor.

3.2.2 Social maturity

The socially mature person enjoys sound interpersonal relationships. He is consistently pleasant and cheerful, helps in building up a good morale and is fully accepted as a member of the group. At the same time he is more concerned with carrying out tasks than with making an impression on others. For example, in the classroom his questions will aim at a full understanding of the subject and will not be asked for the sake of argument. He will accept justified criticism without becoming resentful.

The socially immature person does not get on with others, either because he withdraws or as a result of his other-directed aggression. He will not actively co-operate in a group task and will be disinterested, or disrupt teamwork by insisting on having his own way.

As defined, social maturity implies interpersonal adequacy but not necessarily gregariousness or concern with group interaction. This quality is represented in the following dimensions: Emotional Stability (Gordon Personal Profile), sociability (Gordon Personal Profile) and Interaction-orientation (Bass Orientation Inventory). Social maturity may also be assessed in an interview and by observation of interaction in an unstructured group (Leaderless Group Discussion).

3.2.3 Character

The person who scores high on this dimension is reliable, persistent and tenacious in his work. He carries out instructions thoroughly, for example during a search he will cover all areas even though the quality of his work cannot be checked. He perseveres in adverse conditions, e.g. in extreme cold.

The individual who scores low on this dimension is unreliable and shirks whenever the opportunity arises, for example he will not sweep adequately with his forearms during a tactual search when there is a possibility of sustaining minor injuries; his actions will be chosen to satisfy the instructor rather than to solve the problems at hand; he cannot be trusted to carry responsibility for the welfare of his fellow-diver, etc.

In summary, character refers to those intrapersonal values which determine the individual's conformance to demands placed on him by the task, instructions, safety rules, etc. Three test dimensions which may be expected to cover this area are Responsibility (Gordon Personal Profile), Cautiousness (Gordon Personal Inventory) and Task-orientation (Bass Orientation Inventory).

3.2.4 Concern for others

The person who shows concern for others is constantly aware on the needs of his fellow-diver and of the others in the team. He co-operates with others, for

example in diving he frequently checks his fellow-diver's welfare, adjusts his swimming movements and pace to match others in the diving team, etc.

The person who shows little concern for others does not necessarily clash or withdraw from them but tends to go his own way regardless of the plans and movements of his fellow-divers. Thus he may be excessively task-oriented in the sense that the task is more important to him than the team.

The difference between "concern for others" and "social maturity" lies therein that the latter has to do with general social skills and the former specifically deals with the individual's qualities as a diving partner and team member.

Predictors which come close to the essential nature of this dimension resort under "social maturity" and "character".

3.2.5 Resistance to stress

The person who is resistant to stress maintains self-control in dangerous situations, he assesses dangers realistically and deals with them in an effective way. For example, in a demanding situation such as a dive in nil visibility, cold water, extreme depth, confined spaces, etc., he will not show marked changes in his customary behaviour pattern (e.g. panic, become tense and irritable, withdraw from group interaction, etc.), his actions will be geared to a solution to the problem at hand rather than to coping with his own anxieties.

The person with low stress resistance will try to avoid stressful situations, e.g. by developing imaginary physical ailments, by a deterioration in his social relations and by becoming withdrawn and tense. In diving, the individual with claustrophobic symptoms (e.g. diving experimentally in a Standard Suit, in tunnel diving) is considered to have low resistance to stress.

Relevant predictors are Emotional Stability (Gordon Personal Profile) and assessments of mental health and motivation (Structured Interview). It is assummed that the person who has optimally adjusted to his environment and gains a high level of subjective reward from diving will be most stress-resistant.

3.2.6 Conceptualization

The person with a superior ability to conceptualize quickly understands and interprets new ideas and techniques and can effectively put them into practice, for example, when briefed for a dive or underwater operation he goes through the whole sequence of activities correctly without being at a loss as to what he should do and without making important mistakes; in lessons he quickly grasps the essentials of a problem and distinguishes between significant factors and less important details.

The person with a low conceptualizing ability cannot carry out a task without step-by-step instruction, shows a lack of 'common sense', has difficulty with theoretical work and confuses instructions.

Conceptualization is predicted with a test of mental ability (Mental Alertness Test), of computational ability (Computation Test) and of mechanical insight (Mechanical Comprehension Test).

3.2.7 Motivation

A general factor underlying all work activities comprises the drive brought into the situation by the person involved. Motivation is an exceedingly complex phenomenon which may apply, and be defined, in various ways. For present purposes motivation is seen as a consistent drive towards success on the Diver 3 course. Diving instructors will recognize that 'consistent' is a key term as the course of motivation may take many forms, from an upward gradient or a downward one to a highly varying time/motivation relationship. Various authors (e.g. Miles, 1962) have emphasized the exceptional importance of motivation in diving. In the first place it must be recognized that behaviour is a function, not only of the person, but also of the environment, and in the second place - if motivation follows a simplified model of a cost/reward relationship - that costs and rewards are not only a function of trainee expectations and capabilities but also very much a function of the method of diver training. Trainees commence the course with particular expectations regarding the rewards that will accrue; after all, these constitute the primary reason for volunteering. If subsequent events match expectations, if the trainee's evaluation of the rewards remains

constant, and if the costs match expected costs, the trainee will retain his motivation throughout the course. If the expected rewards are not obtained, if costs exceed expected costs or if the trainee vaccilates in his reward expectations, motivation will be variable and low. A large part of motivation is thus a function of the method of training insofar it provides costs and rewards. However, on the basis that the best predictor of future behaviour is past behaviour (as assumption made in all psychological forecasting from test results), motivation to dive during the course may be predicted by motivation to dive before the course. While seemingly logical, it should be borne in mind that this approach ignores the fact that past opportunities to dive are never equal and that the reasons for volunteering are based on hearsay rather than a realistic appreciation in respect of course activities and may in fact have little to do with diving (Deppe, 1966). It has been asserted, for example (Deppe, 1970), that the reason for volunteering is frequently a self-imposed test for manhood.

On the assumption that previous interest in diving will predict sustained interest on the course, and that previous interest will be reflected in a concommitant increase in knowledge of diving principles, an achievement test (Diving Knowledge Questionnaire) was specially constructed for use as a predictor.

3.3 Summary of predictors

The predictors chosen for the study are given and briefly described in this section.

3.3.1 Mental Alertness Test

This is an NIPR test of mental ability or general reasoning ability. The thirty items sample arithmetical and verbal reasoning, e.g. codes, similarities, analogies, number series and letter series.

3.3.2 Computation Test

While the Computation Test incorporates items which are purely of a computational nature, factorial analysis indicates that the test resorts under the same quantitative-analytical ability factor as the Mental Alertness Test.

3.3.3 Tripod Test

The tripod test measures the speed at which the subject assembles the parts of a dismantled metal tripod, following a picture of the assembled tripod. As such it measures visual-motor co-ordination and manual dexterity. The subject was given three trials to enhance the dexterity component; the third trial time was taken as the subject's score.

3.3.4 Mechanical Comprehension Test

The NIPR Mechanical Comprehension Test measures mechanical and technical comprehension as the ability to apply principles from these fields. Content covers applied mechanics, general physics and spatial relations.

3.3.5 Diving Knowledge (DK) Questionnaire

The DK Questionnaire was specially developed for purposes outlined in section 3.2.7. The content covers barophysics, barophysiology, diving medicine and diving history.

Thirty items are given in an estimated order of increasing difficulty.

Example

"In modern deep diving exercises nitrogen is often replaced with another gas. What is the name of this gas?

A Oxygen
B Hydrogen
C Argon
D Carbon dioxide
E Helium"

The test has not been standardized.

3.3.6 Gordon Personal Profile (GPP) and Gordon Personal Inventory (GPI)

The GPP and GPI are discussed under one heading as they differ only in respect of the dimensions assessed.

Gordon scales are factorially derived dimensions. Items are arranged in sets of four (tetrads) and the subject is required to select the most and least preferred item within each tetrad. Extensive validation studies indicate that the measures frequently show predictive validity in respect of job success and that these validities compare favourably with those commonly associated with personality measures used in this way. Thus theoretical objections to the measures as being ipsative rather than normative must bow before empirical findings.

The GPP scales consist of:

Ascendancy
Responsibility
Emotional stability
Sociability.

GPI scales consist of:

Cautiousness
Original Thinking
Personal Relations
Vigour.

3.3.7 Bass Orientation Inventory

The Bass Orientation Inventory assesses the habitual orientation or concern of the individual as being occupied with self-enhancement, the interaction of groups of people or the task to be done. The three scales are appropriately called self-, interaction- and task-orientation.

Items are presented as triads within which the subject selects one as most preferred and one as least preferred.

3.3.8 Leaderless Group Discussion

The Leaderless Group Discussion (LGD) technique may be described as a social-psychological technique aimed at identifying and evaluating requirements believed to be fundamental to successful leadership. A panel of subjects is given topics to discuss and problems to resolve; in the process of doing so they are rated by

appraisers in respect of personal adjustment, social effectiveness, social acceptability and the ability to conceptualize.

In the present study an overall leadership rating was desired and ratings were summed over dimensions.

3.3.9 The Structured Interview

A structured interview was conducted with each subject. As the term 'structured' implies, the interview was based on a schedule of questions about the subject which were answered by the interviewer and which guided his questions; furthermore, the interviewer was provided with information about the trainee in the form of a biographical inventory and responses on an incomplete sentences measure. The interviewer was not given test results as the predictive validity of the interview by itself was to be tested. Areas covered by the interview were motivation, interpersonal relations, leadership and mental health. Finally, ratings on each of these areas were consolidated in an "overall suitability" rating on a nine-point scale.

3.4 Development of the criterion

This section deals with the analysis of criterion data and the development of criterion job indices.

3.4.1 Factor analysis

Behaviour characteristics described in Section 3.2 were separated into 29 statements of behaviour. These were prepared in the form of a schedule as discussed in Section 2.1.2. Ratings obtained in the application of the schedule were then converted to standard scores. At this stage the (standard) scores of all sample groups were viewed as the scores of a single sample, no further distinction was made between original groupings. This procedure is believed to be justified on the basis that there is no reason to suspect that there are real differences between the groups in terms of predictor or criterion score means and scatter.

Scores accruing to each of the statements were intercorrelated and subjected to Iterative Factory analysis, followed by Varimax rotation to simple structure.

With the exception of one pair of variables, all variables correlated significantly and positively with each other ($p < .05$).

The rotated factor matrix is shown in Table 2.

Table 2: Rotated matrix of criterion factors

Statement	Factor	I	II	III	IV
1		30	30	54	47
2		14	10	64	42
3		32	38	37	44
4		38	57	55	16
5		46	40	44	19
6		49	21	53	38
7		26	43	81	02
8		30	29	36	19
9		75	05	14	27
10		76	31	33	08
11		60	54	38	22
12		46	21	22	60
13		51	27	42	27
14		12	24	17	68
15		24	30	54	46
16		58	52	41	17
17		50	68	38	14
18		31	77	17	36
19		54	62	22	28
20		36	41	23	41
21		49	58	27	37
22		36	71	20	26
23		26	82	25	29
24		37	72	16	25
25		74	43	26	11
26		80	32	17	14
27		79	33	14	30
28		23	83	24	16
29		07	86	25	08

Note: Decimal points are omitted.

n = 71

3.4.2 The meaning of the factors

For interpretation of the factors, the five highest weights under each factor were examined. Weights are given and discussed below.

