Incremental Validity of Personality Measures in Predicting Underwater Performance and Adaptation

Joaquín Colodro[1], Enrique J. Garcés-de-los-Fayos[2], Juan J. López-García[2] and Lucía Colodro-Conde[2]

[1] *Delegación de Defensa en la Región de Murcia (Spain)*
[2] *Universidad de Murcia (Spain)*

Abstract. Intelligence and personality traits are currently considered effective predictors of human behavior and job performance. However, there are few studies about their relevance in the underwater environment. Data from a sample of military personnel performing scuba diving courses were analyzed with regression techniques, testing the contribution of individual differences and ascertaining the incremental validity of the personality in an environment with extreme psychophysical demands. The results confirmed the incremental validity of personality traits ($\Delta R^2 = .20$, $f^2 = .25$) over the predictive contribution of general mental ability ($\Delta R^2 = .07$, $f^2 = .08$) in divers' performance. Moreover, personality ($R_L^2 = .34$) also showed a higher validity to predict underwater adaptation than general mental ability ($R_L^2 = .09$). The ROC curve indicated 86% of the maximum possible discrimination power for the prediction of underwater adaptation, AUC = .86, $p < .001$, 95% CI (.82–.90). These findings confirm the shift and reversal of incremental validity of dispositional traits in the underwater environment and the relevance of personality traits as predictors of an effective response to the changing circumstances of military scuba diving. They also may improve the understanding of the behavioral effects and psychophysiological complications of diving and can also provide guidance for psychological intervention and prevention of risk in this extreme environment.

Diving conditions have a considerable impact on human behavior and performance, since they are generalized stress factors with specific characteristics of environmental, physiological and psychological nature. Among the structural environmental conditions the exposure to high pressures and an aquatic environment are highlighted. The functional ones include modifications of temperature, thermal conductivity and visibility. The main physiological stressor is the toxicity of breathing gases. Lastly, changes in anxiety and sensory stimulation are the major psychological stressors. From the human perspective, divers require a significant process of psychophysiological adaptation in order to avoid the occurrence of aquatic incidents or dysbaric complications. A good adaptation will allow divers to remain under water, preserve their health, and overcome the progressive reduction of performance, the onset of narcosis and the increase in emotional arousal (Anegg et al., 2002;

Bachrach & Egstrom, 1987; Bennett & Elliott, 1993; Brubakk & Neuman, 2003).

Psychology applied to diving has mainly been focused on the analysis of the differential profiles of divers by means of descriptive studies (Beckman, Lall, & Johnson, 1996; Colodro, Garcés de los Fayos, & Velandrino, 2012; van Wijk, 2002; van Wijk & Waters, 2001) and on the experimental study of the effects of the particular environmental conditions on their performance and behavior (Brubakk & Neuman, 2003; Rostain & Balon, 2006). However, correlational studies between individual differences and the results of scuba diving training and underwater adaptation are less frequent (Biersner & Larocco, 1987; Edmons, 1972). Since these three analytical perspectives are fundamental in preventing risks and improving underwater performance, we analyzed the least studied problem, i.e. the contribution of individual differences to diving. In addition, given that this environment requires specific psychological characteristics for the divers to be able to adapt to unusual conditions and overcome the major underwater stressors, this topic is justified not only by scientific reasons but also by safety, ethical and economic reasons (Bachrach & Egstrom, 1987; Brubakk & Neuman, 2003).

Dispositional traits have come to be considered as predictors of human behavior and job performance.

Meta-analytic results contributed to this, quantifying the validity of these predictors and helping to understand the theoretical and empirical relationships between dispositional variables and an extensive range of personal, interpersonal and social criteria. Meta-analysis confirmed that general mental ability is the best predictor of training performance and job performance in all positions and organizations (Salgado et al., 2003; Schmidt & Hunter, 2004) and, also, that personality traits reach valid indices when contingent behaviors are considered (Barrick, 2005; Salgado, 1997, 1998). On the one hand, psychometric tests of general intelligence have a high capacity to achieve effective predictions in different fields of activity (Gottfredson, 2002; Ones, Viswesvaran, & Dilchert, 2005; Ree, Earles, & Teachout, 1994). On the other hand, quantitative review studies confirm the importance of personality traits in explaining and predicting results not only in different organizational criteria and human behaviors in the workplace, but also in the school, personal, and social fields (Judge & Kammeyer-Mueller, 2007; Ozer & Benet-Martinez, 2006; Salgado, 2003). In spite of the low number of joint studies of individual differences, the combination of measures of cognitive ability and personality can provide validity to explain part of the variance that is not adequately explained by the best measures of ability or personality when considered separately (Chamorro-Premuzic & Furnham, 2006; Judge, Higgins, Thoresen, & Barrick, 1999; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007).

Our contribution to this context is based on the hypothesis that the measurement of dispositional traits of intelligence and personality may be useful to predict the acquisition of knowledge and skills necessary for carrying out tasks under water and to forecast the adaptation in the stressful, changing and uncertain environment of the scuba diving field. The functional relationship between psychological traits and human behavior is increased as a result of the environmental demands of scuba diving. Therefore, in this study, we try to delimit the usefulness of general intelligence and verify the incremental validity of personality, as defined by Hunsley and Meyer (2003), in relation to the performance of the divers, the result of their training, and their level of adaptation in the underwater environment. Incremental validity is the extent to which a measure adds to the prediction of a criterion above what can be predicted by other sources of data. Its value provide evidence pertinent to improving on decision making and prediction tasks, especially when the measure represents a statistically significant increase in prediction of the criterion. Do the personality measures add something to the prediction of these criteria over what can be predicted by intelligence scores? It is possible that

the predictive primacy of intelligence changes in this extreme environment and personality traits may become the most significant predictors of the underwater performance and adaptation.

