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Confirmatory factor analysis of the Thought Occurrence Questionnaire for Sport (TOQS) among adolescent athletes

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Abstract
There is an inherent link between theory and measurement suggesting that validation of measures should be the first stage of theory testing. The aim of the present study was to cross-validate the factorial validity of the Thought Occurrence Questionnaire for Sport for use among adolescent athletes. National standard young athletes (Individual N = 204; Team N = 360) completed the TOQS questionnaire. Single-sample and multisample confirmatory factor analysis provided support for the psychometric integrity of the hypothesized three-factor correlated model. Multisample results demonstrated invariance for factor loadings and correlations between individual and team athletes. Internal consistency coefficients were over the .70 criterion for acceptability. Findings lend support to previous validation studies conducted on samples of adult athletes and suggest that the TOQS provides an equally valid measure for use among adolescent athletes. It is suggested that the TOQS can be used to investigate theoretical issues related to cognitive interference during competition.

Keywords: *Measurement, sport, structural equations, model testing, psychological skills*

Over the past 20 years, research and practice in the field of sport psychology has reinforced the importance of adopting a cognitive approach to understanding and improving athletic performance (Hanton & Jones, 1999; Lee-Hill, 2000; Strean & Roberts, 1992; Whelan, Mahoney, & Meyers, 1991). The emergence of cognitive psychology in the sport domain owes a great deal to research demonstrating how levels of athletic performance can be differentiated on the quality of cognitions and subsequent affective responses reported by athletes prior to and during competition (Gould, Eklund, & Jackson, 1992a, b; Jones & Hanton, 1996). These studies reveal the debilitative effects of negative, irrelevant or irregular thought patterns before and during high-level competition, in contrast to the facilitative role of task-focused thinking and task-specific self-talk strategies (Gould, Finch, & Jackson, 1993).

During the 1990s, the study of cognitions within sport psychology research was largely dominated by a multi-dimensional anxiety-based approach (Martens, Vealey, & Burton, 1990). The subsequent focus of research in sport was the measurement, interpretation, and

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consequences of cognitive anxiety symptoms (Jones, 1995) as one dimension (alongside somatic anxiety and self-confidence) of the multi-dimensional anxiety response. However, whilst this line of research focused on the intensity of pre-competition worries, it did not address the specific nature and content of cognitions themselves that occur before or during performance.

In an attempt to bridge the link between pre-competition stress and performance, research turned to affects and cognitions experienced during competition. In recent years, a growing body of research has examined cognitive interference during competition (Hatzigeorgiadis & Biddle, 1999, 2001, 2002). Evidence from educational psychology demonstrates that measures of cognitive interference are linked with poor academic performance (Sarason, Sarason, & Pierce, 1990; Sarason, Pierce, & Sarason, 1996). Sarason et al. (1990) characterized into cognitive interference as task-irrelevant, self-preoccupied thinking, and performance worries that detract attention from the task at hand. Performance is proposed to be debilitated by the effects of interfering thoughts distracting attention from task-relevant cues and using up cognitive resources that could be better used for task-processing (Sarason, 1984).

Studies examining the relationship between anxiety and cognitive interference in sport have provided mixed results. For example, Schwenkmezger and Laux (1986) found a strong association between trait anxiety and cognitive interference among a sample of handball players. Man, Stuchlicova, and Kindlmann (1995) found no significant associations between stressful situations and cognitive interference. Hatzigeorgiadis and Biddle (1999) argued that inconsistent findings could be attributed to using measures not validated for use in sport.