Factor I: Diving skill

1. "Highly proficient in all diving skills, e.g. expertly maneuvers his body, shares air skillfully, works well in any body position, etc." (Statement 26, loading .80).
2. "Functions very well in a variety of diving conditions, e.g. maintains his sense of direction at all times, is calm and collected underwater". (Statement 27, loading .79).
3. "Maintains high performance under emotional stress, e.g. in nitrogen narcosis, low visibility, dangerous work, etc." (Statement 10, loading .76).
4. "Maintains high standard of performance under physical stress, e.g. in cold or dirty water, during exhausting swims, etc." (Statement 9, loading .75).
5. "Proficient at assembling and operating tools, diving equipment and other machinery, e.g. quickly assembles and sets up diving equipment." (Statement 25, loading .74).

This factor clearly describes underwater adaptation and performance. The two statements describing physical diving skills are followed by statements regarding resistance to stress in diving. The fifth statement appears to represent psychomotor proficiency. Results indicate that fear and diving performance are inversely related, a finding that has been reported elsewhere (Deppe, 1969). Factor I is called 'diving skill'. A job index of diving skill was computed as the sum on the above statements.

Factor II: Intellectual ability

1. "Good at figures, i.e. his calculations are always correct." (Statement 29, loading .86).

2. "Quickly learns and easily remembers formulae and fully understands their construction, e.g. in explaining how formulae are derived he easily rebuilds them from basic principles." (Statement 28, loading .83).

3. "Can express himself clearly and accurately, e.g. by his choice of words he can put a complicated idea across simply so that it is easily understood; in discussions he can clearly say what he means in a few words." (Statement 23, loading .82).

4. "He keeps an overview of problems, and, while taking details into account, does not lose sight of main objectives, e.g. when deciding on a plan of action he chooses the most effective and economical in terms of time and effort and remembers to consider regulations, to see that log times are noted, etc." (Statement 18, loading .77).

5. "Quick to grasp mechanical principles, e.g. when instructed on the design of diving equipment and underwater tools he is quick to understand their structure and operation." (Statement 24, loading .72).

This factor clearly represents intellectual skills. The emphasis is on insight into computational and mechanical problems and processing information as in "to put a complicated idea across simply". The factor is labelled 'intellectual ability' and a criterion job index is computed as the sum of scores on the above statements.

Factor III: Task-orientation

1. "In his general outlook he is more concerned with the task or job at hand than with his status or popularity among his fellows, e.g. he is more interested in doing a job properly than in being known as a good fellow". (Statement 7, loading .81).

2. "Accepts authority without resentment, e.g. generally accepts instructions and makes suggestions helpfully rather than argumentatively, etc." (Statement 2, loading .64).

3. "Cautious and systematic in his approach to problems, e.g. considers all aspects of a problem, carefully plans his approach to a job, etc.". (Statement 4, loading .55).

4. "Has a stable and mature approach to life, e.g. is consistent and even-tempered, has a sense of responsibility, is confident, etc.". (Statement 1, loading .54).

5. "Has good insight into the feelings and reactions of others, e.g. understands other people, realises how they feel and does not hurt their feelings, etc.". (Statement 15, loading .54).

Examination of the sequence of loadings indicates the high-loading statement 7 represents this factor; remaining statements reflect secondary characteristics associated with the task-oriented individual. The factor is labelled 'task-orientation' and is represented by standard scores on statement 7.

Factor IV: Emotional maturity

1. "Enjoys good personal relationships with others by being consistently pleasant and friendly, e.g. enjoys being with others, encourages people, etc.". (Statement 14, loading .68).

2. "Is realistic about dangers, e.g. does not show more (or less) fear than the situation warrants". (Statement 12, loading .60).

3. "Has a stable and mature approach to life, e.g. is consistent and even-tempered, has a sense of responsibility, is confident, etc." (Statement 1, loading .47).

4. "Has good insight into the feelings and reactions of others, e.g. understands other people, realises how they feel and does not hurt their feelings." (Statement 15, loading .46).

5. "Flexible in his approach to problems and other persons, e.g. fully accepts solutions to problems which are better than his, easily adapts to any diving role (supervisor, standby diver, timekeeper) etc." (Statement 3, loading .44).

An approximately evenly balanced emphasis on interpersonal adequacy in interpersonal relationships, realism, stability, insight and capacity for flexible adaptation suggests an emotional maturity or stability syndrome. This factor is called "emotional maturity". A criterion job index is calculated as the sum of standard scores on the above statements.

Discussion

The diving criteria that emerged in this study are highly satisfying in two respects. In the first place factors are logically consistent and meaningful when held up to the full range of activities carried out in the Diver 3 course. Secondly the innumberable possibilities of prediction/success comparisons are reduced to four criterion dimensions against predictors.

In a study of success of adaptation in Arctic isolation, criterion factors derived in the same way as in the present study comprised task-orientation, emotional stability and social compatability (Gunderson et al., 1966). The former two are identical to factors in this study, for the remainder differences reflect real differences in the two types of extreme environments. Diving does not involve the enforced cohabitation of Arctic habitation, furthermore the diver's work involves him in physically isolated conditions, social compatability would hardly therefore be viewed as a critical behaviour trait, particularly in the sense of gregariousness rather than in respect of interpersonal relations. On the other hand, diving skill comprises a specific and unique body of demands which emerged as a separate factor. Furthermore, the present study was focussed on a course - a situation which elicits maximum output rather than habitual output - so that the academic work comprises and important area for failure and intellectual ability emerges as a relevant factor.

A final observation from the results is the finding that diving proficiency and resistance to stress both resort under the same factor. This supports previous findings in own and other research (Deppe, 1969; Radloff et al., 1968) that underwater performance and fear are inversely related. The obvious inference is that the extent of fear in immersion must become a target for prediction.

CHAPTER 4 RESULTS AND DISCUSSION: FIRST TIER PREDICTION

Results of the application of predictors to the sample, intercorrelations of predictors and criteria and multiple regression of selected predictors on single criterion dimensions are contained in this chapter. Results are discussed and estimates are made of the efficacy of predictors in forecasting success in diving.

4.1 Predictor means and standard deviations

Means and S.D.s of scores obtained from application of the predictors are given in Table 3.

Table 3: Means and S.D.s of predictor scores

	Predictor	Mean	S.D.
P1	Mental Alertness	19.9	4.6
P2	Computations	16.6	4.1
P3	Mechanical Comprehension	33.6	6.2
P4	Tripod Assembly	122.3	19.9
P5	GPI: Cautiousness	21.0	6.4
P6	GPI: Originality	25.3	4.7
P7	GPI: Personal Relations	22.0	5.9
P8	GPI: Vigour	26.3	5.8
P9	GPP: Ascendancy	21.5	4.6
P10	GPP: Responsibility	24.7	5.0
P11	GPP: Emotional Stability	25.8	4.6
P12	GPP: Sociability	20.1	5.4
P13	Bass Orient. Inventory; Task-orientation	24.2	6.7
P14	Bass Orient. Inventory: Interaction-orientation	17.4	6.5
P15	Bass Orient. Inventory; Self-orientation	18.0	5.8
P16	DK Questionnaire	14.4	4.3
P17	Interview (Overall Rating)	5.3	1.6
P18	Leaderless Group Discussion	13.6	4.2

Only the overall rating of the interview was given in Table 3. This decision was made after the discovery that assessments within the interview correlated highly with each other (Table 4). The overall impression rating, as apparent in Table 4, adequately represents the subsections of the interview.

Table 4: Intercorrelations among interview ratings

	Mo	Ip	L	MH	OI
Motivation (Mo)	100				
Interpersonal Relations (IP)	40	100			
Leadership (L)	52	55	100		
Mental Health (MH)	38	75	67	100	
Overall Impression (OI)	63	72	84	80	100

In Table 4: n = 71; all values $p < .01$. Decimal points are omitted.

4.2 Intercorrelation matrix: Predictors and criteria

Intercorrelations between predictors, criteria, and the two in conjunction, are given in Table 5.

Table 5: Intercorrelations: Predictors and criteria

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	C1	C2	C3	C4
P1	100																					
P2	61	100																				
P3	11	07	100																			
P4	21	02	-20	100																		
P5	-13	-10	02	02	100																	
P6	19	15	24*	12	25*	100																
P7	-02	08	-10	22	34	37	100															
P8	04	-10	12	12	34	38	28*	100														
P9	30*	21	07	09	-25*	26*	25*	17	100													
P10	08	-04	00	10	59	34	21	64	00	100												
P11	19	01	02	22	34	27*	31	29*	11	58	100											
P12	13	22	-13	02	-29*	07	18	10	65	-16	-23	100										
P13	-09	-05	15	-15	33	29*	12	17	-17	26*	24*	-35	100									
P14	08	09	-12	03	-11	08	20	02	28*	-21	-12	47	-59	100								
P15	-04	-06	02	06	-28*	28*	-38	-16	-01	-03	-14	00	-53	-30*	100							
P16	-18	-18	38	-13	-01	10	-23	05	-15	-05	-15	-27*	23	-15	-04	100						
P17	38	30*	-07	10	09	34	17	32	22	34	34	02	15	-16	-03	-10	100					
P18	45	22	22	03	-02	23	-12	09	23	17	19	-06	15	-08	-11	11	49	100				
C1	10	00	05	04	08	05	02	10	18	24*	10	00	-04	-24*	31	06	18	03	100			
C2	39	32	14	09	09	04	03	05	18	28*	13	01	04	-15	12	21	30*	29*	63	100		
C3	12	16	06	09	19	04	-05	01	13	24*	12	-10	09	-20	09	13	26*	16	54	63	100	
C4	18	13	07	08	25*	10	13	16	01	32	16	-16	07	-15	07	06	26*	03	64	65	58	100

Note: (i) If $p < .01$, values are underlined; if $p < .05$ values are accompanied by an asterisk.

(ii) $n = 71$.

(iii) Decimal points are omitted.

4.3 General trends in the intercorrelation matrix

4.3.1 Criteria/Predictors

In the total number of correlations between the criteria (C1 to C4) and the predictors (P1 to P18), chance alone would be estimated to yield 3.5 correlation values significant at the .05 level and a slightly lower than one probability of a correlation coefficient significant at the .01 level. In fact this part of the matrix yields 13 coefficients significant at $p < .05$ of which four also reach $p < .01$.

4.3.2 Criteria/Criteria

All correlation coefficients between job indices are significantly related at the .01 level. This finding may be anticipated as a result of the initially high correlation values between statements: a "halo-effect" of this kind is not uncommon for rating criteria and means that while raters did differentiate among divers in respect of different characteristics, a particular favourable or unfavourable view of a subject markedly influenced ratings across specific traits.

