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**Thinking Aloud: Stress and Coping in Junior Cricket Batsmen during Challenge and Threat States**

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### Article

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# 1            **Thinking Aloud: Stress and Coping in Junior Cricket Batsmen during Challenge** 2                                 **and Threat States**

## 3 4                                 **Abstract**

5    The present study examined stress and coping of cricket batsmen during challenge and threat  
6    states using the Think-Aloud method. Ten male elite-level junior cricket batsmen took part in  
7    the study. A repeated measures design was implemented, with participants verbalizing while  
8    both in (a) a threat state and (b) a challenge state. Participants were required to score 36 runs  
9    in 30 balls during the threat and challenge conditions. Verbalizations were subsequently  
10   transcribed verbatim and analyzed for stressors, coping strategies, and any other reoccurring  
11   themes. A paired-samples t-test was conducted to examine differences in the number of  
12   verbalizations made for each theme between conditions. Ten secondary themes were grouped  
13   into four primary themes; these included (a) stressors, (b) problem-focused coping, (c)  
14   emotion-focused coping, and (d) gathering information. There were significant  
15   differences( $p \leq 0.05$ ) between stressor verbalizations, with significantly more verbalizations  
16   made by participants during a threat state. No significant differences were found between any  
17   other themes. Thus, during a threat state, participants reported significantly more stressor  
18   verbalizations compared to a challenge state, while there were no significant differences in  
19   coping strategies reported ( $p > 0.05$ ). This finding offers a potential explanation for why  
20   athletic performance diminishes when in a threat state, as athletes then experience a greater  
21   number of stressors but do not report engaging in more coping strategies.

22    **Keywords:** Concurrent verbalizations, stress, coping, cricket, think-aloud.

## 23 24 25                                 **Introduction**

26           When performing in pressurized environments, athletes commonly experience stress  
27 before, during, and sometimes after the event (Moore et al., 2013). Given this, sport  
28 psychology researchers have sought to investigate both the physiological responses (e.g.,  
29 Turner et al., 2013) and psychological (e.g., Swann et al., 2017) responses of stress and how  
30 these impact on sport performance. It has been argued that stress is a dynamic and recursive  
31 transaction between the demands of a situation and an individual's resources to manage those  
32 demands (Lazarus, 1991). Whereas coping has been defined as "constantly changing  
33 cognitive and behavioural efforts to manage specific external and/or internal demands that are  
34 appraised as taxing or exceeding the resources of the person" (Lazarus & Folkman, 1984  
35 p.141). One theoretical model that has attempted to try and make sense of individual  
36 differences in stress responses is the biopsychosocial model (BPSM) of challenge and threat  
37 (Blascovich, 2008). Previously, research has used this model to examine the impact of  
38 challenge and threat (CAT) states on the performance of a sporting task (e.g., Moore et al.,  
39 2013). Similar to this, the Theory of Challenge and Threat States in Athletes (TCTSA; Jones  
40 et al., 2009), which is underpinned by the BPSM, collates physiological and emotional  
41 factors underpinning sporting performance. Finally, the Evaluative Space Approach to  
42 Challenge and Threat (ESACT; Uphill et al., 2019) was prompted by both the BPSM and  
43 TCTSA and argued individuals could be both challenged and threatened.

44           The BPSM is underpinned by Lazarus and Folkman's (1984) transactional theory of  
45 stress and Dienstbier's (1989) theory of physiological toughness. BPSM proposes that the  
46 responses of individuals in motivated situations, such as that of a sporting event, is  
47 determined by an individual's evaluations of the demands of the situation and their resources  
48 to cope with these demands. According to the BPSM, when an individual is in a challenge  
49 state, they have evaluated that they have the necessary coping resources to match or exceed  
50 situational demands. A challenge state is characterised by an in heart rate (HR) and cardiac

51 output (CO) and a decrease in total peripheral resistance (TPR). An individual may enter the  
52 threat state when they evaluate the demands of the situation as being greater than their  
53 available resources. Much like the challenge state, sympathetic adrenal medullary activation  
54 has been hypothesized. However, pituitary-adrenal cortical activation has also been predicted.  
55 This activation results in cortisol release, constriction of blood vessels and inhibited effects of  
56 sympathetic adrenomedullary activation (Blascovich & Mendes, 2000; Jamieson et al., 2013).  
57 According to ESACT (Uphill et al., 2019) challenge and threat are not opposite ends of a  
58 bipolar continuum but rather, a unidimensional continuum and as such, individuals can be  
59 challenged, threatened, both or neither.

60         The TCTSA (Jones et al., 2009) further expanded on the BPSM by first clarifying the  
61 cognitive appraisal process that influences an athlete entering a challenge or threat state.  
62 Outlining the influence of self-efficacy beliefs, perceived control, and achievement goals on  
63 determining CAT states in athletes, the model highlights how the sources of self-efficacy  
64 (performance accomplishments, vicarious experiences, verbal persuasion, and physiological  
65 states), as proposed by Bandura (1986), contribute to the belief an athlete may have in their  
66 ability to cope with the demands of a situation. The TCTSA suggests that a challenge state is  
67 more likely to be experienced if an athlete has high self-efficacy, a high perception of control  
68 and typically adopts approach goals. In contrast, an athlete will more likely experience a  
69 threat state if they have low self-efficacy, low perception of control and are more likely to  
70 adopt avoidance goals. The TCTSA also states that the three constructs are all interrelated and  
71 that all three constructs are required for a challenge state.

