Mental health measures in predicting outcomes for the selection and training of navy divers

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Key words
Psychology, military diving, training, performance, questionnaire, research

Abstract
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Introduction: Two models have previously been enlisted to predict success in training using psychological markers. Both the Mental Health Model and Trait Anxiety Model have shown some success in predicting behaviours associated with arousal among student divers. This study investigated the potential of these two models to predict outcome in naval diving selection and training.
Methods: Navy diving candidates (n = 137) completed the Brunel Mood Scale and the State-Trait Personality Inventory (trait-anxiety scale) prior to selection. The mean scores of the candidates accepted for training were compared to those who were not accepted. The mean scores of the candidates who passed training were then compared to those who failed. A number of trainees withdrew from training due to injury, and their scores were also compared to those who completed the training.
Results: Candidates who were not accepted were more depressed, fatigued and confused than those who were accepted for training, and reported higher trait anxiety. There were no significant differences between the candidates who passed training and those who did not. However, injured trainees were tenser, more fatigued and reported higher trait anxiety than the rest. Age, gender, home language, geographical region of origin and race had no significant interaction with outcome results.
Conclusions: While the models could partially discriminate between the mean scores of different outcome groups, none of them contributed meaningfully to predicting individual outcome in diving training. Both models may have potential in identifying proneness to injury, and this requires further study.

Introduction

Anxiety and panic experiences are common occurrences in recreational scuba diving.[1,2] Although one study could not predict actual panic events using trait anxiety in experienced scuba divers,[3] trait anxiety has been identified as a predictor of panic in beginner diving students.[4] Very low and very high levels of arousal could be expected to predict poor performance, and it has been demonstrated that as divers' stress and subsequent arousal increases, so their performance decreases.[5] Panic experiences are extreme forms of autonomic arousal.

Given the costs of diving training, and the risks associated with increased anxiety (i.e., poor task performance, panic, fatalities), two models have been enlisted to predict success in training using psychological markers. These are the Mental Health Model (MHM) and Trait-Anxiety Model (TAM).

MENTAL HEALTH MODEL

The MHM specifies that positive mental health enhances the likelihood of success in sport, whereas psychopathology is associated with a greater incidence of failure.[6] The model uses the Profile of Mood Scale (POMS) to measure psychological distress. This widely used measure identifies and assesses transient, fluctuating affective mood states.[7] The POMS measures six identifiable affective states (tension, depression, anger, vigour, fatigue and confusion).

Elite athletes were found to possess a unique mood profile, which was labelled the 'iceberg profile'.[6] The term refers to the graphic picture that POMS raw scores create when they are plotted on a profile sheet. Successful athletes tend to possess more of an iceberg profile than less successful athletes. However, the usefulness of the iceberg profile to predict sporting performance has been questioned.[8,9] For example, it was found that the POMS accounted for only 1% of general performance outcomes,[8] although it is much more effective as a predictor of single performance.[10] Recent research indicated the utility of the shorter version of the POMS, the Brunel Mood Scale (BRUMS) in predicting dichotomous (win/lose) outcome in some sport competitions, and academic performance.[11–14]

In spite of the above, the POMS is still widely used. Good concurrent and criterion validity have been reported for the BRUMS,[11] and South African (SA) norms for elite athletes are available.[15] Further, a number of studies reported the use of the POMS for diving research, with two that are of particular interest here. The POMS was included in a national diver survey (n = 245 USA scuba divers), and it was found that divers conform to the typical iceberg profile associated with successful athletes across a variety of sports.[16] Divers as a group scored lower than age-matched

controls in undesirable mood variables such as tension and depression and higher for the desirable factor of vigour. Another study followed 42 student scuba divers through 16 weeks of training and found that the POMS (total mood score) predicted students who exhibited panic behaviours better than chance, but was less powerful in predicting panic than using trait-anxiety scores.[17]

TRAIT-ANXIETY MODEL

Trait anxiety represents an enduring feature of a person's personality, and reflects a person's general experience of anxiety. The State-Trait Anxiety Inventory (STAI) and the State-Trait Personality Inventory, Trait Anxiety (STPI) are the most widely used measures of trait anxiety.[18]

