Latent profiles of elite Malaysian athletes' use of psychological skills and techniques and relations with mental toughness

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Background: The majority of past work on athletes' use of psychological skills and techniques (PSTs) has adopted a variable-centered approach in which the statistical relations among study variables are averaged across a sample. However, variable centered-analyses exclude the possibility that PSTs may be used in tandem or combined in different ways across practice and competition settings. With this empirical gap in mind, the purposes of this study were to identify the number and type of profiles of elite athletes' use of PSTs, and examine differences between these clusters in terms of their self-reported mental toughness **Methods**: In this cross-sectional survey study, 285 Malaysian elite athletes (170 males, 115 females) aged 15 to 44 years (M = 18.89, SD = 4.49) completed measures of various PSTs and mental toughness. Latent profile analysis was employed to determine the type and number of profiles that best represent athletes' reports of their use of PSTs in practice and competition settings, and examine differences between these classes in terms of self-reported mental toughness. **Results**: Our results revealed three profiles (low, moderate, high use) in both practice and competition settings that were distinguished primarily according to quantitative differences in the absolute levels of reported use across most of the PSTs assessed in practice and competition settings, which in turn, were differentially related with mental toughness. Specifically, higher use of PSTs was associated with higher levels of mental toughness. **Conclusions**: This study provides one of the first analyses of the different configurations of athletes' use of PSTs that typify unique subgroups of performers. An important next step is to examine the longitudinal (in) stability of such classes and therefore provide insight into the temporal dynamics of different configurations of athletes' use of PSTs.

1   Running head: Profiles of psych skills usage

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28   **Abstract**

29   **Background**: The majority of past work on athletes' use of psychological skills and techniques

30   (PSTs) has adopted a variable-centered approach in which the statistical relations among study

31   variables are averaged across a sample. However, variable centered-analyses exclude the

32   possibility that PSTs may be used in tandem or combined in different ways across practice and

33   competition settings. With this empirical gap in mind, the purposes of this study were to identify

34   the number and type of profiles of elite athletes' use of PSTs, and examine differences between

35   these clusters in terms of their self-reported mental toughness

36   **Methods**: In this cross-sectional survey study, 285 Malaysian elite athletes (170 males, 115

37   females) aged 15 to 44 years (M = 18.89, SD = 4.49) completed measures of various PSTs and

38   mental toughness. Latent profile analysis was employed to determine the type and number of

39   profiles that best represent athletes' reports of their use of PSTs in practice and competition

40   settings, and examine differences between these classes in terms of self-reported mental

41   toughness.

42   **Results**: Our results revealed three profiles (low, moderate, high use) in both practice and

43   competition settings that were distinguished primarily according to quantitative differences in the

44   absolute levels of reported use across most of the PSTs assessed in practice and competition

45   settings, which in turn, were differentially related with mental toughness. Specifically, higher use

46   of PSTs was associated with higher levels of mental toughness.

47   **Conclusions**: This study provides one of the first analyses of the different configurations of

48   athletes' use of PSTs that typify unique subgroups of performers. An important next step is to

49   examine the longitudinal (in) stability of such classes and therefore provide insight into the

50   temporal dynamics of different configurations of athletes' use of PSTs.

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55   **Latent profiles of elite Malaysian athletes' use of psychological skills and techniques and**

56   **relations with mental toughness**

57   The development of psychological skills and techniques (PSTs) alongside the physical,

58   technical and tactical aspects of sporting performance is considered a core feature of athlete

59   development (Bergeron et al., 2015). Within sporting contexts, psychological skills encompass

60   desired personal attributes such as optimism and self-efficacy that are central to high

61   performance (i.e., the 'having' part). In contrast, psychological techniques capture the methods

62   or processes by which individuals attain desired levels of personal attributes, such as self-talk

63   and imagery (i.e., the 'doing' part). In other words, psychological skills are developmental

64   targets that are addressed via training in psychological techniques (Vealey, 1988). Evidence

65   supports the importance of several psychological skills (e.g., confidence; Moritz, Feltz,

66   Fahrbach, Mack, 2000; Woodman & Hardy, 2003) and techniques (Brown & Fletcher, 2017;

67   McCormick, Meijen, & Marcora, 2015) for high performance among athletes. Unsurprisingly,

68   psychological skills training represents core business for psychologists working in sport settings

69   where high performance, innovation, and success are key (Adler et al., 2015; Harmison, 2011).

70   Given this focus in applied practice, an important consideration for future work is understanding

71   athletes' use of PSTs in practice and competition settings.