Meta-analytic results have enhanced the understanding of the relationship between dispositional variables and behavioral manifestations. When training success or job performance is analyzed, general mental ability is the best predictor (Colom & Andrés-Pueyo, 1999; Gottfredson, 1997, 2002). Furthermore, personality traits increase their validity when performance of specific tasks or other important components of the work are analyzed (Barrick, 2005; Barrick, Mount, & Judge, 2001). Campbell and Zook (1991) corroborated that personality variables add validity to intelligence in predicting military performance criteria, defending the combined use of cognitive and noncognitive predictors. Results that sustain the incremental validity of the personality variables have been proven in American and European samples with different performance criteria (Salgado, 1998; Schmidt & Hunter, 1998). Therefore, the use of measures of personality is essential in applied psychology. In general, personality has lower validity indices than intelligence, but complements it and does not interfere with it. If we have to predict job performance or success in training, psychological tests that evaluate the intellectual capacity and dimensions of personality should be used, preferably using questionnaires related to the Five Factors model and, in addition, adapted in the specific working population (Chamorro-Premuzic & Furnham, 2010; Sackett & Lievens, 2008).

This conclusion has special application in the field of professional diving, as it is an activity that is carried out in an adverse environment with high demands and varied risks (Brubakk & Neuman, 2003). On the one hand, the underwater tasks require different abilities such as critical thinking, decision making, and time sharing; deductive and inductive reasoning; selective attention, information gathering, and spatial orientation; static and dynamic strength; manual dexterity, finger dexterity, arm-hand steadiness, and multi-limb coordination. On the other hand, divers are exposed to extreme situations and must overcome emergencies that may cause intense emotional activation and also require an adaptive response, which is sometimes perceived as disproportionate with respect to the available resources (Anegg et al., 2002; Bachrach & Egstrom, 1987; Morgan, Raglin, & O'Connor, 2004). The diving performance and adaptation are related to dimensions of learning diving tasks, technologies, and procedures, solving underwater problems, handling environmental emergencies and work stress, dealing with uncertain and unpredictable situations, or demonstrating physical and

interpersonal adaptability. For the above reasons, the analysis of the specific contribution of individual differences to predicting adaptation and performance is justified in the underwater environment, in which divers must: (1) solve problems of psychophysiological adaptation and incidents that threaten their safety, (2) cope with stressful situations or apply self-control and anxiety management in situations of risk, and (3) carry out their work effectively as well.

The aim of the present study, therefore, is to investigate whether personality traits (in particular traits related to emotional adjustment and conscientiousness) provide incremental validity in an adverse environment and with the specific demands of diving. For this purpose, the relationships between levels of underwater adaptation and performance and individual differences are analyzed in order to: (1) ascertain the correlation of measures of intelligence with adaptation and performance in diving, (2) ascertain the correlation of personality traits with these same criteria, and (3) quantify the contribution of individual differences in personality to the predictive validity of intelligence in the military diving field.

Method

Participants

The sample consisted of staff from the Spanish Armed Forces and Security Forces of the State who started Elementary Diver courses during the period between 1999 and 2009 in the Spanish Navy Diving Center. It was composed of adult Spanish men ($N = 649$) with an average age of 28.16 years ($SD = 3.06$), a majority of single men (61%) and varied educational level: Primary studies, Intermediate vocational education and High School (27%), Higher vocational education and University entrance exams (35%) and University degree (38%). The professional level of the military ($n = 611$) ranged from Troop and Seamen (23%) to Non-commissioned officer (34 %) and Officer (37%); the remaining staff ($n = 38$) belonged to the National Police Corps. The basic 8-week diving course aims to ensure the safe practice of autonomous diving with hyperbaric air up to a depth of 50 m, by training the individuals (a) to plan and perform dives with scuba equipment maintaining adaptation to the underwater environment and (b) to carry out underwater activities dedicated to the safety of persons, vessels and naval installations.

Instruments and variables

The psychological evaluation of the applicants to perform military diving courses included the following tests, which are analyzed in detail elsewhere (Colodro et al., 2012). The General Intelligence Test (Cordero, Seisdedos, González, & de la Cruz, 1994) assesses core functions of general mental ability, abstraction and relationships understanding, though nonverbal symbolic material without cultural content, following the same principles as the g-factor tests ($\alpha = .90$). Spanish edition of the Sixteen Personality Factor questionnaire (Cattell, 1998) is one of the most used personality tests in Spain when a comprehensive assessment of normal personality is needed, with proven efficacy in theoretical and applied psychology. It evaluates 16 bipolar primary factors of normal personality, grouped by factor analysis into five broad or second order factors, just like the currently more accepted model of personality traits. Its scales have adequate indices of construct validity and reliability. The internal consistency of the scales in Spanish divers ($n = 250$) is in a range ($.60 \leq \alpha < .70$) of acceptable magnitude, by using a convenience sample of our study based on the availability of their original answer sheets at the moment of the data analysis. The Facilitating and Inhibiting Anxiety questionnaire is a test for assessing anxiety processes which facilitate (increased autonomic arousal) or inhibit (increased activation and internal concerns) performance in military divers ($.70 \leq \alpha < .90$), derived from Pelechano's work (1975).