The trait-anxiety model (TAM) posits that individuals with higher trait anxiety are at higher risk for panic experiences during diving. The STPI appears to differentiate sporting performance at elite level.[19] One mechanism could be the association between high trait anxiety and measures of chronic elevated arousal.[20] In this regard trait anxiety was originally identified as a predictor of panic in beginner diving students.[4]

More recently, the TAM was tested in the study of the 42 student scuba divers.[17] It was predicted that students with STAI trait-anxiety scores ≥ 39 would exhibit panic behaviour during training. This produced an accurate prediction rate of 83%.[17] Trait anxiety and panic were considered in experienced scuba divers (n = 1415 male divers), using the STPI population average to predict panic.[3] This produced an overall prediction rate of 21%, which questioned the value of the trait-anxiety model. However, when the STPI average score + 1 standard deviation was used, the overall prediction rate went up to 81%.[3] Using survey data, no significant difference was found in average trait anxiety (STPI) scores between panickers and non-panickers among experienced scuba divers.[3]

RATIONALE FOR THIS STUDY

The above models have shown some success in predicting panic behaviours (among others), and they may, therefore, also be useful to predict other performance outcomes associated with heightened arousal. Elevated levels of anxiety or psychological distress may pose a particular risk for adverse underwater experiences. Predicting this would then be important from both safety and training perspectives.

South Africa is a country with limited resources with many social demands vying for restricted state funding. Military diving training is expensive, and accurate prediction of performance (i.e., 'success') may improve selection, thus maximising the use of the limited resources available to the military. This study set out to test the MHM and TAM in the South African Navy (SAN) diving environment, to determine whether any of these models would contribute to predicting success in diving training in the South African context, with its multicultural landscape and, in particular, in its naval context. The usefulness of the models and the value of their measuring instruments were investigated. Measurements were taken prior to any diving involvement, and were used to predict success in selection, as well as overall success during the diving training programme.

Methodology

PARTICIPANTS

Ethics approval for the study was obtained from the South African Military Health Service Ethics Committee. One-hundred-thirty-seven navy sailors (mean age 27.3, SD 6.0), applied to do a volunteer-only entry-level military diving course. Participants completed the BRUMS and STPI on the day prior to their selection. After selection, 73 sailors, 62 men and 11 women (mean age 28.1, SD 6.2) commenced with training. Candidates came from diverse race and language groups and geographical regions of origin. All participants were medically healthy, having completed a comprehensive diving medical assessment (including psychological screening) prior to their selection.

MEASURES

BRUMS

The BRUMS is a shortened version of the POMS.[11,15] It consists of 24 mood items that measure six identifiable affective states through a self-report inventory, with respondents rating a list of adjectives on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely), based on subjective feelings. The instructions referred to how participants "*have been feeling in the past week, including today*". The six mood state subscales are tenseness, depression, anger, vigour, fatigue and confusion. A Total Mood Distress (TMD) score can also be calculated.

STPI

The STPI is a self-administered, 10-item questionnaire, consisting of the ten most valid items from the STAI, designed to measure dispositional anxiety in adults.[18] Respondents rate statements on a four-point frequency scale. Scores range from 10–40, with higher scores indicating a greater level of trait anxiety. The SAN mean is 14 (SD 4) for both women and men.[21]

SELECTION OUTCOME

Selection outcome was either 'accepted' or 'not accepted'. This was based on the decision of an independent naval panel, who were naive about the psychometric measurement results. Acceptance into the training programme is based on objectively prescribed criteria.

PERFORMANCE DURING TRAINING

Performance or success during training is a complex concept and difficult to circumscribe. Successful completion entails candidates having to meet both academic and physical requirements as set down in naval policies. For ease of analysis, two categories were created to describe outcomes, namely qualify within the prescribed time-frame ('pass'), and not qualify within the prescribed time-frame ('fail'). A third category ('injured') was added later, when it became apparent that a number of candidates did not complete the course as a result of injuries.

STATISTICAL ANALYSIS

Prediction rates for the BRUMS were determined using mean score only, as well as mean score +/-1 SD. Prediction rates for the STPI were determined using the SAN mean of 14, as well as +/-1 SD. Overall prediction rates were calculated by dividing the number of accurately predicted cases by the total and reporting the result as a percentage. Comparisons of outcomes were done by means of a t-test for independent groups for selection outcomes, and by means of ANOVA for training outcomes. Effect sizes were calculated using Cohen's d, and eta squared, respectively.

