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**Measurement and validation of a three-factor hierarchical  
model of competitive anxiety**

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## Abstract

*Objectives:* A novel analytical framework was used to re-examine and extend Cheng, Hardy and Markland's (2009) hierarchical model of anxiety. The modified model was characterized by six first order constructs, with worry, private self-focus and public self-focus representing cognitive anxiety, somatic tension and autonomous hyperactivity representing physiological anxiety and perceived control representing the regulatory dimension. It was hypothesized that these six first order constructs were formative indicators of the second order factors and this hypothesis was tested using Partial Least Squares analysis. Factor validity of the original hierarchical model proposed by Cheng et al. was investigated. Subsequently, items were refined, the hierarchical model extended, and factor and predictive validity investigated further.

*Method:* Prospective data was collected from three samples (N= 174, 516, 43), and a series of factor analyses were conducted including Confirmatory Factor Analysis and Partial Least Squares modeling. Multivariate analysis examined the predictive validity of the model using a performance measure as the dependent variable.

*Results:* The original model revealed a poor fit, with poor item loadings and discriminant validity. Subsequent analysis established a refined 25 item measure, which produced support for a fully differentiated hierarchical model of competitive anxiety. MANOVA revealed a significant effect for the control factor, with those achieving superior performance reporting significantly higher levels of perceived control.

*Conclusions:* A fully differentiated hierarchical model was supported, which crucially depicts the first order factors of competitive anxiety that form the three second order dimensions. This provides a model that is a better fit with theory and provides a more refined diagnosis tool for applied sport psychologists.

1                   **Measurement and validation of a three-factor hierarchical model**  
2   **of competitive anxiety**

3           Sport psychology researchers have invested effort and resources developing theories and  
4 models that best represent the competitive anxiety response and its impact on performance.  
5 Much of this research has attempted to provide mechanistic theories to explain why individuals  
6 may perform well under pressure whilst some others may suffer from poor performance. The  
7 results of this research have produced a mixed pattern of findings, with some supporting self-  
8 focus theories, for example, conscious processing hypothesis (Gucciardi & Dimmock, 2008),  
9 some supporting motivational processes, such as effort withdrawal (Hardy & Parfitt, 1991),  
10 others supporting an attentional explanation (Mullen, Hardy, & Tattersall; 2005; Wilson et al.,  
11 2007), whilst still others have produced equivocal results (Mullen & Hardy, 2000). Researchers  
12 (e.g. Cooke, Kavussanu, McIntyre, Boardley, & Ring, 2011) have also investigated alternative  
13 processes that might account for impaired performance, including physiological responses  
14 (e.g., muscle activity) and kinematic variables (e.g., acceleration). Researchers have now  
15 suggested that many of these theories and processes may indeed occur in parallel or at separate  
16 times during performance. Echoing Eysenck's (1988) suggestion that anxiety-related  
17 performance failure might be attributable to multiple causes, Mullen et al. (2005) suggested  
18 that such impairment might be caused by both attentional and conscious processing effects.  
19 Traditionally, however, research has focused on examining these processes in isolation. This  
20 may be one reason for the equivocal results, thus, researchers would be better placed attempting  
21 to tease apart the underlying aspects of anxiety that may trigger these processes, for example,  
22 excessive worry, attentional narrowing, self-focus, or changes in effort expenditure. Current  
23 measurement models do little to represent these processes; therefore, developing a model that  
24 accounts for these aspects of the competitive anxiety response is of clear importance. Adopting  
25 a more fine-grained measurement of anxiety processes would aid researchers investigating the

1 mechanistic effects of competitive anxiety on performance as well as allowing applied  
2 practitioners to individualise pressure training interventions.

3 Cheng, Hardy, and Markland (2009) attempted to address this issue by presenting a new  
4 measure of performance anxiety supported by a strong conceptual framework that emphasized  
5 the multidimensional nature of the performance anxiety response. Rather than use the more  
6 global term performance anxiety, we have used the more specific focused term *competitive*  
7 *anxiety* to refer to the competitive state anxiety construct that is being measured in the studies  
8 reported here. Cheng et al.'s model consisted of three dimensions; cognitive anxiety,  
9 physiological anxiety and a regulatory dimension, which was included to reflect the adaptive  
10 nature of the anxiety response. The model also adopted a differentiated approach to the  
11 cognitive and physiological dimensions to try and account for the unique processes involved  
12 within these dimensions. The resulting conceptual model consisted of three higher order  
13 dimensions that were reflected by five lower order subcomponents; cognitive anxiety reflected  
14 by worry and self-focused attention; physiological anxiety, reflected by autonomic  
15 hyperactivity and somatic tension and a regulatory dimension that included a single  
16 subcomponent of perceived control (please see Cheng et al., 2009, for further detail on these  
17 subcomponents). Cheng et al. developed their Three Factor Anxiety Inventory (TFAI) to test  
18 the proposed hierarchical model. Initial testing with two independent sample groups using  
19 retrospective data did not support the hypothesized model; more precisely, worry and self-  
20 focus, and somatic tension and autonomic hyperactivity had to be merged into two single  
21 factors to produce a good three factor fit, with predictive validity established in subsequent  
22 research (Cheng, Hardy, & Woodman, 2011; Cheng & Hardy, 2016). Of particular note in these  
23 studies was the key role played by the regulatory dimension, an essential part of the framework  
24 as it reflects the adaptive potential of the anxiety response. Given the resurgence of interest in  
25 the construct of self-control, the inclusion of the regulatory dimension may be the most

1 contentious component of Cheng et al.'s (2009) model. However, this dynamic aspect of the  
2 anxiety response is essential as it helps move conceptualizations away from intensity-only  
3 approaches that have been unable to reliably predict performance. As noted by Cheng et al.  
4 (2009), a regulatory or adaptive capacity has been proposed in previous models of anxiety  
5 (Eysenck, Derakshan, Santos, & Calvo, 2007; Carver & Scheier, 1988) and wider emotional  
6 frameworks (Izard & Ackerman, 2000). Cheng et al. (2011) found that the regulatory  
7 dimension had main and interactive effects on sports performance such that high perceived  
8 control was associated with better performance and best versus worst performance was  
9 associated with highest versus lowest perceived control, respectively. Cheng and Hardy (2016)  
10 presented further evidence for the role of the regulatory dimension by establishing relationships  
11 between perceived control and the adaptive dimensions of perfectionism, self-talk and  
12 approach coping, adding further to the construct validity of the model. Consequently, it would  
13 appear important to include the regulatory dimension in ongoing tests of the three-dimensional  
14 model.

15 In sum, the work of Cheng and associates represents a significant step forward in the stress  
16 and performance literature, providing evidence for the only model to date that has attempted to  
17 present a more holistic representation of the anxiety response. The model provides some  
18 support for the three major processes activated in the dynamics of the anxiety response;  
19 however, Cheng et al. noted that further investigation using prospective data was needed to  
20 support the fully differentiated hierarchical model that was originally proposed. The purpose  
21 of the present series of studies is to extend Cheng et al.'s original model. Specifically, we re-  
22 examined the multidimensional nature of the cognitive dimension, and specifically the self-  
23 focus factor. Cheng's original model represents self-focus as a unidimensional construct, but  
24 on closer inspection of the self-focus items used, it is clear that they relate to two unique factors  
25 consistent with Fenigstein, Scheier, and Buss's (1975) model, which differentiates between

1 private and public self-focus. Fenigstein et al. defined private self-focus as being “concerned  
2 with attending to one’s inner thoughts and feelings” (p. 523) and public self-focus as “a general  
3 awareness of the self as a social object that has an effect on others” (p.523). Cheng et al.’s  
4 (2009) model appears to conflate these two distinct aspects of self-focus as both are represented  
5 among the items comprising the cognitive dimension of their TFAI. For example, “I find  
6 myself evaluating myself more critically than usual” is indicative of a private self-focus, whilst  
7 “I am very aware of the possibility of disappointing important others” is indicative of a public  
8 self-focus. Despite using items derived from conceptually distinct sources of self-focus, Cheng  
9 et al. made no formal distinction between private and public self-focus, rather the two aspects  
10 were combined in a unidimensional self-focus construct.