72   Much of the past work on usage of PSTs has compared successful athletes with their less

73   successful counterparts, with a specific focus on usage patterns during training or practice (i.e.,

74   learning or applying skills or tactics in controlled environments) and within competition (i.e.,

75   when competing against other athletes). In a sample of US athletes who took part in the 2000

76   Olympic Games, discriminant function analysis revealed that medalists (n = 52) reported higher

77   use of imagery, emotional control and automaticity in competition than non-medalists (n = 124),

78   whereas the skills and strategies of self-talk and emotional control distinguished these two

79   groups of performers in terms of practice settings (Taylor, Gould, & Rolo, 2008). Within the

80   context of rugby union, discriminant function analysis revealed that elite Japanese players (n =

81   95) reported in competition settings higher levels of goal setting, emotional control, relaxation,

82   and activation, and lower scores of negative thinking when compared with university level

83   players (n = 257); in contrast, goal setting, imagery and relaxation contributed most to these

84   distinction between these two groups in terms of their usage within practice contexts (Tanaka &

85   Gould, 2015). Collectively, the findings of this body of work indicates that more successful

86   athletes use PSTs more frequently than their less successful counterparts (Gould & Maynard,

87   2009).

88   Despite what we have learned about athletes' use of PSTs in recent years, little is known

89   about the different configurations of these developmental targets and methods that typify unique

90   subgroups of performers. In particular, research in this area has been dominated by variable-

91   centered approaches (e.g., regression and discriminant function analyses) that provide insight

92   regarding the statistical relations among study variables averaged across a sample. An inherent

93   assumption within variable-centered analyses where the unit of analysis is the concept or

94   variable is that athletes' use of PSTs is homogenous and that all relations between variables

95   generalize to the entire population (Bergman & Trost, 2006). However, this assumption may be

96   erroneous as the development and maintenance of PSTs typically incorporates both group-based

97   and individualized components (for examples, see Dosil, 2006). With regard to self-talk, for

98   example, practitioners need to consider individual differences in self-talk ability (e.g., low to

99   high skill), cultural factors (e.g., individualistic versus collectivist cultures), and contextual

100 dimensions (e.g., salience of difference forms of self-talk) for effective training (Van Raalte,

101   Vincent, & Brewer, 2017). Person-centered analyses enable researchers to capture the

102   heterogeneity of populations by identifying subgroups of individuals who share common patterns

103   of interacting characteristics (Bergman & Trost, 2006). Applied to the study of athletes' use of

104   PSTs, the potential of a person-centered approach lies in the ability to address an important yet

105   unanswered question: are differences in athletes' use of PSTs quantitative (e.g., low, moderate,

106   or high frequency across all attributes and methods) or qualitative (e.g., low in some techniques,

107   high in others) in nature? In addressing this question, researchers can understand the

108   pervasiveness of subgroups who share common patterns in their use of PSTs, and the differential

109   relations between these profiles and hypothesized determinants and outcomes.

110   The second key extension offered in this study concerns the relations between unique

111   combinations or patterns of athletes' use of PSTs with mental toughness. Drawing from recent

112   advancements in theory and research (e.g., Gucciardi et al., 2015; Hardy, Bell, & Beattie, 2014),

113   mental toughness has been conceptualized as a psychological resource that enables individuals to

114   attain and sustain goal-directed behavior despite varying degrees of situational demands that

115   range from everyday stressors to major adversities (for a review, see Gucciardi, in press).

116   Qualitative (Weinberg, Butt, Mellano, & Harmison, 2017), longitudinal (Gucciardi et al., 2015)

117   and experimental research (Bell, Hardy, & Beattie, 2014) suggests that mental toughness is state-

118   like in that it has properties that can vary or endure across situations and time, yet is open to

119   development and enhancement. Emerging evidence provides support for the significance of

120   mental toughness in terms of fostering high performance (e.g., Arthur, Fitzwater, Hardy, Beattie,

121   & Bell, 2015; Mahoney, Gucciardi, Ntoumanis, & Mallett, 2014; for a review, see Cowden,

122   2017) and maximising adaptive associations with important psycho-social factors such as

123   burnout (Madigan & Nicholls, 2016), motivation and anxiety (Schaefer, Vella, Allen, & Magee,

124   2016). As such, effort has been directed towards understanding the key developmental

125   antecedents of mental toughness (for a review, see Anthony, Gucciardi, & Gordon, 2016). Given

126   their moderate positive effect on sport performance (Brown & Fletcher, 2017), it is unsurprising

127   that psychological techniques are considered essential tools in the toolbox of mentally tough

128   athletes (Jaescjke, Sachs, & Dieffenbach, 2016; Weinberg et al., 2016) and therefore have been

129   the focus of intervention efforts (Fitzwater, Arthur, & Hardy, 2018; Gucciardi, Gordon, &

130   Dimmock, 2009). Consistent with theoretical perspectives of mental toughness as a salient

131   resource for stressful experiences (Gucciardi et al., 2015), common to this past work are

132   psychological techniques that enable individuals to coping with stressors and adversity (e.g.,

133   emotion regulation, arousal regulation, imagery). What remains unknown is the most effective

134   combination of PSTs for mental toughness. Clarifying this information will have important

135   implications for theory and practice. Substantively, it may be that one or two PSTs are most

136   salient in terms of their contribution to the explanation of mental toughness. If this finding is the

137   case, an analysis of the commonalities among these dominant PSTs might shed light on the

138   nature of mental toughness (e.g., primarily cognitive or emotion-based resource). From an

139   applied standpoint, this information would prove fruitful in guiding practitioners' focus for

140   psychological skills training programs.