72         The TCTSA incorporates the physiological responses as proposed within the BPSM,  
73 however, it offers a more detailed description of the emotional response. TCTSA, much like  
74 the BPSM predicts that positive emotions will be typically associated with a challenge state  
75 while negative emotions will usually be associated with a threat state. However, unlike the

76 BPSM, the TCTSA states that negative emotions (e.g., anger or anxiety) are not exclusively  
77 associated with a threat state and can, on occasion be experienced in a challenge state; during  
78 this state, individuals are more likely to perceive these emotions as facilitative. This finding is  
79 explained as CAT states reflect motivational states, and high-intensity emotions of a negative  
80 nature can serve a motivational purpose and would, therefore, be more consistent with a  
81 challenge state (Jones et al., 2009). This is supported by research such as Jones and Uphill  
82 (2004) who stated that athletes could enter a competition feeling anxious, but they view their  
83 anxiety as likely to help performance.

84 Previous research investigating CAT states have suggested that individuals in the  
85 challenge state are more likely to produce a superior athletic performance than when in a  
86 threat state (e.g., Blascovich et al., 2004; Moore et al., 2012; Turner et al., 2013). A recent  
87 systematic review conducted by Hase et al. (2019) found that in 24 of 38 (74%) studies, a  
88 challenge state was associated with enhanced performance. One study found an effect  
89 favoring a threat state and nine studies reported no significant impact on performance.  
90 Further to this, Vine et al. (2016) suggested that during a threat state, individuals' attentional  
91 and visuomotor control skills become disrupted, leading them to become distracted by less  
92 relevant stimuli and suffer a decrease in performance.

93 Research has also suggested that, during a challenge state, athletes are said to interpret  
94 emotions as facilitative, whereas, in a threat state, they view emotions as debilitating (Skinner  
95 & Brewer, 2004). Previous studies have adopted physiological measures such as cardiac  
96 reactivity to capture challenge and threat state (e.g. Allen, Frings & Huntet, 2012; Meijen, et  
97 al., 2014; Arthur et al., 2019). Williams et al. (2010) also found that a threat state is  
98 associated with higher levels of cognitive and somatic anxiety compared to a challenge state,  
99 highlighting that athletes are typically likely to experience increased negative emotions and  
100 less likely to interpret these as facilitative. Turner et al. (2013) explored whether

101 cardiovascular reactivity patterns could predict batting performance in elite cricketers using a  
102 bio-impedance cardiograph integrated system, while also measuring psychological responses  
103 with various psychometrics (e.g. Sport Emotion Questionnaire, Jones et al., 2005). Their  
104 results suggested that challenge reactivity was associated with superior performance.  
105 Likewise, Dixon et al. (2019) who examined cardiovascular reactivity in professional  
106 academy soccer, suggested that challenge reactivity is associated with superior performance,  
107 but they relied on self-report measures to assess participants' emotions.

108         Research examining stress and coping strategies in cricket batsmen such as Thellwell,  
109 Weston and Greenlees (2007) emphasized that perceptions of self, match specific issues,  
110 technique, and current playing status were some of the most pertinent stressors experienced  
111 by cricket batters. Similarly, they also revealed that general cognitive strategies, emotion-  
112 focused coping, general match strategies, and, at the crease, specific cognitive strategies were  
113 the salient coping strategies employed by cricket batsmen. Neil et al. (2016) also highlighted  
114 that athletes' appraisals of stressors were central to the stress and emotion process, thereby  
115 eliciting emotional responses that could be detrimental to performance if not successfully  
116 managed. Nicholls and Polman (2007) conducted a systematic review of stress and coping  
117 research in sport and suggested that the transactional model of stress and coping (TMSC) was  
118 supported in 46 out of 64 studies; they highlighted a significant interaction between athletes  
119 experiencing stressors and the type of coping strategy the athlete used. For example, athletes  
120 in individual sports adopted more coping strategies than did team athletes, and there was  
121 some evidence to suggest that males adopted more problem-focused coping strategies in  
122 response to stressors, while females reported using more emotion-focused coping strategies.  
123 Furthermore, previous stress and coping research in sport has often used the TMSC as a  
124 guiding framework to examine, for example, sources of stress encountered by performers

125 (Fletcher & Hanton, 2003; Arnold, Fletcher & Daniels, 2013), and coping responses to  
126 stressors (Holt & Hogg, 2002; Didymus & Fletcher, 2012).

127         Results from previous CAT studies underpinned by the TCTSA and BPSM highlight  
128 the advantages of collecting physiological data related to challenge and threat states, such as  
129 being able to accurately measure HR, CO and TPR. However, a limitation of previous CAT  
130 studies is they have often measured psychological responses (e.g. emotions, self-efficacy)  
131 using retrospective methods; similarly, previous stress and coping research has relied on  
132 retrospective data collection such as through interviews and self-report measures. Such  
133 retrospective data collection is subject to memory decay (Ericsson & Simon, 1993; Nicolls &  
134 Polman, 2008) and recall bias (Bahrick et al., 1996). While previous research has provided  
135 key findings, such as challenge states being associated with superior performance and stress  
136 and coping occurring as a dynamic process during performance, the present study, aimed to  
137 further develop the stress and coping literature by using the BPSM and TCTSA as guiding  
138 frameworks. Likewise, this study extended previous research by examining the psychological  
139 responses, specifically the stressors and coping responses of cricket batsman, as they  
140 occurred live in the moment. These methods were intended to reduce retrospective recall and  
141 prevent the loss of vital information through memory decay (Ericsson & Simon, 1993;  
142 Nicholls & Polman, 2008), while also enhancing confidence in the accuracy of athletes'  
143 psychological responses during challenge and threat states.