11 The distinction between private and public self-focus could be especially pertinent as the  
12 psychological underpinnings and behavioural effects of these two states are different. Private  
13 self-focus serves to clarify and intensify the affect, motives, or personal standards that are  
14 currently salient to that individual (Fenigstein, Scheier, & Buss, 1975). Thus, individuals who  
15 experience elevated levels of private self-focus may experience heightened awareness of  
16 behaviours and movements in an attempt to maintain the aspect of a movement that is most  
17 salient to them (Masters, 1992). In contrast, Fenigstein et al. suggest that those who experience  
18 elevated levels of public self-focus generally feel a level of discomfort, and evaluation  
19 apprehension because they see themselves as the subject of appraisal. These individuals may  
20 experience a broadening of focus, as they scan the environment to focus on those who are  
21 watching them (Schwarzer & Jerusalem, 1992). In addition, they may attempt to modify their  
22 behaviour to meet the perceived expectations of others. Both private and public self-focus have  
23 been shown to have differential effects on performance in pressure-based laboratory studies  
24 (Geukes, Mesagno, Hanrahan, & Kellmann, 2013), lending further support for this  
25 differentiation in future model development. Consequently, a model that fully differentiates

1 between private and public self-focus should yield a more robust cognitive dimension of  
2 competitive anxiety.

3 In addition to model refinement, one aspect that requires further consideration, but has  
4 received little attention is the *specification* of measurement models. Typically, in measurement  
5 and conceptual development researchers have focused on the structural elements of models  
6 rather than on the direction of the relationships between items and their relevant latent  
7 constructs (Jarvis, Mackenzie, & Podsakoff, 2003). In establishing the relationship between  
8 constructs and indicators, research has generally relied upon classic test theory (Novick, 1966)  
9 and the assumptions this approach adopts regarding the relationships between constructs and  
10 their measures. Specifically, classic test theory assumes that the variation in scores on measures  
11 is a function of the true score, plus error. Such a specification assumes that meaning flows from  
12 the latent construct to the measures, and each measure is viewed as an imperfect reflection of  
13 the whole underlying construct. Therefore, any variation in a construct is reflected in variation  
14 in its indicators (Bollen, 1989). This type of model is known as reflective and assumes that the  
15 same latent construct causes all indicator items. Therefore, all items should be highly correlated  
16 and if one item were dropped the construct would not change. Despite the pervasiveness of this  
17 approach to model testing, not all latent constructs can be conceived of as being reflected by  
18 their first-order subcomponents (Bollen & Lennox, 1991). Rather, it often makes sense to view  
19 meaning as emanating from the measure to the latent variable in a definitional sense rather than  
20 vice versa (MacKenzie, Podsakoff, & Jarvis, 2005). Such constructs are labelled formative.

21 This issue has been completely overlooked in sport psychology measurement research, as  
22 model testing has typically adopted a Confirmatory Factor Analysis (CFA) approach, which  
23 typically specifies models as reflective (Chin, 1998). This potential misspecification in  
24 measurement models results in researchers drawing inaccurate conclusions between the  
25 structural relationships linking constructs, which, in turn, causes measurement error that has a

1 negative impact upon model testing. For example, MacKenzie et al. (2005) cited the example  
2 of transformational leadership as a construct that is traditionally conceptualized as being  
3 reflected by charisma, idealized influence, inspirational leadership, intellectual stimulation,  
4 and individualized consideration (Bass, 1998). However, Mackenzie et al. convincingly argued  
5 that these forms of leadership behaviour are conceptually distinct, are likely to have different  
6 antecedents and/or consequences and are not interchangeable. As a result, MacKenzie et al.  
7 claimed that transformational leadership would be better portrayed as a formative rather than a  
8 reflective construct. MacKenzie et al. noted that the distinction between reflective and  
9 formative indicator models can also be generalized to more abstract higher-order factor  
10 structures. With hierarchical models, there is also the possibility of multiple first order  
11 dimensions serving as either reflective or formative indicators of the higher order constructs.  
12 For example, hierarchical models that have formative second order constructs may have first  
13 order constructs that consist of reflective items, and vice versa.

14       Such hierarchical models can make both a theoretical and empirical contribution by better  
15 representing complex models (Petter, Straub, & Rai, 2007), a case in point being the  
16 competitive anxiety hierarchical model presented here. In the hierarchical model examined in  
17 this series of studies, the first order latent constructs (i.e., worry, private self-focus, public self-  
18 focus, somatic tension, autonomic hyperactivity and perceived control) are measured by  
19 reflective indicators (Diamantopoulos & Winklhofer, 2001). Crucially, each of these constructs  
20 has a unique theme that is common to all items purporting to measure it, therefore, the items  
21 are interchangeable and unidimensional. Furthermore, it is likely that the reflective indicators  
22 within each of the first order latent constructs will co-vary with each other, as suggested by  
23 Jarvis et al. (2003). These first order constructs serve as formative indicators for the second-  
24 order latent variables, the cognitive, physiological, and regulatory dimensions. These variables  
25 are specified as formative as the direction of causality flows from the first to second order



1 constructs, as the first order constructs are defining characteristics of the higher order latent  
2 constructs, and changes in these constructs are likely to cause changes to the second order  
3 construct. In addition, the first order constructs are also likely to differ between athletes. For  
4 example, not all athletes who score highly on private self-focus will score highly on public  
5 self-focus and it is entirely possible for athletes to have elevated levels of private self-focus  
6 and lower levels of public self-focus and vice-versa. Furthermore, the associated behavioural  
7 consequences of these two components may differ as described above. Likewise, both effects  
8 specified for self-focus differ from the hypothesized effects of increased worry, which may  
9 affect performance on tasks in different ways via different mechanisms (Eysenck, Derkashan,  
10 Santos, & Calvo, 2007). Similarly, somatic tension and autonomic hyperactivity are likely to  
11 vary in consequences. For example, somatic tension may directly impact upon the processing  
12 of movements through increased muscle tension, which might potentially cause degrees of  
13 freedom to “freeze” (cf. Vereijken, van Emmerik, Whiting, & Newell, 1992). In contrast,  
14 autonomic hyperactivity may have a different effect on performance through physiological  
15 reactions involved with the involuntary muscles that are associated with the body’s inner  
16 organs, such as increased breathing and heart rate. Changes to these functions might affect  
17 performance by impacting upon an individual’s preferred activation state (Hardy, Jones, &  
18 Gould, 1996; Hockey & Hamilton, 1983).

19       Considering the above arguments, the purpose of the series of studies reported here is to  
20 further develop the work of Cheng et al. (2009) by proposing a measurement model that fully  
21 represents the lower order constructs of competitive anxiety and more accurately describes the  
22 relationships between these lower level constructs and the three primary dimensions. One  
23 further point of clarification regards Cheng et al.’s use of the term performance anxiety. We  
24 have adopted a more focused terminology, specifically, competitive anxiety, as within the  
25 present series of studies all of the participants were athletes taking part in competitive events.

1 As a preliminary step, we re-examined Cheng et al.'s original hierarchical parcelled model with  
2 prospective data to confirm the poor fit already reported by Cheng et al (Study 1, part 1).  
3 Secondly, the original item pool was modified and enhanced to represent the separate private  
4 and public self-focus constructs within the hierarchical model, and Partial Least Squares (PLS)  
5 analysis was conducted to specify a mixed formative and reflective model (Study 1, part 2).  
6 Thirdly, this newly developed model was confirmed using a second large prospective data set.  
7 The adapted model consisted of six first order reflective constructs; worry, public self-focus,  
8 private self-focus, somatic tension, autonomic hyperactivity, and perceived control, which  
9 were formatively related to three higher order constructs of cognitive anxiety, physiological  
10 anxiety and a regulatory dimension (Study 2). Finally, the predictive validity of the hierarchical  
11 model was tested using a performance measure that was derived from both objective and self-  
12 report data (Study 3). All three studies use prospective data, that is, data collected an hour prior  
13 to a competitive event, to capture how participants felt at that moment regarding the upcoming  
14 event.