Hatzigeorgiadis and Biddle (1999) conducted a confirmatory factor analysis on the original Thought Occurrence Questionnaire (TOQ) developed by Sarason et al. (1996). Hatzigeorgiadis and Biddle (1999) used confirmatory factor analysis to test the underlying theory proposed by Sarason et al. (1996). Confirmatory factor analysis is proposed to provide a rigorous test of factorial validity as it tests the extent which data supports a theorized structure established *a priori* by the researcher. Until recently, researchers tended to use exploratory factor analysis as the technique of choice for demonstrating factorial validity. Exploratory factor analysis has been criticized for having too many arbitrary decisions (Biddle, Markland, Gilbourne, Chatzisarantis, & Sparkes, 2001; Schutz, 1994; Thompson & Daniel, 1996). Exploratory factor analysis is a theory generating technique rather than a tool for testing theory. Thompson and Daniel (1996) argued that theory development should be independent of the techniques used to test them.

Confirmatory factor analysis of the original thoughts of occurrence scale among athletes demonstrated fit indices that failed to reach acceptable levels (Hatzigeorgiadis & Biddle, 1999). An analysis of each subscale indicated that items for "task related worries" showed poor coefficients. If researchers cannot trust the validity of existing measures, it is incumbent that researchers develop a valid measure before theoretical issues can be tested (Schutz, 1994). As an attempt to address this issue, and further research on cognitive interference in sport, Hatzigeorgiadis and Biddle (2000) developed a 17-item scale to assess three related constructs of cognitive interference. The three constructs included; (a) Performance Worries, characterized by thoughts associated with a perceived failure to attain performance goals, (b) Task-Irrelevant Thoughts, characterized by thoughts such as day dreaming, and thoughts not associated with competition, (c) Thoughts of Escape, characterized by thoughts related to removing oneself from the situation. Hatzigeorgiadis

and Biddle (2000) argued that although these are discrete constructs, there should be a sufficient degree of association to form a single higher-order construct.

Hatzigeorgiadis and Biddle (2000) developed the Thought Occurrence Questionnaire for Sport (TOQS) over three stages. In stage one, an item pool was derived from interviews with athletes from different sports. In stage two, 15 experts examined the face validity of the scale. In stage three, factorial validity was tested using confirmatory factor analysis techniques. Results showed adequate factorial validity for the psychometric properties of the (TOQS). Cronbach alpha coefficients for estimates of internal consistency were acceptable.

The need for stringent measures becomes especially important when researchers extend a line of investigation to a new population. One population of importance to both sport psychology researchers and practitioners alike are developing adolescent athletes (Gould, Dieffenbach, & Moffat, 2002; Weiss, 1995). This population is particularly significant given the combination of placing greater pressure to excel at a young age and the need to develop psychological skills for use in senior competition. The majority of research in youth sport has taken a social-cognitive or social-psychological perspective to understanding a variety of interpersonal and intrapersonal factors such as achievement motivation (Duda, 1987; Harwood & Swain, 2001), self-perceptions (Weiss, McAuley, Ebbeck, & Weise, 1990), self-evaluation criteria (Horn & Hasbrook, 1987) and perceptions of significant others (Black & Weiss, 1992; Duda & Hom, 1993; Swain & Harwood, 1996). All of these areas of study place cognition as a central component to understanding the young athlete in a competitive setting. However, limited research to date has investigated the nature of cognitions occurring in adolescent athletes that may be influenced by some of the individual differences and contextual factors noted above. A further understanding of the thought processes experienced by adolescent athletes during competition is also important in the development of attentional strategies to enhance mental skills (Gould et al., 2002). The TOQS scale could provide insightful information into the thought processing among young athletes provided the scale can be shown to be valid and internally reliable.

The purpose of the present study, therefore, was to investigate the factorial validity of TOQS among a sample of adolescent athletes using confirmatory factor analysis. Confirmatory factor analysis is proposed to provide a rigorous test of the integrity of a factor structure, an argument made more compelling when the factor structure is supported in two samples simultaneously.

