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Thinking Aloud: An exploration of cognitions in professional snooker

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*Objectives:* Presently, there is no exploration into the cognitive processes of super-elite and elite professional snooker players during real-time performance. Therefore, this study explored the cognitions of seven professional snooker players during real-time solo practice performance. *Design:* A Think Aloud (TA) protocol analysis. *Method:* This involved players verbalizing and explaining their thoughts within naturalistic practice environments. Player's verbalizations were recorded during each solo practice performance, transcribed verbatim, and analyzed via protocol analysis. *Results:* Analyses revealed an array of continuous reactive-adaptive cognitions relating to stressors and coping strategies during performance, as well as general snooker-specific related thoughts. Specifically, the results highlighted key stressor themes which were coded as: Table Conditions, Distractions, and Mistakes. Our main finding was: Shot Preparation being essential to problem-focused coping, with Rationalizing integral to emotion-focused coping. Further results highlighted the visual-perceptual and cognitive expertise of players, with regards to identification of problem balls and cueball spatial awareness, insofar as unearthing the deliberate structure to practice routines. *Conclusions:* The study's original and novel findings lend further support to the transactional process of coping. Whilst accordingly, the utilization of TA significantly contributed to our limited understanding of super-elite and elite real-time cognitions in professional snooker and self-paced sports generally. Future research should continue to dissect the sport-specific nuances that underpin real-time performance, not only during practices, but within competitive play. TA is an appropriate methodology to use in the domain-specific sport of snooker.


Keywords: Coping, Think Aloud protocol, Professional Snooker, Super-Elite, Cognitions, Practice

1    **Introduction**

2          A proliferation of studies exploring the *real-time* cognitive processes of performers in

3    sport has yielded researchers and practitioners with perspicacity over the last decade

4    (Kaiseler, Polman, & Nicholls, 2013; Nicholls & Polman, 2008; Whitehead, Taylor, &

5    Polman, 2015, 2016b). Verbal-cognitive data has been collected from various sports using a

6    Think Aloud protocol (TA) in self-paced closed skill sports, such as golf (Calmeiro &

7    Tenenbaum, 2011; Eccles & Arsal, 2017; Kaiseler et al., 2013; Nicholls & Polman, 2008;

8    Whitehead et al., 2015), and trap shooting (Calmeiro, Tenenbaum, & Eccles, 2010), which

9    have concentrated upon appraisals, *coping*, and differences in stress. TA primarily involves

10   participants to continuously verbalize their thoughts during the performance of a task.

11   Furthermore, researchers have investigated the planning strategies of expert and novice

12   players in tennis (McPherson & Kernodle, 2007). And recently, researchers have extended

13   their verbal cognitive pursuits into endurance sports, such as, cycling, endurance running, as

14   well as coaching in rugby (e.g., Sampson, Simpson, Kamphoff, & Langlier, 2015, Whitehead

15   et al., 2016a; Whitehead et al., 2017, 2018). Yet unanticipatedly, there remains an exiguity of

16   research exploring the real-time cognitions of *super-elite* and *elite* performers *in situ,* and in

17   other sports, such as, *professional snooker*.

18          In general, findings from these verbal protocol enquiries have typically identified how

19   performers thoughts are directed to managing (e.g., cope, mental strategies) continual internal

20   and external dynamical cognitive processes (e.g., stressors) during sporting performance

21   (e.g., Lazarus, 1999). For example, Nicholls and Polman (2008) found that high level golfers

22   appraised a range of stressors and coping strategies during performance, but the golfers

23   frequently experienced a variety of stressors before deploying a coping strategy. Conversely,

24   in a recent TA study on the real-time thought processes of distance runners, Samson et al.,

25   (2015) identified three major themes containing sub-themes relating to; Pain and Discomfort

26   (e.g., stressors), Pace and Distance (e.g., coping/strategies), and Environment (e.g.,

27   coping/strategies). And Whitehead et al. (2017) found very similar results (e.g., pacing

28    strategies and stressors) with cyclists thought processes changing continuously and becoming

29    more prominent at different times.

30          To capture such detailed on-line thought processes of expertise, researchers have

31    moved to utilize Ericsson and Simon's (1993) Think Aloud (TA) protocol analysis as their

32    *modus operandi*. This is due to limitations of retrospective recall investigations (e.g.,

33    forgetfulness, retrospective bias) and growing calls to increase methodological rigor in

34    qualitative research in sport and exercise psychology (e.g., Nicholls & Polman, 2008; Eccles

35    & Arsal, 2017; Smith & McGannon, 2017; Whitehead et al., 2017, 2018. Nevertheless, TA

36    has shown to be an effective method to collect real-time cognitive thought processes in other

37    disciplines, such as chess (de Groot, 1964; Gobet & Charness, 2006) and algebra (Cook,

38    2006).

