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The relative impact of cognitive anxiety and self-confidence upon sport performance: a meta-analysis

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This meta-analysis ($k = 48$) investigated two relationships in competitive sport: (1) state cognitive anxiety with performance and (2) state self-confidence with performance. The cognitive anxiety mean effect size was $r = -0.10$ ($P < 0.05$). The self-confidence mean effect size was $r = 0.24$ ($P < 0.001$). A paired-samples t -test revealed that the magnitude of the self-confidence mean effect size was significantly greater than that of the cognitive anxiety mean effect size. The moderator variables for the cognitive anxiety–performance relationship were sex and standard of competition. The mean effect size for men ($r = -0.22$) was significantly greater than the mean effect size for women ($r = -0.03$). The mean effect size for high-standard competition ($r = -0.27$) was significantly greater than that for comparatively low-standard competition ($r = -0.06$). The significant moderator variables for the self-confidence–performance relationship were sex, standard of competition and measurement. The mean effect size for men ($r = 0.29$) was significantly greater than that for women ($r = 0.04$) and the mean effect size for high-standard competition ($r = 0.33$) was significantly greater than that for low-standard competition ($r = 0.16$). The mean effect size derived from studies employing the Competitive State Anxiety Inventory-2 ($r = 0.19$) was significantly smaller than the mean effect size derived from studies using other measures of self-confidence ($r = 0.38$). Measurement issues are discussed and future research directions are offered in light of the results.

Keywords: cognitive anxiety, meta-analysis, self-confidence, sport performance.

Introduction

The relationship between anxiety and sport performance has attracted much research attention over the past 20 years, and researchers have tried to clarify this relationship by advancing several models and theories. These include multidimensional anxiety theory (Martens *et al.*, 1990), catastrophe models (Hardy, 1990, 1996a), reversal theory (Apter, 1982; Kerr, 1990) and zones of optimal functioning models (Hanin, 1980, 1986).

In multidimensional anxiety theory, Martens *et al.* (1990) proposed a series of two-dimensional relationships between cognitive anxiety, somatic anxiety, self-confidence and performance. Cognitive anxiety was defined as ‘negative expectations and cognitive concerns about oneself, the situation at hand, and potential consequences’ (Morris *et al.*, 1981, p. 541). Somatic anxiety was conceptualized as the perception of one’s physiological arousal. Self-confidence was conceptualized

as one’s belief in meeting the challenge of the task to be performed. In multidimensional anxiety theory (Martens *et al.*, 1990), cognitive anxiety is hypothesized to have a negative linear relationship with performance; somatic anxiety is hypothesized to have a quadratic (inverted-U shaped) relationship with performance; and self-confidence is hypothesized to have a positive linear relationship with performance.

The hypothesized negative linear relationship between cognitive anxiety and performance was largely based upon theories of attention (e.g. Wine, 1971, 1980), whereby cognitive resources are taken up by worrying thoughts and so are not available for use on the task at hand. As Martens *et al.* (1990) conceptualized cognitive anxiety and self-confidence as lying at opposite ends of a continuum, they hypothesized that self-confidence and performance would be related in a positive linear fashion. However, the rationale for the hypothesized inverted-U relationship between somatic anxiety and performance is much less clear. Martens *et al.* (1990) cited Weinberg’s (1978) research, which suggests that too much muscular tension will lead to a deterioration in performance. However, Martens *et al.*

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offered no theoretical explanation for the hypothesized curvilinear relationship between the *perception* of one's physiological arousal (i.e. somatic anxiety) and performance (see Woodman and Hardy, 2001a). Thus, although somatic anxiety is a useful indirect measure of the physiological indices of anxiety, it is of limited theoretical value in explaining the relationship between *physiological arousal* and performance. Consequently, we focus here only on the effects of cognitive anxiety and self-confidence upon sport performance.

Several investigations have been conducted to test the proposed relationships between cognitive anxiety and performance and between self-confidence and performance. For example, Burton (1988) found a negative linear trend between cognitive anxiety and swimming performance and a positive linear trend between self-confidence and performance. In the two samples investigated by Burton, cognitive anxiety accounted for up to 46% of swimming performance variance and self-confidence accounted for up to 21%. Gould *et al.* (1984) also found a significant negative linear relationship between cognitive anxiety and performance, but no significant trend between self-confidence and performance. Conversely, Martin and Gill (1991) found self-confidence to be significantly and positively related to distance running performance, but found no significant relationship between cognitive anxiety and running performance. Similarly, in their study of pistol shooters, Gould *et al.* (1987) found no significant relationship between cognitive anxiety and performance. However, in that study, a significant *negative* relationship between self-confidence and performance was revealed. Other studies have revealed no significant relationships between cognitive anxiety and performance (Maynard and Cotton, 1993; Hammermeister and Burton, 1995; Vadocz *et al.*, 1997) or between self-confidence and performance (Williams and Krane, 1992; Maynard and Cotton, 1993). Thus, the relative impact of cognitive anxiety and self-confidence upon competitive sport performance remains unclear.

The inventory that was used to measure cognitive anxiety and self-confidence in most of the above studies was the Competitive State Anxiety Inventory-2 (CSAI-2; Martens *et al.*, 1990). The CSAI-2 was originally intended to be an anxiety scale comprising two subscales: cognitive anxiety and somatic anxiety. However, in the exploratory factor analysis of the items comprising the CSAI-2, Martens *et al.* (1990) found that the cognitive anxiety items effectively separated into two factors, one that included negatively phrased items and one that included positively phrased items. These factors were subsequently labelled cognitive anxiety and self-confidence, respectively. Thus, a self-confidence subscale was also included in the CSAI-2.

In the discussion of their factor analyses, Martens *et al.* (1990) stated: 'These findings suggest that cognitive A-state and state self-confidence represent opposite ends of a cognitive evaluation continuum, state self-confidence being viewed as the absence of cognitive A-state, or conversely, cognitive A-state being the lack of state self-confidence' (p. 129).