4.4 Predictors and diving skill (C1)

Predictor dimensions yielding significant correlations with the diving skill criterion were Responsibility ($r = .24$, $p < .05$), Interaction-orientation ($r = -.24$, $p < .05$) and Self-orientation ($r = .31$, $p < .01$).

Individuals who score high on the Responsibility dimension of the GPP tend to "..... stick to any job assigned them ..., are persevering and determined, and can be relied upon." Of the two concepts embodied in this description - perseverance and reliability - the former can be seen as a motivational factor of established goal-directed drive independent of the specific nature of the goal; reliability is seen to be an asset in any work situation without being specific to diving. Together, the concepts suggest an effective work-style comprising attitudes towards work and habits in respect of work which match instructor expectations. Furthermore, work-style is an element in instructor-trainee interaction and will not concern underwater adaptation. The inevitable conclusion is that Responsibility predicts the general, favourable or unfavourable, view that the instructor has of the trainee

rather than the specific variance of diving skill.

Interaction-orientation reflects the extent to which the subject is committed to the flow of interpersonal activity within his group. By definition, therefore, his orientation is not directed towards the task, in fact, Interaction-orientation and Task-orientation are commonly found to represent opposite poles on this test (Barrett, 1965). When the negative Interaction-orientation and diving skill relationship is considered together with the significant and positive relationship between Self-orientation and diving skill, further interpretation is possible. If Interaction-orientation is the individual's mode of interaction with the environment then he may be expected to be disturbed by a situation which is characterised by the social and physical isolation it produces. Self-orientation, on the other hand, characterises a person who is unresponsive to the needs of others, and who is consequently rejected by others (Barrett, 1965). This rejection constitutes social isolation so that the individual who achieves autonomy in a social setting may have increased tolerance for underwater isolation. Additional examination of the correlation matrix shows that the more successful diver is not socially oriented as evidenced by negative correlations between Interaction-orientation and all criteria as well as Sociability (P12) and two criteria.

For the multiple regression analysis a step-wise procedure was adopted which considered each of a given number of variables in terms of the contribution of that variable to prediction of the job index criterion. It was arbitrarily decided to include for consideration all those predictors which reached a correlation coefficient of .10 or higher with the criterion. Results are shown in Table 6.

Table 6: Stepwise regression on diving skill

Step	Predictor	Multiple r	Weight validity
1	P15	31	28
2	P10	40	35
3	P9	44	36
4	P14	47	37

While the multiple correlation, as a statistic of within-sample association, increases steadily, weight validity - as an estimate of future observations between the criterion and the sample regression equation value - does not increase meaningfully after the second step. The predictors used in the first two steps and the weights, etc. for fixing observations on the regression plane are given in Table 7.

Table 7: Regression equations for 'best' predictors

Predictor	Weight	S.E. of weight	Constant
Responsibility	.0502	.02	-2.218
Self-orientation	.0541	.02	-2.218

4.5 Predictors and intellectual ability (C2)

Predictor dimensions which reach a significant correlation with intellectual ability are Mental Alertness ($r = .39$, $p < .01$), Computations ($r = .32$, $p < .01$), Responsibility ($r = .28$, $p < .05$), Interview Rating ($r = .30$, $p < .05$) and Leaderless Group Discussion ($r = .29$, $p < .05$).

From an overview of these relationships it becomes apparent that two groups of predictors are operative. In the first place, tests of cognitive ability are significantly associated with a cognitive ability criterion, as may be expected. In the second place, Responsibility again accounts for a proportion of criterion variance, no doubt for the same reasons advanced under paragraph 4.4. Examination of the predictor/predictor part of the matrix will show that the Leaderless Group Discussion (P18) is significantly associated with Mental Alertness and with the Interview Rating and that the latter two are significantly correlated with each other. This leads to the conclusion that the subject's intelligence largely determines his performance in these social assessment settings and that criterion variance can be reduced to cognitive ability or intelligence on the one hand and the "good impression" variance predicted by the Responsibility scale on the other.

Multiple regression was conducted as before. Results are shown in Table 8.

Table 8: Stepwise regression on intellectual ability

Step	Predictor	Multiple r	Weight validity
1	P1	39	37
2	P16	49	45
3	P10	55	50
4	P2	57	51
5	P15	60	52

Multiple r reaches .60; however, weight validity does not increase significantly after the third step. Predictors involved in the first three steps are Mental Alertness, Diving Knowledge (DK) Questionnaire and Responsibility. Whereas the DK Questionnaire did not quite reach significance in the intercorrelation matrix ($r = .21$, n.s.) it obviously contributes to criterion variance prediction. The DK Questionnaire was included to measure motivation on the assumption that the person who is motivated to dive will have gained knowledge of diving before he attended the course, i.e. at the time he was tested in this study. Results show that this line of thinking must be revised; although the DK Questionnaire does not show a relationship with either Mental Alertness ($r = -.18$) or Computations ($r = -.18$) it does so with Mechanical Comprehension ($r = .38$, $p < .01$), suggesting that the test measures technical insight as the ability to resolve the diving-technical problems posed in the Questionnaire. Furthermore the negative correlations of the DK Questionnaire with Interpersonal Relations ($r = -.23$, $p < .05$) and with Sociability ($r = -.27$, $p < .05$), and the positive correlation with task-orientation ($r = .23$, $p < .05$) suggests a dichotomy of interest in respect of things and people and a preference for the former in successful divers.

Predictors chosen to forecast successful divers are given in Table 9.

Table 9: Regression equations for predictors of intellectual ability

Predictor	Weight	S.E. of weight	Constant
Mental Alertness	.0923	.02	-4.132
DK Questionnaire	.0710	.02	-4.132
Responsibility	.0516	.02	-4.132

4.6 Predictors and task-orientation (C3)

The task-orientation criterion was involved in two better than chance relationships with predictors, namely with Responsibility ($r = .24$, $p < .05$) and the Interview Rating ($r = .26$, $p < .05$). Surprisingly the predictor Task-orientation merely correlated to the extent of $r = .09$ with the criterion of that name. From available data it must be concluded that whatever specific and unique variance is present in the criterion task-orientation, this is largely overshadowed by that general component predicted by the dimensions Responsibility and the Interview Rating.

The multiple regression analysis involving predictors and task-orientation, and the regression equations for predictors selected to forecast the criterion, are given in Tables 10 and 11.

Table 10: Step-wise regression on task-orientation

Step	Predictor	Multiple r	Weight validity
1	P17	26	22
2	P10	31	23
3	P16	35	24
4	P2	38	23

The increase in weight validity is minimal after the first step in the regression analysis and drops after the third step. The regression equation for the first step is given in Table 11.

Table 11: Regression equation for predictor of task-orientation

Predictor	Weight	S.E. of weight	Constant
Interview Rating	.1608	.07	-.8519

4.7 Predictors and emotional maturity (C4)

Predictors which reached a significant relationship with emotional maturity were Cautiousness ($r = .25$, $p < .05$), Responsibility ($r = .32$, $p < .01$) and the Interview Rating ($r = .26$, $p < .05$).

The inclusion of Cautiousness in the pattern of significant relationships may be ascribed to the correlation of the same dimension with Responsibility ($r = .59$, $p < .01$). As before, Responsibility and the Interview Rating appear to account for the variance on the criterion arising from the instructor's impression of the subject. However, in the regression analysis (Table 12) the Interview Rating was discarded in favour of the Mental Alertness Test which apparently made a greater contribution to prediction of the criterion.

Table 12: Step-wise regression on emotional maturity

Step	Predictor	Multiple r	Weight validity
1	P10	32	30
2	P1	36	30

Prediction of emotional maturity would be based on the dimension Responsibility, using the regression equation in Table 13.

Table 13: Regression equation for prediction of emotional maturity

Predictor	Weight	S.E. of weight	Constant
Responsibility	.0648	.02	-1.6049

4.8 All predictors and criteria

An important feature of the predictor/criterion correlations is that correlation values above .05 are all positive, with the exception of those which support a negative relationship between sociability and interaction-orientation with the criteria. It may be interpreted from this finding that general superiority across personality and other variables is conducive to diving success and may in fact form the basis of the instructors' good impression in rating success. Taken one step further it may be speculated whether all-round superiority in respect of personality variables may not be a condition of satisfactory adjustment, and whether adjustment in the sense of psychological well-being may not be a pre-requisite for the flexibility necessary for adaptation to the variety and uniqueness of diver training and underwater survival and work. On the basis of these interpretations, an investigation into possible relationships of adjustment and diver performance is proposed as an additional research task.

4.9 Prediction efficacy

The contribution of selected predictors to applied selection may be assessed with reference to appropriate tables (Siegel, 1969); to do so, however, various assumptions must be made. In the first place it is assumed that division between successes and failures can be made around the median - this is an arbitrary procedure which locates the "standard" of the course in such a way that 50% of the course trainees can be called good divers and the remainder classified as poor divers. In the second place it is assumed that the selection ratio, i.e. the number of candidates accepted by the course divided by the number considered for testing, is at least as low as .2. Thirdly, the assumption is made that the present selection procedures have zero validity; whatever the truth of this statement it provides a starting point for assessment whereas the existing selection validity, if present, is not known. If valid selection procedures are applied, the sample will be preselected (other than on a physical basis) and this will have served to suppress the weight validities obtained in the present study.

Given the above assumptions, improvement in selection over present methods are reflected in the percentages in Table 14. Estimates are conservatively based on weight validities rather than multiple correlations.

Table 14: Estimated percentage improvement in selection

Job index	Weight validity	% improvement
Diving skill	.35	40
Intellectual ability	.50	56
Task-orientation	.22	22
Emotional maturity	.30	34

4.10 Discussion

The obtained results show satisfactory prediction of the criterion dimensions, particularly in those areas where the interrelation of the dimensions is logically clear and straightforward, for example in respect of intellectual ability and the Mental Alertness measure. On the other hand high intercorrelations between criteria tended to submerge differential prediction so that specific patterns in the prediction of single criteria did not emerge clearly. In future, studies using the present criterion schedules shall have to be devised in such a way as to discourage high correlation among criteria.

On the whole the personality measures show low to moderate relationships with criteria. Above .05 these relationships are all positive with the exception of those supporting a negative relationship between sociability and diving success. Recent work by others (Biersner et al., 1970) confirms the latter finding, using different measures.

A hypothesis that may be tentatively extracted from the results is that it is the diver who generally scores high on personality measures who is most likely to succeed rather than the person who scores high on one specific dimension. Logically following this hypothesis is the expectation that a candidate should be free from specific psychological weaknesses which may render him vulnerable in the extensive adjustment demands made in diver training. To this end, a clinical screening device is included as predictor in the follow-up study.

Results of this study also lead to the conclusion that more attention should be given to the nature and role of motivation in diving. While definitions of what

constitutes motivation are legion, the results obtained indicate that it is the diver who is responsible, who perseveres and is involved with, and committed to, the task, who is rated highly. Nevertheless other forms of motivation may apply equally, for example Radloff et al. (1968) propose that diving activities can usefully be analysed in terms of costs and rewards to the trainee and that subjective expectations and satisfactions of the course and of diving will determine temporary perseverance, in constrast to relatively stable patterns of perseverance as sampled by the Responsibility scale of the Gordon Personal Profile. Additional research in this regard is needed.