144         Think Aloud (TA) offers opportunities for researchers to capture and examine thought  
145 processes during the performance of a task (Ericsson & Simon, 1980). Ericsson and Simon  
146 (1993) proposed three levels to verbally reporting data. Level 1 involves participants  
147 vocalizing inner speech without any effort to communicate their thoughts. Level 2 requires  
148 participants to vocalize inner speech and internal representations that are not initially part of  
149 inner speech (e.g., sensory experiences, feelings, movements). Level 3 requires participants

150 to expand on merely verbalizing inner speech by explaining thoughts and motives. In line  
151 with the majority of TA sport psychology research, participants in the present study were  
152 required to engage in Level 2 verbalizations. Level 2 was chosen as it provides access to  
153 information from an individual's short term memory (STM; Eccles, 2012), and participants  
154 are not required to provide further explanations for their motives, which, given the  
155 requirements of the task, participants may have struggled to engage in.

156         Recently, researchers have used TA to investigate sport psychology phenomena. For  
157 example, Swettenham et al. (2018) investigated stress and coping during practice and  
158 competitive conditions and examined gender differences across conditions using a Level 2 TA  
159 methodology. With results suggesting that males verbalized significantly more stressors  
160 related to performance during the competition condition and more physical stressors during  
161 the practice condition, whereas females more frequently verbalized external stressors.  
162 Whitehead et al. (2016), adopted a Level 2 TA methodology and also found that higher-  
163 skilled golfers made significantly more verbalizations per shot compared to lower-skilled  
164 golfers. Similarly, when under pressure, higher-skilled golfers shifted cognition and  
165 verbalized significantly more technical aspects of motor control, consistent with Masters's  
166 (1992) reinvestment theory. Kaiseler et al. (2012) examined gender differences in stress,  
167 appraisals and coping during a golf putting task, and their results highlighted both significant  
168 differences in the frequency of stressors verbalized between genders and significant  
169 differences in performance appraisals between genders when participants were in identical  
170 achievement situations. These studies provide evidence for the suitability of TA as a method  
171 for collecting data related to the frequency of verbalized stressors and coping strategies  
172 during threat and challenge states. Similarly, previous TA research also highlighted how  
173 qualitative data can be coded quantitatively as, for example, by coding the frequency of  
174 verbalized stressors.



175 Potential limitations of adopting TA methodology include the process of requiring TA  
176 from participants during a task, as this may interfere with task performance. Whitehead et al.  
177 (2015) addressed these concerns by investigating the effects of Level 2 and Level 3  
178 verbalizations on the performance of skilled golfers. Results indicated that neither level of  
179 verbalizations significantly impacted task performance. Similarly, a meta-analysis conducted  
180 by Fox et al. (2011) suggested that verbalizations during performance of cognitive tasks had  
181 no impact on performance and, in fact, participants who were instructed to explain their  
182 thoughts (Level 3 verbalization) improved their performance. While research suggests Level  
183 3 TA has no significant impact on cognitive tasks, the complexity of the present task led to  
184 the decision that Level 2 TA would provide sufficient data without influencing task  
185 performance.

186 Thus, in the present study, we aimed to use TA to expand on previous research by  
187 investigating stress and coping of young cricket batters during challenge and threat (CAT)  
188 states. Underpinned by the BPSM, TCTSA and previous research (e.g. Thelwell & Greenlees,  
189 2007; Moore et al., 2013; Turner et al., 2013; Whitehead et al., 2016) we predicted that  
190 participants would verbalize significantly more stressors during the threat condition  
191 compared to the challenge condition. Likewise, we hypothesized that there would be no  
192 significant difference in the total number of verbalizations made in relation to coping  
193 strategies between the threat and challenge condition. Finally, in line with Masters (1992)  
194 reinvestment theory which predicts that, under pressure, athletes verbalize more technical  
195 elements of motor control, we hypothesized that participants would make more technical  
196 verbalizations during the threat condition compared to the challenge condition.

197

198

## **Method**

199 **Participants**

200 Ten male elite-level junior cricket batsman aged 16-17 years participated in the  
201 present study. This sample size was based on previous similar research (e.g., Samson et al.,  
202 2017; Whitehead et al., 2018). Participants were recruited from a County Cricket Boards'  
203 excellence training program. The excellence program represents the last training stage for  
204 athletes before coaches select their squad for the forthcoming cricket season. We adopted a  
205 within-subject design whereby all participants took part in both threat and challenge  
206 conditions. Participants were recruited using a purposeful sampling technique, whereby the  
207 lead researcher, who also acted as a trainee sport and exercise psychologist for the County  
208 Cricket Board, identified participants who were both eligible and would provide insightful  
209 information that would answer the research question (Patton, 2002). To prevent demand  
210 characteristics such as verbalizing the thoughts participants believed their coaches might  
211 want to hear, we informed participants that the coaching staff would not hear their recordings.  
212 To be eligible for the study athletes had to be currently enrolled in the excellence program so  
213 as to ensure their athletic skills were of a high level.

