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Development and validation of the Statistical Anxiety Scale

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Nowadays, there is a great deal of evidence to suggest that personality variables can play an important role in the prediction of academic performance. However, many authors have mentioned that the differences in the prediction power of broad and narrow personality measures must be taken into account. We develop and validate a scale to assess the anxiety encountered when taking a statistics course. We designed the inventory as a set of 24 positive sentences that measure three subscales: *Examination Anxiety*, *Asking for Help Anxiety* and *Interpretation Anxiety*. In addition, as the three dimensions correlated with each other, they were considered related subscales from an overall scale, which measures statistical anxiety. Results show that these specific measures of anxiety about statistics have a significant relationship with academic performance in statistics whereas broader measures of anxiety or neuroticism do not.

Desarrollo y validación de la Escala de Ansiedad ante la Estadística. Actualmente hay una amplia evidencia empírica que sugiere que las variables de personalidad pueden jugar un papel importante en la predicción del rendimiento académico. Sin embargo, muchos autores apuntan a que se deben considerar las diferencias de potencia de predicción entre las medidas de personalidad generales y las específicas. Por nuestra parte, presentamos el desarrollo y validación de una escala para evaluar la ansiedad generada por una asignatura de estadística. El cuestionario consiste en 24 afirmaciones que miden tres escalas: Ansiedad por examen, Ansiedad por demanda de ayuda y la ansiedad por interpretación. Además, dado que las tres escalas están correlacionadas entre ellas, se consideran como tres subescalas de una escala general, que mide ansiedad estadística. Los resultados muestran que estas medidas específicas de ansiedad relacionada con la estadística tienen una relación significativa con el rendimiento académico, mientras que medidas generales de ansiedad o neuroticismo no muestran esta relación.

For many years, psychologists have been interested in finding variables that can predict academic performance (AP). Although initially research interest in this field was directed at the role of intelligence and motivation in the prediction of AP, in recent years a great deal of evidence has suggested that personality variables may play an important role, particularly at higher levels of education where the predictive power of ability measures is modest (Chamorro-Premuzic & Furnham, 2003a; Furnham & Chamorro-Premuzic, 2004).

Most of the research on the relationship between personality variables and AP has been carried out within the framework of the Five Factors Model (FFM). This research has shown that broad measures, such as Conscientiousness, present significant and stable relationships with AP at different education levels (Chamorro-Premuzic & Furnham, 2003a; Conrad, in press; Paunonen & Ashton, 2001; Schouwenburg & Kossowska, 1999).

Nevertheless, the relationship between other broad personality measures and AP is not so clear. This is the case of Neuroticism (N), which has shown less consistent results when it has been related with AP (Philips, Abraham, & Bond 2003). Some research reports a negative relationship between N and AP (Chamorro-Premuzic & Furnham, 2003a, 2003b; Duff, Boyle, Dunleavy, & Ferguson, 2004) while other research has failed to find a significant relationship between the two variables (Allik & Realo, 1997; Conrad, in press; Farsides & Woodfieldb, 2003; Furnham & Chamorro-Premuzic, 2004; Halamandis & Power, 1999; Hair & Hampson, 2006).

N seems to affect AP in many ways. Philips et al. (2003) reported that high N students seem to have less confidence in their abilities, are more likely to be distracted by negative emotions and tend to respond to stress by abandoning their goals. Furthermore, N is negatively related to hope for success and adjustment to university life and positively related to fear of failure and emotion-focused coping (Halamandis & Power, 1999). Finally N seems to be related to surface learning or to an undirected learning style, which is characterized by difficulties in processing the material being studied and in discriminating between what is important and what is not. Learners tend not to use systematic strategies and this has a negative impact on academic outcome (Busato, Prins, Elshout, & Hamaker, 1999, 2000; Boyle, Duffy, & Dunleavy, 2003; Duff et al., 2004).