Consistent with previous research (Hatzigeorgiadis & Biddle, 2000), we hypothesized that TOQS data collected on adolescent athletes conform to a three-factor interrelated model. Three other models were tested. These included: (a) a single-factor model; (b) a three-factor uncorrelated model, and (c) a higher-order model on which subscales load onto a single second-order factor (see Hatzigeorgiadis & Biddle, 2000). As previous research has found that higher anxiety scores are associated with playing individual sports (Martens et al., 1990), data were divided into two samples (individual athletes and team athletes) and multisample confirmatory factor analysis was used to test the factorial invariance for the best fitting model.

Method

Participants

Participants were 564 volunteer young athletes (age: 15–18 years, male = 266, female = 298; individual $N = 204$; team $N = 360$). They were drawn from national-level training

camps in the UK organized through a joint initiative between Nike, The Institute of Youth Sport and the Youth Sport Trust. Athletes competed in individual sports including Badminton, Fencing, Squash and Triathlon and team sports including Hockey, Lacrosse, Rugby, and Volleyball. It is important to recognize the level of performance at which the athletes competed. To attend these national training camps, athletes needed to be selected by their respective National Governing Bodies.

Measures

The TOQS is a 17-item questionnaire that comprises three discrete subscales: Performance Worries, Situation-Irrelevant Thoughts, and Thoughts of Escape. Items are pre-fixed with the phrase "During the competition/game I had thoughts . . . ". The Performance Worries subscale has six items with examples being " . . . that we are not going to achieve our goals" and " . . . that the conditions (weather, temperature, pitch, atmosphere) are no good". The subscale Situation-Irrelevant Thoughts has five items with examples being " . . . about personal worries", and " . . . about what I am going to be doing later in the day". The Thoughts of Escape subscale has six items with examples being " . . . about stopping", and " . . . I do not want to take part in this game anymore". Items are rated on a 7-point Likert scale anchored by 1 = never and 7 = very often. Cronbach's alpha coefficients were .90 for Thoughts of Escape, .85 for Situation-Irrelevant Thoughts, and .78 for Performance Worries (see Hatzigeorgiadis & Biddle, 2000).

Procedures

The institution of the second author granted ethical approval. Written parental consent for participation was granted before each training camp through the Youth Sport Trust. The instructions to participants included a reminder to respond to all items and to answer each question honestly, and that data would be treated as confidential. Participants completed the questionnaire during pre-planned break sessions between training under supervision of a research assistant or coach from the respective sport.

Model testing

Confirmatory factor analysis (CFA) using EQS V5 (Bentler & Wu, 1995; Bentler, 1995) was used to test the four models. Model parameters were estimated using the Maximum Likelihood method. As psychometric data have a tendency to be not normally distributed, attention was given to the Mardia coefficient. If Mardia values showed significant deviation from normality, the Satorra-Bentler Scaled statistics (Robust) would be used as these have been found to perform adequately under such conditions (Bentler, 1995).

Based on suggestions by Hu and Bentler (1999), a two-index strategy was used. The Robust Comparative Fit Index (RCFI: Bentler, 1995) was used as an incremental fit index to test the adequacy of model fit. The RCFI is based on comparisons between the hypothesized model and a null model (in which there are no relationships among the observed variables) and are not influenced by sample size. Kline (1998) proposed that values for the RCFI less than .90 indicate that the hypothesized model could be substantially improved, whereas Hu and Bentler (1999) suggested that, in most circumstances, values should approach .95, the criterion for acceptability used in the present study.

The second fit index used to assess model fit was the Root Mean Square Error of Approximation (RMSEA: Steiger, 1990). The RMSEA indicates the mean discrepancy between the observed covariances and those implied by the model per degree of freedom, and therefore has the advantage of being sensitive to model complexity. A value of .05 or lower indicates a good fit and values up to .08 indicate an acceptable fit (Browne & Cudeck, 1993). Hu and Bentler (1999) argued that a good fitting model should show acceptable fit on both fit indices.