#### 214 **Equipment**

215 Participants completed each task with their cricket equipment (e.g., cricket bat, cricket  
216 pads, cricket helmet, cricket gloves, etc.) in an indoor training venue, batting into a training  
217 cricket net. A bowling machine delivered the balls to ensure consistency in speed and location  
218 of delivery across participants. To record verbalizations during tasks, a recording device was  
219 placed in the pocket of the participant, and a wire running inside participants' shirts  
220 connecting the microphone to the recording device was clipped onto the collar.

#### 221 **Procedure**

222 Once ethical approval for the study was acquired from the overseeing ethics  
223 committee, the performance director for the county cricket board was approached and  
224 provided with a research information sheet. The aims of the research and the requirements of

225 the athlete's participation were explained, and we then obtained the director's consent to  
226 approach athletes. Participant athletes who met the initial eligibility criteria attended an  
227 optional workshop to provide a brief of the research aims, and participants who expressed an  
228 interest in participating were supplied with an information sheet. When the number of  
229 participants required for the study had been satisfied, we obtained parental consent from each  
230 participant, and participants took part in TA training exercises. We briefed participants on TA  
231 and informed them that they would be required to verbalize what they were thinking (Level 2  
232 TA; Ericsson & Kirk, 2001). Participants then took part in a series of TA practice tasks, as per  
233 the recommendations of previous TA literature (Eccles, 2012). Tasks included: (a) counting  
234 the number of dots on a page, (b) a problem-solving task, and (c) an arithmetic task.

235 Following training, participants then had a practice session, batting in the cricket nets to  
236 ensure they felt comfortable performing the task while wearing the equipment. Participants  
237 were also required to verbalize during this session as this also presented an ideal opportunity  
238 for the researcher to provide the participant some feedback regarding TA directly related to  
239 the experimental task, and for the participant to ask any questions regarding the use of TA if  
240 they were unsure. For example, if participants were not verbalizing enough, or finding  
241 difficulty in verbalizing during the task, the researcher could address this to ensure data  
242 collected during the experiment would be at a satisfactory level. Once participants felt  
243 comfortable with the procedure, they took part in the first condition, either the challenge or  
244 threat condition. To prevent any order effects and in line with the BPSM and TCTSA, which  
245 state that CAT states may be influenced by previous experience, participants randomly started  
246 with either the challenge or threat condition. For both conditions, participants were required  
247 to face 30 balls from a bowling machine and score 36 runs, with three runs added to the total  
248 each time they lost their wicket. The run demands were calculated based on previous similar  
249 research (e.g. Turner et al. 2013) and following discussions with the lead coach.

## 250 **Challenge condition**

251 To encourage participants in a challenge state, we provided participants with  
252 challenge instructions adapted from previous research (e.g. Moore et al., 2012; Moore et al.,  
253 2013), encouraging participants to view the task as a challenge to be met and overcome, to  
254 believe they are capable of overcoming the challenge, and affirming this message by stating  
255 that previous batsmen have completed the task comfortably. Following challenge instructions  
256 and before the start of the task, to ensure participants were in a challenge state, their demand  
257 and resource evaluations were measured using two items from the cognitive appraisal ratio  
258 (Tomaka et al., 1993). Participants were asked, “How demanding do you expect the  
259 upcoming task to be?” and “How able are you to cope with the demands of the upcoming  
260 task?” Items were measured on a 6-point Likert scale, with 1= not at all and 6= extremely. As  
261 per Moore et al. (2013) recommendations, a score was calculated by subtracting demands  
262 from resources (range of -5 to +5); positive scores reflected a challenge state, and negative  
263 scores reflected a threat state (see Tomaka et al., 1993). All participants scores reflected a  
264 challenge state (i.e., all participants gave a positive score). Participants then completed the  
265 challenge condition and were reminded to verbalize thoughts between shots and not during  
266 shots to avoid interference with motor movement during the execution of the skill (Schmidt  
267 & Wrisberg, 2004).

## 268 **Threat Condition**

269 The second condition involved promoting participants into a threat state. Similar to  
270 the challenge condition, participants were required to face 30 balls from a bowling machine  
271 and score 36 runs, with three runs added to the total each time they lost their wicket.  
272 Participants were provided with threat instructions adapted from previous research (e.g.,  
273 Moore et al., 2012; Moore et al., 2013) highlighting the difficulty of the task and that  
274 previous participants had failed to score the required number of runs. As with the challenge

275 condition, all participants answered two items from the cognitive appraisal ratio to ensure  
276 participants were in a threat state. All participants scores reflected a threat state (i.e., all  
277 participants gave a negative score). Participants then completed the threat condition and were  
278 reminded to verbalize thoughts between shots and not during shots to avoid interference with  
279 motor movement during the execution of the skill (Schmidt & Wrisberg, 2004).