141   As there are a variety of PSTs that are beneficial for athletic performance, it is important

142   that research is directed towards identifying groups of individuals who share similar

143   configurations or patterns of use and understanding the antecedents and outcomes of such

144   profiles. In light of this unexplored area of research, the purposes of this study were to identify

145   the number and type of profiles of elite athletes' use of PSTs, and examine external validity

146   evidence of these clusters in terms of their relations with mental toughness. Given the absence of

147 past research or theory on profiles of athletes' use of PSTs, this study was considered exploratory

148 and therefore no hypotheses regarding the number and type of latent profiles were proposed a

149 priori. In terms of differences between unique profiles according to athletes' use of PSTs, we

150 expect that profiles of athletes who report using a greater number of PSTs will have higher levels

151 of mental toughness. Which specific combination of PSTs would be most adaptive in terms of

152 differences in self-reported mental toughness was not hypothesised a priori.

Methods and Materials

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154 **Participants**

155   In total, 285 Malaysian elite athletes took part in this study (170 males, 115 females). The

156 term elite is used here to characterise both 'semi-elite' (e.g., involved in talent development

157 programs or selected to represent Malaysia) and 'competitive elite' (e.g., top tier competitive

158 league internationally) athletes in terms of their standard of performance, success, experience,

159 and competiveness of sport within Malaysia and the world (Swann, Moran, & Piggott, 2015).

160 Athletes were recruited from national squads across a variety of team (e.g., field hockey, bola

161 sepak) and individual sports (e.g., shooting, archery, taekwondo). At the time of data collection,

162 participants were aged 15 to 44 years (M = 18.89, SD = 4.49), had between 1 and 20 years of

163 experience in their sport (M = 4.28, SD = 3.38), and completed between 2 and 15 training

164 sessions per week (M = 6.00, SD = 2.14).

165 **Measures**

166   We measured mental toughness using a unidimensional, 8-item tool (Gucciardi et al.,

167 2015). Participants were asked to indicate how true each of the statements (e.g., "I strive for

168 continued success" and "I am able to regulate my focus when performing tasks") are an

169 indication of how they typically think, feel, and behave as an athlete using a 7-point response

170   scale (1 = *false, 100% of the time* to 7 = *true, 100% of the time*). The 68-item test of performance

171   strategies (TOPS; Hardy et al., 2010) was employed to measures athletes' use of several PSTs in

172   training (goal setting, self-talk, imagery, attention control, emotional control, activation,

173   relaxation, automaticity) and competition (goal setting, self-talk, imagery, negative thinking,

174   emotional control, activation, relaxation, automaticity, attentional control). Participants were

175   asked to rate how frequently a range of situations applies to them in training and competition

176   (e.g., "I keep my thoughts positive during competitions" and "I visualize my competition going

177   exactly the way I want it to go") using a 5-point response scale (1 = *never,* 2 = *rarely,* 3 =

178   *sometimes,* 4 = *often,* 5 = *always*). Both tools were translated from English into Malay using

179   forward- and back-translation procedures by an independent translator at both stages of the

180   process (Hambleton & Kanjee, 1995).

181   **Procedures**

182   After obtaining ethical approval from the Human Research Ethics Committee of the

183   corresponding author's institution (HR176/2013), we contacted the high performance manager of

184   each sport or head coach of individual teams to provide details on the aims and procedures of the

185   study, and request permission to approach coaches and athletes. Managers and coaches who

186   expressed an interest in participating liaised with the first author to organize a convenient time

187   and location to distribute the survey package to the athletes in person. Consenting athletes (and

188   their parents when aged under 18 years) completed the survey package either at the training

189   venue prior to, or after a practice session; in situations where the time demands of a training

190   session could not accommodate the former method, athletes took the survey home with them,

191   completed it, and returned it at the next training session.