### 15 **Study 1: Model development**

16 This study had two objectives, the first of which was to re-evaluate the psychometric  
17 properties of the original hierarchical 25 item instrument proposed by Cheng et al. (2009) this  
18 time using a prospective data set. The model was specified using traditional reflective methods  
19 (CFA) as adopted in the original model. This first part was conducted in order to re-examine  
20 the original items guided by the prediction that the analysis would confirm the poor fit reported  
21 by Cheng et al. using a dataset collected prior to performance, rather than after the event, a  
22 limitation that characterizes Cheng and associates' work. The second objective of this study  
23 was to address the issues from part 1 by modifying and enhancing the original item pool to  
24 ensure the content was reflective of each of the proposed underlying factors. Additional items  
25 were generated to differentiate and truly reflect each of the five first order factors, as well as

1 including more items that reflected both a private and public self-focus. The second objective  
2 of this part was to test the model using Partial Least Square (PLS) analysis, which allows the  
3 specification of a reflective - formative hierarchical model. PLS was utilised in this step as it  
4 is preferred when looking at constructs measured primarily by formative indicators (Haenlein  
5 & Kaplan, 2004), as well as allowing the specification of hierarchical models using repeated  
6 manifest variables (Wetzels, Odekerken-Schröder, & van Oppen, 2009). In the model proposed  
7 here, the first order constructs (worry, self-focus, autonomic hyperactivity, and somatic tension  
8 and perceived control) are measured reflectively and then serve as formative indicators of the  
9 second order constructs, the cognitive, physiological and regulatory dimensions.

## 10 **Method**

### 11 **Participants**

12 In total 174 British participants took part in the study, consisting of 97 males and 77  
13 females with a mean age of 37.50 (SD = 11.59). The sample consisted of athletes competing  
14 in either running events (n = 121) or triathlons (n = 50). The sample consisted of a wide range  
15 of skill levels, including, international and national (n = 19), regional (n = 22), county (n = 26),  
16 club (n = 54), or other (n = 51). Participants were all taking part in a competitive event,  
17 including half-marathons, 10-kilometre races and full and sprint triathlons, with the average  
18 competitive years' experience as 13.74 (SD = 13.01). All participants were English speakers  
19 and informed consent was obtained before data collection. Ethical approval for the study was  
20 obtained from the institution's ethics committee.

### 21 **Measures**

22 **Part 1: Anxiety Measure.** The Three Factor Anxiety Inventory (TFAI) originally  
23 constructed by Cheng, Hardy, & Markland, (2009) was used in this investigation. The measure  
24 comprises 25 items (see table 1), with 11 items representing the cognitive dimension (worry  
25 and self-focus), 8 items representing the physiological anxiety (somatic tension and autonomic

1 hyperactivity), and 6 items representing the regulatory dimension (perceived control).  
2 Participants were instructed to complete the measure regarding how they felt at that moment.  
3 They were also reminded that their data was confidential, and they should answer as openly  
4 and honestly as possible. A 5-point Likert scale was adopted, with 1 representing totally  
5 disagree and 5 totally agree. Previous research testing the factorial validity of the English  
6 measure produced good fit indices for a three-factor parcelled model, with RMSEA values  $\leq$   
7 .06, CFI values  $\geq$  .97, SRMR values  $<$  .08, and robust chi-square ratios ranged from 1.5 to 2.4  
8 (Cheng et al., 2009, Cheng, Hardy, & Woodman, 2011). These validation studies revealed good  
9 internal consistency with Cronbach's alpha, of .78 to .87. However, the fit of the original  
10 hierarchical model with three second order and five first order factors was unsuccessful due to  
11 improper estimates (coefficient values greater than 1.0; Hair, Black, Babin, & Anderson, 2010)  
12 between the first and second latent factors in the structural model.

13 **Part 2: Measure refinement.** Building on part 1, part 2 involved generating additional  
14 items to fully reflect the hierarchical model proposed in this paper. In order to do so, an initial  
15 item pool with approximately 85 items was generated to assess worry, public self-focus, private  
16 self-focus, autonomic hyperactivity, somatic tension and perceived control. The first stage of  
17 this process involved retaining items from Cheng et al.'s (2009) final published model that  
18 demonstrated a significant factor loading. Additional items were then generated based on  
19 Cheng et al.'s definitions of worry, autonomic hyperactivity, somatic tension and perceived  
20 control. In addition, and in contrast to Cheng et al.'s model, self-focused attention was extended  
21 to include a distinction between private and public elements of self-focus (Fenigstein, et al.,  
22 1975). A range of items were included for each subcomponent to fully capture the dimensions  
23 of each construct. To ensure consistency, the original definitions of constructs used by Cheng  
24 et al. were adopted for worry, somatic tension, autonomic hyperactivity and perceived control.

1 For private and public self-focus, the definitions proposed by Fenigstein et al. were adopted.

2 Below, is a definition of each construct:

3 **Worry:** a cognitive form of apprehension associated with possible unfavourable outcomes.

4 **Private Self-focus:** concern with attending to one's inner thoughts and feelings.

5 **Public Self-Focus:** an awareness of the self as a social object that has an effect on others.

6 **Somatic Tension:** physiological reactions involved with the voluntary muscle groups that  
7 are motor-oriented.

8 **Autonomic Hyperactivity:** physiological reactions involved with the involuntary muscles  
9 that are associated with the body's inner organs.

10 **Perceived Control:** perception of one's capabilities (involving ability and resource) of being  
11 able to cope, and of goal-attainment, regarding the performance of a task under stress.

12 Each item was evaluated in terms of face validity, clarity of wording, and sentence  
13 structure. Items were also assessed for item difficulty (Clark & Watson, 1995), reversed-  
14 worded items (Gana, Martin, Canouet, Trouillet, & Meloni, 2002) and item quantity (Smith &  
15 McCarthy, 1995). Finally, these combined items were subject to extensive scrutiny by the co-  
16 authors: two British Psychological Society Chartered Psychologists and a British Association  
17 of Sport and Exercise Science Chartered Sport Scientist. The final item pool of 55 items was  
18 agreed by all parties. The final item pool consisted of: 25 items to represent the cognitive  
19 dimension (12 items representing worry, 6 representing private self-focus and 7 representing  
20 public self-focus); 20 representing the physiological dimension (10 items representing somatic  
21 tension and 10 representing autonomic hyperactivity); and 10 representing perceived control.

## 22 **Procedure**

23 To collect prospective data, we approached the relevant coach, athlete, and organisation  
24 before data collection and provided them with study details and a brief overview of the  
25 procedures. Following this initial contact, individuals were contacted and were given the

1 opportunity to ask any questions about the study and its procedures. Once participation was  
2 agreed, arrangements were made for the researcher to meet with athletes one hour before  
3 competition to complete the questionnaire pack. At this stage, informed consent was obtained  
4 from all participants. Participants then completed the demographic information and the  
5 competitive anxiety measure. Participants were instructed to complete the questionnaire one  
6 hour prior to competition and were asked to complete the questionnaire about their feelings  
7 towards the upcoming event. All participants were thanked and given contact details if they  
8 had any further questions.

