Confirmatory Factor Analysis of the Competitive State Anxiety Inventory-2

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Abstract

The present study evaluated the factor structure of the Competitive State Anxiety Inventory-2 (CSAI-2: Martens, Vealey, Burton, Bump, and Smith, 1990) using confirmatory factor analysis. Volunteer participants (N = 1,213) completed the CSAI-2 approximately 1 hour before competition and data were analysed in two samples. The hypothesised model showed poor fit indices in both samples independently and simultaneously, suggesting that the factor structure proposed by Martens et al. is flawed. The present results question the use of the CSAI-2 as a valid measure of competitive state anxiety.

Keywords: Anxiety, CSAI-2, Factorial Validity, Structural Equation Modelling, EQS

Anxiety is among the most frequently investigated variables in sport psychology (see Hardy, Jones, and Gould, 1996; Jones, 1995). It is usually conceptualised as a multidimensional construct comprising cognitive and somatic components (Martens, Vealey, and Burton, 1990). Cognitive anxiety is typified by negative self-images and self-doubts, while somatic anxiety is typified by increased heart rate, tense muscles and clammy hands. The Competitive State Anxiety Inventory-2 (CSAI-2: Martens, Burton, Vealey, Bump, and Smith, 1990) has been the measure of choice for most researchers of competition anxiety during the past decade. The CSAI-2 also assesses self-confidence, which is characterised by positive expectations of success. The CSAI-2 has 27 items with nine items in each of three subscales: Cognitive Anxiety, Somatic Anxiety, and Self-confidence. Given the research interest in competitive state anxiety and self-confidence, and the extent to which tests of theory rely upon valid measurement, demonstration of the factorial validity of anxiety measures is an imperative. There are at least three arguments to suggest that it would be prudent to re-evaluate the factor structure of the CSAI-2.

First, the methodological rigour applied by Martens et al. (1990) to test factorial validity is questionable in the light of current knowledge. Validation of the CSAI-2 involved four exploratory analyses using principal components analysis with oblique and varimax rotations. At each stage, the ratio of participants to items was below the minimum recommended (5:1) for trustworthy results (Tabachnick and Fidell, 1996; Thompson and Daniel, 1996). Indeed, Tabachnick and Fidell (p. 640) proposed that “As a general rule of thumb, it is comforting to have at least 300 cases for factor analysis.” Stage 1 analyzed the responses of 162 participants to a 79-item scale (2:1 ratio); Stage 2 re-analysed data from the same participants using a reduced 36-item scale (4.5:1 ratio); Stage 3 included 80 participants and a 52-item scale (1.5:1 ratio), and Stage 4 used the same 80 participants and a 27-item

scale (3:1 ratio). Moreover, exploratory factor analysis has been criticised for its inherently atheoretical nature (e.g., Thompson and Daniel, 1996) which tends to result in spurious factors especially when the participant to item ratio is low. Further methodological concerns include the re-analysis of responses from the same data set rather than cross-validating to new samples; the collection of anxiety data from some participants based on a hypothetical competition at Stages 1 and 2 (especially surprising given Martens et al.'s recommendation that one hour before competition is the optimum time to assess state anxiety); and the use of an exclusively undergraduate athletic sample, limiting the generalizability of the results to athletes from different educational backgrounds. Collectively, these methodological limitations suggest that cross-validation of the CSAI-2 to new samples is desirable.

A second reason for re-evaluating the factor structure of the CSAI-2 derives from the decision taken at Stage 5 of the original validation process to change the word "worried" to "concerned" in the Cognitive Anxiety scale to reduce the influence of social desirability. It appears possible that the semantic difference between these words may have threatened the conceptual integrity of the scale. Also at this stage, Martens et al. (1990) argued that low intercorrelations between the three anxiety subcomponents was sufficient evidence of factorial validity although no further factor analysis was conducted on the participant group of 266 athletes (see Martens et al., 1990, p. 139).

