

THE USE OF SPIELBERGER'S STATE-TRAIT PERSONALITY INVENTORY (TRAIT ANXIETY SUBSCALE) WITH NAVAL SUBAQUATIC SPECIALISTS

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Abstract

Objectives: Panic behavior poses a particular threat to the health and safety of subaquatic occupational specialists. Trait anxiety has previously been identified as a marker of panic behavior under water, and Spielberger's State-Trait Personality Inventory (trait anxiety subscale) has been previously used to measure trait anxiety among subaquatic specialists. Using archived data, the trait anxiety scores of subaquatic specialists were analyzed to meet 3 objectives: 1stly – to develop a trait anxiety profile of subaquatic specialists; 2ndly – to investigate the predictive value of trait anxiety measures upon entering an occupational field; and 3rdly – to establish the reliability of these scores over time. **Material and Methods:** Archival trait-anxiety data from 322 subjects were analyzed statistically. **Results:** Analysis of the available scores revealed a highly homogenous as well as a very low trait anxiety profile for the investigated occupational group. Additionally, low trait anxiety was somewhat associated with success during specialist training: fewer candidates with high trait anxiety scores completed their qualification. Moreover, measurement of trait anxiety was stable over time, which suggests that when scores for this occupational group are screened, deviations from previous scores could signify a potential need for referral to an intervention from health professionals. **Conclusions:** Using the trait anxiety subscale as part of occupational health surveillance of subaquatic specialists could support prevention of accidents by identifying high-risk candidates during their annual health assessments, and referral for timeous intervention.

Key words:

STPI, Divers, Trait anxiety, Submariners

INTRODUCTION

Subaquatic specialists (SAS), here referred to, i.e., people employed to work in underwater environments, operate in an extreme occupational health context. The unique dynamics of their hyperbaric environment, with its physiological, psychological, and social concerns, poses serious potential risk to their health and safety. For this reason, legislation in many countries mandates regular medical screening of subaquatic specialists to prevent adverse health incidents. Medically, barotrauma and decompression illness, which are both associated with rapid pressure changes, comprise the major health threats to SAS when

operating in hyperbaric environments. Psychologically, the greatest risk during underwater activity is panic – usually defined as an extreme expression of anxiety – which constitutes a serious challenge to the health and safety of SAS.

Panic is the leading cause of rapid ascents, which, in turn, could cause both barotrauma and decompression illness [1]. It is implicated as the most common cause of scuba diving fatalities, contributing to 40–60% of all scuba diving deaths [1–5]. In general diving, scuba divers who experience panic when exposed to stressful conditions are at a greater risk of decompression illness compared to the

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divers who do not experience panic [1,2]. Surveys [3] has further shown that individuals with a history of pre-dive panic are twice as likely to develop panic while diving.

Trait anxiety was originally identified as a predictor of panic in beginner diving students [6], and it received much interest as a possible marker of panic proneness [7]. While trait anxiety mean scores effectively predict panic behavior during beginner scuba training [7], the scores only predict panic among experienced scuba divers when adding 1 standard deviation to the mean [8]. A review of the research concluded that trait anxiety was a reliable predictor of panic proneness while using scuba [9]. In particular, the individuals with trait anxiety scores equal to or higher than the population average are at a particular risk of panic behavior during recreational scuba training.

The above studies concern the civilian (and mostly recreational) diving environment. The United States Navy divers traditionally report lower trait anxiety than norm groups [10], and South African Navy (SAN) divers and submariners on measures of generalized anxiety score lower than or close to general local population means [11]. Trait anxiety has further been associated with injury proneness during military diving training [12], and injured naval trainee divers report higher baseline (i.e., pre-course) trait anxiety scores than the non-injured trainees [13].

In general, the research findings [1] indicate that both professional and recreational divers have low scores on measures of anxiety. Trait anxiety scores of scuba divers are lower than the published norms, and there are indications that low scores on measures of trait anxiety are associated with better performance scores (e.g., occupational task performance and emergency procedures) than the high scores. There is also a suggestion that scuba students with higher trait anxiety tend to withdraw from training more frequently than the students with lower trait anxiety. It has further been proposed that individuals with high trait anxiety tend to self-select out of professional diving [7,12].