### 9 **Data Analysis**

10 *Part 1.* The data was analysed using Confirmatory factor analysis (CFA) with the LISREL  
11 9.2 statistics software (Jöreskog & Sorbom, 1993). The analysis was conducted on the full  
12 hierarchical model, which is represented by five first order factors and three second order  
13 factors. The model was tested using a sequential approach (Jöreskog, 1993; Markland &  
14 Ingledew, 1997) to provide a rigorous test of discriminant and convergent validity. At the final  
15 stage of testing the model was tested using the parcelled approach (Marsh, Antill, &  
16 Cunningham, 1989), due to the relatively small sample size. This method produces item  
17 composites of the observed variables for each first-order factor, reducing the number of  
18 estimated parameters in the measurement model. According to Marsh et al. these composite  
19 variables are more normally distributed and more reliable than the original variables. The item  
20 composites were constructed by randomly combining two items from the same subcomponent  
21 of anxiety. The model was analysed by a detailed assessment of the standardised factor  
22 loadings, the standardised residuals and the modification indices. Global fit indices were  
23 examined, in addition a range of fit indices are reported, including the Root Mean Square Error  
24 of Approximation (RMSEA; Steiger, 1990), the Comparative Fit Index (CFI; Bentler, 1990),  
25 and the Standardized Root Mean Square Residual (SRMR). Hu and Bentler's (1999)

1 recommendations for good fit were adopted, with cut off value of 0.06 for RMSEA, and 0.95  
2 for CFI, and 0.08 for SRMR.

3 **Part 2.** The analysis was performed using Partial Least Squares (PLS), which is a structural  
4 equation modelling approach that uses a least squares estimation procedure (Wold, 1974,  
5 1982). The proposed model was tested using the SmartPLS version 2.0 (M3) software (Ringle,  
6 Wende, & Will, 2005). The PLS approach maximises the variance of the dependent variables  
7 explained by the independent variables, as opposed to reproducing the empirical covariance  
8 matrix (Haenlein & Kaplan, 2004). The PLS analysis was conducted using a mix of the  
9 repeated indicator approach and the two-stage approach (Hair, Hult, Ringle, & Sarsedt, 2013).  
10 The model was specified as a reflective-formative type using the repeated indicator approach  
11 (Mode B; Becker, Klein, & Wetzels, 2012). The analysis is reported in two sections, the first  
12 estimates the measurement model, while the second focuses upon examining the structural  
13 model (Roberts & Thatcher, 2009).

14 To assess the reflective first order factors, weight relations were analysed. This is known  
15 as individual item reliability and is assessed by inspecting the loading of the items on their  
16 respective latent variables. It has been suggested that items should be rejected if they have more  
17 error variance than shared variance with their latent variable (Hair, Black, Babin, & Anderson,  
18 2010), and thus, only items of .70 or greater should be retained. However, Chin and Newsted  
19 (1999) report that PLS structural parameter estimates are more stable and converge better on  
20 the true population values with larger numbers of indicators of the latent variables. Based upon  
21 Chin and Newsted's recommendation, items of .40 or greater were retained if they were  
22 statistically significant. Secondly, analysis of how latent variables and indicators were related  
23 was achieved by an examination of convergent validity and discriminant validity of the scales.  
24 Composite reliability (CR) assessed internal consistency as it is considered superior to  
25 Cronbach's alpha reliability coefficient (Peterson & Kim, 2013) and provides a better estimate

1 of variance shared by a set of indicators because it uses item loadings to calculate their internal  
2 consistency. It has been suggested that a CR of .70 or higher represents acceptable internal  
3 consistency (Fornell & Larcker, 1981). The average variance extracted (AVE) for scales was  
4 used to assess convergent validity. This statistic refers to the average amount of variance in a  
5 set of indicators explained by their latent variables, this should be at least .50 or greater (Fornell  
6 & Larcker, 1981). As well as examining cross loadings, the AVE statistic can also be used to  
7 calculate discriminant validity. Fornell and Larcker (1981) suggest that a latent variable should  
8 better explain the variance of its own indicators than the variance of other latent variables.  
9 Hence, the square root of each construct's AVE should be greater than its highest correlation  
10 with any other construct in the model.

11 The second step was to examine the structural part of the model, which tests the  
12 relationship between the latent variables. The cognitive dimension, physiological dimension  
13 and regulatory dimension were modelled as formative second order latent variables. When  
14 assessing structural models with formative constructs the standardized path coefficients are  
15 assessed to examine their significance. This evaluates the strength of the relationship between  
16 the focal formative construct and related endogenous constructs (Roberts & Thatcher, 2009).  
17 If structural paths were significant these paths were retained in the model, and further  
18 examination of the standardised path coefficients ( $\beta$ ) took place to examine the relative  
19 contribution of each factor. When using the repeated indicators approach with higher order  
20 constructs that are formative, the lower order constructs already explain all the variance of the  
21 higher order constructs. Therefore, the variance explained ( $R^2$ ) in the endogenous construct  
22 will typically equal 1.0 (Becker, Klein, & Wetzels, 2012), and so is not reported in this analysis.  
23 To generate a test of significance, SmartPLS implements a bootstrapping procedure. Means  
24 and standard errors for the PLS estimates are generated and these are tested for significance by  
25 the  $t$ -statistic. In the present analyses 5000 bootstrap samples with replacement were requested.



## 1 **Results**

### 2 **Step 1**

3 Inspection of the univariate normality of all items for skewness (values ranged from -.60  
4 to 1.32) and kurtosis (values ranged from -.80 to 1.52) revealed some violation (values greater  
5 than 1 indicating violations to skewness and kurtosis; Bulmer, 1979), so that the multivariate  
6 distributions were significantly non-normal. Consequently, the Robust  $\chi^2$  was adopted as a  
7 method of correcting the  $\chi^2$  statistic for non-normality (Chou & Bentler, 1995). The full  
8 hierarchical model with three second order and five first order factors exhibited a poor fit to  
9 the data, with Robust  $\chi^2$  (30) = 333.84,  $p < .001$ ; RMSEA = .14, CFI = .56 and SRMR = .14.  
10 Reflecting Cheng et al.'s work, this model also produced some improper estimates (coefficient  
11 values greater than 1.0; Hair, Anderson, Tatham, & Black, 1998). The inter factor correlations  
12 between the three dimensions of anxiety were -.49 between the cognitive and physiological  
13 dimensions, -.92 between the cognitive and regulatory dimensions and .85 between the  
14 physiological and regulatory dimensions. In addition, several of the factor loadings for the 25  
15 items (see table 1) were below .40. To replicate the steps taken by Cheng et al., the model was  
16 also tested as a three-dimensional parcelled model, which revealed a better, although still  
17 unsatisfactory, fit to the data, with Robust  $\chi^2$  (35) = 183.30,  $p < .001$ ; RMSEA = .10, CFI = .73  
18 and SRMR = .11. Furthermore, 5 items had factor loadings below .20, which is also indicative  
19 of a poor fit.

### 20 **Step 2**

21 The PLS analysis revealed some issues with the factor loadings of the 55-item scale (table  
22 2). Overall, 12 items had loadings that were less than .40, 11 items had loadings that were  
23 below .70, and the remaining 32 items all had loadings greater than .70. Several factors had  
24 unacceptable CR values as well as AVE's values less than .50 (see table 3). Discriminant  
25 validity was established using the squared root of the AVE'S for each latent variable against

1 the bivariate correlations of all other variables (table 4). Again, several factors violated  
2 discriminant validity, in that some bivariate correlations were greater than the squared root of  
3 the AVE of the latent variable (table 4). In addition, one of the structural path coefficients from  
4 the lower order to the second order constructs in the proposed hierarchical model were not  
5 significant ( $p < 0.05$ , see table 5).

6 The model was refined for further testing and inspection of the item loadings and factor  
7 properties revealed a better fit. More precisely, following a process of item deletion, a model  
8 represented by 25 items presented the most robust measurement model (table 2). All item  
9 loadings were greater than .40, and only 5 items had loadings below .70. All factors had  
10 acceptable AVE and CR values (table 3); however, similar to the aforementioned discriminant  
11 validity analysis, some bivariate correlations were greater than the squared root of the AVE of  
12 the latent variable. Specifically, between worry and private and public self-focus, and between  
13 somatic tension and autonomic hyperactivity (table 4). When examining the structural  
14 properties, the path coefficients presented a much more positive model. All path coefficients  
15 were significant from the first to second order factors (table 5).