Given that cognitive anxiety and self-confidence emerged as orthogonal (i.e. independent) factors in these factor analyses, it is surprising that Martens *et al.* (1990) should view them as bipolar (i.e. interdependent). Furthermore, there appears to be sufficient evidence to suggest that cognitive anxiety and self-confidence are meaningfully distinct constructs (Burrows *et al.*, 1977; Thayer, 1978; Gould *et al.*, 1984, 1987; Hardy and Whitehead, 1984; Jones and Cale, 1989; Hardy, 1996b; Parfitt and Pates, 1999). For example, although Gould *et al.* (1984) found a significant negative linear relationship between cognitive anxiety and performance, they found no significant trend between self-confidence and performance. Also, in their work on the antecedents and temporal patterning of cognitive anxiety and self-confidence, Jones *et al.* (1990, 1991) provided more evidence for the relative independence of cognitive anxiety and self-confidence. Finally, both Hardy (1996b) and Parfitt and Pates (1999) found that self-confidence accounted for a significant proportion of performance variance over and above that accounted for by cognitive anxiety.

In light of the discrepant results revealed between different studies that have reported cognitive anxiety-performance and self-confidence-performance relationships, it is important to consider which variables might be moderating these relationships. We consider three major moderator variables: (a) measurement, (b) type of sport and (c) individual differences.

Measurement

Intra-individual versus inter-individual measurement

Many researchers (e.g. Sonstroem and Bernardo, 1982; Burton, 1988) have contended that inter-individual measurements are inappropriate when examining the relationships between anxiety and performance, as such measurements are not sensitive to individual differences in anxiety or performance. As intra-individual measurements of anxiety, self-confidence and performance control for such differences, we hypothesized that the relationships between cognitive anxiety and performance and between self-confidence and performance would be stronger when these constructs were measured intra-individually rather than inter-individually.

Questionnaire

Several criticisms have been levelled at the Competitive State Anxiety Inventory-2 as a measure of pre-competition affect. These criticisms include the use of the term 'concern' as a measure of cognitive anxiety (Burton and Naylor, 1997; Woodman and Hardy, 2001a), its lack of specificity in relation to the task (Moritz *et al.*, 2000) and its poor overall fit (Lane *et al.*, 1999). However, researchers continue to use the CSAI-2, probably because there is no obvious alternative validated questionnaire that measures pre-competition anxiety and self-confidence. In light of these issues, we examined the use of the CSAI-2 (as opposed to other measures of competitive state cognitive anxiety and self-confidence) as a possible moderator of the relationships between cognitive anxiety and performance and between self-confidence and performance.

Type of sport

Sports can be broadly categorized into team sports and individual sports. As there may be more pressure and personal exposure associated with individual sports than team sports, we hypothesized that cognitive anxiety and self-confidence would be more strongly associated with athletes' performance in individual sports.

Individual differences

Standard of competition

High-standard competition may be associated with increased pressure. Cognitive anxiety probably reflects, in part, athletes' inability to deal with this pressure. Conversely, self-confidence probably reflects, in part, athletes' ability to deal with this increased pressure. Thus, cognitive anxiety and self-confidence are more likely to affect subsequent performance in high-standard competitive settings. Thus, we hypothesized that the relationships between cognitive anxiety and performance and between self-confidence and performance would be stronger for high-standard athletes than relatively low-standard athletes.

Sex

Women typically report higher cognitive anxiety and lower self-confidence than men (cf. Martens *et al.*, 1990; Jones *et al.*, 1991). If it is accepted that there is a cognitive anxiety threshold beyond which cognitive anxiety will more likely affect performance, then cognitive anxiety and performance should be more strongly related for women if this threshold is high. This

is because women's cognitive anxiety would be distributed below and above the threshold, whereas men's cognitive anxiety would largely be below the threshold. Similarly, cognitive anxiety and performance may be more strongly related for men if this threshold is low, as men's cognitive anxiety would be distributed below and above this threshold, whereas women's cognitive anxiety would largely be above the threshold. The same argument holds for self-confidence. That is, if there is a threshold below which self-confidence will more likely affect performance, then self-confidence may be more strongly related to performance for men if this threshold is high, as men's self-confidence would be distributed below and above this threshold, whereas most women's self-confidence would largely be below the threshold. Similarly, self-confidence and performance should be more strongly related for women if this threshold is low, as women's self-confidence would be distributed below and above the threshold, whereas men's self-confidence would be largely above such a threshold. As the existence of such thresholds is largely speculative, we investigated sex as a moderator variable but did not formulate any specific hypotheses regarding the differences between the sexes in the strength of relationships between cognitive anxiety and performance or between self-confidence and performance.

In summary, the aims of the present meta-analysis were threefold: (1) To examine the fundamental predictions of multidimensional anxiety theory; namely, that cognitive anxiety has a negative relationship with performance and that self-confidence has a positive relationship with performance. (2) To examine the relative magnitude of the cognitive anxiety and self-confidence effect sizes to identify which (if either) is the more important and whether it is empirically reasonable to consider them as lying at opposite ends of the same continuum. (3) To examine the moderating variables in the relationships between cognitive anxiety and performance and between self-confidence and performance.

Methods

Literature search

Computer-based literature searches were conducted to locate published and unpublished research on cognitive anxiety, self-confidence and performance. The databases used for this search were: Applied Social Sciences Index and Abstracts (ASSIA), Bath Information and Data Services (BIDS), PsycINFO, PsycLIT, Social Science Citation Index (SSCI) and Sport Discus. The last search was conducted at the beginning of January 2002. Keywords used for the searches were: 'cognitive anxiety', 'confidence', 'sport' and

'performance'. Several 'wild card' searches were also conducted to ensure that the search did not miss studies containing related words such as 'anxiety', 'worry' and 'competition'. The reference lists of the located studies were examined for further possible articles that might fulfil the criteria for inclusion. Studies were included in the meta-analysis if they fulfilled the following criteria:

1. A measure of state cognitive anxiety or state self-confidence was taken before a sport competition.
2. Competitive sport performance was measured in a field setting.