## 280 **Data Analysis and Research Credibility**

281 In this study we adopted a post-positivist epistemology in line with much of the previous TA  
282 research (e.g., Nicholls & Polman, 2008; Arsal et al., 2016; Whitehead et al., 2017;  
283 Swettenham et al., 2018). We feel that is essential to state a paper's philosophical position as  
284 doing so provides transparency and helps to refine and clarify the research method (Easterby-  
285 Smith et al., 2002). Following data collection, audio files were transcribed verbatim, and  
286 checks for relevance and consistency were made, achieved via immersing in the data and  
287 using a critical friend. Transcripts were subjected to line by line content analysis (Maykut &  
288 Morehouse, 1994) to identify themes in participants' thought processes in both conditions.  
289 Similar to Kaiseler et al. (2012), verbalizations that caused the participant's negative concern  
290 or worry or had the potential to do so were coded as stressors; and verbalizations in which  
291 participants attempted to manage a stressor, were coded as coping strategies. Initially,  
292 participant's data were analyzed using an inductive thematic analysis. This involved the  
293 author reading and re-reading all transcripts of interviews (immersion in the data) using  
294 Nvivo 10 (step 1). Following this, the researcher developed a list of codes from the first two  
295 transcripts. At this stage, the initial codes were reviewed and considered by a critical friend  
296 (step 2). Research such as Saldana (2013) has provided support for this collaborative  
297 approach to coding, as it allows a "dialogic exchange of ideas." From the initial inductive  
298 process, codes were grouped into stressors and coping responses, and Lazarus and Folkman's  
299 (1984) coping responses of emotion and problem-focused coping were used in a deductive

300 way to allocate the initial inductive ‘coping responses’ into these coping responses. These  
301 deductive codes were then used as a point of reference to subsequently analyze the remaining  
302 transcripts. However, as new codes were identified from the data, for example, ‘gathering  
303 information,’ they were included as part of the analysis. We then were able to follow the  
304 saliency of these new codes throughout the data, adding new and different theme to those  
305 previously identified. Again this process was considered and reviewed by a critical friend.  
306 This process followed recommendations from Smith and McGannon (2017) to ensure data  
307 quality and rigor. In this way, 11 secondary themes were grouped into four primary themes  
308 for both the threat and challenge conditions (Table 1).

309 In line with most previous TA research in sport psychology (e.g. Kasieler et al., 2012;  
310 Whitehead et al., 2016; Swettenham et al., 2018) and in keeping with the philosophical  
311 position adopted by this paper, we quantified the qualitative data by taking a similar coding  
312 framework to that used in previous research (e.g. Kasieler et al., 2012). Each time a theme  
313 was verbalized it received a frequency count (Table 2), and these data were then statistically  
314 analyzed to determine any significant differences between frequency of verbalizations for  
315 each theme. First, we conducted an outlier analysis and data were found to be normally  
316 distributed; then a series of parametric tests were conducted. As this study adopted a repeated  
317 measures design, we conducted a paired samples *t*-test to investigate differences between the  
318 coded themes for each condition. Similarly, we conducted a paired samples *t*-test to examine  
319 differences between demand/resource evaluation scores between threat and challenge  
320 conditions. A 95% confidence interval was used to determine the significance levels of the  
321 data ( $p \leq 0.05$ ). Effect sizes were reported using Cohens (1988) threshold values: small ( $d =$   
322 0.2), medium ( $d = 0.5$ ), and large ( $d = 0.8$ ).

323 [Insert Table 1 about here]

## 324 **Results**

325 The frequency of verbalizations for each theme across each of the two conditions (threat and  
326 challenge) were analysed using a paired samples *t*-test to test for significance, and a 95%  
327 confidence interval was applied. Effect sizes are reported using Cohen's *d* values ( $\delta$ ). Table 1  
328 presents the coding framework used by the researcher to analyze participant verbalisations.  
329 Descriptions of secondary theme characteristics and examples of raw data quotes are  
330 provided. Table 2 presents the means and standard deviations of primary and secondary  
331 themes, as well as the percentage and total frequency of verbalizations across both  
332 conditions.

333 [Insert Table 2 about here.]

### 334 **Demand/Resource evaluation**

335 A paired-samples *t*-test was used to determine if there was a significant difference  
336 between demand/resource evaluations made before participation in the challenge and threat  
337 condition. Effect sizes are reported using Cohen's *d* values. Results indicated a significant  
338 difference between conditions with a large effect size. (*Threat condition*:  $M=-3.30$ ,  $SD=0.95$ ;  
339 *Challenge condition*:  $M=4.1$ ,  $SD=0.74$ ;  $t(9) = -18.50$ ,  $p = .000$ ,  $\delta = -0.94$  ). This finding  
340 highlights that challenge and threat states were successfully manipulated.

### 341 **Stressors**

342 Secondary themes that emerged from the data related to stressors verbalized were  
343 external stressors, performance stressors, and pressure (see Table 1 for examples). To analyze  
344 coded verbalizations made by participants in relation to stressors experienced across both  
345 conditions, a paired samples *t*-test test was conducted. Significant differences were found for  
346 total verbalizations made regarding stressors and a large effect size was reported. (*Threat*  
347 *condition*:  $M=12.2$ ,  $SD=4.83$ ; *Challenge condition*:  $M=4.4$ ,  $SD=2.63$ ;  $t(9) = 5.374$ ,  $p = .000$ ,  $\delta$   
348  $= -1.53$ ). Focusing specifically on types of stressors reported by participants, when in a threat  
349 state, participants significantly verbalized more about external stressors compared to when in