## 16 **Discussion**

17 The aim of study 1 was firstly to re-test the original hierarchical model proposed by Cheng  
18 et al. (2009) with prospective data. Analysis was conducted using a traditional reflective CFA  
19 approach. Replicating Cheng et al.'s findings, the results from the CFA revealed a poor fit to  
20 the proposed hierarchical model. The same parcelling method utilized by Cheng et al. was  
21 adopted in this analysis, the limitations of which have been reported by Marsh, Lüdtke,  
22 Nagengast, Morin, & Von Davier (2013). However, for the purposes of replication, following  
23 the same procedures used by Cheng et al was considered an important step in developing the  
24 rationale for alternative analysis procedures. Subsequently, in part 2 of this study we took  
25 several steps to attempt to address the issue of poor fit, the first being specification of the model

1 using a mixture of reflective and formative constructs in order to produce a more robust model  
2 that better reflects the complex dynamics of the anxiety response. We also took this opportunity  
3 to address conceptual issues within the original model by extending the cognitive dimension to  
4 include the private and public self-focus distinction proposed by Fenigstein, Scheier, and Buss  
5 (1975). Therefore, the objective of step 2 was to modify and extend the hierarchical model of  
6 competitive anxiety. The items were refined, and the cognitive dimension of the hierarchical  
7 model was extended to include a private and a public self-focus. Therefore, the proposed model  
8 consisted of six reflective constructs (worry, self-focus, autonomic hyperactivity, somatic  
9 tension and perceived control), which served as formative indicators of the second order  
10 constructs (cognitive, physiological and regulatory dimensions). The final 25 items revealed a  
11 good fit to the data, while also providing a measure that could be easily administered to athletes.  
12 In total 11 items were retained from Cheng et al.'s model, the remaining 14 were newly  
13 developed items. However, there were some violations to discriminant validity, thus further  
14 testing of the model was required. Some of these violations might have been due to peculiarities  
15 in this relatively small and homogeneous sample, which might dissipate if the model was tested  
16 with a large more heterogeneous sample. Consequently, a second study using a larger  
17 prospective heterogeneous sample was used to further test the proposed hierarchical model.

## 18 **Study 2: Testing the model**

### 19 **Method**

#### 20 **Participants**

21 In total 516 British participants took part in this study. The sample included both male (n  
22 = 174) and female athletes (n = 342), who competed in a variety of sports (Archery = 40,  
23 Badminton = 22, Basketball = 42, Cheerleading = 6, Football = 40, Hockey = 31, Karate = 8,  
24 Netball = 240, Rugby = 57, Touch Rugby = 14, Volleyball = 16). Participants competed at the  
25 following performance levels, international (n = 73), national (n = 83), regional (n = 118),

1 county (n = 166), or club (n = 76). Participants were all taking part in a competitive event  
2 (International = 30, university = 312, regional = 116, league = 58), with the mean competitive  
3 years of experience as 9.35 (SD = 4.64). All participants were English speaking and informed  
4 consent was obtained before data collection. Ethical approval for the study was obtained from  
5 the institution's ethics committee.

## 6 **Measure**

7 *Anxiety*. The 25-item hierarchical model developed in study 1, part 2 was used in this  
8 study.

## 9 **Procedure**

10 As in the previous studies, the same prospective data collection procedure was utilised.

## 11 **Data Analysis**

12 The PLS analysis used in study 1 was employed.

## 13 **Results**

14 Analysis revealed that all item loadings were greater than .40 and significantly greater than  
15 zero in all cases (table 6). Only three loadings were below .70, one of which ("I have a slight  
16 tension headache") was also below .70 in study 1. Acceptable convergent validity was also  
17 achieved as all lower order constructs within the measurement model had CR values greater  
18 than .70, and all lower order constructs had AVE's greater than .50 (see table 3). Discriminant  
19 validity was examined by comparing the square rooted AVE'S for each latent variable against  
20 the bivariate correlations of all other variables (table 7). All latent variables demonstrated  
21 adequate discriminant validity, apart from autonomic hyperactivity, with somatic tension.  
22 However, on further assessment of the item cross loadings, none of the items correlated more  
23 strongly with the other construct than their own construct, thus there was no violation across  
24 items. The Fornell-Larcker approach is a very conservative test of discriminant validity (Chin,  
25 2010); therefore, based on inspection of the item cross loadings, all latent variables were

1 considered to demonstrate adequate discriminant validity. With this in consideration, and in  
2 view of the results taken together, these findings suggest that the measurement model was  
3 acceptable.

4 With regards to the structural properties of the hierarchical model, the results reveal that  
5 all path coefficients were significant in the proposed model (see table 5). The first order factors,  
6 reflectively measuring the constructs of worry, private self-focus, and public self-focus were  
7 all significantly and positively related to the cognitive factor. Likewise, somatic tension and  
8 autonomic hyperactivity were significantly and positively related to the physiological factor.

## 9 **Discussion**

10 The aim of study 2 was to test the final 25 item hierarchical model presented in study 1,  
11 part 2, which consisted of six reflective constructs (worry, self-focus, autonomic hyperactivity,  
12 somatic tension and perceived control), which served as formative indicators of the second  
13 order constructs (cognitive, physiological and the regulatory dimension). The PLS results  
14 revealed good item loadings for the 25 items and support for a fully differentiated hierarchical  
15 model. All structural paths were significant, which supports a model that consists of first order  
16 reflective constructs and second order formative constructs. This is a novel development in the  
17 anxiety measurement literature, as it is the first time a model has been specified in such a way.  
18 To provide further support for this model, study 3 aimed to establish how the lower order  
19 factors from this model can help explain athletes' performance. We predicted that higher  
20 performance levels during a competition would be associated with lower levels of  
21 precompetitive cognitive and physiological anxiety and higher levels of perceived control when  
22 compared with poorer performance.

## 23 **Study 3: Establishing predictive validity**

### 24 **Method**

#### 25 **Participants**

1 The full sample consisted of 104 British athletes ( $M = 37.58$ ,  $SD = 11.71$ ) who were  
2 assigned to one of three (high, moderate, and low) groups according to their score on the self-  
3 reported performance measure (see below). The high-performance group consisted of 24  
4 athletes, the moderate group 61 athletes, while the low performing group contained 19 athletes.  
5 The final sample consisted of the two extreme groups, i.e., those in the high ( $n = 24$ ) and low  
6 performing groups ( $n = 43$ ). This final sample included both male ( $n = 24$ ) and female ( $n = 17$ )  
7 athletes with an average age of 36.21 ( $SD = 12.51$ ). Athletes were either taking part in a  
8 competitive running race ( $n = 28$ ) or triathlon ( $n = 18$ ) and had an average competitive  
9 experience of 15.88 years ( $SD = 13.22$ ). All participants were English speaking and informed  
10 consent was obtained before data collection. Ethical approval for the study was obtained from  
11 the institution's ethics committee.

## 12 **Measures**

13 **Anxiety.** The final hierarchical model presented in study 2 was used in this study.