Statistical methods

The meta-analytic procedures used in the present study are described in Rosenthal (1991). Effect sizes were calculated for those studies that satisfied the criteria for inclusion. The correlation coefficients (r) between cognitive anxiety and performance and between self-confidence and performance were used to compute effect sizes. As the population value of r gets further from zero, the distribution of r 's becomes more and more skewed (Rosenthal, 1991). Fisher's (1928) transformation converts r to z_r , which results in a more normal distribution. Hence, the present study used z_r as an estimate of effect size. The transformation from r to z_r is:

$$z_r = 0.5 \log_e [(1 + r)/(1 - r)]$$

To calculate the significance of the effect sizes, the standard normal deviate Z was used. The transformation from r to Z is:

$$Z = r\sqrt{n}$$

where n = sample size.

The cognitive anxiety Z 's were reversed to reflect the expected (negative) direction of the effect. For example, if $r = -0.20$ and $n = 100$, then $Z = 2$. If no data were available to calculate the effect size (r) or the level of significance (P , one-tailed), the primary author of the study in question was contacted by telephone or electronic mail. If clarification of the data was not obtained from the primary author, P was assumed to be 0.50 and r was assumed to be 0.00. This is because the omission of studies that report non-significant results can artificially inflate the effect size. However, this procedure is conservative and can result in effect size estimates that are too low. Thus, following Rosenthal's (1995) recommendations, both procedures are presented in the present study.

The following methods (Rosenthal, 1991) were used for transforming a t statistic to r , or an F ratio to r , respectively:

$$r = [t^2/(t^2 + df)]^{0.5}$$

where df (the degrees of freedom) = $n_1 + n_2 - 2$, and

$$r = \{F_{1,-}/[F_{1,-} + df \text{ error}]\}^{0.5}$$

where $F_{1,-}$ represents any F with one degree of freedom in the numerator.

If more than one effect size estimate was available from one study, the method of mean result (Rosenthal, 1991) was employed. That is, each r from the study was first converted to z_r , before calculating the mean of these transformed effect sizes. To calculate the standard normal deviate Z , the mean z_r was converted back to r using the following equation:

$$r = (e^{2z_r} - 1)/(e^{2z_r} + 1)$$

where e is the base of the system of natural logarithms ($e \approx 2.71828$).

Study characteristics

Of the 48 studies retained for the meta-analysis, 46 contributed a cognitive anxiety effect size estimate and 43 contributed a self-confidence effect size estimate. Forty-one of the 48 studies contributed both cognitive anxiety and self-confidence effect size estimates to the meta-analysis. Thirty-three studies were reported between 1991 and 2001, 14 studies were reported between 1981 and 1990, and one study was reported in 1979. Forty-four studies were reported in journals and four studies were reported in theses (three master's theses and one doctoral thesis). We decided to include the results from theses in the meta-analyses to reduce the file drawer threat (see File drawer analysis). However, given that theses undergo a less stringent review process than articles published in peer-review journals, we included the source of the research (i.e. peer-review journal or thesis) as a moderator variable in the analyses (see Moderator variables). Finally, of the 14 authors contacted for further information about the data, 10 (71%) replied and 8 (57%) provided the necessary information for the correlation coefficient not to be assumed as $r = 0$.

Results

Outliers

Outliers were defined as values greater than 1.5 box-lengths from the box, where the box represents the

range of scores from the 25th to the 75th percentile. These outliers were removed from the data set. As a result of this procedure, three cognitive anxiety effect sizes and one self-confidence effect size were removed from the data set. Consequently, the data set contained 47 studies, including 43 cognitive anxiety effect sizes and 42 self-confidence effect sizes. A summary of all the studies included in the meta-analysis is presented in Table 1.

Descriptive statistics

Table 2 displays a stem-and-leaf plot of the cognitive anxiety effect sizes included in the meta-analysis. Table 3 displays a stem-and-leaf plot of the self-confidence effect sizes included in the meta-analysis. Table 4 contains information about central tendency, variability, significance tests and confidence intervals (using studies as the sampling unit) for the cognitive anxiety data. This table presents two sets of results: one with all cognitive anxiety studies, the other without those studies where r was assumed to be zero. Table 5 contains this information for the self-confidence data.

Effect sizes and significance testing

Cognitive anxiety

Of the 43 studies reporting a relationship between cognitive anxiety and performance, 26 (60%) reported a negative relationship, 7 (16%) reported non-significant results (so r was assumed to be zero) and 10 (23%) reported a positive relationship. The mean effect size was -0.10 . When studies were weighted for degrees of freedom, the mean effect size was -0.11 . When those studies where the effect size was assumed to be 0 were omitted from the analyses, the mean effect size was -0.12 and the weighted mean effect size was -0.13 . The Stouffer Z associated with the mean effect size was statistically significant ($Z = 4.73$, $P < 0.001$). The t -test for the mean z_r was also significant ($t_{42} = 2.73$, $P < 0.01$).

Self-confidence

Of the 42 studies reporting a relationship between self-confidence and performance, 32 (76%) reported a positive relationship, 6 (14%) reported non-significant results (so r was assumed to be zero) and 4 (10%) reported a negative relationship. The mean effect size was 0.24 . When studies were weighted for degrees of freedom, the mean effect size was 0.23 . When studies where the effect size was assumed to be 0 were omitted from the analyses, the mean effect size was

0.27 and the weighted mean effect size was 0.27 . The Stouffer Z associated with the mean effect size was statistically significant ($Z = 10.90$, $P < 0.001$). The t -test for the mean z_r was also significant ($t_{41} = 6.38$, $P < 0.001$).