Nevertheless the inconsistencies of the relationships between N and AP need to be explained. From this viewpoint, many authors in recent years have mentioned that it is necessary to take into

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account the differences in the prediction power of broad and narrow personality measures, and the loss in predictive accuracy that may be caused by aggregating low level measures to broader measures such as the FFM ones (Chamorro-Premuzic & Furnham, 2003b; Ferrando, Varea, & Lorenzo, 1999; Hair & Hampson, 2006; Paunonen & Ashton, 2001). As a result, broad measures are less accurate at criterion prediction than narrow measures and, furthermore, if they are used to relate personality measures and criterion variables the results will be less meaningful and interpretable (Paunonen, Rothstein, & Jakson, 1999).

This distinction is important for the relationship between N and AP, which has usually been understood in terms of anxiety, one of the facets of N (Furnham & Chamorro-Premuzic, 2004; Schouwenburg & Kossowska 1999). In this respect, research that has explored the relationships between AP and both super and primary traits has shown that two facets of N, anxiety and impulsiveness, are better predictors of AP than this broad factor (Chamorro-Premuzic & Furnham, 2003b; Hair & Hampson, 2006; Vigil-Colet & Morales-Vives, 2005).

The relationship between AP and N is usually understood in terms of anxiety, particularly under stressful conditions such as university examinations, although it seems that AP can also be affected by other stressful situations.

Furthermore, it seems that the more specific the measure of anxiety is, the closer its relationship with AP. Several studies that have applied different measures have found this effect. For instance, in a sample of high school students Rindermann and Neubauer (2001) found that test anxiety measures are more related to AP than general anxiety measures. Ferrando *et al*. (1999) reported that a general measure of anxiety (Revised Children Manifest Anxiety Scale) does not improve the prediction of how children perform in mathematics using a measure such as the N scale of EPQ-j. A measure that is more related to school anxiety (Test Anxiety Scale for Children), however, showed a significant incremental validity. Finally, this effect was also found for university undergraduates: the effects of test anxiety on AP were more related to the worry component than to the emotional component (Ferrando, 1999).

In recent years, research on the relationships between personality and AP has not analyzed only the general relationships between the two variables but has also focused on the relationships between anxiety and performance in specific academic domains. As a result, several authors have investigated the predictive power of personality on performance in statistics courses.

This interest is due to the fact that courses in statistics produce some of the highest levels of anxiety in students of education and other non-math-oriented disciplines, and statistics examinations are more anxiety-inducing than other types of examinations (Baloglu, 2003; Benson, 1989; Musch & Bröder, 1999; Onwuegbuzie & Seaman, 1995; Zeidner, 1991). Therefore, many students believe that this course is a major threat to the attainment of a degree, and low performance has become a problem in many educational institutions worldwide.

The specific characteristics of this situation have led to «Statistics anxiety» being developed as a concept that is different from test-anxiety. Statistics anxiety has been defined as anxiety which occurs as a result of encountering statistics in any form and at any level, involving a complex array of emotional reactions which hinder the learning process (Onwuegbuzie & Daley, 1999). What is more, this adverse reaction is not only to the evaluation itself, as in the case of test-anxiety, implying also a negative reaction that affects the attitude towards the matter which characterizes statistics-anxiety (Onwuegbuzie & Seaman, 1995).

It also seems that both N and general measures of anxiety do not have significant relationships with AP in statistics subjects. In fact, some of the research that failed to find relationships between N and AP or between general test anxiety and AP have used performance on statistics as a measure of AP (Finney & Schraw, 2003; Furnham & Chamorro-Premuzic, 2004; Hair & Hampson, 2006). This seems to indicate that this kind of subject may be an example of the appropriateness of using specific measures instead of superfactors to predict AP.

To test this hypothesis, this paper compares the predictive power of general and specific measures on the AP in statistics. These measures will comprise superfactors such as N, general measures of anxiety and specific measures of statistics anxiety. Nevertheless, the lack of an instrument designed to assess statistics anxiety in Spanish means that the first step must be to develop or to adapt one. A test that assesses statistical anxiety can be found in the literature: the *Statistical Anxiety Rating Scale* (STARS). STARS is a self-administered questionnaire consisting of 51 statements and 6 subscales (Cruise & Wilkens, 1980; Cruise, Cash, & Bolton, 1985). Even though the scale aims to assess anxiety, however, only the first three subscales are directly related to statistical anxiety: (a) the first dimension contains 8 items and is related to *Test and Class anxiety*; (b) the second dimension contains 4 items and is related to *Fear of Asking for Help Anxiety* (it focuses more on the «fear» that the student might experience in this situation than on anxiety); and (c) the third dimension contains 11 items and is related to *Interpretation Anxiety* (thisis restricted to data interpretation). The last three subscales in STARS are related to the perception the students have of the applicability of the subject, their own self-concept, and their perception of the teacher. Because of these difficulties, we aimed to develop a new instrument that was: (a) shorter that STARS, with the same number of items in each dimension; (b) specifically focused on statistical anxiety; and (c) better adapted to current class situations in statisitics for the social sciencies. Subsequently we wanted to use the instrument to test the substantive hypothesis mentioned above.