The third argument for re-evaluating the CSAI-2 is that recent developments of computer software to test the factor structures of psychological questionnaires have prompted researchers (see Bentler, 1992, 1995; Hendrick and Hendrick, 1985; Schutz and Gessaroli, 1993; Thompson and Daniel, 1996) to emphasise the benefits of structural equation modelling techniques such as confirmatory factor analysis (CFA). CFA has a clear advantage over exploratory techniques as data are tested against a prior model and the fit of the model

assessed using more stringent criteria. It would appear incumbent upon contemporary researchers involved in questionnaire development to use confirmatory procedures to establish factorial validity. Therefore, the purpose of the present study was to re-examine the proposed 27-item, three-factor structure of the CSAI-2 using confirmatory factor analysis techniques.

Method

Participants

A total of 1,213 volunteer participants (Age range = 15 to 39 yr., Male = 1,025, Female = 262) completed the CSAI-2. Participants were from a number of different sports including track and field, basketball, duathlon, hockey, jujitsu, karate, rugby, soccer, swimming, 10 km running, tae-kwon-do, tennis, and triathlon. It is suggested that the uneven gender distribution of the participants is representative of the respective proportion of males and females competing in sport. Although previous research has demonstrated gender differences in the intensity of anxiety responses (e.g., Martens et al., 1990), there has been no research to suggest that anxiety is conceptualized differently by males and females (Perry and Williams, 1998). Further, it is suggested that factorial validity is best demonstrated in large samples which represent the population to which findings are to be inferred (Tabachnick and Fidell, 1996).

Proposed Structure of the CSAI-2

It was proposed (Martens et al., 1990) that the 27 items of the CSAI-2 describe feelings of cognitive anxiety, somatic anxiety and self-confidence. The nine items in the Cognitive Anxiety scale include eight that refer to being “concerned” about a forthcoming competition. Two relate to specific outcomes (“I am concerned about losing” and “I’m concerned that others will be disappointed with my performance”), five to a self-referenced

standard (“I am concerned about performing poorly”, “I’m concerned I won’t be able to concentrate”, “I’m concerned about reaching my goal”, “I am concerned that I may not do as well as I could” and “I’m concerned about choking under pressure”), and one assesses general concerns about the competition (“I am concerned about this competition”). The remaining item assesses general doubts (“I have self-doubts”).

The nine items in the Somatic Anxiety scale include two that describe generalised somatic responses (“I feel nervous”, and “I feel jittery”), three that refer to muscular tension, (“My body feels tense”, “My body feels relaxed”, and “My body feels tight”), and four that describe somatic responses in specific parts of the body (“I feel tense in the stomach”, “My heart is racing”, “I feel my stomach sinking”, and “My hands are clammy”).

The nine items in the Self-confidence scale include five that describe positive expectations (“I feel self-confident”, “I am confident I can meet the challenge”, “I’m confident about performing well”, “I’m confident because I mentally picture myself reaching my goal”, and “I’m confident about coming through under pressure”), and four that describe a generalised feeling of calmness (“I feel calm”, “I feel comfortable”, “I feel secure”, “I feel mentally relaxed”). All items are rated on a 4-point scale anchored by 1 (“Not at all”) and 4 (“Very much so”).

Procedure

The CSAI-2 was administered to participants approximately 1 hr. before competition. Prior to completing the questionnaires, the Martens et al. (1990) “antisocial desirability” statement was read aloud, using the response set “How are you feeling right now?”

Data analyses

Confirmatory factor analysis (CFA) using EQS V5 (Bentler and Wu, 1995) was used to test the three-factor model proposed by Martens et al. (1990). It has been suggested that

an hypothesised model is examined more rigorously by randomly dividing participants into two samples, conducting CFA on one sample and then cross-validating the results on the other sample (Bynner and Ronney, 1985). Hence, the sample was split randomly into two samples of equal size (Sample A, $\underline{N}$ = 606; Sample B, $\underline{N}$ = 607) through the EQS V5 package.

The model tested specified that items were related to their hypothesised factor, with the variance of the factor fixed at 1, and the three factors were correlated. As there was evidence of multivariate non-normality in the data, the model was tested using the Robust Maximum Likelihood method which has been found to effectively control for overestimation of $\underline{X}^2$, under-estimation of adjunct fit indexes, and under-identification of errors (see Hu and Bentler, 1995).