File drawer analysis

Non-significant results are less likely to be published and more likely to remain in the file drawers of researchers' laboratories (Rosenthal, 1991). If adding only a few such non-significant studies renders the mean effect size non-significant, then the findings of a meta-analysis are not robust to the threat posed by studies hidden away in researchers' file drawers. Rosenthal (1991) suggested some simple calculations for determining the extent to which a meta-analysis is robust to this file drawer threat. The two questions that are addressed here are: (1) How many non-significant studies (where $r = 0$, $P = 0.50$) would have to be unearthed to make the probability of the effect size determined by the meta-analysis non-significant? (2) What constitutes an unlikely number of unearthed non-significant studies? If the number of non-significant studies that would have to be unearthed is greater than the 'unlikely number of unearthed non-significant studies', then the meta-analysis is said to be robust to the file drawer threat. The following figures for cognitive anxiety and self-confidence are based on fairly conservative calculations suggested by Rosenthal (1991).

Cognitive anxiety

For the probability of the cognitive anxiety effect size to become non-significant ($P > 0.05$), 312 studies with a mean probability of 0.50 would have to be stored away in researchers' file drawers. A figure of 225 would have been considered robust to the file drawer threat. Thus, the cognitive anxiety data are robust to the file drawer threat.

Self-confidence

For the probability of the self-confidence effect size to become non-significant, 1801 studies with a mean probability of 0.50 would have to be stored away. A figure of 220 would have been considered robust to the file drawer threat. Thus, the self-confidence data are highly robust to the file drawer threat.

Moderator variables

Heterogeneity tests revealed that the effect sizes were heterogeneous for cognitive anxiety ($\chi^2_{42} = 146.73$,

Table 1. Summary of the studies ($k = 47$) included in the meta-analysis

Authors	Measures	Sport	n	Cognitive anxiety		Self-confidence	
				r	Z	r	Z
Barnes <i>et al.</i> (1986)	CSAI-2	Swimming	14	-0.39	1.46	0.19	0.71
Bejek and Hagtvet (1996)	CSAI-2	Artistic gymnastics	69	-0.09	0.76	0.09	0.72
Bird and Horn (1990)	CSAI-2	Softball	161	0.21	-2.63	0.05	0.58
Burton (1988)	CSAI-2	Swimming	98	-0.39	3.85	0.30	2.97
Chapman <i>et al.</i> (1997)	CSAI-2	Tae kwon-do	142	-0.37	4.36	0.43	5.10
Cox <i>et al.</i> (2001)	ARS-2	Basketball	248	-0.13	2.06	0.15	2.33
Duesing (1984)	CSAI-2	Middle-/long-distance running	40	0.31	-1.97		
Edwards and Hardy (1996)	CSAI-2	Netball	45	0.10	-0.67	-0.17	-0.12
Gayton and Nickless (1987)	SSCI	Marathon	35			0.36	2.13
Gould <i>et al.</i> (1981)	Wrestling questionnaire	Wrestling	49	0.20	-1.42	0.52	3.64
Gould <i>et al.</i> (1984)	CSAI-2	Wrestling	37	-0.29	1.74	0.02	0.09
Gould <i>et al.</i> (1987)	CSAI-2	Pistol shooting	39	0*	0.00	-0.27	-1.67
Gould <i>et al.</i> (1993)	CSAI-2	Middle-/long-distance running	11	-0.07	0.23		
Grasso (1999)	CSAI-2	Basketball	42	-0.12	0.76	0.18	1.17
Guest and Cox (1999)	MRF-3	Golf	216	-0.27	3.97	0.35	5.14
Hammermeister and Burton (1995)	CSAI-2	Endurance sports	293	-0.08	1.37		
Hardy (1996a)	CSAI-2	Golf	8	0.10	-0.27	0.16	0.44
Highlen and Bennett (1979)	Wrestling questionnaire	Wrestling	39			0.56	3.47
Jerome and Williams (2000)	CSAI-2	Bowling	143	0*	0.00	0*	0.00
Jones <i>et al.</i> (1993)	CSAI-2	Artistic gymnastics	48	-0.01	0.07	0.29	2.01
Krane and Williams (1987)	CSAI-2	Golf and gymnastics	80	0*	0.00	0*	0.00
Krane <i>et al.</i> (1992)	CSAI-2	Golf	100	0.04	-0.40	0.07	0.70
Krane (1993)	CSAI-2	Soccer	16	0*	0.00	0*	0.00
Martin and Gill (1991)	CSAI-2 & SSCI	Middle-/long-distance running	86	-0.10	0.86	0.57	4.83
Maynard and Howe (1987)	CSAI-2	Rugby	22	-0.20	0.93	-0.01	-0.05
Maynard and Cotton (1993)	CSAI-2	Field hockey	20	0*	0.00	0*	0.00
Maynard <i>et al.</i> (1995)	CSAI-2	Soccer	24	-0.14	0.66	0.40	1.94
McAuley (1985)	CSAI-2	Golf	7	-0.11	0.28	0.01	0.02
McCann <i>et al.</i> (1992)	CSAI-2	Road cycling	23	-0.42	2.01	0.37	1.77
McKay <i>et al.</i> (1997)	CSAI-2	Golf	15			0.07	0.27
Moraes (1987)	CSAI-2	Judo	70	0*	0.00	0*	0.00
Parfitt and Pates (1999)	CSAI-2	Basketball	12	-0.07	0.26	0.49	1.69
Perreault and Marisi (1997)	CSAI-2	Wheelchair basketball	37	-0.02	0.23	-0.02	-0.15
Psychountaki and Zervas (2000)	SCWI-C & SSCQ-C	Swimming	143	-0.12	1.44	0.22	2.58
Rodrigo <i>et al.</i> (1990)	CSAI-2	Soccer	51	-0.52	3.71	0.16	1.14
Smith <i>et al.</i> (2001)	MRF-3	Volleyball	12	-0.54	1.87	0.44	1.52
Swain and Jones (1996)	CSAI-2	Basketball	10	-0.18	0.57	0.34	1.07
Taylor (1987)	CSAI-2	Mixture	84	0.35	-2.09	0.34	2.05
Terry and Slade (1995)	CSAI-2	Karate	208	-0.46	6.49	0.42	5.92
Terry <i>et al.</i> (1996)	CSAI-2	Tennis	100	-0.12	1.15	0.42	4.20
Thelwell and Maynard (1998)	CSAI-2	Cricket	20	-0.32	1.43	0.64	2.86
Vadocz <i>et al.</i> (1997)	CSAI-2	Roller skating	57	0*	0.00	0.51	4.48
Wiggins and Henson (2000)	CSAI-2	Tennis	7	0.05	-0.13		
Williams and Krane (1992)	CSAI-2	Golf	83	-0.22	2.00	0*	0.00
Woodman <i>et al.</i> (1997)	CSAI-2	Bowling	25	0.05	-0.25		
Yang (1994)	CSAI-2	Mixture	56			0.49	3.67
Zhu and Fang (1998)	CSAI-2	Distance running	88	0.39	-3.69	0.26	2.39