The independent variables used in this study corresponded to the psychological factors of intelligence, personality and anxiety evaluated with the tests mentioned in the preceding paragraph. Demographic and professional variables were also analyzed to understand the characteristics of the sample.

The dependent variables were the performance and adaptation during the diving course. The underwater performance was evaluated through the Final Average Grade (FAG), constituted by the weighted average of the weekly results obtained in exams (Physics, Medicine and Psychology of diving) and exercises (scuba diving practices, underwater search and recovery, underwater tools and work techniques) to test the divers' understanding of the theoretical materials and mastery of the practical aspects of the course. This index represents the official result of the diving training at the Spanish Navy Diving School. In addition, adaptation to diving was categorized with a dichotomous indicator, low or high underwater adaptation, defined on the basis of the first and third quartile of the FAG distribution, i.e. subjects who have less or more success to overcome all aspects of diving course ($n = 177$ in each group). Those who overcome all aspects of diving training and complete the diving course get the certification of Elementary Diver and recognition of their competence for underwater adaptation. Therefore, our criteria are related to the components of

task proficiency and the dimensions of adaptive performance of the general model proposed by Campbell et al. (Campbell, McCloy, Oppler, & Sager, 1993; Pulakos, Arad, Donovan, & Plamondon, 2000).

Procedure

The psychological tests were applied collectively during the first week of the course in the Spanish Navy Diving School. Application instructions provided by a military psychologist (one of the authors) highlighted the preventive character of psychological tests in relation to underwater adaptation, without the consideration of selective checks in the strict sense. The methodology for data collection and confidentiality observed the guidelines set out in the Armed Forces Psychology Service Regulations and it was similar to that used in applied research in the field of Work and Organizational Psychology. The collected data with the aim of risk prevention in the diving activities were grouped in a confidential database, consisting of a single record per subject without personal identification.

In this empirical study, two correlational research designs with quantitative methodology were used. The first employed a predictive plan, in order to determine the validity of the independent variables in relation to the performance in diving activities. The second design was a case-control study performed by grouping the participants in the dependent variable, with the aim of obtaining the best indicators for predicting underwater adaptation. The greatest advantage of these designs lies in the use of a large sample and in the external validity.

Data analysis

The relevance of individual differences in the prediction of underwater performance and adaptation were analyzed with techniques of multiple and logistics regression and ROC (Receiver Operating Characteristic) curve analysis using the statistical package SPSS 19.0 (SPSS, 2010). After checking the basic assumptions of the methods of least squares and maximum likelihood and the existence of significant differences in the centroids of the groups of adaptation, we have tried to confirm the incremental validity of some personality traits whose relevance has already been proven in diving.

Results

In the initial correlation analysis, summarized in Table 1, significant coefficients were obtained that indicate a positive association between measures of intelligence (general intelligence, reasoning) and the criteria of performance and adaptation in diving. When the effect of the non-cognitive traits was controlled, these correlations remained significant. In addition, some traits of personality (emotional stability, liveliness, facilitating anxiety, self-control) correlated directly and meaningfully with diving performance, and others (sensitivity, apprehension, tension, inhibiting anxiety) did so in reverse mode; being still significant when the cognitive traits were controlled. Similar results were obtained regarding the relationship between personality traits and the level of underwater adaptation, with the addition of dominance and abstractedness in this dichotomous criterion. Therefore, a significant correlation of

Table 1. *Means, standard deviations and correlations of measures of intelligence and personality with underwater performance and adaptation*

			Performance (n = 581)		Adaptation level (n = 354)
Variable	M	SD	r_{xy}	r_{ij}	r_{bp}
General intelligence	28.03	5.86	.26***	(.17)***	.34***
Reasoning	9.28	1.92	.19***	(.14)***	.21***
Emotional stability	20.53	3.89	.27***	[.24]***	.39***
Dominance	12.68	3.44			.12*
Liveliness	16.49	3.66	.14***	[.10]*	.19***
Sensitivity	7.22	3.25	−.32***	[−.27]***	−.40***
Abstractedness	11.91	3.03			.12*
Apprehension	7.36	3.60	−.24***	[−.23]***	−.34***
Self-control	14.41	2.82	.26***	[.26]***	.33***
Tension	5.60	4.18	−.17***	[−.17]***	−.27***
Facilitating anxiety	13.05	3.57	.27***	[.23]***	.35***
Inhibiting anxiety	2.90	2.82	−.14***	[−.12]**	−.16**

Note: Linear (r_{xi}), partial (r_{ij}) and point-biserial (r_{bp}); correlation; (partialling out personality traits) [partialling out intelligence].
*p < .05. **p < .01. ***p < .001.

the intelligence and personality measures with the criteria of underwater performance and adaptation is confirmed.