Trait anxiety – using Spielberger’s model – is conceptualized as an enduring feature of an individual’s personality. This model proposes that individuals with elevated scores on this measure are more likely to experience stress responses when exposed to a stressor than those scoring within the low or moderate range [7].

Spielberger’s State-Trait Anxiety Inventory (STAI) and State-Trait Personality Inventory (STPI) are the most frequently used instruments to study anxiety and stress responses in scuba divers [7,12], and the STPI has also been recommended for studies investigating the relationships between anxiety and narcosis [14], a condition associated with deep diving.

The implied contribution of trait anxiety to safe diving practices suggests that monitoring anxiety to identify individuals at-risk may have value for preventing adverse medical events. This has been the approach at the Institute for Maritime Medicine (IMM), an organization delivering specialist health services to SAS in the South African context. They have been collecting STPI scores of SAS in the military environment for a number of years.

All naval SAS (mainly divers and submariners) undergo an occupational health screening annually or bi-annually, during which they also complete the STPI. Given the potential of the STPI to support prevention interventions, this study set out to explore whether measuring trait-anxiety could contribute to a better identification of individuals at-risk, for the eventual purpose of referral for timeous intervention. The study set itself 3 objectives. The 1st objective was to formulate a trait anxiety profile of SAS (using the STPI). The 2nd objective was to investigate the value of collecting entry STPI scores, in order to determine whether these might predict who was likely to achieve qualification as a SAS. The 3rd objective was to investigate the STPI’s reliability over time, in order to determine its use for the long-term psychological health monitoring.

MATERIAL AND METHODS

Participants

Entry STPI scores have been collected at IMM since 2011. The scores of SAS were included in the study if they met the following criteria:

- they completed entry and/or single or multiple STPIs (during the annual occupational health screenings) between January 2011 and April 2014;
- had no psychiatric diagnoses over the time mentioned above;
- provided written informed consent for the use of their data.

The study sample comprised 322 SAS, representing all South African race groups, and within the age range of 19 to 52 years (mean (M) = 29.2, standard deviation (SD) = 8.1). The age and gender breakdown is presented in Table 1.

Table 1. Age and gender breakdown of the sample

| Age (years) | Respondents | | |
|-------------|-------------|---------|-----------|
| | total (%) | men (n) | women (n) |
| 18–24 | 38.2 | 102 | 21 |
| 25–34 | 36.6 | 103 | 15 |
| ≥ 35 | 25.2 | 79 | 2 |
| Total | 100.0 | 284 | 38 |

From this larger group different subgroups were used for different analyses; the subgroups' sizes are indicated each time in the discussion that follows. For some participants, only their entry data were available (because they did not complete their qualification); some had entry data and the first follow-up scores available; and some had only annual data, with multiple follow-up scores.

A number of subgroups or sub-specialties are represented in the sample: Fleet support divers are entry level divers, qualified to dive to 21 m on air in protected sites (e.g., harbors) doing routine duties. Clearance divers are qualified

to dive to 54 m, use mixed gases and operate underwater tools and demolitions. Submariners are sailors qualified to serve on submarines.

Scale

The STPI is a self-administered questionnaire. The trait-anxiety subscale consists of the 10 most valid items from the STAI trait-anxiety scale, which was designed to measure dispositional anxiety in adults [15]. The 'trait' items, which are rated on a 4-point frequency scale, aim at assessing the subject's emotional disposition. Scores range from 10 to 40, and the higher the score, the greater the level of trait anxiety. The current version (often referred to as STPI Form Y) was validated in North America using male and female navy recruits, college students and working adults. Full references to the reliability and validity, and other psychometric information, are available [15]. The USA population mean for Form Y is 15 for men and 17 for women.