Overall conclusions are that satisfactory prediction can be achieved but that follow-up investigations are required with particular attention given to measures of adjustment and motivation.

CHAPTER 5 RESULTS AND DISCUSSION: SECOND TIER PREDICTION

This chapter deals with the development of a criterion of underwater adaptation and with predictor/criteria relationships.

5.1 Criteria of underwater adaptation

Criteria comprise measures of anxiety, underwater test performance as a function of performance on the same test on the surface, and of instructor and peer ratings of underwater diver performance.

5.1.1 Anxiety

Anxiety was assessed by measuring the increase in heart rate for individuals in both trainee groups from control values taken at rest at the end of a training day to values obtained with the subject resting just prior to a dive to 3 metre in clear, calm water. Control values were obtained after two weeks of diver training and pre-dive values after two and seven weeks.

Table 15 gives the means and standard deviations obtained.

Table 15: Means and S.D.s of minute heart rates

Values	Group E (n=12)	Group T (n=9)
(a) Control	66.1 (10.9)	67.1 (7.0)
(b) Pre-dive; 2 weeks	87.3 (12.2)	106.0 (9.0)
Ratio a/b	.75 (.11)	.63 (.09)
(c) Pre-dive; 7 weeks	72.3 (7.7)	84.4 (6.5)
Ratio a/c	.88 (.16)	.78 (.09)

In the above table a low ratio represents a substantial increase in heart rate from control to pre-dive; a high ratio indicates a small increase, or, if the ratio exceeds unity, a drop in heart rate.

Examination of Table 15 will show that control values were equivalent and that heart rate variance in the T group was comparatively small - a pecularity of the sample.

The E group was significantly less anxious than the T group, according to the Mann-Whitney U test, both at two weeks ($p < .01$) and at seven weeks ($p < .05$). The results indicate firstly that heart rates are useful in the present context as a measure of anxiety. A second and important conclusion that can be drawn is that the two groups, trained differently as part of NIPR diver training research, show significant differences in manifest anxiety and that, apart from the implications for training, this essentially alters the inherent demands of the course and thereby influences the criterion structure. Consequently predictor/criterion analyses will have to take such differences into account. This is done by dichotomizing each group around the median; those ranked above the median are considered adapted divers and those below the median, non-adapted divers.

5.1.2 Underwater performance

In line with the view that underwater adaptation can be assessed as the ability to use available resources underwater, a measure of verbal reasoning, the Baddeley (1968) Reasoning test, was applied three times on the surface and once underwater after two weeks (S1...3, UW1), and again once on the surface and once underwater after seven weeks (S4, UW2). Ratio scores were then derived as S3/UW1 and S4/UW2. Results are given in Table 16.

Table 16: Means and S.D.s of Reasoning Test scores

Measure	Group E (n=12)	Group T (n=9)
S3	23.1 (7.8)	23.0 (8.3)
UW1	18.3 (7.6)	19.4 (6.9)
S3/UW1	1.20 (.12)	1.26 (.28)
S4	27.5 (7.5)	32.4 (9.4)
UW2	25.2 (8.0)	27.4 (10.4)
S4/UW2	1.14 (.24)	1.23 (.25)

In spite of the assertion by Baddeley (1968) that practice effects on this test are small after the first trial, both groups improved from S3 to S4. The higher increase by the T group may be ascribed to initial suppression of performance in this group after two weeks as a result of significantly higher anxiety, and to an accidently higher mean verbal reasoning ability in the T group sample*.

The purpose of using change scores was to measure an anticipated drop in performance, however at the end of two weeks two individuals in the total sample produced superior scores underwater as compared to surface performance, and after seven weeks six individuals did so, indicating that in these cases performance was enhanced by an increase in arousal. Results may be interpreted as following an inverted U curve relating arousal and performance to each other in such a way that performance is low at low and high arousal and optimal at moderate arousal. If performance improves with immersion, the degree of arousal of the individual has spanned the low to moderate arousal part of the curve; if performance decreases with immersion the upper part of the curve will have been sampled. These relationships become clearer when further calculations are considered. It was established that surface and underwater scores correlated to the extent of $r_s = .77$ ($p<.01$) and .93 ($p<.01$) at the end of two weeks by the E and T groups respectively. After seven weeks the surface/underwater scores correlated .66 ($p<.05$) and .87 ($p<.01$) by the E and T groups respectively. The relatively high correlations, and the differences in correlation values for the two groups, permit two conclusions. In the first place the correlation values approach reasonable test-retest correlation values so that a sound predictor of underwater reasoning test performance is performance on the same test on the surface. In the second place, surface/underwater correlations are highest for the T group suggesting that whatever factors influenced them influenced them equally; in terms of what was discovered about anxiety it is therefore likely that all were equally anxious. Is there any point then in selecting in those less prone to anxiety when all are made

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*The samples were matched for age, home language and body size but not for test scores.

anxious by the training methods applied? The E group, with lower surface/ underwater correlations, were differentially affected, either by the extent of manifest anxiety or by other variables, so that a greater (but still unsatisfactory) amount of unique variance remains to be covered by predictor dimensions.

In spite of their dubious value as criteria, performance ratios were used to split both groups into a total sample of above and below median scorers. This decision was based on the finding that there was some consistency in ordinal position from the second to the seventh weeks, namely .54 ($p < .05$) and .45 (n.s.) for the T and E groups respectively.

Finally, results indicate that, given certain training methods and adequate acclimatization, divers' reasoning ability on the test used can produce a decrement as low as 14% - a figure which may be produced by the human engineering difficulties of underwater test-taking. An unknown proportion of this decrement and any decrement in excess of it, may be ascribed to anxiety.

5.1.3 Ratings

Ratings of underwater performance and resistance to stress (IA and IB) were conducted by instructors and peers.

The agreement in instructor ratings among factors IA and IB is given by the correlation between them, namely .82 ($p < .01$) and .90 ($p < .01$) for the E and T groups respectively, and .79 ($p < .01$) and .33 (n.s.) for peer ratings among these factors for the two groups. With the exclusion of the T group peers, all other ratings show that diving skill and resistance to stress are highly correlated. While association cannot be taken as causation, judges apparently do not distinguish between diving skill and underwater stress, to them (with the exclusion of T group peers) these are equivalent concepts. Furthermore, these findings confirm those of the first tier prediction study in which diving skill and resistance to stress appear under the same factor.

Combining conclusions from this and the previous section leads inevitably to the conclusion that underwater performance is a function of surface performance modified by the stress or anxiety experienced by the subject. If, however,

anxiety experienced is largely a function of the training methods employed then training methods have an equal, if not superior, role as determinant of ultimate performance than individual psychological differences. This does not leave much for psychological tests to predict until after such training methods are adopted as to make maximal use of individual resources, unhampered by anxiety. A change in the method of training will thus alter the predictive validity of appropriate tests in the direction given above.

When ratings on IA and IB were combined, as justified by the high correlations between them, and instructor ratings were compared with peer ratings, the two agreed to the extent of $r_s = .78$ ($p < .01$) and .71 ($p < .01$) for the E and T groups. The general agreement among raters and among factors indicates that ratings should constitute a reliable and meaningful criterion of diver performance.

5.1.4 Agreement among criteria

Rankorder correlations between ratings, heart rate ratios (HR) and performance ratios (PR) were calculated for each group. Results are shown in Table 17. Subscripts 1 and 2 refer to the second and seventh week trials.

Table 17: Correlations among criteria; E group data

Measure	Ratings	PR1	PR2
HR1	.35	-.14	
HR2	.24		-.14
PR1	-.35		
PR2	-.26		

n = 12

No values in Table 17 reach significance at the .05 level. According to the manner in which scores were ranked for the correlation statistics, there is a moderate association between freedom from anxiety and high ratings but a negative set of correlations between underwater performance (in respect of surface performance) with ratings and freedom from anxiety.

The above results will be discussed in conjunction with those from the T group in Table 18.

Table 18: Correlations among criteria; T group data

Measure	Ratings	PR1	PR2	n
HR1	.09	.39		9
HR2	.19		.61*	10
PR1	-.32			9
PR2	-.02			10

*p .05

Values in Table 18 follow the same pattern as those in Table 17 with the exclusion of relationships between performance and arousal measures. The correlation value in respect of heart rate and performance after seven weeks was significant at the .05 level.

The following interpretations follow from the data in the above tables. In the first place the agreement between criteria is generally low. Within-table consistency can be found in respect of the less anxious E group; in respect of the T group signs are consistent but values fluctuate. One exception may however be found in respect of the relationships between heart rate and performance ratios. If the inverted U curve which is believed to apply to arousal/performance relationships is applied to the present data, then the heart rate/performance ratio differences between the groups are entirely consistent. According to this model an increase from low arousal (anxiety) to moderate arousal will accompany an increase in performance. If this section of the curve applies to the E group, which from previous evidence is shown to be less anxious, the negative correlations between PR1/HR1 and PR2/HR2 as were found in Table 17 may be expected. The finding that these correlations have low values may well be due to the fact that some individuals in the E group will have exceeded "moderate" arousal. On the other hand, according to the model, those individuals with moderate to high arousal will produce positive correlations in respect of HR1/PR1 and HR2/PR2 as appeared in Table 18. This leads to the conclusion that the underwater performance

of the groups was largely determined by the amount of arousal experienced, that moderate arousal leads to optimal performance and that the high arousal in the T group, as a function of training methods, deteriorates the performance of that group. Again it becomes clear that training methods should be corrected before selection may be expected to operate effectively. A second conclusion from the data in the tables is the finding that ratings are, in the E group, largely influenced by the extent of trainee's anxiety. The lower correlations between heart rate ratios and ratings in respect of the T group will result from the generally high anxiety levels within the group, if all trainees are markedly anxious then discrimination among them on the basis of anxiety becomes less exact, training methods have produced a "selected" or homogeneous group in respect of manifest anxiety.

General conclusions that are drawn in the aforegoing discussion are, first, that criteria do not show a straightforward and linear relationship with each other and secondly, that interpretation of the trends among criteria indicate that underwater performance is largely a function of anxiety which, in turn, is mainly determined by training methods rather than be differences in the innate psychological properties of the individuals concerned.

If it is true that underwater performance is a function of surface performance modified by the anxiety experienced then selection should proceed to discover and measure those abilities which are pertinent to underwater tasks and to identify those individuals who are markedly aroused by the underwater environment while training must maintain anxiety at near-optimum levels. Of these three tasks that have been identified, the second tier prediction is only concerned with one, namely identifying the individual who is easily aroused in the diving situation. Any predictors that successfully emerge here will only go a third of the way to prediction of underwater performance.