Additionally, we confirmed the relevance of intelligence and personality in predicting underwater performance by grouping individual differences in three models: (1) a comparison block, consisting of personality variables with little theoretical or empirical impact on the underwater environment (warmth, dominance, rule-consciousness, social boldness, vigilance, abstractedness, privateness, radicalism, self-reliance); (2) a intelligence model; and (3) a personality model, composed of dispositional variables that predict the outcome of training and performance in diving. The hierarchical regression analysis summarized in Table 2 indicated that, in relation to a non significant comparison model, intellectual variables contribute significantly to the prediction of performance in the diving course, $\Delta R^2 = .07$, $F(2, 522) = 20.80$, $p = .001$, increasing by 7% the explained variance of the FAG with a small effect size magnitude ($f^2 = .08$). In addition, general intelligence and reasoning showed statistically significant coefficients, indicating that divers with higher scores on intelligence tests tend to achieve better performance in diving. Personality also contributed significantly to this prediction, $\Delta R^2 = .20$, $F(8, 514) = 18.68$, $p = .001$, adding 20% to the variance explained by previous models with a medium effect size ($f^2 = .25$). Most of the regression coefficients were significant, confirming that the divers with higher

scores on emotional stability, self-control and facilitating anxiety, and lower scores on sensitivity, apprehension and tension tend to achieve greater underwater performance.

Finally, using hierarchical logistic regression analysis, we tested the possibility of predicting the level of underwater adaptation (*Q1-Q3* of the FAG) with three similar models (Table 3). The intelligence model was statistically significant and had an appropriate fit according to the Hosmer and Lemeshow test, $\chi^2(8) = 11.97$; $p = .153$, and Nagelkerke's coefficient ($R_N^2 = .19$). The personality model was also statistically significant and presented a proper adjustment, $\chi^2(8) = 10.79$; $p = .214$; $R_N^2 = .58$. When comparing the efficacy in predicting the level of adaptation attained in the underwater environment, a significant predictive gain, $\chi^2(1) = 102.30$; $p < .001$, and an increase in the effect size of large magnitude ($R_N^2 = .40$) were obtained in the case of personality traits. After estimating the incremental validity through the coefficient of likelihood (R_L^2), intelligence model explained 7% of the dependent variable, with the two predictors used being statistically significant. By adding individual differences in personality traits (emotional stability, self-control, facilitating anxiety, apprehension, emotional sensitivity and tension), the model explained an additional 25% of the variation, being significant the coefficients of six predictors.

The obtained rates of sensitivity (79%) and specificity (81%) were associated with a significant success, $\chi^2(1) = 114.47$, $p < .001$, in the classification of divers with high and low levels of adaptation. Figure 1 represents the ROC curve for the prediction of underwater adaptation, analyzing all possible cut-points of sensitivity (true positive rate) and 1-specificity (false positive rate) over the reference line and comparison model. The value of the area under the curve, AUC = .86, $p < .001$, 95% CI (.82–.90), indicated 86% of the maximum possible discrimination power, assuming a value of .139 in the overlap of the two distributions.

Table 2. *Hierarchical regression in prediction of underwater performance (n = 581)*

Block	Variable	R^2	ΔR^2	F	β	t
1		.03	.03	1.68		
2		.10	.07	20.80***		
	General intelligence				.211	4.68***
	Reasoning				.119	2.59**
3		.30	.20	18.68***		
	Emotional stability				.127	2.31*
	Liveliness				.007	0.14
	Sensitivity				−.182	−4.42***
	Apprehension				−.126	−2.43*
	Self-control				.194	4.20***
	Tension				−.102	−2.01*
	Facilitating anxiety				.131	3.19**
	Inhibiting anxiety				−.021	−0.46

Note: Comparison model: Block 1 (warmth, dominance, rule-consciousness, social boldness, vigilance, abstractedness, privateness, radicalism, self-reliance). Intelligence model: Block 2. Personality model: Block 3. Dependent variable: Final Average Grade.

*p < .05. **p < .01. ***p < .001.

Discussion

In order to verify the relevance of individual differences in the adaptation to an extreme environment, an analysis of psychological variables in basic diving courses developed in the Spanish Navy has been presented in this paper. The aim was to estimate the specific contribution of personality to the validity of the intelligence measures to predict the level of performance in diving activities and underwater adaptation. The results indicate, in the first place, a significant association of the intelligence and personality measures with the criteria of performance and adaptation in this environment. When compared to a reference

Table 3. *Hierarchical logistic regression in prediction of underwater adaptation level (n = 354)*

Block	Variable	χ^2	R_L^2	B	Wald	OR (95% CI))
1		8.72	.02			
2		42.46***	.09			
	General intelligence			.107	22.73***	1.113 (1.065–1.163)
	Reasoning			.141	4.22**	1.151 (1.006–1.316)
3		144.76***	.34			
	Emotional stability			.185	10.26***	1.203 (1.074–1.347)
	Sensitivity			−.200	13.71***	0.819 (0.737–0.910)
	Apprehension			−.125	4.15*	0.882 (0.782–0.995)
	Self-control			.179	7.02**	1.196 (1.048–1.366)
	Tension			−.703	8.28**	0.495 (0.306–0.799)
	Facilitating anxiety			.149	9.94**	1.160 (1.058–1.273)

Note: Comparison model: Block 1 (warmth, dominance, rule-consciousness, social boldness, vigilance, abstractedness, privateness, radicalism, self-reliance). Intelligence model: Block 2. Personality model: Block 3. R_L^2 = Coefficient of likelihood. OR = Odds ratio. CI = Confidence interval. Dependent variable: *Q1-Q3* of Final Average Grade distribution.

*p < .05. **p < .01. ***p < .001.

model, general intelligence increases by 7% the explanation of the variation of underwater performance, with significant contribution from the two predictors used (general intelligence and reasoning). Adding personality traits, the model explains an additional 20% of the variance, most of the predictors being significant (emotional stability, self-control, facilitating anxiety, sensitivity, apprehension and tension). Using logistic regression analysis, we have ascertained that intelligence explain about 7% of the variance of the level of underwater adaptation and that personality account for an additional 25% of the mentioned variance. Our results altogether confirm the incremental validity of individual differences in personality to predict the underwater performance and the probability of diving adaptation over the cognitive factors.