An initial normative standardization was previously done with the SAN [16], with a sample consisting of 664 active duty sailors, representing all race groups and musterings (except divers and submariners), and spanning ages from 19 to 49 years. All the participants had at least completed high school. Prospective participants with psychiatric diagnoses were excluded from that sample. Women comprised 22% of the sample, and men 78%, reflecting the composition of the SAN at the time. The SAN scores appeared slightly lower than the original normative data samples, and the scores were more uniform across gender than in the original norm groups, with a mean score of 14 for both genders. The standard STPI, trait anxiety subscale, Form Y [15], was used in this study.

Data analysis

Objective 1

Trait anxiety profiles were reported using descriptive statistics, for the total SAS group, as well as speciality-specific subgroups. Correlational statistics in a form of

Pearson's r , as well as t -tests and ANOVA were employed to investigate the effect of biographical variables (namely age, gender, and specialty) and to compare the SAS to other samples (the general SAN norms and normative data from the STPI manual).

For these analyses, only the participants with at least 1 year post-qualification experience of working in their respective specialist field were used. This criterion is considered a sign of both identification with the field identity (i.e., as a diver or submariner), and possession of the characterological or dispositional coping mechanisms to operate adaptively within that field for at least 1 year post-qualification.

Objective 2

To answer the question whether there are any differences between the means of candidates who complete their courses and the means of those who do not, the entry STPI scores were compared between the candidates who succeeded in training and those who did not, using t -tests.

Objective 3

Determination of how reliable the STPI is for SAS over a period of 1 year or longer was done in 2 ways. Firstly, where only 2 sets of annual scores were available, these were compared. Where more annual sets were available, the 1st and the last sets were compared to determine reliability over a longer period of time. For this analysis only the participants with at least 2 sets of post-qualification scores were analyzed.

Ethics

This study was performed in accordance with the principles of the Declaration of Helsinki. The data were drawn from the participants' diving or submarine medical files, and entered into the analysis as anonymous data. All the participants gave their prior written

consent that the psychometric data from their files may be used.

RESULTS

Objective 1: Trait-anxiety profiles of subaquatic specialists

Trait-anxiety profiles of the SAS are presented in Table 2. Candidate SAS (divers and submariners who were not yet qualified) were not included here. The mean score for this group was 12.7 ($SD = 2.7$), with no significant differences between the subgroups ($F(2,319) = 2.184, p = 0.12$).

Table 2. Trait-anxiety profile of naval subaquatic specialists, using the State-Trait Personality Inventory (STPI) scores

| Group | Respondents (n) | STPI score | | |
|------------------|--------------------|------------|------|-------|
| | | M | SD | range |
| Fleet divers | 71 | 13.28 | 3.00 | 10–23 |
| Clearance divers | 100 | 12.74 | 2.62 | 10–21 |
| Submariners | 149 | 12.47 | 2.00 | 10–24 |
| Total | 322 | 12.73 | 2.71 | 10–24 |

M – mean; SD – standard deviation.

When biographical factors that might influence scores were examined, there were, as mentioned before, no significant differences between the scores of the different specialties. Neither were there any significant differences based on gender (Table 3, series 1), nor any significant correlations between trait anxiety scores and age ($r = -0.07, p = 0.10$). The SAS appeared to be a particularly homogenous group in terms of their trait anxiety profiles. Due to this, the whole group's scores were used for the subsequent analyses. However, both gender and age distributions were skewed, which cautions against final interpretations.

Next, the naval SAS were compared to the full dataset of the original general SAN sample described earlier [16]. The SAS scored significantly lower than the rest

Table 3. Results of the t-test analysis (t) of subaquatic specialist groups and other comparative samples