14 **Performance.** In line with previous research (Cheng, Hardy, & Woodman, 2011; Hardy  
15 & Hutchinson, 2007), a self-report measure of performance was designed specifically for this  
16 study. In contrast to previous research, this measure was derived from a subjective measure of  
17 performance as well as two dichotomous questions that established whether the athletes had  
18 achieved a personal best and achieved their personal goals in the event they had just completed.  
19 To capture the subjective element of performance, athletes completed a 6-item measure, which  
20 was developed with the assistance of running and triathlon coaches and athletes ( $n = 38$ ) who  
21 were contacted and asked to provide a list of factors that they considered to be indicative of  
22 superior performance. This list was then reviewed by the research team and two international  
23 level coaches before the 6 items were agreed. The scale consisted of the following items: (a) I  
24 remained focused throughout the race; (b) I executed a well-paced and consistent race; (c) My  
25 fuel and hydration strategies were effective; (d) During the race, I established a good rhythm

1 throughout; (e) I remained motivated and determined throughout; (f) I employed effective in-  
2 race strategies to complete the race well. These items were rated on a 5-point Likert scale from  
3 1 (least satisfactory) to 5 (highly satisfactory). Total scores ranged from 6 to 30. The  
4 performance measure was pilot tested on 4 athletes from the target population to ensure clarity  
5 of wording and ease of use of the scale. Factor validity of the single factor scale was examined,  
6 and the results revealed item loadings from .86 to .72, and composite reliability of .90  
7 Participants were separated into high and low performance groups based on the following three  
8 aspects of performance; a) did they achieve a personal best, b) did they achieve their goals, c)  
9 the overall score on the 6-item performance measure. Individuals were placed into the good  
10 performance group if they reported yes to the first two questions and received a score over 25  
11 on the performance measure. Individuals were placed in the poor performance group if they  
12 reported no to both questions and received a score below 20 on the performance questionnaire.

### 13 **Procedure**

14 The same procedure as the studies reported earlier was adopted, with the addition of the  
15 collection of performance data. Specifically, athletes were informed that they were required to  
16 complete a short performance measure following the event that they were taking part in.  
17 Immediately after the competitive event, athletes were asked to fill out the brief performance  
18 measure. They were then thanked and debriefed on the purpose of the study.

### 19 **Data Analysis**

20 A one-way MANOVA compared the levels of precompetitive anxiety between the high  
21 and low performing groups. The independent variable, performance level, was based on  
22 performance recorded at the same event at which the pre-competition anxiety was measured  
23 The six first-order variables of the competitive anxiety model (i.e., worry, private self-focus,  
24 public self-focus, somatic tension, autonomic hyperactivity, perceived control) served as  
25 dependent variables.

## 1 **Results**

2 All of the assumptions underlying the use of MANOVA were met. The MANOVA  
3 revealed a significant effect for performance level, Wilks = 0.74,  $F(6, 40) = 2.33$ ,  $p < .05$ ,  
4 partial  $\eta^2 = .259$ . Follow-up one-way ANOVA's were conducted on each of the six dependent  
5 variables. The tests revealed a significant effect for the control factor only,  $F(1, 99) = 9.79$ ,  $p$   
6  $< 0.01$ ,  $\eta^2 = .20$ , with those achieving high performance reporting significantly higher levels of  
7 perceived control than those who performed poorly.

## 8 **Discussion**

9 The aim of study 3 was to establish whether the lower order factors from this model were  
10 related to athletes' performance. The results revealed that those who performed well had higher  
11 levels of perceived control. This provides only partial support for the predictive validity of the  
12 model; however, this finding does lend support to previous research that also demonstrated that  
13 higher levels of perceived control lead to better performance (Cheng, Hardy, & Woodman,  
14 2011). The absence of any differences between High and Low performing athletes in terms of  
15 cognitive and physiological anxiety is in line with much of the literature in this area (e.g.,  
16 Edwards & Hardy, 1996; Gould, Petlichkoff, Simons, & Vevera, 1987) and forms the basis of  
17 including the regulatory dimension, which accounts for the sometimes adaptive nature of the  
18 anxiety response.

### 19 **General Discussion**

20 The purpose of the present series of studies was to develop and extend the work of Cheng  
21 et al. (2009) and validate a hierarchical model of competitive anxiety based on their original  
22 model. Study 1 confirmed that the model proposed by Cheng et al. required further attention.  
23 Echoing Cheng et al.'s results, a number of the items reported poor loadings, thus the  
24 measurement model was refined and examined as a mixed reflective-formative hierarchical  
25 model. The results of the initial 55 item measure revealed poor measurement and structural fit



1 statistics, but a smaller 25 item measure provided good fit statistics. Study 2 revealed support  
2 for the differentiated hierarchical model represented by the five underlying subcomponents.  
3 The model presented here is in line with Cheng et al.'s (2009) originally proposed five factor  
4 hierarchical model. Study 3 distinguished between athletes who have performed well and those  
5 who have not performed well. The results revealed that good performance was associated with  
6 higher pre-competition levels of the first order factor of perceived control.

7 The current research represents an important step in developing a valid hierarchical model  
8 of competitive anxiety. The results support the adoption of a hierarchical structure, with six  
9 lower order reflective constructs and three higher order formative constructs. In contrast to  
10 Cheng et al.'s (2009) analysis, the results of the current study were able to support a hierarchical  
11 structure. Thus, the results add support to the re-conceptualization of model proposed by Cheng  
12 et al., whilst also providing support for the multidimensionality associated with both the  
13 cognitive and physiological dimensions. Theoretically, this allows for greater differentiation in  
14 our understanding of each dimension of competitive anxiety, which will allow more  
15 meaningful testing of theories. Despite these positive findings, there remains some uncertainty  
16 about the nature of the cognitive dimension. Structurally, the private and public self-focus  
17 factors appear to load weakly onto cognitive anxiety. Whilst all the structural paths make a  
18 contribution to the higher order construct of cognitive anxiety, the nature of this dimension  
19 could be further explained by a second level within the cognitive dimension. Specifically, the  
20 cognitive dimension could contain one overarching dimension of self-focus formed by private  
21 and public components at a lower level. Future research could test this proposition and ensure  
22 that the factors that form the cognitive dimension fully encompass the whole anxiety response  
23 (Derakshan & Eysenck, 2001).

24 In addition to the issues outlined with the cognitive dimension, the measurement results of  
25 study 2 revealed a violation of inter-item correlation between somatic tension and autonomic

1 hyperactivity. The approach of measuring perceptions of physiological anxiety in performance  
2 contexts has previously received criticism (e.g., Woodman & Hardy, 2001) and research has  
3 demonstrated that individuals are poor at accurately reading their own physiological symptoms,  
4 unless trained to do so (e.g., Yamaji, Yokota, & Shephard, 1992). Therefore, measuring  
5 physiological symptoms via self-report instruments may not be the most effective method,  
6 which may go some way to explain the issues reported here. Consequently, further validation  
7 of the physiological dimension alongside a greater understanding of the interoceptive  
8 capabilities of individuals may be required (Craig, 2002).

9 In terms of perceived control, the results provide further support for the integration of a  
10 regulatory dimension in a model of competitive anxiety. In addition, these results support  
11 Cheng, Hardy, and Woodman's (2011) predictive validity study, which found perceived  
12 control to be the single best predictor of

13 . It appears that perceived control might be the most important constituent of the  
14 performance anxiety relationship, further highlighting the adaptive potential of the regulatory  
15 dimension. Further studies are required to explore the adaptive nature of the perceived control  
16 construct, the conceptualization of which in this series of studies is in line with that adopted by  
17 Cheng and colleagues. Specifically, perceived control in this context evolved from Carver and  
18 Scheier's conceptualization of the construct within their control-process model of anxiety and  
19 is specifically related to an individual's perception of their capacity to be able to cope and attain  
20 goals under pressure (Cheng et al., 2009, p. 273). Of course, the construct of control is  
21 potentially much wider in scope and has been linked to other emotions (e.g., Izard & Ackerman,  
22 2000) and future research might also focus on how the specific construct of control adopted in  
23 this series of studies relates to other, perhaps wider notions of control.

24 Despite the attempt to record more objective performance data by asking athletes if they  
25 had achieved their personal best, other, more subjective questions formed the basis of the

1 performance measure in Study 3. Consequently, there remains the issue of social desirability  
2 when using self-report measures. Composite indices of performance comprising objective and  
3 self and coach rated measures may help researchers build up a more holistic and reliable picture  
4 of “performance” that is more sensitive to fluctuations in competitive anxiety. Furthermore,  
5 apart from the regulatory dimension, the current research did not find any significant effects  
6 for any of the other first order factors in the model. To continue to support the hierarchical  
7 model presented in this research, future studies should continue to look for effects at the lower  
8 order and should consider using more sophisticated analysis to accomplish this goal, such as  
9 pattern recognition techniques (Witten, Frank, Hall, & Pal, 2016).