From the first quantitative reviews, data were obtained that supported the relevance of general mental ability in predicting job performance and training success in a wide range of activities. However, despite being the best predictor of performance, intelligence explains only a part of the criterion variance (Furnham, 2008; Ree & Earles, 1992; Ree et al., 1994). The predictive validity of intelligence was already found in the first psychological studies in the field of basic and specialized diving training (Bachrach et al., 1976; Baddeley, Godden, Moray, Ross, & Synodinos, 1978; Berghage, 1972; Edmonds, 1972). This is confirmed in our results with a significant correlation of intelligence with the underwater criteria.

The low significance of personality measures in the workplace was a reasonable conclusion to draw, based on the correlation coefficients magnitude obtained in the initial reviews. Theoretical and methodological progress, however, enabled the provision of data

which clearly supports the validity of personality traits in predicting the behavior and performance criteria (Barrick, 2005; Furnham, 2008; Salgado, 2003). However, there is not unanimous agreement: some criticize their use in personnel selection because of the low association with occupational criteria or training results (Morgeson et al., 2007) and others support the increased validity of personality traits if contingent performance criteria are chosen (Hogan & Holland, 2003; Judge et al., 1999). Although initial studies about the relationship of personality traits with diving training and performance criteria showed data with marginal significance (Bachrach et al., 1976; Baddeley et al., 1978; Moray, Ross, & Synodinos, 1979), subsequent conclusions have indicated a greater association (Biersner, 1984; Biersner & Larocco, 1987; Edmonds, 1972). This is also ascertained in our study with a significant association of the personality traits with the underwater criteria.

Meta-analytic reviews about the joint validity of individual differences in American and European samples or in civilian and military activities have determined that general mental ability is the best predictor in the workplace and that personality traits increase their validity in specific tasks or contexts (Barrick, 2005; Salgado, 1998; Schmidt & Hunter, 1998). Moreover, the incorporation of personality measures can provide incremental validity and greater efficacy to predict specific working efficiency parameters, as noted in the military field (Campbell & Zook, 1991). Individual differences in intelligence and personality have also been shown to be explanatory in stressful situations, with the particularity that these conditions of emotional activation significantly increase the proportion of variance explained by personality
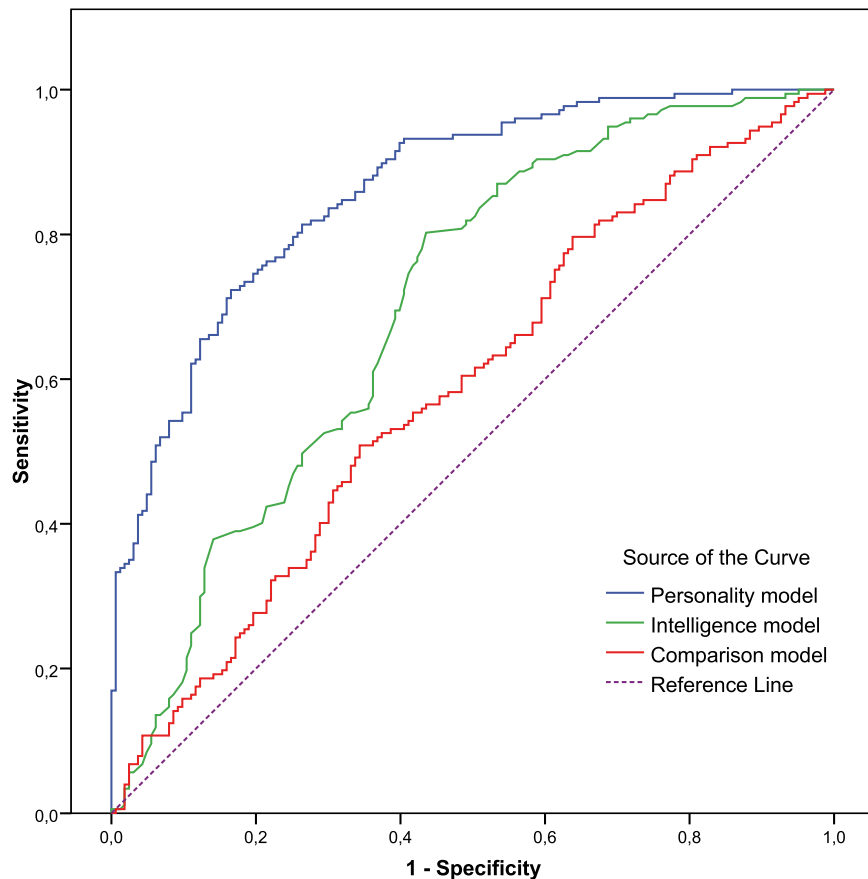
Figure 1. ROC curves of psychological traits in relation to underwater adaptation. Comparison model: Warmth, dominance, rule-consciousness, social boldness, vigilance, abstractedness, privateness, radicalism, self-reliance. Intelligence model: General intelligence, reasoning. Personality model: Emotional stability, sensitivity, apprehension, self-control, tension, facilitating anxiety (AUC = .86, $p < .001$).