Method

Subjects

The participants in the study were 159 undergraduates students enrolled on a statistics course in a faculty of Psychology in Spain. There were 139 women and 20 men; the mean age and standard deviation was 21.6 and 3.5, respectively. We asked the participants to answer the inventory in their classroom.

Development of the statistical anxiety scale

Our aim was to develop a scale to assess the anxiety of students taking a statistics course. We wanted the scale to be (1) strictly related to anxiety to statistics; and (2) short enough to be easily administered individually and also in class groups. We shall now provide a detailed description of the procedure that we followed to develop our *Statistical Anxiety Scale* (SAS).

We wanted the SAS to be three dimensional, so that it could assess three different aspects of anxiety. These aspects are:

1. *Examination Anxiety*. A high score would suggest that students suffer from high anxiety when taking statistics exams. In our experience, students nowadays are not anxious when attending a statistic class. However, the examination process still seems to be an extremely anxious situation.
2. *Asking for Help Anxiety*. A high score would suggest that students suffer from high anxiety when asking the course teacher, another student, or a private teacher questions about statistics.
3. *Interpretation Anxiety*. A high score would suggest that students suffer from high anxiety when they have to interpret statistical data and understand the formulation used in statistics.

We obtained items in two different ways:

(1) We selected items from STARS, and translated them from English using the *back translation procedure*.
(2) We asked statistics teachers in the Social Sciences with more than ten years of university experience to write statements about the three aspects of anxiety that we wanted to measure.

We used both sources of items to obtain a set of 33 items. In a pilot study, we discarded nine items because of their poor psychometric propierties (more specifically, a low communality with the other 24 items). Please note that the sample used in the pilot study was discarded and is not part of the present study. So we finally selected 24 items (8 items per subscale), which can be found in the Appendix. They were translated into English using the back translation procedure. The items we eventually used from STARS were numbers 1, 8, 10 and 15 (which we expected to be related to *Examination Anxiety*), numbers 3 and 16 (*Asking for Help Anxiety*), and numbers 2, 6, 9, 17, 18 and 20 (*Interpretation Anxiety*). So 12 items were adapted from STARS, and 12 items were completely new. The final set of items was again submitted to statistics teachers, and they agreed on the content validity of items.

Each item is a positive sentence that describes a typical situation that can be experienced by a student enrolled on a statistics course. The participants must indicate the level of anxiety that they would feel in such a situation using a five-point scale ranging from «no anxiety» (1) to «considerable anxiety» (5). The Spanish and English version of the inventory can be obtained from the authors.

Measures

In addition to SAS, participants completed the trait scale of the State Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1988), and a questionnaire that consisted of the N scale items from the Spanish reduced version of the Eysenck Personality Questionnaire Revised (EPQ-R, Eysenck, Eysenck, & Barrett, 1985). Although the studies that failed to find a relationship between N and AP in statistics used the N scale of the FFM, we