350 a challenge state while a large effect size was also observed. (*Threat condition*:  $M=4.1$ ,  
351  $SD=3.21$ ; *Challenge condition*:  $M=1.7$ ,  $SD=1.49$ ;  $t(9) = 2.571$ ,  $p = .030$ ,  $\delta = 0.96$ ). There  
352 were also significantly more verbalizations (large effect size) made by participants related to  
353 performance stressors (*Threat condition*:  $M=5.8$ ,  $SD=2.90$ ; *Challenge condition*:  $M=2.3$ ,  
354  $SD=2.00$ ;  $t(9) = 3.612$ ,  $p = .006$ ,  $\delta = 1.41$ ). Finally, verbalizations coded as pressure stressors,  
355 (i.e., verbalizations regarding factors related to feeling or experiencing pressure) were  
356 analyzed. There was a large effect size and significant difference between the number of  
357 verbalizations made when in a threat state compared to a challenge state (*Threat condition*:  
358  $M=2.4$ ,  $SD=1.17$ ; *Challenge condition*:  $M=0.40$ ,  $SD=0.97$ ;  $t(9) = 3.612$ ,  $p = .001$ ,  $\delta = 1.87$  ).  
359 These results all indicate that when in a threat state, there is a significant main effect with  
360 participants experiencing and verbalizing more stressors than when in a challenge state.  
361 These findings offer support to the first hypothesis and provide further explanations as to why  
362 performance is more likely to decrease when in a threat state compared to a challenge state,  
363 since an increased number of reported stressors indicates more instances when the participant  
364 has experienced and reported verbalisations that have caused either negative concern or  
365 worry.

### 366 **Emotion-focused coping**

367 Secondary themes that emerged from the data related to emotion-focused coping were  
368 emotional release, relaxation, and positive self-talk (see Table 2 for examples). A paired  
369 samples *t*-test was carried out on the total number of verbalizations for the coded data related  
370 to emotion-focused coping. There were no significant differences between any of the  
371 secondary themes related to emotion-focussed coping. Total emotion-focused verbalizations  
372 for threat and challenge conditions were not significantly different and demonstrated a small  
373 effect size (*Threat condition*:  $M=8.70$ ,  $SD= 7.24$ ; *Challenge condition*:  $M=7.70$ ,  $SD= 3.62$ ;  
374  $t(9) = .525$ ,  $p = .612$ ,  $\delta = 0.18$ ). Emotional release verbalizations between threat and



375 challenge conditions were also not significantly different and demonstrated a medium effect  
376 size (*Threat condition: M=2.70, SD= 2.26; Challenge condition: M=1.30, SD=1.16; t(9) =*  
377 *2.14, p = .061,  $\delta = 0.78$* ). Similarly, a small effect size with no significant differences were  
378 found between threat and challenge conditions for relaxation (*Threat condition: M=2.00,*  
379 *SD=4.00; Challenge condition: M=0.80, SD=0.63; t(9) = .970, p = .357,  $\delta = 0.42$* ). Finally, no  
380 significant differences were identified between conditions for positive self-talk while a  
381 medium effect size was reported (*Threat condition: M= 4.00, SD= 2.83; Challenge condition:*  
382 *M= 5.60, SD=3.47; t(9) = -1.99, p = .078,  $\delta = -0.51$* ). These results suggest that participants  
383 do not verbalize more emotion-focused coping strategies when in a challenge or threat state.  
384 This finding provides support for this study's second hypothesis.

### 385 **Problem-focused coping**

386         Secondary themes that emerged from the data related to problem-focused coping were  
387 technical instruction, planning, increasing effort, and concentration (see Table 1 for  
388 examples). A paired samples *t*-test was carried out on verbalizations for the coded data  
389 related to problem-focused coping. First, total number of verbalizations made by participants  
390 related to problem-focused coping strategies was analyzed, and no significant differences  
391 were found between the threat and challenge condition (large effect size) (*Threat condition:*  
392 *M=14.6, SD= 6.77; Challenge condition: M=18.3, SD=2.19; t(9) = -1.713, p = .121,  $\delta = -1.90$*   
393 *)*. Analyzing secondary themes, there were no significant differences for total number of  
394 verbalizations coded related to concentration between the threat condition (medium effect  
395 size) (*Threat condition: M=2.10, SD=2.38; Challenge condition: M=3.20, SD=2.04; t(9) = -*  
396 *1.295, p = .227,  $\delta = -0.50$* ). No significant differences were identified for verbalizations  
397 regarding increasing effort condition (medium effect size) (*Threat condition: M=2.70,*  
398 *SD=2.21; Challenge condition: M=4.50, SD=3.21; t(9) = -1.575, p = .150,  $\delta = -0.70$* ).  
399 Verbalizations made in relation to planning demonstrated a small effect size and were not

400 found to be significantly different (*Threat condition: M=5.3, SD=2.76; Challenge condition:*  
401 *M=4.20, SD=2.61;  $t(9) = .879, p = .402, \delta = 0.41$* ). Finally, there was no significant difference  
402 and a small effect size for verbalizations made in relation to technical instruction between  
403 threat and challenge conditions (*Threat condition: M= 4.5, SD=2.42; Challenge condition:*  
404 *M=4.70, SD=2.91;  $t(9) = -1.43, p = .889, \delta = -0.07$* ). These results suggest that participants do  
405 not verbalize more problem-focused coping strategies when in a challenge or threat state.  
406 This finding provided support for this aspect of the study's second hypothesis. However,  
407 there were also no significant differences between the two conditions for technical  
408 verbalizations, meaning that this finding also provided support for the third hypothesis.