39          According to Ericsson and Simon (1993) there are three differing types of

40    verbalizations; Levels 1 and 2 are purported to not affect performance outcomes, and Level 3

41    verbalization requires the individual(s) to explain their thoughts, ideas, hypotheses, or

42    motives. Though, Level 3 verbalization is suggested to impede performance through

43    reinvestment (e.g., Beilock & Carr, 2001; Masters, 1992). However, Whitehead et al., (2015)

44    demonstrated that Level 3 TA verbalizations did not lead to reinvestment (i.e., disrupt motor

45    performance) among skilled golf performers during a putting task and over six holes of play.

46    Data showed that Level 3 TA protocol generated richer detailed and nuanced information in

47    both the quantity and quality when compared with the Level 2. And despite the preferential

48    use of Level 2 verbalization within TA studies, it is suggested that there is no assessment of

49    completeness under some conditions because some cognitive processes do not form part of

50    focused attention, or are readily verbalized (Wilson, 1994; Whitehead et al. 2015). More

51    explicitly, Level 3 enabled the golfers to provide greater explanations of their performances,

52    with regards to planning and evaluation of shots, about the score, and the pre-performance

53    activities they engaged in prior to a shot.

54      Unequivocally, such TA literature has augmented our theoretical understandings of

55    the transactional nature of psychological variables and coping processes experienced by

56    performers in sport. However limitations remain, as it could be argued that particular certain

57    sports have been overly employed (e.g., golf, cycling, running etc.) throughout the sport and

58    cognitive psychology literature. Thus, in order to progress our theoretical appetite of how

59    experts appraise and cope with the ever-changing cognitive demands during sporting

60    performance (e.g., Lazarus, 1999), it is vital that other types of sports are brought to the fore.

61      Exploring the cognitive dynamics of professional snooker theoretically widens the

62    opportunity to understand how performers' cognitions unfold in real-time elite sport and

63    generally. Indeed, such is the limited research into professional snooker, Abernethy et al.

64    (1994) remain to our empirical knowledge the closest and sole TA contribution in

65    deciphering the cognitive differences between various skill levels of Australian snooker

66    players (i.e., novice, intermediate and expert), albeit using artificial stimuli. Thus, naturalistic

67    endeavors capturing the real-time mental representations of super-elite and elite world

68    professional snooker players *in situ* currently do not exist.

69      Notwithstanding the concerns of ecological validity, Abernethy et al.'s research is

70    highly commendable. From their battery of visual (i.e., pattern recall and pattern recognition

71    tasks) and sport-specific perceptual and cognitive tests, they found that expert snooker

72    players did not differ from novices in their general visual skills, but rather in their ability to

73    rapidly encode, recall, and recognize structured perceptual information. In addition, expert

74    players had greater cognitive ability to evaluate and discriminate the strengths and

75    weaknesses of varying game situations, as well as planning six or more shots in advance of

76    the current shot.

77      Drawing on comparable research that involves strategic thought processes, Gobet and

78    Charness (2006) established that expert chess players possess heightened procedural (i.e.,

79    knowhow and pattern recognition) and strategic knowledge (i.e., concepts and rules) during a

80    TA protocol. More specifically, that expert chess players exhibit more depth, breadth, and

81    speed when searching for a correct move than novices (e.g., Abernethy et al., 1994; Chase &

82    Simon, 1973; de Groot, 1965). Concurrently, studies on algebra tasks using TA protocol have

83    shown that experts firstly expend a considerable amount of time in qualitatively

84    understanding the problem, then construct mental representations of the problem to define the

85    situation and constraints (Cook, 2006). Therefore, collectively speaking, it would appear

86    experts (across various disciplines) strategize their cognitive processes towards pondering

87    more alternatives, thinking more ahead in moves, and are better adept at evaluating the

88    options more rapidly than novices (e.g., problem/task focused).

89         To date, the TA sporting literature has provided rich in-depth of cognitions of self-

90    paced and endurance sports, insofar as demonstrating that thoughts occur as an ever-changing

91    process (e.g., Lazarus, 1999). However, despite these efforts, there appears to be an overuse

92    of particular sports investigated. Also, there is a highly notable absence of super-elite and

93    elite performers employed within TA research and across the sport psychology literature..