Appendix
Items of the Statistical Anxiety Scale

1. Studying for an examination in a statistics course. *
2. Interpreting the meaning of a table in a journal article.*
3. Going to ask my statistics teacher for individual help with material I am having difficulty understanding.*
4. Realizing the day before an exam that I cannot do some problems that I thought were going to be easy.
5. Asking a private teacher to explain a topic that I have not understood at all.
6. Reading a journal article that includes some statistical analyses.*
7. Asking the teacher how to use a probability table.
8. Trying to understand a mathematical demonstration.
9. Doing the final examination in a statistics course.*
10. Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.*
11. Walking into the classroom to take a statistics test.*
12. Asking the teacher about how to do an exercise.
13. Getting to the day before an exam without having had time to revise the syllabus.
14. Waking up in the morning on the day of a statistics test.*
15. Realizing, just before you go into the exam, that I have not prepared a particular exercise.
16. Copying a mathematical demonstration from the blackboard while the teacher is explaining it.
17. Asking one of your teachers for help in understanding a printout.*
18. Trying to understand the odds in a lottery.*
19. Seeing a classmate carefully studying the results table of a problem he has solved.
20. Going to a statistics exam without having had enough time to revise.
21. Asking a teacher for help when trying to interpret a results table.
22. Trying to understand the statistical analyses described in the abstract of a journal article.*
23. Going to the teacher's office to ask questions.
24. Asking a private teacher to tell me how to do an exercise.

* *Items adapted from START*

preferred to use the N scale of the EPQ-r in order to ensure that the lack of relationships is not specific to the questionnaire used. Academic performance was assessed using the qualifications in a statistics exam that consisted of a number of theoretical questions and a number of exercises.

Procedure

In the classroom group, students that had already done a statistics exam were asked to participate voluntarily in a research study, and to respond to three questionnaires. The first questionnaire to be administered was the SAS, followed by the questionnaires related to personality traits. The administration was anonymous, and the respondents only had to provide the following particulars: gender and date of birth (day, month and year). This was sufficient to pair the scores on the inventories and the examination marks for each respondent without confusion.

Data analysis

In order to study the factor structure of the scale, an Exploratory Factor Analysis (EFA) was performed using Factor (Lorenzo-Seva & Ferrando, 2006). Three dimensions were extracted using the method known as Minimum Rank Factor Analysis (ten Berge & Kiers, 1991). The MRFA method has the advantage of distinguishing the common variance explained from the total common variance, hence making it possible to assess the proportion of common variance explained. To obtain a simple factor solution, we used Promin (Lorenzo-Seva, 1999). This rotation method allows factors to be oblique, if necessary, for factor simplicity. Most rotation methods need the items in the analysis to be pure measures of a single trait in order to obtain the simplest possible factor solution after rotation. However, the assumption that all the items in a multidimensional questionnaire are pure measures of a single trait is unrealistic (Ferrando & Lorenzo-Seva, 2000). Promin can deal with such situations better than other rotation methods, so it should be the method of choice (Lorenzo-Seva, 1999).

We used SPSS 12.0 to compute the analysis related to the items and the scales.

Results

Exploratory Factor Analysis

First of all, we computed the Pearson correlation matrix between the 24 items of the SAS. The Kaiser-Meyer-Olkin test value was .89, which indicated that the matrix was well suited to factor analysis. Parallel Analysis (Horn, 1965) showed that three dimensions were underlying the data, so the overall scale could be considered three-dimensional.

Table 1 shows the item loading values, communalities, and common variance explained after the oblique rotation. To help in the interpretation, the items are labelled 'E', 'A', and 'I', depending on the dimension they were expected to be related to (*Examination Anxiety*, *Asking for Help Anxiety*, and *Interpretation Anxiety*, respectively). All the items seemed to be mainly related to the expected dimension. The lowest salient loading value was 0.34, and the lowest communality value was .50. In addition, the total variance explained by the factors was 13.28 (i.e. 70.90% of the total common variance). Finally, Bentler's simplicity (S) index (1977) and the Loading Simplicity (LS) index (Lorenzo-Seva, 2003) had values of .99 and .60, respectively. The values obtained in our study meant that each item was mainly related to only one dimension, and the overall solution showed high factor simplicity.

Table 2 shows the inter-factor correlation matrix. As can be observed, the three dimensions were correlated with each other. This suggested that the three dimensions could be considered as related subscales from an overall scale. In addition, Parallel Analysis was computed to analyze the inter-factor correlation matrix and it suggested that there was one dimension underlying it. If the three subscales were *Examination Anxiety*, *Asking for Help Anxiety* and *Interpretation Anxiety*, the overall scale would be *Statistical Anxiety*.