Note: CSAI-2 = Competitive State Anxiety Inventory-2; ARS-2 = Anxiety Rating Scale-2; SSCI = State Sport-Confidence Inventory; MRF-3 = Mental Readiness Form-3; SCWI-C = State Competitive Worries Inventory for Children; SSCQ-C = State Sport Confidence Questionnaire for Children.

* Not significant, effect size assumed to be zero, $P = 0.50$, one-tailed.

Table 2. Cognitive anxiety stem-and-leaf plot

Stem	Leaf (with all studies included), $k = 43$	Stem	Leaf (excluding $r = 0$ results), $k = 36$
+0.4		+0.4	
+0.3	1 4 9	+0.3	1 4 9
+0.2	0 0	+0.2	0 0
+0.1	0	+0.1	0
+0.0	0 0 0 0 0 0 0 3 5 5 9	+0.0	3 5 5 9
−0.0	1 2 6 7 8 9	−0.0	1 2 6 7 8 9
−0.1	0 0 1 2 2 3 3 7 9	−0.1	0 0 1 2 2 3 3 7 9
−0.2	1 7 8	−0.2	1 7 8
−0.3	2 6 8 9	−0.3	2 6 8 9
−0.4	2 6	−0.4	2 6
−0.5	2 4	−0.5	2 4
−0.6		−0.6	

Table 3. Self-confidence stem-and-leaf plot

Stem	Leaf (with all studies included), $k = 42$	Stem	Leaf (excluding $r = 0$ results), $k = 36$
+0.7		+0.7	
+0.6	4	+0.6	4
+0.5	1 2 6 7	+0.5	1 2 6 7
+0.4	0 2 2 3 4 9 9	+0.4	0 2 2 3 4 9 9
+0.3	0 4 4 5 6 7	+0.3	0 4 4 5 6 7
+0.2	2 6 9	+0.2	2 6 9
+0.1	5 6 6 8 9	+0.1	5 6 6 8 9
+0.0	0 0 0 0 0 0 1 2 5 7 7 9	+0.0	1 2 5 7 7 9
−0.0	1 2	−0.0	1 2
−0.1	7	−0.1	7
−0.2	7	−0.2	7

Table 4. Statistical summary of the cognitive anxiety studies ($k = 43$) included in the meta-analysis

Statistic	Value (including assumed $r = 0$ results), $k = 43$	Value (excluding assumed $r = 0$ results), $k = 36$
<i>Central tendency (r)</i>		
Unweighted mean	−0.10	−0.12
Weighted mean	−0.11	−0.13
<i>Significance tests</i>		
Combined Stouffer Z ($\sum Z/\sqrt{k}$)	4.73, $P < 0.001$	5.17, $P < 0.001$
t -test for mean z_r	2.73, $P < 0.01$	2.77, $P < 0.01$
<i>Variability (r)</i>		
Maximum	0.39	0.39
Quartile 3 (Q_3)	0.00	0.05
Median	−0.08	−0.11
Quartile 1 (Q_1)	−0.22	−0.28
Minimum	−0.54	−0.54
$Q_3 - Q_1$	0.22	0.33
Standard deviation (SD)	0.22	0.24
Standard error (SE ; SD/\sqrt{k})	0.03	0.04
<i>Confidence intervals (r)</i>		
90% ($r \pm$ critical $t_{(df=k-1)} SE$)	−0.15 to −0.04	−0.18 to −0.05
95% ($r \pm$ critical $t_{(df=k-1)} SE$)	−0.16 to −0.03	−0.19 to −0.04
99% ($r \pm$ critical $t_{(df=k-1)} SE$)	−0.18 to −0.01	−0.22 to −0.01

$P < 0.001$) and self-confidence ($\chi^2_{41} = 138.29$, $P < 0.001$).

As the Rosenthal method can inflate effect size estimates in the heterogeneous case (see Field, 2001), we re-ran the meta-analysis using the Hunter-Schmidt method (Hunter and Schmidt, 1990; Schmidt and Hunter, 1999), which is more conservative. This analysis revealed similar results for both cognitive

anxiety (mean $r = -0.11$, $Z = 3.32$, $P < 0.001$; mean r excluding non-significant results = -0.12 , $Z = 3.36$, $P < 0.001$) and self-confidence (mean $r = 0.22$, $Z = 7.33$, $P < 0.001$; mean r excluding non-significant results = 0.26 , $Z = 8.28$, $P < 0.001$). Consequently, we proceeded with the Rosenthal method only.