Following the recommendations of Hu and Bentler (1995), a number of fit indices were used to test the factor structure. First, the $\underline{X}^2$ statistic was considered. A good fitting model tends to produce a non-significant $\underline{X}^2$ value, although its value is inflated among large samples. Recent research has addressed the issue of how to interpret a significant $\underline{X}^2$ among large samples, with the ratio of $\underline{X}^2$ to degrees of freedom being proposed as a superior index. Byrne (1989) suggested that a ratio of two or lower indicates an acceptable fit.

Two incremental fit indices were also used. First, the Non-Normed Fit Index (NNFI: Tucker and Lewis, 1973) assesses the adequacy of the hypothesised model in relation to a baseline model, taking sample size into account. Second, the Comparative Fit Index using the Robust $\underline{X}^2$ value (RCFI) evaluates the adequacy of the hypothesised model in relation to the worst (independent) model. If the hypothesised model is not a significant improvement on the independent model the fit indices will be close to zero (Bentler, 1995). Two absolute indices were also used; the Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index

(AGFI) which indicate the relative amount of the observed variances and covariances accounted for by the model. The criterion value associated with an acceptable model fit is .90 for all fit indices (Bentler, 1995).

Multisample CFA was used to test the strength of the factor solution across both samples simultaneously. In multisample analysis, it is assumed that data from more than one sample provide comparable information about the hypothesised model. This assumption is tested by analysing data from different samples simultaneously to verify whether the model reproduces the data of each sample to within sampling accuracy (see Bentler, 1992). As with one-sample CFA, $\underline{X}^2$ statistics and adjunct fit indexes represent the extent to which variance/covariance matrices from different samples are identical. In multisample analysis, the Lagrange Multiplier (LM) test assesses the extent to which the fit of the model would be improved if equality constraints were removed. Cronbach (1951) alpha coefficients of internal consistency were also calculated for each factor. Tabachnick and Fidell (1996) suggested that Cronbach alpha coefficients for an internally consistent scale should be .70 or higher.

Results

Results of the single-sample CFAs of the model proposed by Martens et al. (1990) are reported in Table 1. The ratio of $\underline{X}^2$ to degrees of freedom indicated a questionable fit between the data and the model in both samples (Sample A = 4.07, Sample B = 3.88). More importantly, all fit indices were lower than the .90 criterion level (e.g., Sample A: RCFI = .82; Sample B: RCFI = .84) required of an acceptable fit (see Bentler, 1995).

The rationale for multisample CFA in the present study was to test the generalisability of the results. As single-sample results had demonstration a poor model fit, the purpose of the multisample analysis was examine the extent to which parts of the model that were strong

and the parts of the model that were weak were consistent across both samples. The model tested the extent to which factor loadings were equal in both samples.

Multisample CFA results also indicated a poor overall fit (see Table 2). The emphasis of multisample analysis is on the extent to which equality constraints placed on the factor loadings differ significantly between samples. Standardised correlation coefficients, error variances, and $\underline{X}^2$ difference test from the multisample LM test are contained in Table 3. Standardised factor coefficients indicated poor relationships between four items and their hypothesised factor ("I am concerned about this competition" and "My body feels relaxed"). These items demonstrated low factor loadings and high error variances in one or both samples. The multisample LM test results indicated that none of the factor loadings differed significantly between the samples. Further, the multivariate multisample LM test indicated that differences in item-factor relationships were not significant. This casts substantial doubt upon the inclusion of these four items in the CSAI-2 as they do not contribute to their hypothesised factor.

Table 4 contains the intercorrelations among factors. The variance shared between Cognitive Anxiety and Somatic Anxiety scores was 43% for Sample A and 38% for Sample B. Self-confidence and Cognitive Anxiety shared 19% (Sample A) and 22% (Sample B) common variance; Self-confidence and Somatic Anxiety shared 26% (Sample A) 22% (Sample B) common variance. The strength and direction of these correlations are consistent with those reported by Martens et al. (1990).