192   **Statistical Analyses**

193   Consistent with recommendations for mixture modeling (Asparouhov & Muthén, 2013;

194   Lanza, Tan, & Bray, 2013), we conducted the primary analyses in two phases. First, we used

195   latent profile analysis (LPA) with a robust maximum likelihood estimator (MLR) to determine

196   the type and number of profiles that best represent athletes' reports of their use of PSTs during

197   practice and competition. Aligned with an inductive approach, we first specified two profiles and

198   sequentially increased the number of latent profiles until we arrived at the class structure that

199   represented an optimal balance between model fit and parsimony (Nylund, Asparouhov, &

200   Muthén, 2007). Model comparisons were assessed using a combination of relative fix indices

201   (Akaike Information Criteria [AIC], Bayesian Information Criteria [BIC] and its sample size

202   adjusted version [ABIC]), ratio test (Lo-Mendell-Rubin likelihood [LMR]), and an indicator of

203   the clarity of class allocation (entropy). The best model is one that has the lowest value for

204   relative fit indexes, entropy values that are closest to 1 and larger in comparison to other class

205   structures, and statistically significant ratio test (Berlin, Williams, & Parra, 2014; Nylund,

206   Asparouhov, & Muthén, 2007). These statistical criteria were considered alongside an

207   examination of the distinctiveness of solutions and sample size within each cluster (Lubke &

208   Neale, 2006). Second, we examined age, sex (0 = female, 1 = male), and years playing

209   experience as determinants of latent profile membership, and mental toughness as an outcome of

210   membership within an LPA framework. The R3STEP and DU3STEP commands were used to

211   model age, sex, and playing experience and mental toughness as an auxiliary outcome using the

212   3-step method (Asparouhov & Muthén, 2013). The 3-step procedure first determines the latent

213   classes based on the proposed indicator variables, then classifies participants, and finally relates

214   this classification to covariates, determinants or distal outcomes. Coefficient H provided an

215   estimate of construct reliability evidence, with a value of $\geq$ .80 considered desirable (Hancock &

216   Mueller, 2001). All analyses were performed using M*plus* 7.4 (Muthén & Muthén, 2015) using

217   full information maximum likelihood (FIML) to make use of all available data.

Results

219   Data screening procedures indicated the study variables were normally distributed in the

220   sample (i.e., skewness/kurtosis > 2), yet included three univariate outliers (z > ±3.5); the

221   exclusion of these outliers did not alter the primary findings so they were retained for reporting

222   purposes (Tabachnick & Fidell, 2013). Descriptive statistics, internal reliability estimates and

223   bivariate correlations among study variables are presented in Table 1. Several of the construct

224   reliability estimates were below the recommended value of .80 (Hancock & Mueller, 2001), so it

225   is important to keep this evidence in mind when interpreting the results of the primary analyses.

226   An overview of the statistical criteria employed to identify the optimal solution for

227   practice and competition settings is detailed in Table 2. The results show that the 3-class model

228   represents the optimal solution for both practice and competition settings. First, an examination

229   of the percentage change values in relative fit indices (AIC, BIC, ABIC) presented in Table 2

230   indicates there is a steep decrease in models with two to three classes at which point the degree

231   of improvement in model fit plateaued (Morin et al., 2011). Second, the 3-class model was the

232   point at which the highest degree of classification accuracy was observed in competition settings

233   (.89), and was among the highest for practice settings (.78). Finally, the average probability that

234   participants were correctly classified in the given latent profile or misclassified provided

235   additional evidence for the suitability of the 3-class solution in practice and competition settings

236   (see Table 3). Thus, we retained the 3-profile solution for subsequent analyses.

237   An inspection of the estimated means indicated that differences between classes were

238   primarily quantitative in nature (see Figures 1 and 2). In terms of practice settings, class 1 (n =

239 59) reported higher levels of all PSTs than both classes 2 (n = 72) and 3 (n = 154) except for

240 emotional control and automaticity; these latter two PSTs were comparable across all three

241 classes. In turn, class 2 reported higher levels than class 3 on all but these two PSTs. Similar

242 findings were observed in competition settings. With the exception of emotional control, class 1

243 (n = 102) reported higher levels of positive psychological skills and lowest levels of negative

244 psychological skills (negative thinking) than both classes 2 (n = 25) and 3 (n =158); similar

245 findings were observed for the comparison of class 2 with class 3. As such, we labelled class 1 as

246 'high adaptive use', class 2 as 'moderate adaptive use' and class 3 and 'low adaptive use' of

247 PSTs.

248   Age, sex, and years playing experience were examined as determinants of latent profile

249 membership (see Table 4). With regard to practice settings, older athletes and those with greater

250 playing experience in their sport were less likely to be in the high adaptive use and low adaptive

251 use profiles when compared with the moderate adaptive use profile. Within competition settings,

252 male athletes were less likely to be in the high adaptive use profile when compared with the

253 moderate use profile. Additionally, older athletes were more likely to be in the low used profile

254 when compared with the moderate use profile.