The heterogeneity of the effect sizes suggests that other factors were moderating the relationships between

Table 5. Statistical summary of the self-confidence studies ($k = 42$) included in the meta-analysis

Statistic	Value (including assumed $r=0$ results), $k = 42$	Value (excluding assumed $r=0$ results), $k = 36$
<i>Central tendency (r)</i>		
Unweighted mean	0.24	0.27
Weighted mean	0.23	0.27
<i>Significance tests</i>		
Combined Stouffer Z ($\Sigma Z/\sqrt{k}$)	10.90, $P < 0.001$	11.77, $P < 0.001$
t -test for mean z_r	6.38, $P < 0.001$	6.96, $P < 0.001$
<i>Variability (r)</i>		
Maximum	0.64	0.64
Quartile 3 (Q_3)	0.42	0.43
Median	0.20	0.30
Quartile 1 (Q_1)	0.01	0.08
Minimum	-0.27	-0.27
$Q_3 - Q_1$	0.41	0.35
Standard deviation (SD)	0.22	0.22
Standard error (SE ; SD/\sqrt{k})	0.03	0.04
<i>Confidence intervals (r)</i>		
90% ($r \pm$ critical $t_{(df=k-1)} SE$)	0.18 to 0.29	0.21 to 0.33
95% ($r \pm$ critical $t_{(df=k-1)} SE$)	0.17 to 0.30	0.20 to 0.34
99% ($r \pm$ critical $t_{(df=k-1)} SE$)	0.15 to 0.32	0.18 to 0.37

Table 6. Summary of the effect sizes (r) for the moderator variables

	Cognitive anxiety mean effect size		Self-confidence mean effect size	
<i>Measurement</i>	<i>Inter-individual</i>	<i>Intra-individual</i>	<i>Inter-individual</i>	<i>Intra-individual</i>
	-0.08	-0.11	0.24	0.20
	(-0.17 to 0.01)	(-0.21 to -0.01)	(0.17 to 0.31)	(0.04 to 0.36)
	<i>CSAI-2</i>	<i>Other</i>	<i>CSAI-2</i>	<i>Other</i>
	-0.09	-0.18	0.19	0.38 ^a
	(-0.16 to -0.02)	(-0.54 to 0.18)	(0.11 to 0.27)	(0.22 to 0.54)
<i>Sport type</i>	<i>Individual</i>	<i>Team</i>	<i>Individual</i>	<i>Team</i>
	-0.09	-0.14	0.25	0.19
	(-0.19 to 0.01)	(-0.26 to -0.02)	(0.16 to 0.34)	(0.05 to 0.34)
<i>Individual differences</i>	<i>High standard</i>	<i>Low standard</i>	<i>High standard</i>	<i>Low standard</i>
	-0.27**	-0.06	0.33*	0.16
	(-0.43 to -0.11)	(-0.13 to 0.01)	(0.19 to 0.47)	(0.06 to 0.25)
	<i>Men</i>	<i>Women</i>	<i>Men</i>	<i>Women</i>
	-0.22***	-0.03	0.29***	0.04
	(-0.34 to -0.10)	(-0.11 to 0.05)	(0.18 to 0.40)	(-0.05 to 0.13)

^aSignificantly higher than the CSAI-2 ($P < 0.05$). * Significantly higher than low standard ($P < 0.05$). ** Significantly higher (in absolute terms) than low standard ($P < 0.01$). *** Significantly higher (in absolute terms) than women ($P < 0.005$). Confidence intervals (95%) are presented in parentheses.

cognitive anxiety and performance and between self-confidence and performance. Measurement, sport type and individual differences were considered to be possible moderator variables. The results of these analyses are given below and a summary is presented in Table 6.

Measurement

Two measurement questions were addressed: (1) Did the study employ an intra-individual or an inter-individual design? (2) Was cognitive anxiety (or self-confidence) measured using the CSAI-2 or using another measure?

Intra-individual versus inter-individual measurement. We coded studies based on whether the cognitive anxiety, self-confidence and performance measurements were either inter-individual or intra-individual. In light of the increased sensitivity of intra-individual measurements, we hypothesized that such measurements would yield stronger effect sizes than inter-individual measurements. However, independent means *t*-tests revealed no significant difference between inter-individual and intra-individual measurements for either cognitive anxiety effect sizes ($t_{41} = 0.51$, $P = 0.31$) or self-confidence effect sizes ($t_{40} = 0.54$, $P = 0.30$).

CSAI-2 versus other measures. Despite the criticisms that have been levelled at the Competitive State Anxiety Inventory-2, it remains the questionnaire of choice for most researchers interested in the relationships between cognitive anxiety, self-confidence and sport performance. To test whether the use of the CSAI-2 moderates the relationships between cognitive anxiety and performance and between self-confidence and performance, we categorized studies into those that used the CSAI-2 and those that used other measures of cognitive anxiety or self-confidence. For self-confidence, an independent means *t*-test revealed that the mean effect size for studies employing the CSAI-2 was significantly smaller than the mean effect size for studies employing other measures of self-confidence ($t_{39} = 2.14$, $P < 0.05$). For cognitive anxiety, an independent means *t*-test revealed no significant difference between the effect sizes for studies employing the CSAI-2 and studies employing other measures of cognitive anxiety ($t_{41} = 0.91$, $P = 0.37$).

Sport type

We hypothesized that the cognitive anxiety and self-confidence effect sizes would be higher for individual sports than team sports. However, independent means

t-tests revealed no significant differences between individual and team sports for either the cognitive anxiety effect sizes ($t_{36} = 0.64$, $P = 0.26$) or the self-confidence effect sizes ($t_{36} = 0.85$, $P = 0.20$).

Individual differences

Two individual-difference comparisons were made: standard of competition (high- and low-standard athletes) and sex (men and women).

Standard of competition. It should be noted that although the skill of the athlete and the standard of competition are likely to be highly related, strictly speaking the high- versus low-standard distinction reflects the competitive setting rather than the skill of the athlete. Studies were classified as 'high standard' if the sample studied was competing at national or international standard. Studies were classified as 'low standard' if the sample was competing at a competitive standard below national standard (e.g. state, regional, etc.). In line with the hypotheses, an independent means *t*-test revealed that the mean cognitive anxiety effect size of high-standard athletes was significantly larger than the mean effect size of low-standard athletes ($t_{39} = 2.93$, $P < 0.01$). Also, an independent means *t*-test revealed that the mean self-confidence effect size for high-standard athletes was significantly larger than that for low-standard athletes ($t_{37} = 2.23$, $P < 0.05$).