The best fitting model was tested in individual and team samples independently, and then simultaneously using multisample CFA. Multisample CFA tests the extent to the invariance of relationships found in two samples, and is proposed to provide a rigorous test of specified relationships within the measurement model (Bentler, 1995; Tabachnick & Fidell, 1996). Multisample analysis was conducted in three stages. First, a baseline unconstrained model was tested. Second, the hypothesis that factor coefficients are invariant across samples was tested by placing equality constraints on factor loadings. Third, the hypothesis that relationships between factors will be invariant across groups was tested. In the present study, it is suggested that factor loadings will not be significantly different across samples, demonstrated by acceptable incremental fit indices over .95.

Results

Mardia values showed that the data deviated significantly from normality (Mardia = 78.78), hence the decision was to use the Robust Maximum Likelihood estimation method. CFA results provided support for the three-factor correlated model (RCFI = .97; RMSEA = .05) and the higher-order model (RCFI = .96; RMSEA = .05). No support was found for the single-factor model (RCFI = .76; RMSEA = .13) or the three-factor uncorrelated model (RCFI = .85; RMSEA = .10). Therefore, results indicated that the three-factor correlated model showed the best fit, albeit marginally.

Confirmatory factor analysis results for individual and team athletes demonstrated that fit indices were comparable, and importantly, the RCFI fit index was greater than the .95 (Hu & Benter, 1999) fit index criterion and the RMSEA lower than .08 (Browne & Cudeck, 1993) (see Table I). As single sample results showed support for the hypothesized model, multisample CFA was used to test the invariance of the relationships between individual and team samples. Multisample results indicated support for the baseline unconstrained model and the constrained factor loadings model with the RCFI being equal to the .95 for acceptable fit and the RMSEA results being below the .08 criterion (see Table I). However, with multisample analysis, the key results derive from the multivariate Lagrange Multiplier test. Results indicated that factor loading for the items " . . . about what I'm going to do

Table I. Single Sample and Multisample Confirmatory factor analysis of the Thoughts of Occurrence Questionnaire for Sport.

			Multisample		
Fit Indices	Individual ($N = 204$)	Team ($N = 360$)	Unconstrained	Constrained factor loadings	Constrained factor loadings and correlations
RCFI	.98	.97	.96	.95	.95
RMSEA	.06	.05	.04	.04	.04

Note. RCFI = Robust Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation.

later in the day" ($\chi^2 = 5.40$, $p < .05$) and " ... that other competitors are better than me" ($\chi^2 = 4.83$, $p < .05$) differed significantly between individual and team samples. It could be argued that these χ^2 values are relatively low given the sample size and the complexity of the model.

Standardized factor loadings and error variances for TOQS scores showed support for the notion that items load onto their hypothesized subscale (see Table II). Significant correlations were evidenced between subscales (Situation-Irrelevant Thoughts and Performance Worries, Individual $r = .71$, $p < .01$; Team $r = .63$, $p < .01$; Thoughts of Escape and Performance Worries; Individual $r = .61$, $p < .01$; Team $r = .68$, $p < .01$; and Thoughts of Escape and Situation-Irrelevant Thoughts, individual $r = .61$, $p < .01$; Team $r = .61$, $p < .01$). Alpha coefficients for the TOQS subscales were above the .70 criterion for acceptable fit suggested by Tabachnick and Fidell (1996) for both samples; Performance Worries, Individual alpha = .77, Team alpha = .79; Situation-Irrelevant Thoughts, Individual alpha = .85, Team alpha = .86; Thoughts of Escape, Individual alpha = .86, Team alpha = .88.

Descriptive statistics are contained in Table III. Mean scores for TOQS were highly comparable to data reported by Hatzigeorgiadis and Biddle (2000) with Performance Worries experienced to a moderate degree, but more frequently than Situation-Irrelevant Thoughts and Thoughts of Escape. A repeated measures analysis of variance of TOQS

Table II. Factor Loadings for Thought Occurrence Questionnaire for Sport among Individual N = 204; Team N = 360 athletes.