The LM test results indicated that the fit of the model would be improved if items were allowed to load onto more than one factor. The multivariate LM test results indicated that the fit of the model would be significantly improved ($\underline{X}^2$ improvement = 477.69) by adding 17 new parameters in Sample A (see Table 5) and by adding 20 new parameters in

Sample B (see Table 6: $\underline{X}^2$ improvement = 469.95). Most notably, results indicated that three items ("I have self-doubts": Sample A: $\underline{X}^2$ = 99.00, $\underline{p}$ < .001 and Sample B: $\underline{X}^2$ = 86.98, $\underline{p}$ < .001; "My body feels relaxed" - Sample A: $\underline{X}^2$ = 55.07, $\underline{p}$ < .001 and Sample B: $\underline{X}^2$ = 79.79, $\underline{p}$ < .001; and "I am concerned that I may not do as well in this competition as I could" - Sample A: $\underline{X}^2$ = 54.67, $\underline{p}$ < .001 and Sample B: $\underline{X}^2$ = 55.24, $\underline{p}$ < .001) should cross-load into the Self-confidence scale.

Internal consistency coefficients for the three subscales were: Cognitive Anxiety, alpha = .80; Somatic Anxiety, alpha = .85; and Self-confidence, alpha = .88, all above the .70 criterion value. Although this provides support for the hypothesised model, the analysis was re-run including all 27-items producing an alpha coefficient of .70. This result could be construed as evidence to show that including all items in a single anxiety dimension produces an internally consistent factor. It also reinforces the LM test results which suggest that several items should load onto more than one factor to increase the fit of the model.

When examined collectively, the results provide strong evidence that the model proposed by Martens et al. produced an unacceptable level of fit to satisfactorily explain the observed variance within the data.

Discussion

The present study re-evaluated the factorial validity of the CSAI-2 (Martens et al., 1990). The rationale for the investigation was based on the argument that theory testing and construct measurement are inextricably linked (Hendrick and Hendick, 1996; Thompson and Daniel, 1996). If the validity of a measurement instrument is in question, then it is not possible to accurately test the associated theory. Results of the present study bring into question the validity of the three-factor model for the CSAI-2 proposed by Martens et al. (1990).

Given the nature of cognitive anxiety, it is hypothesised that an item such as “I have self-doubts” should have shown the strongest relationship with the Cognitive Anxiety scale rather than the weakest. Therefore, at a theoretical level, it could be argued that the item “I have self-doubts” genuine assesses cognitive anxiety, while the other eight items in the scale which refer to feeling “concerned” assess a slightly different construct. Logically, an athlete who is about to compete in an important competition is likely to report feeling concerned about performance, and thereby produce a high score for cognitive anxiety, even though they may remain confident in their ability to meet the demands of the task. Being concerned about an impending performance does not necessarily mean that an athlete is experiencing negative thoughts, but that the athlete is acknowledging the importance and difficulty of the challenge and is attempting to mobilise resources in order to cope.

Research has found that athletes sometimes interpret cognitive anxiety symptoms as facilitative of performance. Indeed, this has prompted the development of a directional scale for the CSAI-2 (Jones, Swain, and Hardy, 1993) whereby respondents quantify the extent to which they feel that anxiety symptoms will facilitate or debilitate performance. Recent research has suggested that using the CSAI-2 without a direction scale may provide a misleading measure of anxiety (Perry and Williams, 1998). It seems paradoxical that cognitive anxiety, a construct proposed to be typified by negative expectations, could be perceived as facilitative of performance or that self-confidence, typified by positive expectations, could be seen as debilitative of performance. Interestingly, Jones and co-workers have abandoned using the directional scale to assess self-confidence due to the strong relationship between intensity and direction of perceptions (see Jones, 1995 for review). Given the proposed nature of cognitive anxiety, it would seem appropriate that the same logic should apply. To reconcile this contradiction, we are suggesting that items of the

cognitive anxiety scale should be reworded to reflect the extent to which individual are "worried" about performance, as the notion of worry better captures the negative self-images proposed to be central to the cognitive anxiety construct. It is proposed that such a change reflects more than a semantic nuance and indeed lies at the heart of conceptual integrity.

Martens et al. (1990) originally used the word "worried" in some items in the Cognitive Anxiety scale but replaced it to "concern" in the final stage of the factorial validation process to reduce social desirability. It is not unreasonable to assume that athletes would more readily acknowledge concern about a competition than worry, and perhaps report this as likely to facilitate good performance. However, the more "honest" responses may simply reflect the importance attached to the event by the individual rather than negative expectations. Therefore, the price of reduced social desirability bias may have been the conceptual integrity of the cognitive anxiety construct. Evidently, there is a need for further examination of this issue.