10 All 733 participants in the series of studies reported here were athletes from a variety of  
11 sports who competed at a number of ability levels. Similarly, Cheng and associates (2009,  
12 2011, 2015), focused their efforts on collecting data from competitive athletes, 1992 in total,  
13 again from a range of sports and competitive levels. Within Cheng et al.’s (2015) sample, there  
14 were 485 dancers, but these were also performing in a dance competition. Thus, the focus of  
15 all of the research thus far has been on athletes in competitive situations. Future research should  
16 seek to examine the generalizability of the three-dimensional model to other potentially  
17 stressful environments, for example, using military personnel or musicians.

18 From a measurement perspective, the results of the PLS analysis suggest that modelling  
19 competitive anxiety using a mixture of reflective and formative methods may provide a more  
20 accurate reflection of the factors associated with the competitive anxiety response. Moreover,  
21 the results provide clear support for modelling the relationship between the lower order and  
22 higher order constructs as formative. This is crucial as the lower order constructs of worry,  
23 private self-focus, public self-focus and of somatic tension and autonomic hyperactivity are  
24 conceptually distinct, are likely to have different antecedents/consequences, and are not  
25 interchangeable. Therefore, adopting a formative approach will reduce the potential for

1 misspecification of relationships between constructs and the associated measurement error.  
2 This will result in researchers specifying appropriate relationships and making accurate  
3 conclusions about the structural relationships between constructs. To further explore the  
4 hierarchical model researchers should examine relationships between the first order constructs  
5 of this model with other measures to establish further validity.

6 Partial least squares has become a viable estimator for testing theoretical models in  
7 psychological research (Bollen & Diamantopoulos, 2017). However, this form of analysis is  
8 not commonly seen in the sport psychology literature, nonetheless the authors feel that this  
9 approach to model specification has the potential to have a significant impact on model testing.  
10 One reason for its absence might be due to the lack of clear guidelines when testing more  
11 complex models. The model proposed here used a combination of reflective and formative  
12 methods; yet similar models in the literature often fail to provide details on how models were  
13 specified (Becker, Klein, & Wetzels, 2012). The debate on this form of model specification is  
14 ever changing, thus future testing using this approach, should be mindful of further  
15 developments in model testing procedures.

16 Whilst greater differentiation may prove useful in theoretical terms, there is also practical  
17 significance in these findings. The differentiated approach afforded in this model permits  
18 greater understanding of an individual's response. Consequently, if a more refined diagnosis  
19 of anxiety can be made; sport psychologists can adopt more precise intervention strategies to  
20 facilitate task success in pressure situations. For example, athletes who report high scores on  
21 the private self-focus subscale might benefit from using holistic process goals to prevent lapses  
22 into conscious control (Mullen, Jones, Oliver, & Hardy, 2016). In contrast, athletes who report  
23 elevated levels of autonomic hyperactivity may benefit from a relaxation-based strategy  
24 focused on rhythmic breathing, which could decrease an individual's breathing and heart rate.

1        In conclusion, the studies reported here provide support for a differentiated hierarchical  
2 model of competitive anxiety. The refinement of the measure and the addition of a private and  
3 public self-focus strengthen the model's validity and provide a deeper understanding of the  
4 competitive anxiety response. This differentiated approach at the first order level has the  
5 potential to make a significant impact on both theoretical testing in the competitive anxiety  
6 literature and on the practice of applied sport psychologists.

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Author accepted manuscript

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1 **Table 1. Study 1, part 1 factor loadings**

Items	Factor loadings
<b>Worry</b>	
I am worried that I may make mistakes	.81
I am worried about the uncertainty of what may happen	.76
I am worried that I may not perform as well as I can	.13
I am worried about the consequence of failure	.81
<b>Self-Focus</b>	
I tend to dwell on shortcomings in my performance	.59
I am aware that I will be conscious of every movement I make	.48
During my performance I will evaluate myself more critically	.00
I am conscious that people might disapprove of my performance	.76
I dwell on how I might not impress important others	.91
I am very aware of the possibility of disappointing important others	.88
I am conscious that others will be judging my performance	.48
<b>Somatic Tension</b>	
I feel easily tired	.74
I feel restless	.72
I have a slight tension headache	.14
My body feels tense	.81
<b>Autonomic Hyperactivity</b>	
My mouth feels dry	.18
My heart is racing	.45
I feel the need to go to the bathroom more often	.55
My hands are clammy	-.01
<b>Perceived Control</b>	
I feel ready for my performance	.78
I believe in my ability to perform	.81
I believe my performance goal is achievable	.56
I believe that I have the resources to meet this challenge	.73
I am confident that I can stay focused during my performance	.64
I feel confident about my upcoming performance	.84

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1 **Table 2. Study 1, part 2 PLS factor loadings**

Items	Factor loadings	
	Study 2a	Study 2b
<b>Worry</b>		
I am worried that I may make mistakes	.81	.85
I am worried about the uncertainty of what may happen	.81	.79
I am worried about the consequence of failure	.85	.83
I am worried that I may not perform to the best of my ability	.21	.83
I am worried about the outcome of my performance	.11	.83
I am worried that I may not meet the expectations of important others	.75	
I am worried that I may not perform as well as I can	.17	
I am worried because I don't know what to expect	.79	
I am worried that others will be disappointed with my performance	.23	
I am worried because I can not predict the performance result	.78	
I am worried about what may happen if things to not go well	.87	
I am worried that things are going to go wrong	.73	
<b>Private Self-Focus</b>		
I tend to dwell on shortcomings in my performance	.82	.83
I am aware that I will be conscious of every movement I make	.64	.69
I am aware that I will scrutinise my performance	.68	.74
During my performance I will evaluate myself more critically	-.21	
During the performance I will be instructing myself what to do	.17	
I am aware that I will focus on the weaknesses in my performance	.8	
<b>Public Self-Focus</b>		
I am conscious about the way I will look to others	.73	.83
I am conscious that others will be judging my performance	.79	.87
I am worried that I might not meet the expectations of important others		.85
I dwell on how I might not impress important others	.88	
I am very aware of the possibility of disappointing important others	.83	
I am aware that other are going to evaluate me critically	.87	
I am aware that people will be watching me	.18	
I am conscious that people might disapprove of my performance	.82	
<b>Somatic Tension</b>		
I have a slight tension headache	.17	.62
My body feels tense	.84	.83
I feel physically nervous	.09	.79
I find myself trembling	.77	.8
I feel lethargic	.73	.72
I feel easily tired	.75	
I feel restless	.69	
I feel my body feeling shaky	.83	
I am suffering from a headache	.61	
My body feels tight	.51	
<b>Autonomic Hyperactivity</b>		

My hands are clammy	-.07	.82
My heart is racing	.63	.61
My chest feels tight	.77	.73
I feel tense in my stomach	.79	.81
I feel a lump in my throat	.74	.83
My mouth feels dry	.21	
I feel the need to go to the bathroom more often	.56	
My palms are sweaty	.14	
I feel difficulty breathing	.67	
My heart rate has increased	.74	
<b>Perceived Control</b>		
I believe in my ability to perform	.84	.9
I am prepared for my upcoming performance	.66	.58
I am confident that I will be able to reach my target	.72	.69
I feel I have the capacity to cope with this performance	.77	.85
I feel ready for my performance	.8	
I believe my performance goal is achievable	.66	
I believe that I have the resources to meet this challenge	.76	
I am confident that I can stay focused during my performance	.67	
I feel confident about my upcoming performance	.82	
I believe I have the skills to be successful in my competition	.73	

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1 **Table 3. Quality overview**

First-order constructs	Study 1 (part 2a)		Study 1(part 2b)		Study 2	
	AVE	CR	AVE	CR	AVE	CR
Worry	.44	.66	.69	.91	.60	.88
Private self-focus	.37	.60	.57	.80	.55	.79
Public self-focus	.58	.76	.72	.88	.63	.84
Somatic tension	.42	.64	.58	.87	.53	.84
Autonomic Hyperactivity	.35	.59	.58	.87	.55	.85
Perceived Control	.56	.92	.59	.85	.59	.85

2 *Note.* AVE = Average variance extracted; CR = Composite reliability.