	Individual		Team	
"During the competition/game I had thoughts ... "	Standardized factor loading	Error variance	Standardized factor loading	Error variance
Performance Worries				
about previous mistakes I have made	.50	.87	.55	.84
that I'm having a bad day	.75	.66	.70	.71
that the conditions (weather, temperature, pitch, atmosphere) are no good	.41	.91	.47	.88
that I am not going to achieve my goals today	.64	.77	.66	.75
that I am not going to win this competition	.62	.79	.71	.71
that other competitors are better than me	.63	.77	.71	.70
Situation-Irrelevant Thoughts				
about other activities (e.g. shopping, having tea, TV	.71	.71	.76	.65
about what I'm going to do later in the day	.85	.53	.76	.65
about personal worries (e.g. school, work, relations)	.70	.72	.72	.69
about friends	.70	.72	.76	.63
about what I'm going to do when I get home	.77	.63	.82	.58
Thoughts of Escape				
that I want to quit	.73	.69	.78	.63
that I do not want to take part in this competition any more	.80	.61	.81	.59
that I want to get out of here	.76	.65	.80	.60
about stopping	.63	.77	.71	.71
that I am fed-up with it	.83	.56	.81	.59
that I cannot stand it any more	.84	.54	.75	.66

Table III. Descriptive Statistics for Thoughts of Occurrence Sport Questionnaire scores between Individual and Team Adolescent Athletes.

	Individual		Team				
	M	*SD*	*M*	*SD*	$F_{1,556}$	*p*	Eta^2
Performance Worries	3.40	1.10	3.12	1.16	7.56	.006	.013
Situation-Irrelevant Thoughts	2.48	1.16	2.08	1.06	17.83	.000	.030
Thoughts of Escape	2.13	1.08	1.85	1.04	9.25	.002	.016

Note. $n = 204$ individual athletes and $n = 360$ team athletes.

subscale scores indicated significant differences ($F_{2.575} = 2106.95$, $p < .001$, $Eta^2 = .88$) with post hoc test indicating differences between each subscale. Multivariate analysis of variance indicated a significant difference in mean scores between individual and team sports on TOQS scores (Hotelling $T_{3,574} = .03$, $p < .001$, $Eta^2 = .03$) with individual sport players reporting higher scores on Performance Worries, Situation-Irrelevant Thoughts, and Thoughts of Escape (see Table III).

Discussion

The present study investigated the validity of the TOQS scale for use with young athletes. Three models were tested. Results indicate a three-factor correlated and a higher-order model showed acceptable fit indices. Results for the single-factor and uncorrelated three-factor model showed poor fit. These results suggest that although items are part of the same conceptual framework as suggested by Hatzigeorgiadis and Biddle (2000), examination of the cognitive interference in sport construct should be conducted by exploring the interplay between the subscales of Performance Worries, Situation-Irrelevant Thoughts and Thoughts of Escape. We suggest that researchers and practitioners interpret subscale scores independently and investigate the interplay between each scale rather using a composite score of the sum of items.

Results of the present study demonstrate that the TOQS has acceptable factorial validity and internal consistency among a sample of individual athletes and team athletes adolescents athletes. Multisample confirmatory factor analysis is proposed to provide a rigorous test of the psychometric integrity of a questionnaire (Bentler, 1995). These results indicate that factorial invariance was evidenced for a highly restricted model with equality constraints being placed on factor loadings and correlations between factors.