Item and scales analyses

Table 3 shows the maximum and minimum discrimination indices of items for each subscale and the overall scale. As can be seen in the table, the item discriminations in each subscale were systematically higher than.38, with a maximum of .86. For the overall scale, values ranged between .28 and .70. These analyses

Table 1
Loading matrix (loading values larger than absolute .30 are printed in bold face)

Items	Examination anxiety	Asking for help anxiety	Interpretation anxiety	Communality
15E	**.88**	-.16	-.01	.98
20E	**.82**	-.05	.01	.77
9E	**.80**	-.03	-.05	.84
11E	**.71**	.08	-.01	.75
13E	**.68**	.00	-.04	.73
14E	**.61**	.12	-.02	.60
4E	**.60**	.05	.14	.69
1E	**.57**	.12	.12	.71
17A	-.06	**.92**	.04	.92
12A	.05	**.89**	-.10	.87
3A	.02	**.88**	-.21	.91
23A	.02	**.88**	-.10	.90
7A	.01	**.85**	.03	.93
21A	.00	**.65**	.25	.78
24A	.02	**.61**	.12	.81
5A	.02	**.50**	.24	.71
22I	-.03	-.04	**.89**	.92
2I	-.01	-.13	**.77**	.85
6I	-.12	.10	**.75**	.73
10I	-.01	-.20	**.71**	.68
18I	-.09	.18	**.52**	.66
8I	.25	.21	**.44**	.80
19I	.19	.17	**.43**	.50
16I	.20	-.03	**.34**	.68
Common variance explained	4.40	5.32	3.56	
Percentage	23.5%	28.4%	19.0%	

indicated that all the items were closely associated with one another in the corresponding subscale, but also as an overall scale. They were therefore combined into a single scale. The mean, standard deviation and item total correlation of the 24 items are shown in table 4. In addition, the table shows the internal consistency if each item is removed. Note that there was a slight increase only if item 12 was removed. However, it was so slight that we decided not to remove the item.

Table 2
Inter-factor correlation matrix

Factors	Examination anxiety	Asking for help anxiety
Asking for help anxiety	.445	–
Interpretation anxiety	.342	.308

Table 3
Descriptive statistics for items, subscales and the overall scale

Scale	Item-total correlation		Internal consistency	Mean	Standard deviation
	Minimum	Maximum			
Examination anxiety	.56	.73	.874	34.2	5.3
Asking for help anxiety	.57	.86	.924	20.3	7.5
Interpretation anxiety	.38	.74	.819	18.6	5.6
Statistical anxiety	.28	.70	.911	73.0	14.7

Table 4
Descriptive statistics for items

Items	Mean	Standard deviation	Item-total correlation	Internal consistency if the item was removed
1	3.7	1.0	.58	0.907
2	2.3	1.1	.35	0.911
3	2.9	1.3	.54	0.908
4	4.6	0.7	.56	0.908
5	2.3	1.1	.55	0.907
6	2.1	1.0	.46	0.909
7	2.5	1.2	.68	0.904
8	3.4	1.2	.63	0.905
9	4.6	0.7	.51	0.908
10	2.0	1.1	.28	0.913
11	4.0	1.2	.57	0.907
12	2.7	1.2	.67	0.905
13	4.6	0.7	.45	0.909
14	3.6	1.2	.52	0.908
15	4.6	0.7	.47	0.909
16	2.4	1.3	.33	0.912
17	2.5	1.1	.70	0.904
18	2.4	1.2	.39	0.911
19	2.1	1.1	.56	0.907
20	4.3	0.9	.55	0.907
21	2.1	1.0	.67	0.905
22	2.1	1.0	.50	0.908
23	3.0	1.3	.63	0.905
24	2.1	1.1	.56	0.907

The internal consistency (alpha coefficient) of subscales and the overall scale were then computed. The values of these coefficients, printed in table 3, showed that the reliability of the sub-scales and the overall scale was acceptable. The mean and standard deviation of participants' scores are also shown in table 3. The Kolmogorov-Smirnov test showed that only the distribution of scores of the *Examination Anxiety* subscale significantly differed from a normal distribution (Z= 1.79 and P= .003). The distribution of scores of the overall scale was closer to normal (Z= 0.82 and P= .507).