The statement made above, viz. that "training must maintain anxiety at near optimum levels" is a simplified principle based on performance/arousal relations. When the diver undergoes increased anxiety he will be better motivated to perform highly and will respond by working faster. In working faster he will produce a greater output (e.g. respond to a larger number of test items) and become prepared to tolerate an increased probability of errors in the work performed. Unfortunately

perhaps, errors and output are not linearly related variables which may cancel each other out; normally an initial increase in output is accompanied by a smaller increase in errors, whereafter the output increases in smaller units than errors. This is why underwater performance may be better than surface performance. However, this example is cited simply to show that an increase in anxiety may improve performance in situations where the testee is not given standards to maintain regarding a permissable error count, these levels of anxiety may not be conducive to fast learning as is desired in a diver training course.

5.2 Predictor/criterion relationships

Relationships between predictors and criteria are examined by the application of the Mann-Whitney U test (Siegel, 1956) to the differences in predictor scores of the above and below median achievers on criteria.

5.2.1 Predictor measures

Means and standard deviations of predictor measures are given in Table 19.

Table 19: Means and S.D.s of predictor measures

Area	Measure	Mean	S.D.
Arousability	GSR lability	63.0	35.3
Vulnerability	GSR L/R	1.34	.74
Information	CFF	57.5	6.2
Processing	Gottschaldt Figrues	21.4	8.5
	Reasoning Test (S3)	23.1	8.1
Indirect	Personality Questionnaire	25.8	6.6
Measures	Temperament Questionnaire	14.7	2.4
Motivation	Handgrip Time	1.53	.33

n = 22

5.2.2 Differences between high and low achievers

Predictor score means of high and low achievers are compared by means of the Mann-Whitney U test (Siegel, 1956). High and low achievement occurs in respect of anxiety (heart rate ratios), underwater performance (Reasoning Test score ratios) and ratings. Results are given in Table 20.

Table 20: Differences in predictor means for high and low achievers

Criterion	Anxiety			UW Performance			Rating		
Measure	Low	High	Diff.	High	Low	Diff.	High	Low	Diff.
GSR lability	68	58	n.s.	70	53	n.s.	64	55	n.s.
GSR L/R	1.2	1.4	n.s.	1.1	1.5	n.s.	1.5	1.4	n.s.
CFF	55	60	.05	57	58	n.s.	59	55	n.s.
Gottschaldt Fig.s	20	23	n.s.	19	24	n.s.	22	21	n.s.
Reasoning T. (S3)	24	21	n.s.	-	-	-	23	23	n.s.
Personality Quest.	25	26	n.s.	25	26	n.s.	25	26	n.s.
Temperament Quest.	14	14	n.s.	14	16	n.s.	14	15	n.s.
Handgrip Time	1.7	1.4	.02	1.6	1.4	n.s.	1.5	1.6	n.s.

n = 22

Results in Table 20 are generally disappointing; differences in means are more often in the opposite to the predicted direction. Of the two significant differences the first (CFF) may be ascribed to chance effects of the total number of calculations involved. The second significant difference (Handgrip time) may also be due to chance, however additional evidence comes from the knowledge that of the two trainees ejected from the T group before the end of two weeks, one failed due to an "inability to take it"* and that this person had the lowest handgrip time of the whole group.

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* Instructor's comment.

5.3 Discussion

On the whole, use of the concepts of susceptibility to arousal and rate of information processing did not lead to successful prediction. Analysis of criterion data was more fruitful and it was concluded that the following principles apply:

5.3.1 The best predictor of underwater performance is surface performance. If the subject is required to practice verbal reasoning underwater his performance may be predicted on an equivalent verbal reasoning task on the surface.

5.3.2 The statement in 5.3.1 is affected by anxiety as an intervening variable. Moderate to high levels of anxiety are accompanied by a negative relationship between anxiety and performance.

5.3.3 Mean level of anxiety experienced by a group of individuals is a function of training methods. However, variation about the group mean is a function of differences in the attributes of individuals. The purpose of second tier prediction was to predict these differences but this was unsuccessful and shall have to be followed up in new approaches.

To enhance the effectiveness of underwater adaptation in SAN divers three courses shall have to be adopted, viz. a change to NDT diver training methods, continued attempts to predict differences in arousal and an analysis of underwater performance variances.

CHAPTER 6 RESULTS AND DISCUSSION: FOLLOW-UP STUDY

This chapter deals with the results of the follow-up study. Promising predictors were re-applied in cross-validation and new predictors were provisionally evaluated.

6.1 Criteria

Four criterion factors, each described by a list of appropriate behaviours as emerged under the factor in the first tier prediction study, were applied by the instructors of groups A and B.

Intercorrelations among factor ratings for the two groups are shown in the following two tables.

Table 21: Group A; intercorrelations among factor ratings

Factor	DS	IA	TO	EM
Diving skill	100			
Intellectual ability	51*	100		
Task-orientation	84+	51*	100	
Emotional maturity	73+	79+	79+	100

n = 13, * $p < .05$, + $p < .01$.

In Table 21 all values are positive; decimal points are omitted.

As in the first tier prediction study, criterion factors are positively correlated with each other, two at the .05 level and four at the .01 level.

Table 22: Group B; intercorrelations among factor ratings

Factor	DS	IA	TO	EM
Diving skill	100			
Intellectual ability	51	100		
Task-orientation	53	76+	100	
Emotional maturity	48	56*	86+	100

n = 10, * $p < .05$, + $p < .01$.

In Table 22 all values are positive; decimal points are omitted.

One correlation value in Table 22 is significant at the .05 level and two at the .01 level. The remaining values are high but not significant, mainly because of the small sample size (n = 10).

In view of the high intercorrelations, a composite criterion score was calculated for each subject and given priority in the analysis of predictor/criterion relationships. Nevertheless factor ratings were included in the analyses where it was felt this may be of use to interpretation.

6.2 Predictor/criterion relationships

6.2.1 Cross-validation

Predictors included in the cross-validation study comprised the Gordon Personal Profile (GPP), Mental Alertness Test (MA), Bass Orientation Inventory (Oril), the Interview rating (IRa) and the Diving Knowledge (DK) Questionnaire. The DK Questionnaire was only applied to Group B as Group A had already undergone training in diving theory.

Results obtained in respect of groups A and B are given in the following Tables.

Table 23: Group A; predictor/criterion relationships

Predictors	Criteria DS	IA	TO	EM	Composite
Mental Alertness	14	02	16	11	00
GPP: Ascendancy	54*	26	26	20	25
Responsibility	51*	32	30	54*	60*
Emotional stability	63*	37	55*	46	53*
Sociability	45	27	18	15	21
Ori: Task-orientation	10	-17	09	04	04
Interaction-orient.	14	12	-16	03	00
Self-orientation	-31	11	09	-12	05
Interview rating	45	61*	35	58*	48*

n = 13, * $p < .05$.

In Table 23 decimal points are omitted; all values are positive unless indicated otherwise.

Table 24: Group B; predictor/criterion relationships

Predictors	Criteria DS	IA	TO	EM	Composite
Mental Alertness	-30	-35	-35	00	-44
GPP: Ascendancy	-07	03	-05	01	-01
Responsibility	02	68*	73*	72*	57*
Emotional stability	-49	-03	-02	14	-16
Sociability	-25	-03	-44	-33	-34
Ori: Task-orientation	-16	-06	18	02	-05
Interaction-orient.	-09	-05	-20	-05	00
Self-orientation	38	28	25	16	40
Interview rating	03	30	34	33	26
DK Questionnaire	27	-23	-24	-11	-23

n = 10, * $p < .05$.

As before, decimal points are omitted in Table 24 and all values are positive unless specified otherwise.

Tables 23 and 24 reflect the different prediction configurations that are obtained in respect of two differently trained groups, viz. training methods following NDT methods (Group A) and traditional methods (Group B). While these courses were not the same as those used in a comparison of experimental methods (Deppe, 1970), present courses followed on the latter and were conducted by the same instructors.

On the whole prediction was more successful in respect of Group A. The Responsibility scale was a highly successful predictor as in the first tier prediction study and the Interview rating was significantly associated with the Composite criterion at the .05 level. The Mental Alertness Test and the Self-orientation scale failed to materialise as predictors. Emotional Stability on the other hand, significantly related to performance ($p < .05$) in this group. Sociability, while not significantly associated with any criterion, took a positive direction in the obtained relationships in contrast to the negative relationships in the first tier prediction study. The general trend in Table 23 is to positive relationships, out of the 45 correlation values 41 have a positive sign, lending support to a previous conclusion that there is a general, diffused relation between personality attributes in a favourable direction with diver success.

Results in respect of Group B present a markedly different picture. The only similarity in the configurations is the emergence of Responsibility as a successful predictor and the non-emergence of Mental Alertness as a successful predictor. Tendencies found in the first tier prediction study with regard to Self-orientation and Sociability are supported in moderate but non-significant correlations ($r_s = .40$ and $-.34$). The DK Questionnaire failed to show a positive relationship with the criterion. Finally, of the total number of 50 correlation values, 27 had negative signs which is approximately the number that would be expected on a purely chance basis. The negative but non-significant relationship between Mental Alertness and the Group B Composite criterion is in the opposite to the predicted direction and raises interesting opportunities for speculation - Zubek (1969, p. 442) quotes evidence that the conceptually simple person is more likely to be stress-resistant than the conceptually complex person, this may be reflected in the course of the Mental Alertness Test scores in the more stressful T group training. While it may be argued that Mental Alertness should have related positively to at least the Intellectual Ability criterion, it may be, and all results

point in this direction, that the presence or absence of anxiety overrode other interindividual differences and that measures are in fact predicting stress-resistance.

Another point worth noting in a comparison of group results is that Self-orientation and unsociability, normally grouped among less desirable personality traits, are characteristic of the high performer in stressful training. This finding is reminiscent of those obtained in respect of frogman training by Heyder et al. (1964) who found that subjects who passed the course were more Self-oriented than those who failed, were more anxious, less able to verbalize and were interpreted as following self-destructive and masochistic aims.

The implications of this study are perfectly clear; NDT training methods shall have to become firmly entrenched before appropriate selection can be applied. The alternative is to provide different means of selection to groups trained by different methods. Up to this point the methods of two instructors have been compared, what about all the other instructors with their own variations in diver training methods?

6.2.2 New predictors

Predictors which were applied in the follow-up study for the first time were certain biographical and encephalographical variables, the Minnesota Multiphasic Personality Inventory (MMPI), a Need-Achievement (N-Ac) measure, risk-taking and aggression measures and selected physiological variables. The predictors either follow from recommendations in the first and second tier prediction studies or retest findings by other researchers in respect of prediction of diver success.

6.2.2.1 Biographical variables

Diver success has been reported to be related to age (Deppe, 1966; Radloff et al., 1968) in favour of high age while Caille (1969) reports that failure rates are related to age as 75% for 19 year-olds, 12% for 25 year-olds and 100% for those of 30 or older. Radloff et all. (1968) also found, in his study of adaptation in extended deep submergence, that birth order was indicative of diver performance with laterborns more successful than first-borns ($p < .01$) and that individuals from small towns

fared better than those from large towns ($p < .05$). Finally, a previous Commanding Officer of the Diving Establishment* expressed the conviction that trainees who smoked and drank alcohol were certain to fail the course; these ideas were also tested.