Findings of the present study lend further support to those reported by Hatzigeorgiadis and Biddle (2000) that the TOQS is a valid measure of interfering thoughts in sport. It is argued that the extension of factorial validity of the TOQS to adolescent athletes represents an important contribution to developing research in this area. In particular, it addresses a limitation pertaining to the measurement of psychological constructs in sport and exercise psychology as suggested by Schutz (1994). In a summary of measurement issues, Schutz (1994) argued that researchers in the field have developed a plethora of scales, with each study providing evidence for its validity only for a later study to show its limitations. He suggested that: "Premature publication of measurement tools has led to a proliferation of psychological tests and a considerable amount of research of questionable validity" (p. 38). Schutz (1994) argued that a test should not be developed unless; (a) a clear need can be demonstrated, and (b) researchers use a rigorous set of criteria for questionnaire

development. It is argued that the methods used in the present study and those reported by Hatzigeorgiadis and Biddle (2000) adhered to these principles. Hatzigeorgiadis and Biddle (1999, 2000) based the TOQS on sound theoretical principles developed initially from educational research and from interviews with athletes, and therefore, it should not be surprising that factorial validity of the TOQS was supported when applied to a different population.

Research could question whether Hatzigeorgiadis and Biddle (1999, 2000) needed to develop a new scale when there is already an existing measure of competition anxiety (see Martens et al., 1990). It should be emphasized that recent research has questioned the factorial validity (Cox, 2000; Cox, Martens, & Russell, 2003; Lane, Sewell, Terry, Bartram, & Nesti, 1999) and the predictive validity of the Competitive State Anxiety Inventory-2 (Craft, Magyar, Becker, & Feltz, 2003; Woodman & Hardy, 2003). Both Lane et al. (1999) and Craft et al. (2003) argued that future research should focus on developing a valid and appropriate measure. Further, it is suggested that a sport-specific measure of cognitive interference in sport could: (a) help extend the literature from pre- to during-competition cognitive activation, and (b) help identify whether different kinds of thoughts have different effects.

Gould et al. (2002) argued that it is important to nurture psychological skills among emerging athletes. Development and validation of the TOQS can provide a standardized tool for assessing this process. Findings from the present study suggest that the TOQS can be used among samples of individual and team athletes, and we suggest that descriptive statistics (see Table III) could be used for comparative purposes in future research. In this particular sample of relatively elite adolescent athletes, whilst overall cognitive interference was low to moderate, the most frequent interfering thoughts were those associated with performance standards as opposed to those irrelevant to competition or about withdrawal from the contest. Whilst this profile of cognitions is not surprising given the nature of the sample, it nevertheless reinforces to practitioners the importance of giving primary attention to self-efficacy building strategies to help maintain high performance expectations in the athlete.

Several relevant lines of investigation could be conducted to extend research with the TOQS in youth sport populations. Firstly, we have limited knowledge of the relationships between cognitive interference, pre-competitive states and performance in youth sport. A great deal of research has focused on relationships between variables such as pre-competitive emotional states and performance outcomes such as win/loss or achievement of a personal best performance etc. (see Beedie, Terry, & Lane, 2000; Jones, 1995), with a relative absence into investigating how such variables influence thought processing during performance which may in turn affect performance detrimentally. Hatzigeorgiadis and Biddle (2001) provided indirect evidence of this in a follow-up study of volleyball players where interfering thoughts disrupted concentration and resulted in decreased effort amongst those athletes with lower goal attainment expectancies.

A more enterprising line of research may be to investigate the thoughts occurrence profiles of adolescent athletes longitudinally as they progress through different athletic transitions from junior to senior status. Recent research in youth sport settings has focused on the normative transitions that young athletes move through as they developmentally progress to higher standards of competition (Wylleman & Lavallee, 2004). Examining differences in TOQS scores between junior elite age groups is one method of understanding the potential effects and pressures of these transitions. However, longitudinal idiographic research that tracks changes on a case by case basis may offer researchers a clearer insight

into quality and quantity of cognitions that characterize a transition or move up to a higher level/age group. This information is of clear relevance to practitioners dealing with adolescent athletes entering the first year of senior competition. The validation of the TOQS in this study should provide researchers with a measure to fulfill these various lines of investigation.

In conclusion, results offer confirmatory support to the notion that the TOQS shows factorial validity for use among adolescent athletes. Future research should use the TOQS to investigate the extent to which thought processes of athletes during competition relate with other psychological measures.

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