traits in a wide range of behavioral criteria (Judge et al., 1999; Stankov, Boyle, & Cattell, 1995). Studies to determine the relevance of psychometric tests in the diving field initially emphasized the importance of intellectual characteristics and indicated the modest significance of personality traits, but anticipated that the prediction of underwater adaptation could be improved by incorporating measures of personality, motivation and physical fitness (Bachrach et al., 1976; Baddeley et al., 1978; Moray et al., 1979). The combined use of cognitive and non-cognitive variables has special application in the field of professional diving, because it is an extreme activity carried out in an adverse environment with high demands and varied risks, in which divers must overcome emergencies that can cause intense emotional activation (Anegg et al., 2002; Bachrach & Egstrom, 1987; Morgan et al., 2004). The results of our study support this joint practice. Personality traits related to emotional adjustment, conscientiousness and adaptability are useful in anticipating success in diving training and underwater performance, estimating a higher predictive

validity compared to general intelligence. This result is in line with the environmental circumstances and the high psychological demands required from those who carry out this professional activity.

The hierarchical regression analysis results support the conclusion that individual differences may be used to predict levels of underwater performance and adaptation, highlighting the validity of personality traits. These findings can improve the understanding of the behavioral effects and psychophysiological complications of diving, since the significant predictors are related to the perception and interpretation of stressful circumstances, to the type of strategies chosen for overcoming them, and to the performance level and behavioral reaction that can be expected in an extreme environment. By providing the ability to learn efficiently and the possibility of general adaptation, intelligence predicts the level of performance and adaptation, accounting for 7% of its variance in the underwater environment. General mental ability allows the application of the acquired knowledge and available resources to solve problematical situations,

to attain an adequate performance level, and to adapt to new environments and unexpected circumstances (Gottfredson, 2004). However, in this environment, the magnitude of the contribution of personality stands out over the predictive validity of the general intelligence, which is not the case using other occupational, personal or social criteria. In particular, we have confirmed that personality traits allow us to explain, approximately, an additional 20% of the variance of performance and adaptation. The explanation of this finding may have two facets. On the one hand, some traits (sensitivity, apprehension, and tension) are likely to elicit emotional reactions that may interfere with performance and adaptation as a result of their influence on the cognitive mechanisms underpinning the capacity for problem solving and decision-making processes (Castillo, 2010). On the other hand, there are personality traits (emotional stability, self-control, and facilitating anxiety) that may favor behavioral trends that are able to increase performance and emotional control in stressful situations and to improve stress experience or management (Carver & Connor-Smith, 2010).

Therefore, this study confirms the predictive validity of individual differences in intelligence and personality in the underwater environment and the greater relevance of the dispositional traits related to emotional adjustment and adaptability to anxiety and stress. These are indices of low vulnerability and susceptibility to stress and they predict the possibility of developing an effective response in changing or unforeseen situations such as those that happen in diving activities. The value of incremental validity of personality measures provide evidence which can be used to improve decision making and prediction tasks, especially when these measures represent a statistically significant increase in prediction of the diving criteria. This significant increase indicates a shift in the value of the measures of intelligence and personality validity, and a change of roles within the direction of the prediction derived from the meta-analytical studies, being the personality measures the ones which provide incremental validity to the intelligence measures in diving field.

The conclusion of the shift and reversal of the incremental validity of the psychological traits in the diving environment is limited by the use of a convenience sample, which represents all military divers who have carry out basic diving courses in the Spanish Diving School over a decade. However, the size and previous homogeneity of the sample ensure its statistical power and support the generalization of the results in the professional diving field. The use of new psychometric instruments with the same theoretical models, the increase of evaluated variables

and the analysis of complementary samples should be considered in future research.

The contribution of personality to the validity of the intelligence measures to predict the level of performance and adaptation in the underwater environment has been confirmed in this study. Emotional adjustment and adaptability constitute a set of psychological traits associated with underwater behavior and performance and they are also necessary factors to respond to the psychophysiological demands of diving. Therefore, it may be beneficial to take advantage of the incremental validity of personality traits in order to estimate performance in scuba diving, predict the human adaptation to underwater environments, and implement measures of psychological prevention and intervention which could be effective at training in exposure to environmental stress and coping with diving emergencies.

References

Anegg U., Dietmaier G., Maier A., Tomaselli F., Gabor S., Kallus K. W., & Smolle-Juttner F. M. (2002). Stress-induced hormonal and mood responses in scuba divers: A field study. *Life Sciences*, *70*, 2721–2734. http://dx.doi.org/10.1016/S0024-3205(02)01537-0

Bachrach A. J., & Egstrom G. H. (1987). *Stress and performance in diving*. San Pedro, CA: Best Publishing.

Bachrach A. J., Ginzburg H., Joiner J., Miller J. W., Parks R., & Stewart J. (1976). Psychological factors involved in undersea-hyperbaric exposures: Selection and training of professional divers. In M. W. Beckett (Ed.), *National Plan for the Safety and Health of Divers in their quest for subsea energy* (pp. 5.1–5.43). Bethesda, MD: Undersea Medical Society.

Baddeley A. D., Godden D. R., Moray N. P., Ross H. E., & Synodinos N. E. (1978). *Final report on training services agency contract - Selection of diving trainees*. Cambridge, UK: Stirling University and Medical Research Council.