#### 409 **Gathering information**

410 Verbalizations made in relation to gathering information were statements made in  
411 relation to obtaining information from the environment or situation to facilitate performance.  
412 A paired-samples *t*-test was conducted on verbalizations related to gathering information, and  
413 no significant differences were found (medium effect size) (*Threat condition: M=4.10, SD=*  
414 *2.77; Challenge condition: M=2.90, SD=1.59;  $t(9) = 1.450, p = .181, \delta = 0.53$* ).

#### 415 **Total verbalizations**

416 Mean, standard deviation values, and total verbalizations and percentages of primary  
417 and secondary theme verbalisations are presented in Table 2. A paired-samples *t*-test was  
418 performed on the total number of verbalizations across both conditions. No significant  
419 differences were found (medium effect size) (*Threat condition: M= 39.70, SD=11.60;*  
420 *Challenge condition: M=31.6, SD=8.72;  $t(9) = 1.727, p = .118, \delta = 0.79$* ).

#### 421 **Discussion**

422 In present study we aimed to investigate stress and coping of academy cricket batsmen during  
423 CAT states using Level 2 TA. First, results indicated a significant difference for demand and  
424 resource evaluation scores taken prior to participation in the threat and challenge conditions,

425 meaning that participants were in a challenge state for the challenge condition and in a threat  
426 state for the threat condition. Results supported the first hypothesis, which predicted that  
427 participants would significantly verbalize more stress sources during a threat state compared  
428 to a challenge state. Results also supported the second hypothesis, which predicted that there  
429 would be no significant difference in the number of verbalizations made concerning coping  
430 strategies between challenge and threat conditions. Results did not provide support for the  
431 third hypothesis which was that participants would make more technical verbalisations during  
432 a threat state compared to a challenge state as there were no significant differences. Finally,  
433 results also indicated that there were no significant differences in the total number of  
434 verbalizations made in relation to gathering information between the two conditions.

435         There were significant differences found between total overall verbalizations for  
436 stressors experienced by participants between both conditions. Significant differences were  
437 also found for each primary stressor theme (external, performance, and pressure stressors).  
438 These findings provide further support to both the BPSM and TCTSA and further extends the  
439 scope to where this knowledge can be applied. The results suggested that when in a threat  
440 state, participants are more likely to experience stress sources than when in a challenge state.  
441 Both models suggest that if athletes appraise that they do not possess the coping resources  
442 required to manage a situation, they will enter a threat state. This finding is in line with  
443 research such as Moore et al. (2013) who suggested demand/resource evaluations made  
444 before a competition can significantly predict competitive performance. When participants  
445 evaluated the competitive demands to outweigh their resources (i.e., a threat state), this was  
446 significantly associated with reduced performance compared to those who perceived their  
447 resources to match or exceed the competitive demands (i.e., a challenge state).

448         Previous research investigating stress in sport had suggested that athletes experience a  
449 wide variety of stressors, similar to those identified in the present study (external stressors,

450 performance stressors, and pressure). For example, Swettenham et al. (2018) highlighted  
451 external stressors as a salient stressor in tennis players. The findings from the present study  
452 further extend on this by highlighting that external stressors are more likely to be reported  
453 during a threat state than a challenge state. Similarly, the findings from the present study  
454 support previous research investigating stress sources in cricket batsman. Thelwell, Weston,  
455 and Greenlees (2007) suggested cricket batsman experience a wide variety of stressors when  
456 performing in competition, and a few examples include perceptions of self, match specific  
457 issues and technique. In the current study, performance-related stressors were the most  
458 frequently cited stressors across both conditions. However, performance-related stressors  
459 were reported significantly more often by participants when in a threat state compared to a  
460 challenge state. This finding suggests that during a threat state, participants more frequently  
461 verbalize stressors related to skill performance, probably because participants' performances  
462 decline while in a threat state. Of the ten participants, only one participant in a threat state  
463 successfully completed the task (i.e. scored the target amount of runs), whereas all  
464 participants in a challenging state were successful. This provides further support to previous  
465 research (e.g., Blascovich et al., 2004; Moore et al., 2012; Turner et al., 2012). Hase et al. 's.  
466 (2019) systematic review suggested that a challenge state is beneficial to performance. The  
467 findings from the present study extend the work in previous research by highlighting that, in  
468 real-time, participants in a threat state (versus a challenge state) verbalize significantly more  
469 stressors. This finding offers a potential explanation for why athletic performance is more  
470 likely to decrease when athletes are in a threat state.

471         Despite the significant increase in stressor verbalizations made during a threat state,  
472 there was no significant difference found in the number of verbalizations made to cope with  
473 stressors reported by participants (external stressors, performance stressors, and pressure).  
474 This finding suggests that athletes in a threat state will experience more stressors without

475 verbalizing significantly more coping strategies. The BPSM and TCTSA propose that during  
476 a threat state athletes have appraised that the demands outweigh their resources, therefore,  
477 this finding enhances our confidence in previous research. Perhaps surprisingly, this study's  
478 results also indicated that, during a challenge state, participants did not verbalize a higher  
479 number of coping strategies. Arguably, this finding may result from some coping strategies  
480 having not been verbalized (e.g. breathing techniques,). Likewise, a possible explanation for  
481 this finding may be that, during a challenge state, there is a higher quality of coping strategies  
482 that leads athletes to naturally engage in fewer verbalizations. An alternative explanation for  
483 these findings could offer support to the ESACT (Uphill et al., 2019), suggesting that  
484 individuals can be experiencing challenges, threats, neither or both. It could be argued that  
485 this finding provides support to this model as the lack of verbalized coping responses may  
486 result from athletes being *both* challenged and threatened, rather than alternatively challenged  
487 *or* threatened (as is implied by a theory that challenge and threat are on a bipolar continuum).