The place of a self-confidence scale in an anxiety inventory needs a strong theoretical rationale. Martens et al. (1990) found that the Self-confidence scale emerged out of exploratory factor analysis techniques. The items in the scale had originally been included in the item pool to assess cognitive anxiety through positively-worded items. Recent research has questioned the reproducibility of the structure of the original self-confidence factor. Prapavessis, Cox, and Brookes (1996) replicated the techniques used by Martens et al. on a sample of 199 athletes from a variety of different sports[1]. Results indicated that Self-confidence divided into two factors; one comprising five items that describe positive

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[1] These details, which were not reported by Prapavessis et al. (1996), were supplied via personal correspondence.

performance expectations (e.g., I am confident I can meet the challenge" and "I'm confident about performing well"), the other comprising four items that describe an absence of cognitive anxiety (e.g., "I feel comfortable" and "I feel at ease") and therefore seem to assess what could be described as a sense of calmness.

The doubts expressed about the psychometric integrity of the CSAI-2 are founded on analyses which were not available at the time of the development and validation of the measure. Confirmatory factor analysis is proposed to be a rigorous test of theory as data are tested against a hypothesised model. The CSAI-2 was developed using exploratory factor analysis which, it has been argued (Thompson and Daniel, 1996) lack a theoretical basis by virtue of its exploratory nature. Factors derived from exploratory techniques will a product of the items entered into the analysis and may be anomolous to the participants under investigation rather than generalizable constructs. Further, Mulaik (1987) argued that data can inform judgements, but the development of psychological measurements should be grounded in theory not data.

Overall, it may be concluded that investigators of anxiety responses to sport competition cannot have faith in data obtained using the CSAI-2 until further validation studies have been completed and possible refinements to the inventory have been introduced.

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Table 1

Confirmatory Factor Analysis of the Competitive State Anxiety Inventory-2

Fit index	Sample A (N = 606)	Sample 2 (N = 607)
Satorra-Bentler X^2	1299	1246
Degrees of freedom	321	321
Satorra-Bentler X^2/df ratio	4.07	3.88
NNFI	.79	.81
RCFI	.82	.84
GFI	.83	.83
AGFI	.80	.80

Note. NFI = Normed Fit Index, NNFI = Bentler Bonett Nonnormed Fit Index, RCFI = Robust Comparative Fit Index, GFI = Goodness of Fit Index, AGFI = Adjusted Goodness of Fit Index

Table 2

Multisample Factor Analysis of the Competitive State Anxiety Inventory-2

Fit index	Multisample CFA
X^2	2892
Degrees of freedom	669
X^2/df ratio	4.32
NNFI	.81
CFI	.82
GFI	.83
AGFI	.81

Note. NFI = Normed Fit Index, NNFI = Bentler Bonett Nonnormed Fit Index, CFI = Comparative Fit Index, GFI = Goodness of Fit Index, AGFI = Adjusted Goodness of Fit Index

Table 3

Standardised Factor Loadings and Error Variances of Items

	Sample A (N = 606)		Sample B (N = 607)		LMT X^2
	Factor loading variance	Error	Factor loading	Error varaince	difference test
Cognitive Anxiety					
I am concerned about this competition	.46	.89	.46	.89	.16
I have self-doubts	.55	.83	.56	.83	.95
I am concerned that I may not do as well in this competition as I could	.63	.78	.64	.77	.42
I am concerned about losing	.54	.84	.54	.84	.22
I am concerned about choking under pressure	.52	.86	.49	.87	.21
I am concerned about performing poorly	.70	.72	.69	.72	.16
I'm concerned about reaching my goal	.47	.88	.47	.88	.68
I'm concerned that others will be disappointed with my performance	.65	.76	.65	.76	.20
I'm concerned I won't be able to concentrate	.51	.87	.49	.87	.04
Somatic Anxiety					
I feel nervous	.58	.82	.58	.81	.05
I feel jittery	.62	.78	.62	.79	.28
My body feels tense	.72	.71	.68	.73	.06
I feel tense in the stomach	.74	.68	.72	.70	.01
My body feels relaxed	.40	.92	.39	.92	.18
My heart is racing	.70	.72	.69	.73	.30
I feel my stomach sinking	.69	.72	.70	.72	.32
My hands are clammy	.55	.83	.58	.82	.33
My body feels tight	.67	.74	.68	.73	.15
Self-confidence					
I feel at ease	.55	.84	.52	.85	.08
I feel comfortable	.63	.78	.64	.77	.30
I feel self-confident	.74	.68	.73	.67	.28
I feel secure	.66	.76	.63	.79	.03
I feel mentally relaxed	.75	.66	.74	.67	.01
I am confident I can meet the challenge	.77	.64	.75	.66	.36
I'm confident about performing well	.64	.77	.64	.77	.08
I'm confident because I mentally picture myself reaching my goal	.63	.77	.62	.78	.48
I'm confident at coming through under pressure	.68	.74	.68	.74	.75