(a) Age

In Group A the correlations between age and the criteria were as follows: Diving skill, .23; Intellectual ability, .41; Task-orientation, .16; Emotional maturity, .52 ($p < .05$), and with the Composite criterion, .42.

In Group B the correlations were: Diving skill, .19; Intellectual ability, .32; Task-orientation, .14; Emotional maturity, .16, and Composite criterion, .10.

In Group A all values were positive and moderately high, reaching the .05 level of significance in one case. In Group B the values were positive but low.

An attempt was made to search for a curvilinear relationship between age and performance but none was apparent to the eye after scores were plotted. The present sample (mean age 19.5 years, range 18 to 24 years) covers the lower-age part of Caille's proposed curvilinear relationship, and provides supportive evidence for the existance of this part of the curve but not for the relationship concerning those over 24 years.

(b) Birth order

In the present study there was no significant performance difference between first-borns and later-borns. In Group A the 3 first-borns out of the sample of 13 were ranked 2nd, 8th and 11th in terms of the Composite criterion. In Group B the one first-born was ranked 4th out of the 10 subjects.

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* Lt. Cmdr. P. Viljoen

(c) Size of home town

Subjects were classified as spending the greater part of their lives in small towns or in cities and the obtained frequencies were compared with above and below-median performance on the Composite criterion. There was a slight tendency for the more successful divers to come from towns rather than cities but when tested by the Fisher Exact Probability Test (Siegel, 1956) this difference yielded a probability of .28, far short of the .05 level required. Groups A and B were combined for this investigation.

(d) Smoking and drinking

Group A and B trainees were dichotomized around the median into "good" and "poor" divers according to position on the Composite criterion. Good and poor divers of both groups were combined for the comparison. Regular smoking occurred in 73% of good divers and in 54% of poor divers. While the consumption of alcohol was reported in 82% of good divers and in 64% of poor divers. The differences are not significant and therefore due to chance. They do demonstrate, however, the risk of accepting hypotheses from belief rather than evidence.

6.2.2.2 Electroencephalographic variables

Caille (1969) maintained that a fast, "flat" alpha rhythm in the EEG record was a feature of divers who had failed on training courses.

As it was felt that as characteristics of the alpha rhythm may reflect a condition of arousal, which in turn was hypothesized to play an important role in diving, both Diving skill and the Composite criterion were used in the present analysis. Alpha amplitude and frequency were measured, evenly weighted in the expected direction (low amplitude plus high frequency), and correlated with the criteria.

In Group A alpha properties correlated .34 with Diving skill and .03 with the Composite criterion. In Group B the respective correlations were .28 and .32. These values are not significant but are promising and justify a closer look at the nature of the phenomena involved.

6.2.2.3 Minnesota Multiphasic Personality Inventory (MMPI)

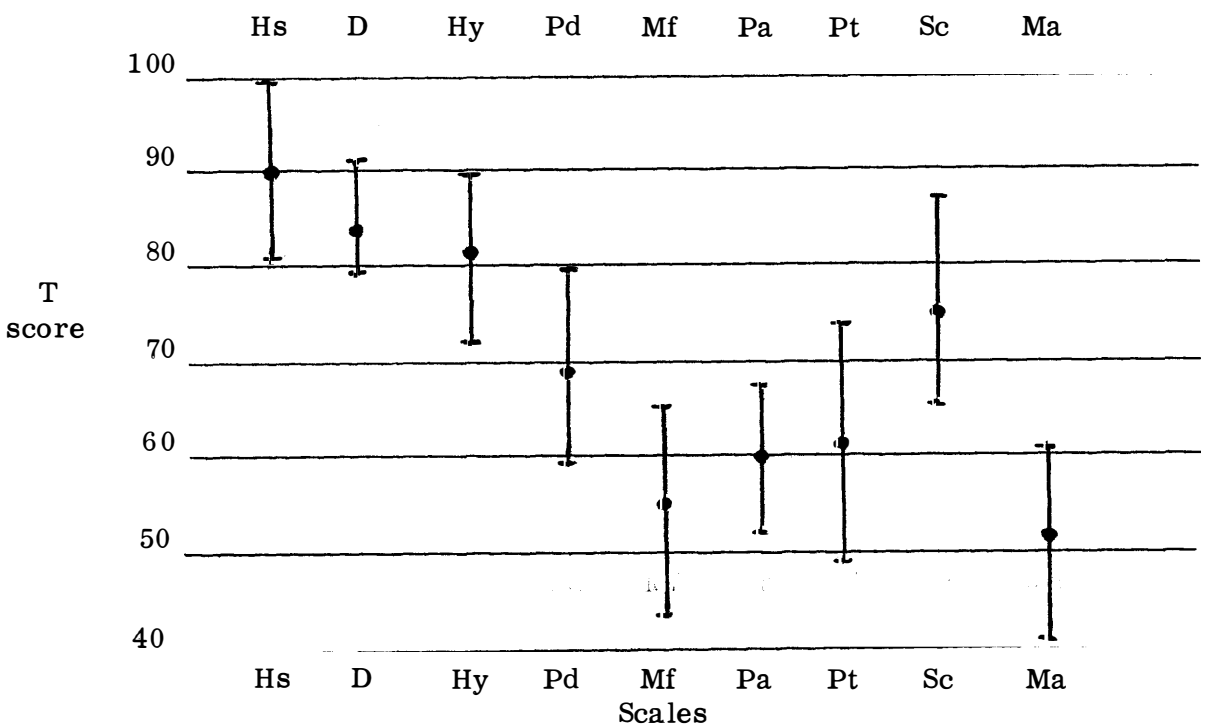
Results of the MMPI were considered in two ways, a profile of group scores was examined and correlations between scale scores and criterion ratings were considered for each group.

Scale abbreviations are listed below for reference.

Hs	Hypochondriasis
D	Depression
Hy	Hysteria
Pd	Psychopathic deviate
Mf	Masculinity-femininity
Pa	Paranoia
Pt	Psychasthenia
Sc	Schizophrenia
Ma	Mania

Combined sample means (circles) and standard deviations are shown in Figure 1.

Figure 1: Means and S.D.s of the combined sample on the MMPI



The group profile differed markedly from the expected profile which should have been grouped around the mean (T score 50) with a standard deviation of $\pm$ 10. The data would suggest that the group tested was highly selected. Agreement between individual scores on the scales, as indicated by the standard deviation distances, was so high as to be suspect, particularly in view of the fact that Biersner et al. (1970) found no significant differences between divers and a control group of Navy personnel on all scales but one (Mf) on the MMPI. The scores obtained in the present study may reflect the attributes of the late adolescent (the mean age was 19.5 years as compared to a median of 28 years in Biersner's study, it may reflect aspects of the testing conditions in that the lengthy questionnaire was applied during a hot afternoon after prolonged testing and trainees may have felt resentful by this time* or it may in fact be a realistic indication of the sort of person who volunteers for SAN diver training. If the latter proposition is true then it would follow that in the past an undefined problem facing the diving establishment has been to identify well-balanced individuals from a group in which psychopathology, as measured by the MMPI, is prevalent. The implications would be that screening of all individuals is required on the basis of MMPI scores before the selection procedures described in the remainder of this report are followed. Before such steps are taken, however, it would be advisable to verify the results obtained here with special attention given to the conditions of testing and trainee attitudes.

A second aim in applying the MMPI was to examine the relationships between scales and criteria. In this regard particular interest revolved around the Pd and Mf scales; Caille (1969) reported a negative relationship between the former and diving success and Biersner et al. (1970) found that divers gave lower Mf scores, i.e. in the direction of greater masculinity, than did controls.

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* In interviews it transpired that trainees were generally resentful about the number of interruptions that had occurred in the training course, e.g. parades, demands on instructors for operations, and now, testing.

Results of intercorrelations between MMPI scales and criteria are shown in Tables 25 and 26 for groups A and B respectively.

Table 25: Group A; correlations between MMPI scales and criteria

Scale	Criteria				Composite
	DS	IA	TO	EM	
Hs	-34	-37	-06	-27	-42
D	25	14	41	-04	02
Hy	-40	-38	-06	-33	-38
Pd	48*	05	34	41	45
Mf	-40	-38	-18	-36	-35
Pa	09	-06	21	-14	-06
Pt	09	01	13	11	12
Sc	34	-02	31	20	06
Ma	00	-34	13	-03	-03

n = 13, *p $<$ .05

In Tables 25 and 26 rank 1 was assigned to low scores on the scales. Decimal points are omitted.

Table 26: Group B; correlations between MMPI scales and criteria

Scale	Criteria				Composite
	DS	IA	TO	EM	
Hs	-68*	35	01	-10	-19
D	13	30	05	19	13
Hy	-03	-18	11	15	-02
Pd	14	22	24	52	30
Mf	64*	65*	62*	81**	58*
Pa	-20	35	33	49	32
Pt	-37	37	45	54	25
Sc	-25	25	39	38	16
Ma	27	18	59*	87**	56*

n = 10 *p $<$ .05, **p $<$ .01.

Results of the MMPI again demonstrated the substantial differences in predictive validities for the two groups. Caille's (1969) prediction regarding the Pd scale and diving success was affirmed in Table 25 with low Pd and Diving skill significantly related at the .05 level and other correlations involving Pd moderately high. In Table 26 the correlations between Pd and the criteria were generally low but positive, just falling short of the .05 level of significance (for $p<.05$, $r_s = .56$ with $n = 10$) in the case of Pd and Emotional maturity.

The Mf scale showed quite different trends for the two groups. In Group A the relationship was consistently negative but not significant, in Group B the relationships were positive and high throughout, once reaching the .01 level of significance. Superior divers in a stressful course therefore tended to view themselves as more masculine; again this finding is reminiscent of those of Heyder et al. (1964) in which successful frogmen trainees felt the need for "a masculine, adventurous occupation with self-destructive and masochistic implications."

The Ma scale was significantly related to Task-orientation ($p<.05$), the Composite criterion ($p<.05$) and to Emotional maturity ($p<.01$). The superior diver in the B group therefore tended to be ascendant, outgoing and enthusiastic according to the definition of this scale (Drake et al., 1959). As all scores fell well into the normal range (see Fig. 1) the extent of hypomania did not reach psychopathological levels accompanied by flights of ideas and mood instability.

A tendency for Hs and Hy scores in Group A to show an inverted relationship with diving success as well as for Hs and diving success in Group B to be negatively related provides some clues as to the nature of diving motivation. People who score high on these scales are body-orientated and are highly concerned about somatic disorders. In many cases therefore diving as a primarily body-centred skill may provide opportunities to "test the body" on a counterphobic principle. This would explain the high group mean Hs and Hy. Self-selection will follow this principle, but it does not explain why those who are body-oriented show superior adaptation as evidenced by the significant correlation between Diving skill and Hs in Table 26.

Many of the relationships and interpretations given here are tenuous and the only results which will be followed up for selection are those in respect of the Pd and

Mf scales. The former has been found to predict diving success elsewhere (Caille, 1969), shows a consistent pattern of relationships for both groups and logically fits into the selection pattern as the obverse of a predictor previously found to forecast diving success, viz. the Responsibility scale of the Gordon Personal Profile. The Mf scale would appear to be a highly successful predictor but only for traditional training courses.