Results

SELECTION OUTCOMES

Of the 137 candidates, 83 (60.6%) were selected for the diving course. The BRUMS failed to predict acceptance significantly better than chance would. Although candidates who were selected did not display a more distinct iceberg profile than candidates who were not (Figure 1), there were significant differences in three of the subscales and the TMD scale (Table 1). Candidates who were not accepted were more depressed ($P < 0.01$), more fatigued ($P < 0.05$), and more confused ($P < 0.01$), and had a higher overall TMD score ($P < 0.05$). The effect size in each significant difference was only moderate.

Figure 1
Iceberg profile of 137 diving candidates per selection outcome

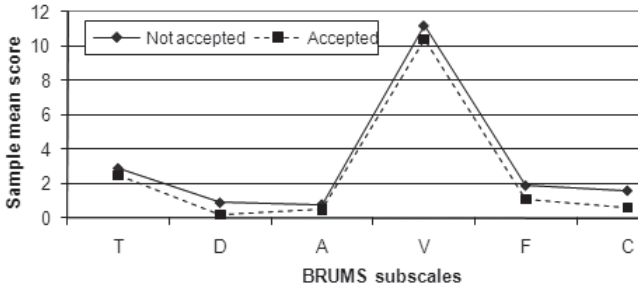


Table 1
BRUMS and STPI mean (SD for STPI) scores of study sample according to selection outcomes

	Not accepted (n = 54)	Accepted (n = 83)	t	d
BRUMS				
Tension	2.9	2.5	0.8	0.2
Depression	0.9	0.2	3.6‡	0.7
Anger	0.8	0.5	0.9	0.2
Vigour	11.2	10.4	1.5	0.3
Fatigue	1.9	1.1	2.2*	0.4
Confusion	1.6	0.6	3.1†	0.6
TMD	-2.9	-5.7	2.3*	0.4
STPI	14.1 (3.1)	12.5 (2.5)	2.7†	0.5

*$P < 0.05$, † $P < 0.01$, ‡ $P < 0.001$

The overall prediction rate for the STPI was only 60%. It correctly classified 86% of candidates who were accepted, but only 21% of those who were not. Candidates who were not accepted had a significantly higher mean score ($P < 0.01$) (Table 1).

As these self-report measurements were completed shortly before selection, the possibility of a response bias could not be excluded. However, inspection of scores revealed a normal distribution curve.

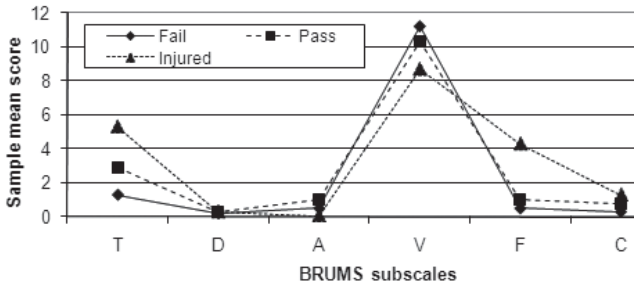
TRAINING OUTCOMES

Of the 83 candidates who were accepted after selection, 73 started on the diving course (ten had conflicting operational commitments). Forty seven (64.4%) qualified, 20 (27.4%) did not, while 6 (8.2%) did not complete the course because of injuries sustained during training.

The BRUMS again failed to predict success and/or failure significantly better than chance. Both 'pass' and 'fail' candidates displayed an iceberg profile (Figure 2), without significant differences on any of the sub-scale scores (Table 2). However, candidates who had to withdraw due to injuries sustained during the course were more tense ($P < 0.01$), more fatigued ($P < 0.001$), and had a higher overall TMD score ($P < 0.001$) prior to commencing the course than both the candidates that passed and those who failed. The effect size in each significant difference was again only moderate.

The STPI was 64% accurate in its prediction. Here, 33% of injuries, 0% failures, and 93% passes were correctly classified. There were no significant differences on the mean scores between the participants who passed and those who failed. Again the injured group scored significantly higher ($P < 0.05$) than the successful group ($P < 0.05$) and non-successful group ($P < 0.05$) (Table 2).

Figure 2
Iceberg profile of 73 diving candidates per training outcome



Age, gender, home language, geographical region of origin and race had no significant interaction with the outcome results.