| Series | Group 1 | | | Group 2 | | | t | p | Difference (M) | Cohen's d |
|--------|---------|-------|------|---------|-------|------|--------|--------|----------------|-----------|
| | n | M | SD | n | M | SD | | | | |
| 1 | 284 | 12.66 | 2.70 | 38 | 13.29 | 2.81 | -1.31 | 0.20 | 0.6 | |
| 2 | 322 | 12.73 | 2.71 | 664 | 14.19 | 3.96 | -5.75 | < 0.01 | 1.5 | 0.43 |
| 3 | 38 | 13.29 | 2.81 | | 17.00 | | -8.15 | < 0.01 | 3.7 | |
| 4 | 284 | 12.66 | 2.70 | | 15.00 | | -14.66 | < 0.01 | 2.3 | |
| 5 | 92 | 15.14 | 3.35 | 62 | 16.60 | 4.44 | -2.32 | < 0.05 | 1.5 | 0.37 |
| 6 | 92 | 15.14 | 3.35 | 92 | 14.18 | 3.07 | 2.86 | < 0.01 | 1.0 | 0.15 |
| 7 | 14 | 19.57 | 4.72 | 159 | 15.69 | 4.22 | -2.97 | < 0.01 | 3.9 | 0.87 |
| 8 | 220 | 12.59 | 2.72 | 220 | 12.42 | 2.47 | 1.09 | 0.28 | 0.2 | |
| 9 | 158 | 12.56 | 2.83 | 158 | 12.23 | 2.48 | 1.71 | 0.09 | 0.3 | |

1 – comparison of subaquatic specialist men (group 1) and women (group 2) subgroups; 2 – comparison of subaquatic specialists (group 1) with general South African navy norm group (group 2); 3 – comparison of subaquatic specialist women (group 1) with female normative sample from manual (group 2); 4 – comparison of subaquatic specialist men (group 1) with male normative sample from manual (group 2); 5 – comparison of candidates who successfully completed training (group 1) with those who did not complete their training (group 2); 6 – comparison of pre-training (group 1) and post-training (group 2) scores of candidates who successfully completed training; 7 – comparison of candidates who did not commence with training (group 1) with those who did (group 2); 8 – comparison of subaquatic specialists over 2 consecutive administrations; 9 – comparison of subaquatic specialists from 1st (group 1) to last (group 2) administration.

of the SAN (Table 3, series 2), with a moderate effect size. The SAS group was also compared to the published norms [15], using a t-test for single samples. The women scored significantly lower than the normative female sample (Table 3, series 3), similarly did men (Table 3, series 4).

Objective 2: Value of entry STPI scores to predict qualification

Entry STPI scores (prior to entering the specialist field) (N = 154) show a mean of 15.7 (SD = 3.9, range: 10–34). When the scores of the SAS who qualified through this study period (N = 92) were compared to the scores of those sailors who had started out with them but who did not complete their qualifications (N = 62), the SAS who qualified scored significantly lower on entry than the others (Table 3, series 5), with a moderate effect size. However, when considering the performance of the STPI as a classification tool to predict completion of a training, a ROC analysis revealed an Area Under the Curve of 0.585, which suggests a poorer ability to

classify training completion using STPI scores. The specificity and sensitivity was also unsatisfactory (Table 4).

Table 4. Specificity and sensitivity of the State-Trait Personality Inventory (STPI) in predicting successful training completion

| Cut-off | STPI | |
|---------|-----------------|-----------------|
| | specificity (%) | sensitivity (%) |
| 17 | 73.9 | 41.9 |
| 16 | 68.5 | 43.5 |
| 15 | 54.3 | 51.6 |

Interestingly, those SAS with scores prior to entry and 1 year after qualifying showed a significant but small reduction in scores (Table 3, series 6) from before the training to 1 year after qualifying.

There were further 14 individuals who applied to do diving training and who completed the entry STPI, but who never started the training. While the reasons for the non-commencement are not known, the non-starter group

reported significantly higher STPI scores than the sample that commenced their training (Table 3, series 7), with a large effect size. When considering the performance of the STPI as a classification tool to predict commencement of training, a ROC analysis revealed an Area Under the Curve of 0.737, which suggests a moderate ability to classify training commencement using STPI scores.

Objective 3: Stability over time

The analysis above showed a (small) change in the scores of the newly qualified sailors over 1 year, which leaves the question whether the STPI – as a measure of trait anxiety – has the long-term reliability for the already qualified personnel.