94    And even though the TA protocol has been used within laboratory settings on snooker

95    (Abernethy et al., 1994), no naturalistic studies examining the real-time thoughts of super-

96    elite or elite professional snooker players during practice exists.  According to Lazarus

97    (2000), the hallmarks of best research on cognitive processes ought to involve a framework

98    which allows data to be process orientated, and the TA method has been utilized well when

99    investigating expertise (Whitehead et al., 2015). Collectively therefore, TA offers a

100   propitious methodology to capture the real-time cognitions of world professional snooker

101   players in their environments for the first time.

102        As such, the purpose of this study was to employ a 'think aloud' procedure to

103   examine the real-time cognitions of professional snooker players during solo practice

104   performances within naturalistic settings. Crucially, whilst we offer no *a priori* hypotheses

105   due to the exploratory nature of this study, we remained cognizant of the extant TA and

106   coping literatures findings.

107

108   **Method**

109   **Participants**

110         Participants were seven male UK professional snooker players, comprising super-elite

111   (rank, < 5, $n = 1$), elite (rank < 17 – 48, $n = 2$), and lower ranked professionals (rank > 64, $n =$

112   4). As such, this cohort included a "Triple Crown Winner" (i.e., World Championship, UK

113   Championship, and Masters). In addition, other participants had reached ranking finals, semi-

114   and quarter-finals, as well as multiple Crucible (i.e., World Championship) and TV

115   appearances (e.g., BBC, ITV, Eurosport UK). Participants ranged from 27 to 40 years of age

116   ($M = 34.0$, $SD = 4.5$) with a total of 185 ($M = 26.4$, $SD = 3.6$) years of playing experience

117   between them. All participants were to known the first author and initially contacted by

118   phone, with written informed consent subsequently provided by all participants. The

119   participants were assigned pseudonyms of James, Michael, Steven, Anthony, Dene, Paul, and

120   Stuart.

121   **Pilot study**

122         Following ethical approval from a UK Higher Education Institution, a pilot study was

123   performed to refine the material and procedural elements of this study. Based upon the rich

124   in-depth findings and discovery that Level 3 verbalizations do not lead to reinvestment in

125   skilled performers (e.g., Whitehead et al., 2015), we posited that Level 3 would not disrupt

126   our super-elite and elite sample. The pilot study consisted of a former professional snooker

127   player verbalizing (Level 3) and explaining his thoughts during a solo snooker practice

128   session (various routines) within a naturalistic practice setting (private matchroom in club).

129   This aided in determining the feasibility for; (a) a snooker player to freely verbalize and

130   explain their thoughts, ideas, actions in their own environment; (b) whether the snooker

131   players cueing would be obstructed by recording equipment; and (c) if cueing sound would

132   interfere with clear recordings of verbalizations.

133         For brevity, the pilot study participant followed the Level 3 TA guidelines as set out

134   in the main procedures below. The participant demonstrated his ability to freely verbalize and

135    explain his thoughts and actions using Level 3 without disrupting play. Unfortunately, it was

136    discovered that cueing noise interfered with the capture of verbalizations, as well as the

137    microphone wire detaching from the digital voice recorder when at full stretch across the

138    snooker table on certain shots. Therefore, to counteract these issues, a longer microphone

139    wire and readjustment of microphone position was enforced. Subsequently, from playback of

140    the pilot study's audio recording it was deemed 40 minutes of playing time was appropriate

141    for sufficient data collection (i.e., demonstrated a highly rich and detailed overview of real-

142    time cognitions).

143    **Materials**

144        Olympus DS-50 digital voice recorder with a small microphone attached to the collar

145    was used to capture all participants' verbalizations.

146    **Procedure**

147        In alignment with Ericsson and Simon's (1993) guidelines, all participants took part

148    in a TA pre-practice exercise, specifically: (1) counting the number of dots on a page, (2) an

149    arithmetic exercise, and (3) an anagram problem-solving task. Additionally, participants were

150    asked to explain how they completed their exercise (Level 3 TA). Whereas during play, this

151    related to asking participants to describe their thoughts before and after shot execution as

152    well as providing explanations for their actions (e.g., why a certain shot was played/chosen).