6.2.2.4 Need-Achievement (n-Ach)

The need to achieve as measured by the test used here measures the desire to compete against a standard of excellence, in other words the extent of motivation allied to a target set by the subject himself. A ranking of n-Ach scores was correlated with criteria for groups A and B. Results are shown in Table 27.

Table 27: Need-Achievement and diving criteria

Criteria	Group A	Group B
DS	37	49
IA	-02	58*
TO	29	59*
EM	22	40
Composite	25	56*
n	10	13

* p .05

In three out of five correlations of n-Ach with Group B criteria values reached the .05 level of significance. Values for Group A were mostly positive but moderately low. A closer examination of scores indicated that Group A subjects clustered into sub-groups of very low and very high task-orientation; doubtless scores were affected by this accidental sampling feature.

A difficulty inherent to the test is the involved scoring procedure which requires a certain amount of expertise before confidence can be placed in its reliability. While this is acceptable in a research context, problems will be encountered in applied selection.

On the whole the approach is promising and it is recommended that attempts should be made to construct a simply and objectively scored modified version of the test.

6.2.2.5 Risk-taking

Correlations between risk-taking scores were calculated for a diving skill criterion* and for a combined criterion. This was done separately for the subgroups of sample C, viz. C1, C2 and C3. Unfortunately no calculations could be made in respect of sub-sample C3 and the diving skill criterion, ratings on a nine-point scale ranged from four to six on this sub-sample and criterion dimension, and this range is considered inadequate for determining correlation coefficients.

Correlation coefficients are shown in Table 28.

Table 28: Risk-taking and diving criteria

Group	Criterion	Measure A	B	Total	n
C1	DS	-04	23	10	14
	Comb.	-20	27	03	14
C2	DS	-32	22	-05	15
	Comb.	-16	13	06	15
C3	Comb.	-13	02	-22	9

There was a slight but non-significant tendency for willingness to take risks - as betting preferences - to be negatively associated with criteria. When the risk was defined as physical involvement there was a slight but non-significant positive association between risk-taking behaviour and diving performance. The trends in relationships are not high enough to justify inclusion of risk-taking measures in a diver selection battery.

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* Measures of risk-taking and aggression are considered to be particularly relevant to diving rather than to all criteria. However, the combined criterion is included as a check on the relationship with all criteria.

6.2.2.6 Aggression

As above, scales of aggression were compared with diving skill and combined criteria for the sample sub-groups with the exception of the diving skill criterion for sub-sample C3.

The scales are the following: Type of aggression is scaled as Direct (Di), Indirect (In) or Denied (De). Type of response is scored as Constructive (Co), Unconstructive (Un) or Destructive (Ds).

Results are shown in Table 29.

Table 29: Aggression scales and criteria

Group	Criterion	Scale	Di	In	De	Co	Un	Ds	n
C1	DS		48*	16	-41	-09	-16	54*	14
	Comb.		42	-07	-34	-30	-05	37	14
C2	DS		-37	20	06	05	13	-12	15
	Comb.		-24	25	18	24	-08	-14	15
C3	Comb.		-38	44	11	13	-03	-13	9

* p .05

To understand the trends in Table 29 it is again necessary to have a closer look at the training methods employed. Sub-sample C1 was allocated to the trainer conducting traditional training, and C2 to the trainer applying NDT methods. Group C3 was trained by a third instructor who had been taught the principles of NDT methods with instructions to put them into practice.

Traditional group trainees who succeeded on the course were significantly direct and destructive in their aggression. Those who succeeded on NDT methods tended to express aggression indirectly and to show more constructive responses; the latter findings, however, must be interpreted as possible trends because no significant correlations emerged; on the other hand the fact that results are highly similar for groups C2 and C3 would suggest at least trial inclusion and use of scores in a selection battery.

CHAPTER 7 SUMMARY AND CONCLUSIONS

The development of a selection battery for Divers 3 was conducted in three stages, viz. the first tier prediction study, the second tier prediction study and the follow-up study.

The first tier study was focussed on diver training. Analysis of the demands in diver training was used as a basis for the choice of predictors and the development of a multi-dimensional criterion. The second tier study concentrated on the immersion part of diver training and tested the hypothesis that arousal and rate of information processing constitute the critical factors differentiating success and failure. The follow-up study cross-validated the findings of the first tier study and tested specific hypotheses which appeared from various sources, mainly from publications issued after the present project was started.

On the whole, prediction possibilities based on predictor/criterion intercorrelations in respect of a sample of 71 trainees promised moderate success. Prediction of underwater performance was markedly unsuccessful in the second tier study. The cross-validation study, which by coincidence was conducted on samples trained by different methods, clearly demonstrated how different effective criteria and prediction patterns associated with the two groups. Previously it was shown how NDT methods lead to superior underwater performance and less in-training stress (Deppe, 1970); in the present study it was shown that favourable scores on personality measures are associated with successful response to NDT methods and that unfavourable personality characteristics (e.g. Self-orientation and destructive aggression) and even conceptual simplicity contribute to success on the traditional course. The emphasis placed on diver training research is therefore fully justified by the results of the present study. Furthermore it is clear that, if diver selection is to be successful, NDT methods must in future be accurately and consistently applied.

7.1 The Diver 3 selection battery

The final choice of instruments for the Diver 3 selection battery was based on previously described studies and takes into account the magnitude of predictor/criterion correlations, the consistency with which a predictor related to the

criterion when used in more than one study, as well as practical considerations regarding the ease with which a test can be scored and applied and the expertise required for interpretation.

The battery was compiled with three principles in mind. In the first place those instruments were included which predict success in a diving course run on NDT principles. This step is taken as NDT training has been shown to lead to superior results in comparison with traditional training (Deppe, 1970) and because the present study has demonstrated that those personality features which may be termed positive, socially desirable and generally conducive to success in occupations, promote success in NDT but not in traditional training. In the second place diver testing must be conducted by the NIPR until such time as the necessary expertise in respect of this particular selection battery becomes available in the military setting. The expertise referred to comprises training in the interpretation of the Aggression and Gordon measures as well as a certain degree of training in the psychology of diving in order to ensure effective use of the interview as a selection instrument. The third principle is that a sequential selection strategy should be followed; this is an efficient procedure and economizes on time and effort.

The acceptance-rejection decision should take place after the first stage of testing and again after the second stage which should comprise the interview. Weights are subjectively assigned to the scores which are obtained from the instruments used in Stage 1, these weights being based on the factors mentioned in the first paragraph above. In view of the consistently high intercorrelations between criterion dimensions, differential prediction of single dimensions will not be attempted at this stage. (See "Recommendations").

A proposed diver report form is given in Appendix III.

First stage instruments and their weights are shown below.

Stage 1:

GPP:	Ascendancy	0.7	Mental Alertness (I.B.)		0.8
	Responsibility	1.7	MMPI:	Pd Scale	0.4
	Emotional Stability	1.0	PST:	Direct Aggr.	-0.3
	Sociability	0.0		Indirect Aggr.	0.3
	Age	0.4			

The Gordon Personal Inventory should also be applied, with all scales weighted zero, to make these scores available for follow-up studies. With the anticipated change to NDT methods this instrument may still show predictive validity (See "Recommendations").

Stage 2:

The second stage should consist of the interview. As in the studies described in this report, the interview should be conducted without knowledge of other predictor scores. The subject should be rated on a 9-point scale in terms of "overall acceptability".

7.2 Acceptance - rejection strategy

The selection ratio largely determines the effectiveness of selection. As a general principles the larger the proportion of candidates in relation to the proportion accepted, the higher the mean level of diver potential in the accepted group.

In Diver 3 selection the number of candidates and the number that can be accepted varies from course to course. It is therefore not feasible to set cut-off points for test scores and to base the selection decision on them. The strategy called for involves subtracting the number of trainees required from the number of applicants, and dividing the remainder by half to denote the number that can be rejected at each stage of selection. Assume that 30 candidates volunteer and that ten of these will be accepted. The number to be rejected at each stage is calculated as:

$$\frac{30 - 10}{2} = 10.$$

7.3 Recommendations

1. It is recommended that the Diver 3 selection battery as described above be used by SAN and applied by NIPR as the need arises.

2. It is further recommended that performance appraisal be conducted on each course, using the rating schedule developed and previously used for this purpose. The aim of the appraisal exercises would be to record criterion information for the purpose of:

2.1 Permitting final validation of the predictors used in this study on a comparatively large sample (bearing in mind the restrictions of what will then be a highly selected group);

2.2 Permitting accurate determination of the weights assigned to predictors.

3. Finally, it is recommended that a cross-validation, as set out in 2., be conducted when the sample size has reached 100.

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APPENDIX

APPENDIX I

STATEMENTS USED FOR RATINGS IN FIRST TIER STUDY

1. (Pos) Has a stable and mature approach to life, e.g. is consistent and even-tempered, has a sense of responsibility, is confident, etc.

   (Neg) Has an unstable and immature approach to life, e.g. is moody, impulsive, self-centered and generally lacks confidence.

2. (Pos) Accepts authority without resentment, e.g. generally accepts instructions, makes suggestions helpfully rather than argumentatively, etc.

   (Neg) Resents authority, e.g. becomes hostile, complains to others, etc. when given a reasonable instruction.

3. (Pos) Flexible in his approach to problems and other persons, e.g. fully accepts solutions to problems which are better than his, easily adapts to any diving role (supervisor, standby diver, timekeeper, etc.)

   (Neg) Rigid and uncompromising in his approach to problems and other people, e.g. will not change his viewpoint even if proved wrong, persists in wrong diving, searching, etc. methods.

4. (Pos) Cautious and systematic in his approach to problems, e.g. considers all aspects of a problem, carefully plans his approach to a job.

   (Neg) Impulsive and inconsistent in tackling problems, e.g. jumps to conclusions, will tackle problems without considering various aspects.

5. (Pos) Is persistently enthusiastic about his work, e.g. frequently discusses aspects of diving with others, studies on his own, etc.

   (Neg) Usually lacks enthusiasm, e.g. avoids discussing diving matters, not interested in furthering knowledge of diving, etc.

6. (Pos) Can always be relied upon to be consistent and thorough in his work without supervision, e.g. will conduct a thorough search even though it will not be obvious how well he did it.

(Neg) Cannot be relied upon when not closely supervised, e.g. will pretend he searched an area properly without having done so.

7. (Pos) In his general outlook he is more concerned with the task or job at hand than with his status among his fellows, e.g. he is more interested in doing a job properly than in being known as a good fellow.

(Neg) Is more concerned with "putting up a good front" or being well-liked than in doing a job properly, e.g. will try to gain credit whenever possible or mix with his friends when he should be planning or working.

8. (Pos) He allies himself with the general aims of the (diving establishment).

(Neg) He dislikes the (diving establishment) generally and does not identify with it.

9. (Pos) Maintains high standards of performance under physical stress, e.g. in cold dirty water, exhausting swims, etc.

(Neg) Performance drops badly under conditions of physical stress, e.g. he gives up easily, bungles jobs, etc.