Sex. The mean cognitive anxiety effect size for men was significantly larger than the mean effect size for women ($t_{24} = 2.84$, $P < 0.005$). Also, the self-confidence effect sizes for men were significantly larger than those for women ($t_{25} = 3.19$, $P < 0.005$).

The possible confound of the standard of the competitive setting and sex is addressed in the discussion.

Publication status

As the meta-analysis included research results from published and unpublished sources, we included the publication status as a possible moderator variable. Although it is possible that peer-review journals are more likely to accept manuscripts that report significant findings, we did not expect the source of the research to be a significant moderator variable for either relationship. Independent means *t*-tests confirmed that there were no significant differences between peer-review journal articles and theses for either the cognitive anxiety effect sizes ($t_{34} = 1.29$, $P = 0.21$) or the self-confidence effect sizes ($t_{34} = 0.50$, $P = 0.62$).

The relative impact of cognitive anxiety and self-confidence

If cognitive anxiety and self-confidence lie at opposite ends of the same continuum, then they should have a correlation of approximately $r = -1$ and their effects on performance should mirror each other. That is, the strength of the relationship between self-confidence and performance should be similar to the strength of the relationship between cognitive anxiety and performance, only in the opposite direction. If cognitive anxiety and self-confidence affect sport performance independently, the strength of their relationships with performance will probably be different. Thus, a paired samples t -test was run between the cognitive anxiety and self-confidence effect sizes to determine whether cognitive anxiety and self-confidence were independently related to performance. To make meaningful comparisons between cognitive anxiety and self-confidence, cognitive anxiety effect sizes were first transformed using $y = -x$.

The paired samples t -test (with all effect sizes included) revealed a significant difference between cognitive anxiety and self-confidence effect sizes ($t_{37} = 2.22$, $P < 0.05$). When non-significant effect sizes (i.e. those effect sizes where $r = 0$ was assumed) were removed, a significant difference between cognitive anxiety and self-confidence effect sizes remained ($t_{29} = 2.42$, $P < 0.05$).

To test the degree of co-dependence between the cognitive anxiety and self-confidence effects, correlation coefficients were calculated between the effect sizes for cognitive anxiety and self-confidence from those studies that reported both effect sizes. The correlation between the effect sizes for cognitive anxiety and self-confidence was not significant ($r = -0.25$, $P = 0.13$). Equally, when the non-significant effect sizes (i.e. those effect sizes where $r = 0$ was assumed) were removed from the analyses, the correlation was not significant ($r = -0.22$, $P = 0.25$).

Discussion

The focus of this meta-analysis was on two relationships: (1) the relationship between cognitive anxiety and competitive sport performance and (2) the relationship between self-confidence and competitive sport performance. The mean effect size for cognitive anxiety was $r = -0.10$; the mean effect size for self-confidence was $r = 0.24$. Both of these mean effect sizes were significant, thus supporting two of the fundamental predictions of multidimensional anxiety theory (Martens *et al.*, 1990). Sex and competitive standard were significant moderating variables for the relationship between

cognitive anxiety and performance. Sex, competitive standard and measurement were significant moderating variables for the relationship between self-confidence and performance. The results also revealed that self-confidence was significantly more strongly related to sport performance than was cognitive anxiety.

Both sets of effect sizes (cognitive anxiety and self-confidence) were heterogeneous. Sex and competitive standard were identified as significant moderating variables, with the mean effect sizes being significantly higher for men and high-standard athletes for both cognitive anxiety and self-confidence. Also, measurement was identified as a moderating variable for self-confidence with the CSAI-2 measurements revealing significantly lower effect sizes than other measurements of self-confidence. The differences in mean effect sizes between the sexes suggest that pre-competitive cognitive anxiety and self-confidence have a greater impact on the performance of men than that of women. However, apart from the thresholds argument presented in the Introduction, there does not appear to be any obvious reason why this should be. Indeed, although previous research has shown that, compared with men, women report higher cognitive anxiety (Martens *et al.*, 1990; Russell *et al.*, 1998), lower self-confidence (Martens *et al.*, 1990; Jones *et al.*, 1991; Krane and Williams, 1994) and less stability before competing (Jones and Cale, 1989; Jones *et al.*, 1991), such findings do not explain why cognitive anxiety and self-confidence should be more *related* to performance for either sex. The idea of a threshold is not new, as it is central to catastrophe models of anxiety and performance (Hardy and Fazey, 1987; Hardy, 1996a), where performance suffers a catastrophic drop above a physiological arousal threshold. In light of the present results, further research on cognitive anxiety and self-confidence thresholds appears worthwhile.

The cognitive anxiety and self-confidence mean effect sizes were greater for high-standard athletes than lower-standard athletes. One possible reason for these differences is that high-standard performance is typically associated with increased pressure. If an athlete is not able to deal with such pressure, then the effect upon performance is likely to be fairly dramatic. Another possible reason for these differences is that high-standard performance is typically associated with fewer 'random effects'. That is, high-standard athletes typically operate within a more controlled personal environment than their comparatively low-standard counterparts. In other words, athletes competing at a higher standard are more likely to 'control the controllables' (Hardy *et al.*, 1996). As such, it is reasonable to expect that the effect of self-confidence (and cognitive anxiety) upon performance will be clearer with elite athletes. In the present meta-analysis,

truly high-standard (international) performers were investigated in one study only. The other studies comprising the 'high-standard' group used national standard athletes. This lack of studies involving truly elite athletes poses a fairly serious problem in terms of generalization of research findings to elite performers. For example, the stress that elite athletes endure may be rather different to that endured by relatively low-standard athletes. Certainly, recent research (Woodman and Hardy, 1998, 2001b; Gould *et al.*, 1999) has suggested that elite performers may be exposed to various kinds of relational and organizational stress before and during major international competitions. Thus, generalizations of findings with lower-standard sport performers to elite performers might be inappropriate (cf. Hardy *et al.*, 1996; Balague, 1999). Further research with truly high-standard performers is needed to enhance our understanding of the effects of stress, anxiety and self-confidence in an elite sport environment.