Table 4

Correlation Coefficients Among Competitive State Anxiety Inventory-2 Subscales

	Somatic Anxiety	Self-confidence
Cognitive Anxiety		
Sample A	.65*	-.44*
Sample B	.62*	-.46*
Somatic Anxiety		
Sample A		-.51*
Sample B		-.47*

* P < .01

Table 5

Lagrange Multiplier Test Scores for Adding Parameters in Sample A: Significant Predictors Only ($P < .01$)

Item - Factor	Univariate X^2	Multivariate X^2
I have self-doubts - Self-confidence	99.00	99.00
My body feels relaxed - Self-confidence	154.07	55.07
I am concerned that I may not do as well in this competition as I could - Self-confidence	208.54	54.47
I'm concerned I won't be able to concentrate - Self-confidence	245.41	36.87
I am concerned about choking under pressure - Somatic Anxiety	281.78	36.36
I feel at ease - Somatic Anxiety	310.63	28.86
I feel nervous - Cognitive Anxiety	330.98	20.35
I'm concerned about reaching my goal - Self-confidence	350.39	19.41
I feel comfortable - Somatic Anxiety	367.50	17.10
I'm confident about performing well - Somatic Anxiety	385.86	18.36
I feel secure - Somatic Anxiety	408.50	22.64
My heart is racing - Self-confidence	422.56	14.06
I am concerned about losing - Self-confidence	435.20	12.64
I feel tense in the stomach - Self-confidence	447.06	11.86
I'm concerned I won't be able to concentrate - Somatic Anxiety	458.38	11.32
I am concerned about this competition - Self-confidence	469.52	11.14
I have self-doubts - Somatic Anxiety	477.69	8.17

Table 6

Lagrange Multiplier Test Scores for Adding Parameters in Sample B: Significant Predictors Only

Item - Factor	Univariate X^2	Multivariate X^2
I have self-doubts - Self-confidence	86.96	86.96
My body feels relaxed - Self-confidence	166.76	79.79
I am concerned that I may not do as well in this competition as I could - Self-confidence	222.02	55.24
I feel nervous - Cognitive Anxiety	258.46	36.45
I'm confident because I mentally picture myself reaching my goal - Somatic Anxiety	282.90	24.44
I'm concerned I won't be able to concentrate - Self-confidence	307.16	24.26
I feel comfortable - Somatic Anxiety	327.17	20.01
I feel at ease - Somatic Anxiety	350.85	23.68
I'm concerned about reaching my goal - Self-confidence	365.93	15.08
I feel tense in the stomach - Self-confidence	382.19	16.26
I feel jittery - Self-confidence	395.19	13.01
I am concerned about performing poorly - Somatic Anxiety	407.08	11.89
I feel secure - Somatic Anxiety	417.35	10.27
I'm confident about performing well - Somatic Anxiety	427.45	10.10
My heart is racing - Self-confidence	436.23	8.79
I am concerned about choking under pressure - Somatic Anxiety	444.59	8.36
I'm concerned I won't be able to concentrate - Somatic Anxiety	453.19	8.60
I'm concerned about this competition - Self-confidence	460.29	7.11
I feel nervous - Self-confidence	465.33	5.03
I'm concerned that others will be disappointed with my performance - Self-confidence	469.95	4.62