Scale validation

To validate SAS, we computed the correlations between general measures of anxiety (*Trait anxiety* and *Neuroticism*) and the scores on the subscales and the overall scale. These correlations are shown in table 5. As can be seen in the table, all the subscales were related to *Trait Anxiety*. The lowest correlation value corresponded to *Interpretation Scale* (r= .16; P= .044). However, only *Asking for Help Anxiety* and *Statistical anxiety* were related to *Neuroticism*.

These results showed that the subscales and the overall scale were related to the anxiety of participants. It must be said that the coefficients of validity were not expected to be high, as the anxiety assessed by SAS is a very specific kind of anxiety, whereas the other two criteria were general measures of anxiety.

Relationships between statistical performance and anxiety

Table 6 shows the correlations between statistical performance and personality measures. Performance on both the theory and

Table 5
Correlations between general measures of anxiety and the scores on the subscales and the overall scale

Scale	Trait anxiety	Neuroticism
Examination anxiety	.39**	.09
Asking for help anxiety	.31**	.28**
Interpretation anxiety	.16*	.08
Statistical anxiety	.34**	.20*

* P<0.05; ** P<0.001

Table 6
Correlations between anxiety measures and academic performance

Measures	Statistical qualifications		
	Theory	Exercises	Mean
Statistical anxiety	–.29*	–.31*	–.32*
Examination anxiety	–.26*	–.31*	–.31*
Asking for help anxiety	–.29*	–.30*	–.31*
Interpretation anxiety	–.13	–.13	–.14
Anxiety	–.15	–.14	–.15
Neuroticism	.03	.05	.04

* P<0.01

exercises was equally related to specific measures of anxiety while no relationship was found between AP and overall measures of anxiety or superfactors such as N. For the SAS scales, only the interpretation anxiety scale did not show any relationship with AP, while the overall score in the SAS and the examination anxiety and the asking for help scales showed similar correlations with AP (ranging from –.26 to –.32).

Discussion

The aim of this study was to develop and validate a scale to assess the anxiety encountered when taking a statistics course. The exploratory factor analysis showed that (1) the questionnaire was three dimensional; (2) all the items seemed to be mainly related to the expected dimension; (3) the overall solution showed high factor simplicity; and (4) the factors extracted explained 70.90% of the total common variance. In addition, as the three dimensions were correlated with each other they could be considered to be related subscales from an overall scale. The instrument is meant to be an alternative to the STARS, which is available nowadays.

The results of this research exemplify the increase in prediction power obtained when narrow not broad measures of personality are used to predict AP. Furthermore, in the specific field of statistics anxiety, results show that broad measures of personality such as N or overall anxiety have no power in the prediction of AP. As we have mentioned above, this result has been reported by other authors who have tried to relate N (from the FFM) with achievement in statistics. Nevertheless, the increase in the prediction power of narrow measures cannot explain why there is no relationship between N or overall anxiety and AP in this domain when, in other facets of AP, several authors have found low but significant relationships between them (Chamorro-Premuzic & Furnham, 2003a, 2003b; Duff et al., 2004).

As Onwuegbuzie and Seaman (1995) pointed out, it seems that statistics anxiety involves a negative reaction that goes beyond the anxiety generated by an evaluation situation. In this respect, several studies show the specificity of this kind of test anxiety. For instance, Benson (1989) found that college students show low levels of test anxiety in courses other than statistics; Musch and Bröder (1999) found that statistics examinations are more anxiety inducing than other examinations; and, finally, Finney and Schraw (2003) reported that general test anxiety was not related to performance in statistics but was related to statistics test anxiety. Moreover the relationship reported by Finney and Schraw (2003) between statistics test anxiety and AP was $r = -.271$ which falls in the range of correlations reported in our study.

It seems clear that more research is needed to clarify the factors that generate or modulate this specific form of anxiety. The low relationships founded between statistics anxiety and trait anxiety seem to indicate that most of the variance of statistics anxiety is due to other factors such as procrastination (Walsh & Ugumba-Agwunobi, 2002), math skills (Musch & Bröder, 1999), perfectionism (Onwuegbuzie & Daley, 1999), achievement expectation levels (Onwuegbuzie, 2003) or statistics self-efficacy (Finney & Schraw, 2003).

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