Barrick M. R. (2005). Yes, personality matters: Moving on to more important matters. *Human Performance*, *18*, 359–372. http://dx.doi.org/10.1207/s15327043hup1804_3

Barrick M. R., Mount M. K., & Judge T. A. (2001). Personality and performance at the beginning of the new millennium: What do we know and where do we go next? *International Journal of Selection and Assessment*, *9*, 9–30. http://dx.doi.org/10.1111/1468-2389.00160

Beckman T. J., Lall R., & Johnson W. B. (1996). Salient personality characteristics among Navy divers. *Military Medicine*, *161*, 717–719.

Bennett P. B., & Elliott D. H. (Eds.) (1993). *The physiology and medicine of diving* (4th Ed.). London, UK: Saunders.

Berghage T. E. (1972). *The use of Standard Navy Classification Test scores for the selection of diver first class candidates*. NEDU Res. Rep. 20–72. Panama City, FL: U.S. Navy Experimental Diving Unit.

Biersner R. J. (1984). Physical and psychological examination of diver: Psychological standards for diving.

In C. W. Shilling, C. B. Carlston, & R. A. Mathias (Eds.), *The physician's guide to diving medicine* (pp. 520–530). New York, NY: Plenum Press.

Biersner R. J., & Larocco J. M. (1987). Personality and demographic variables related to individual responsiveness to diving stress. *Undersea Biomedical Research*, *14*, 67–73.

Brubakk A. O., & Neuman T. S. (Eds.) (2003). *Bennett and Elliott's physiology and medicine of diving* (5th Ed.). London, UK: Saunders.

Campbell J. P., McCloy R. A., Oppler S. H., & Sager C. E. (1993). A theory of performance. In N. Schmitt & W. C. Borman (Eds.), *Personnel selection in organizations* (pp. 35–70). San Francisco, CA: Jossey-Bass.

Campbell J. P., & Zook L. M. (1991). *Improving the selection, classification, and utilization of Army enlisted personnel: Final report on Project A*. Res. Rep. ARI-1597. Alexandria, VA: Army Research Institute for the Behavioral and Social Sciences.

Carver C. S., & Connor-Smith J. (2010). Personality and coping. *Annual Review of Psychology*, *61*, 679–704. http://dx.doi.org/10.1146/annurev.psych.093008.100352

Castillo M. D. (2010, February). *Estrés, ansiedad y rendimiento cognitivo. Una síntesis de seis teorías* [Stress, anxiety and cognitive performance. A synthesis of six theories]. Paper presented at the 11th Virtual Congress of Psychiatry. Interpsiquis 2010. Retrieved from http://www.psiquiatria.com/bibliopsiquis/bitstream/10401/1193/1/8cof345431.pdf

Cattell R. B. (1998). *16 PF, Cuestionario Factorial de Personalidad (adolescentes y adultos)* [16PF, Personality Factor Questionnaire (adolescents and adults)]. Madrid, Spain: TEA.

Colodro J., Garcés de los Fayos E., & Velandrino A. (2012). Diferencias de personalidad en la aptitud psicológica para el buceo militar [Personality differences in the psychological fitness for military diving]. *Anales de Psicología*, *28*, 434–443. http://dx.doi.org/10.6018/analesps.28.2.148971

Colom R., & Andrés-Pueyo A. (1999). El estudio de la inteligencia humana: Recapitulación ante el cambio de milenio [The study of human intelligence. A revision at the turn of the century]. *Psicothema*, *11*, 453–476.

Cordero A, Seisdedos N. González M., & de la Cruz M. V. (1994). *TIG-2: Test de Inteligencia General (serie dominós - Forma 2)* [TIG-2: General Intelligence Test (series dominoes - Form 2)]. Madrid, Spain: TEA.

Chamorro-Premuzic T., & Furnham A. (2006). Intellectual competence and the intelligent personality: A third way in differential psychology. *Review of General Psychology*, *10*, 251–267. http://dx.doi.org/10.1037/1089-2680.10.3.251

Chamorro-Premuzic T., & Furnham A. (2010). *The psychology of personnel selection*. Cambridge, UK: Cambridge University Press.

Edmonds C. W. (1972). *The diver*. RANSUM Project 2/72. Balmoral, UK: Royal Australian Navy School of Underwater Medicine (RANSUM).

Furnham A. (2008). *Personality and intelligence at work: Exploring and explaining individual differences at work*. New York, NY: Psychology Press.

Gottfredson L. S. (1997). Why g matters: The complexity of everyday life. *Intelligence*, *24*, 79–132. http://dx.doi.org/10.1016/S0160-2896(97)90014-3

Gottfredson L. S. (2002). Where and why g matters: Not a mystery. *Human Performance*, *15*, 25–46. http://dx.doi.org/10.1080/08959285.2002.9668082

Gottfredson L. S. (2004). Intelligence: Is it the epidemiologists' elusive «fundamental cause» of social class inequalities in health? *Journal of Personality and Social Psychology*, *86*, 174–199. http://dx.doi.org/10.1037/0022-3514.86.1.174

Hogan J., & Holland B. (2003). Using theory to evaluate personality and job-performance relations: A socioanalytic perspective. *Journal of Applied Psychology*, *88*, 100–112. http://dx.doi.org/10.1037/0021-9010.88.1.100

Hunsley J., & Meyer G. J. (2003). The incremental validity of psychological testing and assessment: Conceptual, methodological, and statistical issues. *Psychological Assessment*, *15*, 446–455. http://dx.doi.org/10.1037/1040-3590.15.4.446

Judge T. A., Higgins C. A., Thoresen C. J., & Barrick M. R. (1999). The Big Five personality traits, general mental ability, and career success across the life span. *Personnel Psychology*, *52*, 621–652. http://dx.doi.org/10.1111/j.1744-6570.1999.tb00174.x

Judge T. A., & Kammeyer-Mueller J. D. (2007). Personality and career success. In H. P. Gunz & M. A. Peiperl (Eds.), *Handbook of career studies* (pp. 59–78). Thousand Oaks, CA: Sage Publications. http://dx.doi.org/10.4135/9781412976107.n4

Moray N. P., Ross H. E., & Synodinos N. E. (1979). *Final report on a tests battery for the selection of trainee divers*. Stirling, UK: Stirling University.