Discussion

Within the MHM, all candidates conformed to an iceberg profile, although the outcome groups differed on some of their mean scores. However, notwithstanding the differences in mean scores, the model failed to predict individual performance with significant accuracy.

In spite of the MHM being used in previous diver studies, concerns have been raised regarding its power to predict performance outcomes.[8,9] It was concluded previously that it would be less effective as a predictive instrument in environments with strong demand characteristics,[8] and in samples with heterogeneous levels of skill and physical conditioning, and it has been suggested that mood assessment is more relevant to short duration activities.[9,10] Selection and diving training are conditions with strong demand characteristics, extending over prolonged periods of time, and where the entrance fitness of candidates may vary considerably, which may explain why the MHM was not supported. While the BRUMS distinguished between the mean score of outcome groups on some of the sub-scales, the high number of false negatives and false positives limits its ability to predict individual passes or fails with confidence.

Table 2
BRUMS and STPI mean (SD for STPI) scores of study sample according to training outcomes

	Fail (n = 20)	Pass (n = 47)	Injured (n = 6)	F	η^2
BRUMS					
Tension	1.3	2.9	5.3	7.8†	0.06
Depression	0.2	0.3	0.3	0.1	0.01
Anger	0.5	1.0	0.7	0.1	0.01
Vigour	11.2	10.3	8.7	1.7	0.04
Fatigue	0.5	1.0	4.3	16.7‡	0.08
Confusion	0.3	0.8	1.3	0.9	0.05
TMD	-8.5	-5.3	3.3	10.3‡	0.09
STPI	12.8 (2.4)	12.4 (2.4)	15.7 (1.9)	4.9*	0.07

* $P < 0.05$, † $P < 0.01$, ‡ $P < 0.001$

The TAM has been used to predict panic among beginner divers,[4,17] but this study did not find the STPI useful to predict training success. Some of the previous studies used the STAI, which may influence comparisons. The psychological screening done during the diving medical assessment may have sifted out individuals with raised inner apprehension, leaving a group generally less prone to anxiety. While the STPI distinguished between the mean scores of the outcome groups, it was only able to predict individual passes with some sense of accuracy, and none of the failures, which limits its usefulness. This can again be attributed to the high number of false negatives and false positives. In contrast to a previous study,[3] the addition of 1 SD to the scores (both up and down) did not improve the predictive accuracy of the STPI.

The injured subgroup was only added during data analysis, and did not come with a clear theoretical basis. It was, therefore, unexpected that the measures identified, to some extent, the injury-prone group from the rest. The small number of injured candidates (n = 6) and very moderate effect sizes would caution against premature interpretation. Still, the injured group were more tense, had higher trait anxiety, and were more fatigued prior to selection, similar to the associations that others have found with the BRUMS scores of athletes with performance-induced injuries.[22,23] While this association may be co-incidence, it could also indicate poor physical preparation (e.g., fitness training left too late, and thus tired on days preceding selection), from which they never recovered during the training. It is interesting to note that the reasons for withdrawal were stress injuries. Thus, it could be hypothesised that their efforts to maintain or improve their fitness might have led to the stress injuries experienced. The 'injury-prone' psychological associations might add value in two spheres, namely at the point of initial screening of candidates, and also to alert instructors to monitor such candidates closely during training, in order to reduce withdrawal due to injury. However, the link remains hypothetical, as the fatigue could also be an indication of superior motivation (e.g., train hard until the last moment), and this association will need to be explored in future studies.

None of the participants exhibited a consistent pattern of extreme arousal (raised scores across all measures), which would have more clearly been problematic (in terms of leading to non-success). This may be a result of their positive mental health status, and other groups may display a greater range of unhealthy psychophysiological arousal.

The focus would be on individual consistency of arousal, not on differences between mean scores of groups.

Conclusion

This study set out to test two psychological prediction models in the SAN diving environment. Although the measures could partially differentiate between successful and non-successful outcome groups, based on group mean scores, none of them contributed meaningfully to predicting individual outcome in diving training (as circumscribed in this study). This could be a result of the psychological screening process that would enhance mental health homogeneity, through sifting out vulnerable individuals. Alternatively, this could also mean that the psychological models of industrialised societies are not directly applicable in resource-limited countries such as South Africa, or that models developed on civilian sport diving cannot directly be used within the SA military context.

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