Research investigating female athletes in high-standard environments would be particularly helpful, as most studies of high-standard athletes in this meta-analysis were of men. More specifically, of the 12 studies conducted with high-standard athletes, seven were with men and only one was with women (the remaining four were with both men and women). Thus, notwithstanding the threshold arguments presented earlier, the most parsimonious explanation of sex as a moderator variable is that it was confounded by the standard of competition. Further research investigating high-standard women athletes should help to clarify this issue.

The vast majority of studies included in this meta-analysis used the Competitive State Anxiety Inventory-2 (Martens *et al.*, 1990) as a measure of cognitive anxiety and self-confidence. The moderator analyses revealed the CSAI-2 to be a significant moderator of the self-confidence-performance relationship, with the effect size being smaller for the CSAI-2 ($r = 0.19$) than for the other measures of self-confidence ($r = 0.38$). This is consistent with the results from a recent meta-analysis of the self-efficacy-sport performance relationship (Moritz *et al.*, 2000), which revealed that task-specific measures of self-efficacy correlated significantly more strongly with performance ($r = 0.38$) than other methods of assessment such as the CSAI-2 ($r = 0.24$). Certainly, studies that match the task with more specific measures of self-confidence appear more likely to reveal stronger effect sizes. The near *sine qua non* status that the CSAI-2 seemingly holds for researchers interested in pre-competition sport affect could be problematic for at least two other reasons. First, a recent confirmatory factor analysis (Lane *et al.*, 1999) found the CSAI-2 to have weak structural validity. However, as this factor

analysis tested only the structure of the three-factor model (cognitive anxiety, somatic anxiety and self-confidence) and not the structure of each factor separately, it offers no direct evidence about the relative structural integrity of the cognitive anxiety and self-confidence subscales. Second, eight of the nine cognitive anxiety items in the CSAI-2 use 'concern' as an expression of cognitive anxiety (e.g. 'I'm concerned about reaching my goal'), and it has been argued that the expression 'I am concerned' can be interpreted positively or negatively (Barnes *et al.*, 1986; Jones, 1991; Jones and Swain, 1992; Burton and Naylor, 1997; Woodman and Hardy, 2001a). These differences in interpretation led Jones and his colleagues (Jones, 1991; Jones and Swain, 1992) to add an interpretation scale to the CSAI-2, which measures the extent to which performers interpret their anxiety symptoms as either facilitative or debilitating. Research using this modified scale suggests that interpretation may be an important moderating variable in the relationship between cognitive anxiety and performance. For example, Jones *et al.* (1993) found that high- and low-performance gymnasts did not differ in cognitive anxiety intensity. However, the high-performance gymnasts reported their cognitive anxiety to be more facilitative than the low-performance gymnasts. Similar findings have been reported in other studies (e.g. Jones *et al.*, 1994; Swain and Jones, 1996; Perry and Williams, 1998). As the present analyses did not reveal the CSAI-2 to be a significant moderator of the cognitive anxiety-performance relationship, one cannot conclude that the cognitive anxiety subscale of the CSAI-2 is problematic in relation to other measures of cognitive anxiety. However, too few studies employed other measures of cognitive anxiety to make comparisons between the CSAI-2 and any other single measure of cognitive anxiety. If researchers develop another measure of cognitive anxiety, then one will be able to measure its predictive validity in comparison to that of the CSAI-2. This is a worthwhile avenue for future research.

The difference in magnitude between the cognitive anxiety and self-confidence mean effect sizes is consistent with past research (e.g. Gould *et al.*, 1984; Jones and Cale, 1989; Jones *et al.*, 1990, 1991; Martens *et al.*, 1990; Hardy, 1996b) that has suggested that cognitive anxiety and self-confidence are orthogonal constructs, which do not lie at opposite ends of the same continuum. Thus, future researchers would do well to consider cognitive anxiety and self-confidence either independently or as an interactive dyad. It is the interaction between cognitive anxiety and self-confidence that is likely to yield the most fruitful findings (Hardy, 1996b). Certainly, from an anecdotal perspective, it seems that many exceptionally fine performances are achieved when athletes are both anxious ('I am so

worried, this is the biggest competition of my life') and self-confident ('I know I can do well, I have prepared so well for this competition'). From a theoretical perspective, both processing efficiency theory (Eysenck and Calvo, 1992; Smith *et al.*, 2001) and higher-order catastrophe models (Hardy, 1996b) would support this view. More precisely, processing efficiency theory predicts that cognitively anxious individuals will invest more effort in the task at hand provided they perceive themselves to have a reasonable chance of success. Also, within a higher-order catastrophe model framework, Hardy (1990, 1996b) has proposed that high self-confidence might protect cognitively anxious performers from catastrophic drops in performance. Thus, both processing efficiency theory and catastrophe models are worthy of further research with respect to investigating interactions between cognitive anxiety and self-confidence.

In conclusion, this meta-analysis has revealed that both cognitive anxiety and self-confidence are significantly related to competitive sport performance. The mean effect sizes for cognitive anxiety and self-confidence were significantly higher for men than for women. They were also higher for high-standard athletes than for low-standard athletes. Furthermore, compared with other measures of self-confidence, the CSAI-2 revealed a significantly smaller mean self-confidence effect size. In view of the significant difference in magnitude between the two mean effect sizes, researchers should view cognitive anxiety and self-confidence as distinct constructs, rather than two extremes of a single construct. Finally, the interaction between cognitive anxiety and self-confidence is likely to be a fruitful avenue for future research, and the current theoretical paradigms that are the most amenable to investigation of this interaction are processing efficiency theory and higher-order catastrophe models.

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