10. (Pos) Maintains high performance under emotional stress, e.g. under N_2 narcosis, low visibility, dangerous work, etc.

(Neg) Performance drops markedly under emotional stress, e.g. panics when he experiences nitrogen narcosis and threat, is often excessively anxious, etc.

11. (Pos) Remains calm and rationally makes decisions when confronted with a number of problems simultaneously, e.g. in an emergency he remains calm and carries out the correct drills.

(Neg) Becomes confused and agitated when confronted with a number of problems simultaneously, e.g. in an emergency he becomes flustered and either looks to others for decisions or takes incorrect action.

12. (Pos) Is realistic about dangers, e.g. does not show more (or less) fear than the situation warrants.

(Neg) Is unrealistic about dangers, e.g. exaggerates dangers and shows excessive fear or else ignores dangers and is foolhardy.

13. (Pos) He co-operates well in teamwork, e.g. adjusts to his fellow diver's movements, is concerned about his buddy's welfare.

(Neg) Does not co-operate in teamwork, e.g. goes his own way, hampers team efforts, does not look after his buddy diver.

14. (Pos) Enjoys good personal relationships with others by being consistently pleasant and friendly, e.g. enjoys being with others, encourages people.

(Neg) Frequently conflicts with people or does not interact with them, e.g. does not argue, criticize or ignore others.

15. (Pos) Has good insight into the feelings and reactions of others, e.g. understands other people, realises how they feel and does not hurt their feelings, etc.

(Neg) Has very little insight into others, e.g. does not understand others, does not know how to handle them, hurts people without realizing it.

16. (Pos) Has common sense and the ability to put new ideas or tools into practice, e.g. can successfully apply a new piece of equipment using his initiative to sort out minor problems.

(Neg) Shows a lack of common sense and an inability to put new ideas or tools into practice, e.g. needs constant advice to apply a new tool correctly, must be prompted or uses initiative unrealistically and unsuccessfully.

17. (Pos) He learns quickly in both theoretical work e.g. use of formulae, principles of pressure and in practical diving, e.g. quickly learns searches, lifesaving. etc.

(Neg) Slow to learn theoretical work. e.g. cannot follow formulae or make advanced calculations and in practical diving, e.g.operates equipment incorrectly, bungles searches, etc.

28. (Pos) Quickly learns and easily remembers formulae and fully understands their construction, e.g. in explaining how formulae are derived, he easily rebuilds formulae from principles of volume, pressure, etc.

(Neg) Has difficulty understanding, remembering and explaining formulae, e.g. often asks advice on how to calculate gas proportions, etc. Is often at a loss to explain formulae in the classroom, etc.

29. (Pos) Good at figures, i.e. his calculations are always correct.

(Neg) Frequently makes mistakes in calculations, i.e. they must always be checked.

APPENDIX II

SAN DIVER 3 RATING SCHEDULE

INSTRUCTIONS

This is a rating schedule in which each trainee is rated on a nine-point scale in respect of four criterion dimensions, viz. diving skill, intellectual ability, task-orientation and emotional maturity.

To rate subjects follow the procedure outline below:

1. Read the positive and negative definitions of diving skill only and rate all subjects on these definitions.

2. Next, rate subjects on each of the other criterion dimensions, completing ratings on one dimension before studying the next one.

3. Look at the lower set of columns (Rating, %, etc.). Establish, for the number of subjects in your group, how many comprise 10%, 30%, etc., of the total and write the obtained figures under "approximate frequency".

4. Count, under "diving skill", the frequencies of ratings 1 and 2, 3 and 4, 5, etc., and enter the frequencies in column a. The frequencies should be roughly the same as those under "approximate frequency". If not, you have been too strict in your assessment, or too lenient, or have not used the extremes, etc. Adjust your ratings accordingly.

5. Do the same for remaining criterion dimensions.

DIVING SKILL

9	8	7	6	5	4	3	2	1

This trainee:

(a) Is highly proficient in all diving skills, e.g. in sharing air.

(b) Functions very well in a variety of diving conditions.

(c) Maintains high performance under emotional stress, e.g. in low visibility.

(d) Maintains high performance in physical stress, e.g. cold water.

(e) Is proficient at assembling and operating tools, diving equipment, etc.

Group Average

This trainee:

(a) Is clumsy underwater, e.g. bungles sharing air.

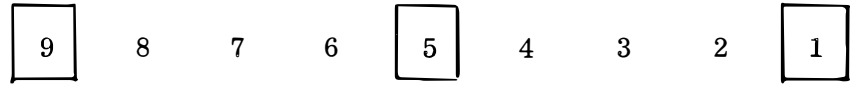
(b) Loses critical faculties when diving in varied conditions, e.g. responds incorrectly to signals.

(c) Performance drops markedly under emotional stress, e.g. excessively anxious.

(d) Performance drops markedly under physical stress, e.g. gives up easily.

(e) Clumsy and makes mistakes in assembling or operating equipment.

TASK-ORIENTATION



This trainee:

(a) Is more concerned, in his general outlook, with the task or job at hand than with his status or popularity among his fellows, i.e. he is more interested in doing a job properly than in being known as a good fellow.

Group Average

This trainee:

(a) Is more concerned with "putting up a good front" or being well-liked than in doing a job properly, e.g. he will try to gain credit whenever possible or mix with his friends when he should be planning or working.

INTELLECTUAL ABILITY

9	8	7	6	5	4	3	2	1

This trainee:

(a) Is good at calculations.

(b) Quickly learns and easily remembers formulae and understands their construction.

(c) Can express himself clearly and accurately, e.g. can explain a complicated idea simply.

(d) Keeps an overview of problems and remembers details but does not lose sight of main objectives.

(e) Is quick to grasp mechanical principles, e.g. of diving equipment.

Group Average

This trainee:

(a) Frequently makes mistakes in calculations.

(b) Has difficulty in understanding, remembering and explaining formulae.

(c) Cannot put ideas across, i.e. does not present ideas in understandable form.

(d) Becomes so confused and lost in details that he cannot maintain an overview of the problem at hand, e.g. cannot see what is and is not important in the problem.

(e) Is slow in grasping mechanical principles.

EMOTIONAL MATURITY

9	8	7	6	5	4	3	2	1

This trainee:

(a) Enjoys good relations with others by being consistently pleasant and friendly.

(b) Is realistic about dangers, i.e. not foolhardy or overly anxious.

(c) Has a stable and mature approach to life, e.g. even-tempered, responsible, confident, etc.

(d) Has good insight into the feelings and reactions of others.

(e) Is flexible in his approach to problems and other people, e.g. easily adapts to diving roles.

Group Average

This trainee:

(a) Frequently conflicts with people or does not interact with them.

(b) Unrealistic about dangers, e.g. either very anxious or foolhardy.

(c) Has an unstable and immature approach to life, e.g. moody, impulsive, self-centred, lacks confidence.

(d) Has very little insight into others.

(e) Rigid and uncompromising in his approach to problems and other people, e.g. persists in erroneous views.

Name	Diving Skill	Intellectual Ability	Task-Orient.	Emotional Maturity	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

Rating	%	Approximate Frequency	a	b	c	d	
1 & 2	10						
3 & 4	30						
5	20						
6 & 7	30						
8 & 9	10						

Rater's name: . . . . . .

Date: . . . . . .

23. (Pos) Can express himself clearly and accurately, e.g. by his choice of words he can put a complicated idea across simply, can say what he means in a few words, etc.

(Neg) Cannot put ideas across, i.e. does not present ideas in an understandable form, e.g. explains in a roundabout fashion, has to re-explain his ideas to others, etc.

24. (Pos) Quick to grasp mechanical principles, e.g. when instructed on the design of diving equipment and underwater tools, etc. he is quick to understand their structure and operation.

(Neg) Slow in grasping mechanical principles, e.g. has difficulty understanding mechanical principles and design in such items as demand valves, UBA set, underwater tools, etc.

25. (Pos) Proficient at assembling and operating tools, diving equipment and other machinery, e.g. quickly assembles and sets up equipment.

(Neg) Clumsy and makes a number of mistakes when assembling or operating equipment and machinery, e.g. strips threads, slow in assembling equipment, etc.

26. (Pos) Highly proficient in all diving skills, e.g. expertly maneuvers his body, shares air skillfully, works well in any body position, etc.

(Neg) Is clumsy underwater, e.g. swims into other divers and obstacles, bungles sharing air techniques, gets tied up in his own equipment, etc.

27. (Pos) Functions very well in a variety of diving conditions, e.g. maintains his sense of direction at all times, is calm and collected underwater, etc.

(Neg) Loses critical faculties when diving in varied conditions, e.g. loses his sense of direction, has to be given signals a number of times before he responds, is anxious and frightened underwater.

18. (Pos) He keeps an overview of problems and, while taking details into account, does not lose sight of main objectives, e.g. when deciding on a plan of action he chooses the most effective and economical (in terms of time and effort) and remembers to consider regulations, to see that log times are noted, etc.

(Neg) He becomes so confused and lost in details that he cannot maintain an overview of the problem at hand, e.g. has great difficulty in deciding on a plan of action because he does not discriminate between what is, and is not, important in the problem.

19. (Pos) When required to lead he does so very successfully, e.g. as supervisor he constantly directs and controls the operation, as No. 1 diver he leads effectively, etc.

(Neg) Fails in leadership roles, e.g. hitches, delays and inefficiencies occur in operations he supervises, etc.

20. (Pos) Effectively organizes and leads group effort without being authoritarian, e.g. gets people to carry out jobs as a team, instilling enthusiasm, etc. without being bossy.

(Neg) Cannot get the group to produce a team effort without being authoritarian, e.g. pulls rank, bosses others and generally lowers the morale and frustrates the efforts to work together smoothly.

21. (Pos) His leadership is fully accepted by others, e.g. others turn to him for solutions to problems, show confidence in him, etc.

(Neg) His attempts to lead (e.g. as supervisor) are rejected by others, e.g. his proffered solutions are rejected or disregarded, others lack confidence in him, etc.

22. (Pos) Can express himself fluently, e.g. is never at a loss for words to convey an idea to others, talks easily and naturally.

(Neg) Has difficulty in expressing himself, e.g. frequently searches for words to express ideas, may stutter and search for the right word.

APPENDIX III

DIVER 3 REPORT FORM

Subject:

Surname_____ Initials_____ Date _____

Birthdate_____ N.S. No. _____ Tester_____

Stage 1 testing

		RS	T_w
Mental Alertness Test (Interm. Batt.)		_____	_____
G.P. Profile:	Ascendancy	_____	_____
	Responsibility	_____	_____
	Rmotional Stability	_____	_____
MMPI:	Psychopathic Deviant Scale	_____	_____
PST:	Direct Aggression Scale	_____	_____
	Indirect Aggression Scale	_____	_____
Age:		_____	_____

Total

Stanine

Decision

Accept	Reject

Stage 2 interview

Overall Suitability Rating

1 2 3 4 5 6 7 8 9

Comments by interviewer _____

_____

_____

_____

_____

Final decision

Accept	Reject

Signed: _____