488         The present study and previous research (e.g., Blascovich et al., 2004; Moore et al.,  
489 2012; Turner et al., 2012) highlighted how a threat state is associated with decreased  
490 performance. A potential solution to promoting a challenge state and facilitating performance  
491 may be to develop coping strategies to manage the increase in stressors. A recent paper  
492 conducted by Hase et al. (2019) specifically highlighted the potential for motivational self-  
493 talk to be used as a tool for promoting a challenge state and improving performance.  
494 Therefore, future research could further examine the effectiveness of psychological skills  
495 training, arousal reappraisal, and imagery interventions. These interventions are aimed at  
496 developing coping strategies to manage increased stressors when in a threat state; such  
497 interventions may reduce the impact a threat state may have on performance by better  
498 regulating emotional arousal and eliminating stressors.

499           While it was predicted participants in the threat state would make more technical  
500 verbalizations compared to when in a challenge state, there were no significant technical  
501 verbalization differences found in this study, in contrast with previous research. For example,  
502 Whitehead et al. (2016) highlighted that higher-skilled golfers, when under pressure, were  
503 more likely to verbalize technical rules, consistent with Masters (1992) reinvestment theory.  
504 Reinvestment theory states that a skilled performer may regress to an earlier stage of learning  
505 during a stressful situation – a phenomenon referred to as choking in which there is a  
506 breakdown in performance under situations of stress or pressure (Beilock & Gray, 2012).  
507 Similarly, Vine et al. (2016) argued that during a threat state, performers are more likely to  
508 focus their attention inwardly towards internal cues. In the present study, while there were no  
509 significant differences between groups during both conditions, technical verbalizations during  
510 both conditions (11.3% and 14.9%, respectively) represented an important percentage of total  
511 verbalizations. It may be argued that this finding was due to these participants' younger stage  
512 of development (i.e., junior athletes). At these younger ages, technical verbalizations might  
513 still be a vital training tool for athletic development, meaning that they facilitate, rather than  
514 hinder performance. For example, athletes in this study, used statements such as “*watch the*  
515 *ball, keep your eye on it,*” “*keep your feet moving*” and “*play the ball straight,*” perhaps to  
516 reinforce correct technical elements of batting. Thus, rather than hinder performance by  
517 directing attention inwardly, these verbalizations may be facilitating performance by  
518 strengthening best practice. In this way, they may be a useful coping technique for athletes at  
519 this stage of development. Further research is needed, however, to better understand the  
520 underlying mechanisms for this finding.

### 521 **Limitations and future research**

522           A potential limitation of the present study is the lack of any physiological participant  
523 measures during CAT states. The present study relied on self-report measures, including two

524 items from the cognitive appraisal ratio (Tomaka et al., 1993), to determine whether  
525 participants were in a challenge or threat state. Previous research has used alternative  
526 measurement methods, such as Turner et al. (2012), who measured CV reactivity and self-  
527 report measures of self-efficacy, control, achievement-goals, and emotions. Similarly, Moore  
528 et al. (2013) used cardiovascular measures, performance measures, and a series of self-report  
529 measures. While physiological testing would not have further addressed the present studies  
530 main aims, they may have contributed to a determination of the participants' CAT states,  
531 increasing the validity and reliability of obtained outcome data. Future research could,  
532 therefore, consider this limitation and better address it. Level 2 TA does not require  
533 participants to expand on their thoughts or provide motives/explanations for verbalizations,  
534 and this may have limited data in this study. However, we felt that, given the dynamic nature  
535 of batting in cricket, Level 2 TA provided sufficient data while limiting potential batting  
536 performance disruptions.

537 Future research might examine the effectiveness of interventions aimed at promoting  
538 athletes' challenge state and preventing their threat state. Based on the results of the present  
539 study, such interventions should focus on developing coping strategies to manage the increase  
540 of stressors during a threat state. Our results also suggest that stressors and the threat state  
541 had a detrimental effect on sporting performance. Hase et al. (2019) offer a potential  
542 intervention for addressing such issues (e.g., use of motivational self-talk), although the  
543 effectiveness of other psychological interventions should also be examined. Based on the  
544 findings of the present study, future research could explicitly investigate the performance  
545 impact of technical instruction in junior athletes.

## 546 **Conclusions**

547 To conclude, in this study we used a novel approach to collect data from cricket  
548 batsmen during CAT states. We adopted an idiographic design, as advocated by Lazarus

549 (2000) and extended it to previous CAT research by solely examining stress and coping during  
550 CAT states as they occurred. Our findings provide some to support both the BPSM and  
551 TCTSA by highlighting that, during threat states, participants experience an increase in  
552 stressors compared to a challenge state. However, our results did not suggest the increase in  
553 coping strategies during a challenge state that previous theories have eluded to. Alongside  
554 this, elite junior athletes verbalized technical elements of skills during both CAT states, which  
555 they may have used as a coping mechanism, although further research is needed to verify this  
556 possibility. Future research should investigate potential interventions aimed at promoting a  
557 challenge state, perhaps by helping athletes reduce the number of stressors experienced and  
558 increase coping skills matched to perceived task demands.

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