255   We subsequently tested the degree to which these classes differed on mental toughness.

256 With regard to practice settings, mental toughness differed as a function of class membership.

257 High adaptive PSTs use athletes (M = 6.48, SD = .38) reported significantly (p <.001) higher

258 levels of mental toughness than athletes classed within the moderate adaptive (M = 5.88, SD =

259 .74, d = 1.02) and low adaptive PSTs use groups (M = 5.21, SD = .18, d = 1.45); the difference in

260 mental toughness between the moderate and low adaptive PSTs use groups was also significant

261 (p <.001, d =.69). Similar results were obtained in competition settings, whereby mental

262   toughness differed as a function of class membership. High PSTs use athletes ($M = 6.36$, $SD =$

263   .71) reported significantly ($p < .001$) higher levels of mental toughness than the moderate ($M =$

264   5.61, $SD = .88$, $d = .94$) and low PSTs use groups ($M = 5.06$, $SD = 1.05$, $d = 1.45$); the difference

265   in mental toughness between the moderate and low PSTs use groups was also significant ($p =$

266   .017, $d = .57$).

Discussion

268   Using a person-centered approach to investigate athletes' use of PSTs in practice and

269   competition settings, we identified the existence of distinct profiles or subgroups of athletes who

270   share similarities in their reported frequency. Overall, our results revealed three profiles in both

271   practice and competition settings that were distinguished primarily according to quantitative

272   differences in the absolute levels of reported use across most of the PSTs assessed, which in turn,

273   were differentially related with mental toughness.

274   As the predominant analytical approach in past work (Tanaka & Gould, 2015; Taylor,

275   Gould, & Rolo, 2008), variable centered-analyses exclude the possibility that PSTs may be used

276   in tandem or combined in different ways across practice and competition settings. Our focus on

277   uncovering different configurations of athletes' use of PSTs that typify unique subgroups of

278   performers has shed light on a key substantive issue. Our results indicated that differences in

279   athletes' reported use of PSTs are primarily quantitative in nature, that is, they vary in the

280   absolute level of each developmental target and method within practice and competition settings.

281   In terms of prevalence data, the majority of athletes were classified as moderate users of PSTs in

282   practice (54%) and competition (55%) settings. The proportion of athletes classified as high

283   users of PSTs was greater in competition settings (36%) when compared with practice (21%),

284   with the prevalence of athletes profiled as low users of PSTs was lower in competitions (9%)

285   versus practice settings (25%). That the majority of athletes in this study reported moderate-to-

286   high use of PSTs in practice and competition is unsurprising, given their positive effects on sport

287   performance (Brown & Fletcher, 2017; McCormick, Meijen, & Marcora, 2015) and the elite

288   status of the sample. Across both practice and competition settings, the largest differences

289   between classes in absolute use scores were observed for goal setting, self-talk, imagery,

290   activation, and relaxation. Substantively, these PSTs are primarily cognitive (e.g., imagining

291   alternative performance strategies) and arousal-focused (e.g., psyching oneself up/down for

292   competition) in nature. An important next step is to examine the longitudinal (in)stability of such

293   classes and therefore provide insight into the temporal dynamics of different configurations of

294   athletes' use of PSTs.

295   We assessed external validity evidence of these classes of differing use of PSTs in terms

296   of their relations with mental toughness. Only one study to date has examined the associations

297   between mental toughness and athletes' use of several PSTs. Correlational analyses of a sample

298   of 107 university or county level athletes revealed positive associations between mental

299   toughness and self-talk, emotional control, goal setting, relaxation, and activation ($.24 < r > .37$),

300   and an inverse relation with negative thinking (-.47) within competition (Crust & Azadi, 2010).

301   For practice settings, total mental toughness was associated with automaticity, emotional control,

302   relaxation and self-talk ($.24 < r > .35$). In contrast, we observed primarily moderate associations

303   between mental toughness and athletes' use of all PSTs in practice and competition settings (see

304   Table 1). One explanation for this discrepancy is that we sampled elite athletes only who have

305   greater access to psychological servicing through the national institute of sport. The bivariate

306   associations between mental toughness and PST use observed in the current study are broadly

307   consistent with qualitative work in which scholars have emphasised the importance of teaching

308   athletes techniques to cope with stress and adversity (e.g., Jaescjke et al., 2016; Powell &

309   Myers, 2017; Weinberg et al., 2016), most of which are captured in the TOPS. A key

310   consideration for psychological skills training is the simulation of stressors and adversities to

311   provide athletes with opportunities to test out different techniques (Weinberg, Freysinger, &

312   Mellano, 2018). Our findings provide indirect support for this assertion in that the associations

313   between mental toughness and PST use were similar across practice and competition settings.