Determination of the reliability of the STPI for SAS over a period of 1 year or longer was performed by comparing subsequent annual scores to each other. One subgroup of the sample ($N = 220$) had scores available for a single cycle (2 post-qualification scores). There was no significant difference between the 2 administrations (Table 3, series 8; $r = 0.61$, $p < 0.01$), which had a mean interval of 16.1 (SD = 5.2) months. The mean difference between the 2 administrations was 0.2.

A further subgroup of the sample ($N = 158$) had scores available for more than 1 cycle, and their 1st and last scores (both post-qualification) were compared. Again there was no significant difference between the administrations (Table 3, series 9; $r = 0.59$, $p < 0.01$), which had a mean interval of 28.4 (SD = 3.3) months. The mean difference between the 2 administrations was 0.3.

DISCUSSION

The STPI described a particularly homogenous trait anxiety profile for SAS with regard to age, gender, and specialty. The STPI also described a very low trait-anxiety profile. Given the known association between trait anxiety and panic behavior, and the association between panic

and hyperbaric injury, the low scores are contextually appropriate and support the outcomes of the previous studies [1,7,10–12,17].

It has been suggested that standard deviations > 1.5 above the mean could be used as a cut-off point between clinical and non-clinical scores, to be consistent with the international use of other psychological measures [18]. For this sample, it may be prudent to refer scores of > 17 to a psychologist for a further investigation, or at least clarification. The low trait anxiety profile raised the question whether the subaquatic environment attracts low-anxiety people, or whether the training ‘selects-out’ high-anxiety candidates, or even whether the SAN training actually reduces higher trait anxiety.

Given the range of scores on entry, it seems that not only low trait anxiety candidates apply. However, lower trait anxiety was associated with success in achieving qualification, whereas higher trait anxiety was associated with withdrawal from the training programs, and with the failure to initiate training. The significant differences between the scores of the candidates who qualified and those who did not, as well as those who started training and those who did not, provide support for the hypothesis that subaquatic specialties ‘select-out’ individuals with high trait anxiety [1,7]. While the mechanism for this is not clear, it is hypothesized that this occurs during training, when direct exposure to the extreme environmental demands and operational stressors of these fields takes place. In spite of the above association, the poor outcome of the ROC analysis, and low sensitivity and specificity limit the practical value of STPI scores for selection into training programs. The small reduction in STPI scores after qualification does suggest that training ‘reduced’ trait anxiety. In the case of the STPI, some of the items refer to self-confidence and related constructs, and these are indeed amenable to change. For example, mastering the skills of diving or submarine operations may counter poor self-confidence and feelings of inadequacy. Additionally, the entry age

of the SAS is fairly young, and many of the new candidates are of age where personality is still under development, and where their dispositional anxiety is thus not yet cemented. However, it cannot be concluded from the available data that training changes trait anxiety profiles.

Among qualified SAS, STPI scores were remarkably consistent over time. This stability suggests that significant deviations from baseline scores could be used as markers for referral for a further investigation or clarification. In this sample, deviations of ≥ 3 points from the previous scores would serve to initiate referral to a psychologist.

There is some limitation to the STPI as a self-report scale for medical screening, in its vulnerability to response bias, where individuals may give answers that are influenced by the demands of the context [19]. Such response bias is particularly problematic in health research [20]. It would be important to ensure that SAS understand beforehand the importance of completing the STPI honestly, as its purpose is not punitive but supportive and preventative (i.e., candidates with high scores will be supported, rather than excluded). Future studies could also consider alternative measures to corroborate trait anxiety scores, for example incorporating physiological markers to measure anxiety proneness [21,22].

CONCLUSIONS

This study has a number of implications for occupational health practice. The highly homogenous trait-anxiety profile, as well as the reliability of the STPI, allows for effective monitoring. Significant deviations from the group norm (> 17), or from previous scores (≥ 3), could serve as markers to indicate when referral for further attention might be appropriate. Using the STPI as part of occupational health surveillance of SAS would support prevention of accidents by identifying high-risk candidates during their routine health assessment, and referring them for a timeous intervention. Such monitoring (both the instrument and the time to administer, score and interpret

it) is relatively inexpensive, and could support efforts to keep SAS safe in their high-risk work environment.

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