3 **Table 4. Study 1 (part 2) latent variable correlations**

First-order Construct	1	2	3	4	5	6
1. Worry	<b>.66</b>	.74	.84	.71	.68	-.54
2. Private self-focus	.74	<b>.60</b>	.61	.56	.51	-.36
3. Public self-focus	.84	.67	<b>.76</b>	.57	.53	-.39
4. Somatic tension	.41	.55	.61	<b>.64</b>	.86	-.57
5. Autonomic Hyperactivity	.68	.52	.60	.89	<b>.59</b>	-.56
6. Perceived Control	-.57	-.33	-.45	-.52	-.52	<b>.74</b>

*Note.* Squared root AVE are presented in bold on the diagonal line. Latent variable correlations for the 55 item (part 2a) model is presented below the diagonal, whilst the 25 item (part 2b) model is presented above the diagonal. (i.e., weak – 0.20, moderate – 0.50, and strong – 0.80)

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5 **Table 5. Path coefficients**

Relationship	Study 1 (part 2a)	Study 1(part 2b)	Study 2
Worry -> Cognitive	1.12*	.69*	.69*
Private Self-focus -> Cognitive	-.04	.17*	.25*
Public Self-focus -> Cognitive	-.13*	.20*	.16*
Somatic tension -> Physiological	1.24*	.74*	.51*
Autonomic Hyperactivity -> Physiological	-.32*	.27*	.53*
Perceived Control -> Regulatory	.30*	.21*	.22*

6 *Note.* \* = significant path coefficients,  $p < .05$ .

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1 **Table 6. Study 2 PLS factor loadings**

<b>Items</b>	<b>Factor loadings</b>
<b>Worry</b>	
I am worried that I may make mistakes	.80
I am worried about the uncertainty of what may happen	.72
I am worried about the outcome of my performance	.84
I am worried that I may not perform to the best of my ability	.78
I am worried about the consequence of failure	.74
<b>Private Self-Focus</b>	
I tend to dwell on shortcomings in my performance	.75
I am aware that I will scrutinise my performance	.77
I am aware that I will be conscious of every movement I make	.71
<b>Public Self-Focus</b>	
I am conscious about the way I will look to others	.77
I am conscious that others will be judging my performance	.82
I am worried that I may not meet the expectations of important others	.79
<b>Somatic Tension</b>	
I feel physically nervous	.75
I find myself trembling	.76
I have a slight tension headache	.67
I feel lethargic	.62
My body feels tense	.80
<b>Autonomic Hyperactivity</b>	
My chest feels tight	.73
I feel tense in my stomach	.83
My heart is racing	.71
I feel a lump in my throat	.73
My hands are clammy	.69
<b>Perceived Control</b>	
I believe in my ability to perform	.84
I am prepared for my upcoming performance	.70
I am confident that I will be able to reach my target	.72
I feel I have the capacity to cope with this performance	.79

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**Table 7. Study 2 latent variable correlations**

First-order Construct	1	2	3	4	5	6
1. Worry	<b>.77</b>					
2. Private self-focus	.56	<b>.74</b>				
3. Public self-focus	.70	.57	<b>.79</b>			
4. Somatic tension	.53	.4	.44	<b>.72</b>		
5. Autonomic Hyperactivity	.51	.36	.40	.82	<b>.74</b>	
6. Perceived Control	-.34	-.21	-.35	-.35	-.28	<b>.76</b>

*Note.* Squared root AVE are presented in bold on the diagonal line. (i.e., weak – 0.20, moderate – 0.50, and strong – 0.80)

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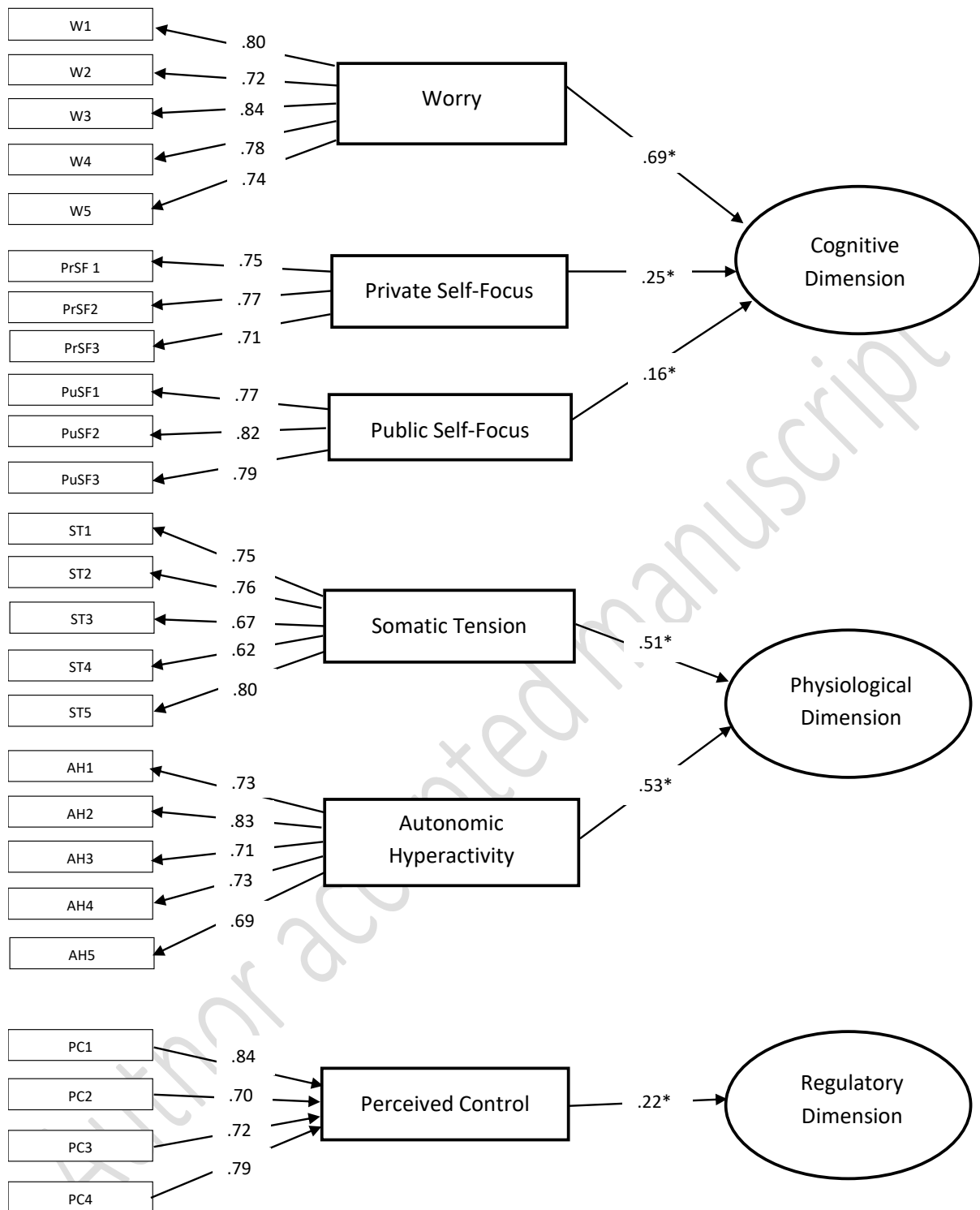


Figure 1. Results of the PLS model for the final 25 item model presented in study 2 with factor loadings and path coefficients. *Note.* For the path coefficients, the estimate is the PLS estimate,  $p < .05$ .