314   With regard to the results of the person-centered analyses, there were salient distinctions

315   in mean levels of mental toughness between the three classes that confirmed the quantitative

316   nature of the differences in the configurations of athletes' use of PSTs. Specifically, the high

317   PSTs use class reported the highest levels of mental toughness; the low PSTs use class reported

318   the lowest levels of mental toughness; and the moderate PSTs use class reported mental

319   toughness levels between these two classes. Broadly, these findings are consistent with past

320   intervention work in which athletes who have received psychological skills training packages

321   including multiple techniques have evidenced increases in their mental toughness (Fitzwater et

322   al., 2018; Gucciardi et al., 2009). An examination of the variability in mental toughness scores

323   provides further support for this substantive finding, such that the least amount of variation was

324   observed in the high PSTs use class and the most variation in the low use class. Collectively,

325   these findings shed light on the nature of mental toughness and suggest that it may best be

326   conceptualized as a resource that is characterized by cognitive and motivational factors. The

327   broad use of multiple PSTs for athletes with high levels of mental toughness suggests that they

328   have at their disposal a greater repertoire of techniques from which to draw to manage the

329   various stressors and adversities within their performance environment. Equally, it could also be

330   that greater PST use is an outcome of high mental toughness. Determining the causal

331   characteristics between mental toughness and PSTs remains an important avenue for future

332   research.

333   Key strengths of this study include a modest sample of elite athletes, direct test of the

334   hypothesis that PSTs may be used in tandem or combined in different ways across practice and

335   competition settings, and incorporation of error in profile classification for the examination of

336   differences in mental toughness between the latent classes. Nevertheless, there are several

337   limitations of the current study that might motivate future research. First, a limitation of the

338   TOPS is that it measures the frequency of athletes' use of PSTs only and therefore excludes

339   information regarding the effectiveness of their implementation or utilization. As the majority of

340   PSTs assessed with the TOPS are primarily cognitive and arousal-based in nature, it is also

341   important to consider additional measures that capture emotionally-salient PSTs. Second, our

342   focus on Malaysian elite athletes means it is important that future research examines the extent to

343   which these findings generalize to other cohorts of athletes (e.g., culture), and test the invariance

344   of latent profiles across different subgroups (e.g., sex, sport type; Olivera-Aguilar & Rikoon, in

345   press). Third, we relied on one outcome variable to assess external validity evidence of the latent

346   profiles. Future research could expand on our efforts to focus on a variety of antecedent (e.g.,

347   contextual, social or organizational factors) and outcome (e.g., decision-making, perceptions of

348   stress) variables, which could include both subjective assessments from the self or informants

349   (e.g., coaches) and objective performance data.

350   **Conclusion**

351   The burgeoning literature on PSTs among elite athletes has been limited by the

352   dominance of variable-centered analyses that do not account for the unique ways in which

353   athletes may use multiple skills or methods in conjunction with each other. By adopting an

354   alternative, person-centered approach, this study offers several contributions to theoretical and

355   applied perspectives on athletes' use of PSTs and their relations with mental toughness, namely,

356   the use of PSTs is primarily quantitative in nature, and that classes with more frequent use report

357   higher levels of mental toughness.

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488

Descriptive statistics, internal reliability, and correlations among study variables.

Table 1. *Descriptive statistics, internal reliability, and correlations among study variables.*

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	MT	(.86)																	
2	Goals-p	.44*	(.73)																
3	Imag-p	.33*	.53*	(.68)															
4	Attcon-p	.31*	.34*	.25*	(.89)														
5	Selftalk-p	.36*	.65*	.52*	.35*	(.71)													
6	Activate-p	.37*	.44*	.30*	.38*	.44*	(.65)												
7	Emocon-p	.16*	-.05	-.03	.39*	.03	.24*	(.69)											
8	Auto-p	.17*	.12	.17*	.00	.08	.10	-.08	(.72)										
9	Relax-p	.31*	.44*	.33*	.20*	.41*	.47*	.03	.20*	(.77)									
10	Goals-c	.40*	.57*	.50*	.35*	.67*	.46*	.05	.12*	.46*	(.82)								
11	Selftalk-c	.38*	.62*	.53*	.42*	.70*	.46*	.13	.05	.38*	.65*	(.80)							
12	Imag-c	.41*	.57*	.57*	.38*	.65*	.50*	.04	.16*	.45*	.62*	.63*	(.69)						
13	Negthink-c	-.24*	-.15*	-.07	-.48*	-.24*	-.34*	-.38*	.02	-.05	-.26*	-.31*	-.27*	(.78)					
14	Emocon-c	.19*	.05	.12*	.40*	.10	.16*	.54*	-.06	.03	.04	.20*	.11	-.43*	(.82)				
15	Activate-c	.41*	.52*	.36*	.33*	.49*	.66*	.11	.25*	.52*	.54*	.52*	.58*	-.28*	.12	(.71)			
16	Relax-c	.35*	.52*	.33*	.34*	.49*	.53*	.07	.18*	.58*	.53*	.52*	.53*	-.27*	.03	.69*	(.79)		
17	Auto-c	.32*	.37*	.26*	.20*	.29*	.37*	.05	.52*	.38*	.41*	.31*	.40*	-.12	-.03	.58*	.52*	(.65)	
18	Attcon-c	.21*	.31*	.20*	.32*	.30*	.41*	.11	.01	.20*	.40*	.30*	.38*	-.25*	.01	.44*	.40*	.35*	(.69)
	Age	.05	-.09	.12	.02	.16	-.09	.16*	.22*	.02	-.04	.02	-.02	-.12	-.14	.23*	-.12	-.07	.06
	Experience	.01	.20	-.11	-.10	.02	.18*	-.15*	-.03	-.06	.08	-.15	.05	-.06	.19*	-.29*	.15	.18*	.08
	Sex	.03	-.06	-.06	.03	.01	.03	.04	-.08	.08	.06	-.07	.09	.24*	.03	-.12	-.01	.19*	.04
	Mean	5.83	3.69	3.74	3.39	3.75	3.40	3.06	3.05	3.45	3.81	3.90	3.72	2.53	3.19	3.58	3.62	3.46	3.26
	SD	.83	.64	.71	.55	.62	.54	.58	.61	.68	.65	.68	.61	.80	.74	.61	.69	.62	.42
	Skewness	-.91	-.28	-.20	.23	-.01	.09	.35	-.39	-.30	-.16	-.27	-.29	.35	.05	-.41	-.18	.08	-.22
	Kurtosis	.91	-.10	-.37	.21	-.50	.29	.37	1.09	.34	-.14	-.59	.15	-.25	-.14	.73	.40	-.05	.21