Morgan W. P., Raglin J. S., & O'Connor P. J. (2004). Trait anxiety predicts panic behavior in beginning scuba students. *International Journal of Sports Medicine*, *25*, 314–322. http://dx.doi.org/10.1055/s-2004-815829

Morgeson F. P., Campion M. A., Dipboye R. L., Hollenbeck J. R., Murphy K., & Schmitt N. (2007). Are we getting fooled again? Coming to terms with limitations in the use of personality tests for personnel selection. *Personnel Psychology*, *60*, 1029–1049. http://dx.doi.org/10.1111/j.1744-6570.2007.00100.x

Ones D. S., Viswesvaran O., & Dilchert S. (2005). Cognitive ability in selection decisions. In O. Wilhelm & R. W. Engle (Eds.), *Handbook of understanding and measuring intelligence* (pp. 431–468). Thousand Oaks, CA: Sage Publications.

Ozer D. J., & Benet-Martinez V. (2006). Personality and the prediction of consequential outcomes. *Annual Review of Psychology*, *57*, 401–421. http://dx.doi.org/10.1146/annurev.psych.57.102904.190127

Pelechano V. (1975). *El cuestionario MAE (Motivación y Ansiedad de Ejecución)* [The questionnaire MAE (Motivation and achievement anxiety)]. Madrid, Spain: Fraser Española.

Pulakos E. D., Arad S., Donovan M. A., & Plamondon K. E. (2000). Adaptability in the workplace: Development of a taxonomy of adaptive performance. *Journal of Applied Psychology*, *85*, 612–624. http://dx.doi.org/10.1037//0021-9010.85.4.612

Ree M. J., & Earles J. A. (1992). Intelligence is the best predictor of job performance. *Current Directions in Psychological Science*, 1, 86–89. http://dx.doi.org/10.1111/1467-8721.ep10768746

Ree M. J., Earles J. A., & Teachout M. S. (1994). Predicting job performance: Not much more than g. *Journal of Applied Psychology*, 79, 518–524. http://dx.doi.org/10.1037/0021-9010.79.4.518

Roberts B. W., Kuncel N. R., Shiner R., Caspi A., & Goldberg L. R. (2007). The power of personality: The comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. *Perspectives on Psychological Science*, 2, 313–345. http://dx.doi.org/10.1111/j.1745-6916.2007.00047.x

Rostain J. C., & Balon N. (2006). Recent neurochemical basis of inert gas narcosis and pressure effects. *Undersea and Hyperbaric Medicine*, 33, 197–204.

Sackett P. R., & Lievens F. (2008). Personnel selection. *Annual Review of Psychology*, 59, 419–450. http://dx.doi.org/10.1146/annurev.psych.59.103006.093716

Salgado J. F. (1997). The Five Factor Model of personality and job performance in the European Community. *Journal of Applied Psychology*, 82, 30–43. http://dx.doi.org/10.1037/0021-9010.82.1.30

Salgado J. F. (1998). Big Five personality dimensions and job performance in Army and civil occupations: A European perspective. *Human Performance*, 11, 271–288. http://dx.doi.org/10.1080/08959285.1998.9668034

Salgado J. F. (2003). Predicting job performance using FFM and non-FFM personality measures. *Journal of Occupational and Organizational Psychology*, 76, 323–346. http://dx.doi.org/10.1348/096317903769647201

Salgado J. F., Anderson N., Moscoso S., Bertua C., de Fruyt F., & Rolland J. P. (2003). A meta-analytic study of general mental ability validity for different occupations in the European Community. *Journal of Applied Psychology*, 88, 1068–1081. http://dx.doi.org/10.1037/0021-9010.88.6.1068

Schmidt F. L., & Hunter J. E. (1998). The validity and utility of selection methods in personnel psychology: Practical and theoretical implications of 85 years of research findings. *Psychological Bulletin*, 124, 262–274. http://dx.doi.org/10.1037/0033-2909.124.2.262

Schmidt F. L., & Hunter J. E. (2004). General mental ability in the world of work: Occupational attainment and job performance. *Journal of Personality and Social Psychology*, 86, 162–173. http://dx.doi.org/10.1037/0022-3514.86.1.162

SPSS. (2010). *IBM SPSS Regression 19*. Chicago, IL: SPSS, Inc.

Stankov L., Boyle G. J., & Cattell R. B. (1995). Models and paradigms in personality and intelligence research. In D. H. Saklofske & M. Zeidner (Eds.), *International handbook of personality and intelligence* (pp. 15–43). New York, NY: Plenum Press.

Van Wijk C. (2002). Comparing personality traits of Navy divers, Navy non-divers and civilian sport divers. *Journal of the South Pacific Underwater Medicine Society*, 32, 2–8.

Van Wijk C., & Waters A. H. (2001). Personality characteristics of South African Navy divers. *Undersea and Hyperbaric Medicine*, 28, 25–30.