Note: MT = mental toughness; Goals-p = goal setting in practice; Imag-p = imagery in practice; Attcon-p = attention control in practice; Selftalk-p = self-talk in practice; Activate-p = activation in practice; Emocon-p = emotional control in practice; Auto-p = automaticity in practice; Relax-p = relaxation in practice; Goals-c = goal setting in competition; Selftalk-c = self-talk in competition; Imag-c = imagery in competition; Negthink-c = negative thinking competition; Emocon-c = emotional control in competition; Activate-c = activation in competition; Relax-c = relaxation in competition; Auto-c = automaticity in competition; Attcon-c = attention control in competition; * $p < .05$. Readers interested in the 95% confidence intervals for these bivariate correlation can locate this information in the online supplementary material.

Model fit indices for all latent profile models tested.

1 Table 2. *Model fit indices for all latent profile models tested.*

	AIC	BIC	ABIC	LMR LR test p value	ALMR LR test p value	Entrophy
			Practice Settings			
2-class	3957.36	4048.67	3969.40	.054	.056	.752
3-class	3833.84 (-3.22%)	3958.03 (-2.29%)	3850.21 (-3.09%)	.096	.099	.778
4-class	3810.54 (-.61%)	3967.60 (.24%)	3831.24 (-.49%)	.373	.379	.787
5-class	3788.73 (-.57%)	3978.66 (.28%)	3813.76 (-.45%)	.196	.200	.779
6-class	3770.64 (-.48%)	3993.44 (.37%)	3800.01 (.36%)	.481	.487	.809
			Competition Settings			
2-class	4420.40	4522.67	4433.88	<.001	<.001	.858
3-class	4260.39 (-3.76%)	4399.19 (-2.81%)	4278.68 (-3.63%)	.01	.01	.886
4-class	4189.00 (-1.70%)	4364.32 (-.80%)	4212.11 (-1.58%)	.142	.148	.841
5-class[#]	4148.86 (-.97%)	4360.71 (-.08%)	4176.79 (-.85%)	.167	.17	.867
6-class[#]	4108.06 (-.99%)	4356.43 (-.10%)	4140.80 (-.87%)	1	1	.885

3 Note: Number in parentheses for AIC, BIC and ABIC = change value in percentage; AIC = Akaike Information Criteria; BIC =
4 Bayesian Information Criteria; ABIC = sample size adjusted BIC; LMR LR test = Lo-Mendell Rubin likelihood ratio test; ALMR LR
5 = Lo-Mendell Rubin adjusted likelihood ratio test; [#] = non-positive definite matrix.
6

Classification probabilities for the 2-4 profile solutions.

1 Table 3. *Classification probabilities for the 2-4 profile solutions.*

	Practice Settings						Competition Settings			
	1	2	3	4			1	2	3	4
1	.889	.111				1	.964	.036		
2	.045	.955				2	.045	.955		
1	.868	0	.132			1	.951	.049	0	
2	0	.863	.137			2	.013	.949	.038	
3	.043	.042	.915			3	0	.057	.943	
1	.891	0	0	.108		1	.932	.011	.058	0
2	0	.795	.090	.116		2	.085	.0915	0	0
3	0	.042	.836	.121		3	.077	0	.885	.038
4	.060	.008	.031	.900		4	0	0	.097	.903

4 *Note*: The 5-profile and 6-profile solutions are omitted here due to a non-positive definite matrix.
5

Age, sex and years playing experience as determinants of latent profile membership.

1 Table 4. *Age, sex and years playing experience as determinants of latent profile membership.*

Predictor	Reference Class	Practice Settings		
		High adaptive use	Moderate adaptive use	Low adaptive use
	High adaptive use			
Age (n = 250)			.15 (.05)**	.04 (.05)
Sex (N = 285)			.25 (.40)	.27 (.35)
Years playing experience (n = 230)			.22 (.07)**	.11 (.07)
	Moderate adaptive use			
Age (n = 250)		-.15* (.05)**		-.11 (.04)**
Sex (N = 285)		-.25 (.40)		.02 (.39)
Years playing experience (n = 230)		-.22 (.07)**		-.11 (.05)*

		Competition Settings		
		High adaptive use	Moderate adaptive use	Low adaptive use
	High adaptive use			
Age (n = 250)			.07 (.10)	.15 (.10)
Sex (N = 285)			.99 (.50)*	.92 (.50)
Years playing experience (n = 230)			.06 (.08)	.11 (08)
	Moderate adaptive use			
Age (n = 250)		-.07 (.10)		.08 (.03)*
Sex (N = 285)		-.99 (.50)*		-.07 (.29)
Years playing experience (n = 230)		-.06 (.08)		.05 (.04)

4 *Note*: listwise deletion used for missing values on predictors; * $p < .05$, ** $p <.01$, *** $p <.001$; standard errors are reported

5 parentheses.

Figure 1

Estimated means for psychological skills and techniques used in practice as a function of class membership.
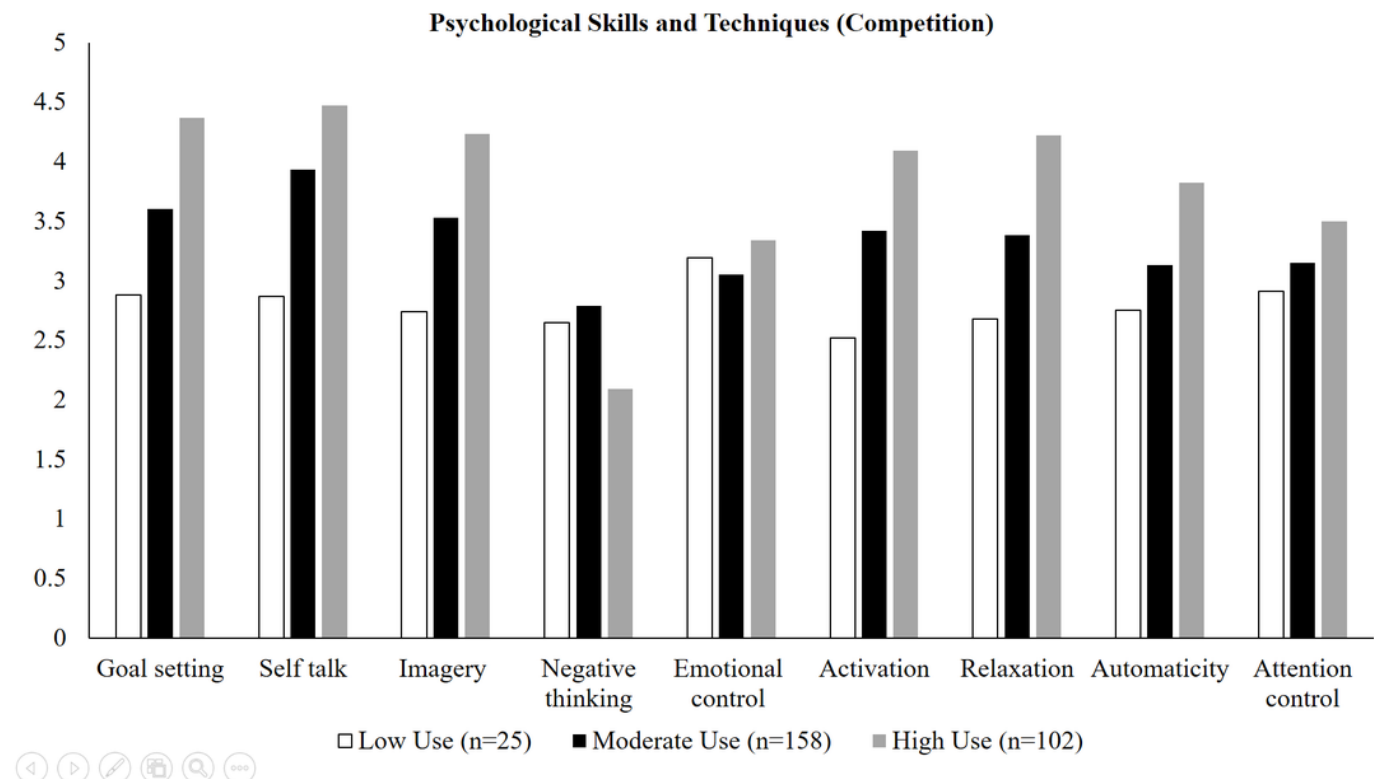
Figure 2

Estimated means for psychological skills and techniques used in competition as a function of class membership.