153    Also, snooker players were told that they could engage in TA between shots if they had any

154    thoughts they wished to verbalize. Sequentially, participants were instructed to, "Think

155    Aloud and say everything/anything that comes into your mind before and after each shot you

156    take. Every time you TA can you please explain your thoughts on this" (apart from the

157    striking of the cueball phase). In accordance with the extant literature (e.g., Nicholls &

158    Polman, 2008; Whitehead et al., 2016), if in the event that participants fell silent for an

159    extended period (20 seconds), they would be asked to resume thinking aloud by using

160    prompts, such as, "Please think aloud" and/or "Please continue to explain your thoughts".

161    However, such reminders were extremely minimal as players demonstrated excellent abilities

162    in talking amidst playing. Throughout the whole of the data collection period, the first author

163    was present during each participant's solo practice session.

164            All participants were permitted to practice whatever routines they felt comfortable

165    with during their solo practice sessions. These sessions resulted in familiar routines, such as,

166    line-up's, T's, color clearances, actual frames of snooker, and hypothetical pressure game

167    situations requiring clearances (e.g., 49 behind with three reds left and all of the colors, 70

168    behind with five reds left and all of the colors etc.). Thus, all players routines were deliberate

169    (i.e., goal-driven or stressor induced), with the emphasis on total clearances, or imagining

170    themselves playing in match pressure situations.

171    **Data Collection**

172            All participants were wired up to a digital voice recorder, with a small microphone

173    attached to their t-shirts. The microphone wire was placed under the t-shirt and connected to

174    the digital voice recorder which was placed inside their trouser pocket or on the back of the

175    trouser attached to their belts. Participants recorded their chosen routine from the onset and

176    before the commencement of any other routine performed during their solo session.

177            Data collection commenced from the player setting up their practice routine(s). Data

178    collection lasted from 41 minutes, to the longest at 166 minutes ($M = 83.71$, $SD = 54.04$).

179    These times varied due to the players availability (and table availability within snooker

180    clubs), playing speeds, shot/decision times, and articulation of verbalizations. Each snooker

181    player played on his own table (tournament standard), used their own snooker cues (various

182    makes) and played with tournament match balls.

183    **Data Analysis**

184            Each participant's TA verbalizations were transcribed verbatim and checked for

185    relevance and consistency using inductive analysis. This allowed for content to be grouped

186    into raw themes. To adhere to the relevance criterion the verbalizations associated to snooker

187    performance, and in relation to the consistency criterion, there was a consistency of

188    verbalizations with verbalizations that preceded those (Nicholls & Polman, 2008). The

189   constancy of these verbalizations typified cognitive processes that, "can be used as evidence

190   for the course and nature of these processes" (Ericsson & Simon, 1993, p.170). Critically

191   however, we took all verbalizations into account (i.e., not those just deemed task relevant)

192   following calls from researchers who assert that "unimportant information" could be

193   interpreted as an external dissociation strategy (e.g., Brick, McIntyre, & Campbell, 2014;

194   Whitehead et al., 2017).

195          In keeping with the extant TA literature (e.g., Nicholls, & Polman, 2008; Samson et

196   al., 2015; Whitehead et al., 2017) we used line-by-line inductive content analysis to identify

197   recurring themes (Maykut & Morehouse, 1994). Thus, our idiographic methodology

198   positioned ourselves in ontological relativism, with a subjectivist epistemology (e.g., Sparkes

199   & Smith, 2009). Furthermore, during this exploratory inductive approach, it became eminent

200   to the researchers that the cognitions elicited from the participants generally aired towards

201   stressors, coping strategies, and further snooker related aspects. Therefore, in order to deduce

202   what stressors and coping strategies were, we drew upon the phenomenological findings of

203   Nicholls, Holt, and Polman (2005). Thus, we identified verbalizations that had the potential

204   to cause snooker players concern or negative worry, which were coded as stressors.

205   Alternatively, verbalizations that highlighted attempts to manage stressors, or facilitated

206   performance in an optimal way were coded as coping strategies. Concurrently, all stressors

207   and coping strategies were tallied across the sample.

208          Stressors and coping strategies were grouped together as first-order themes and

209   assigned a descriptive label, with a rule of inclusion written for each theme. For example, one

210   first order theme was described as "planning shot" with the rule of inclusion "The snooker

211   players planned all aspects of the shot (e.g., cannons, screw, stun etc.), including the cueball

212   path, cueball and other balls' landing areas/spatial awareness, and cushion use".

213   *Credibility*

214          Following calls to further strengthen methodological rigor, provide transparency, and

215   attempt to deepen our analyses (Smith & McGannon, 2017), we adapted a member

216    reflections procedures (Bloor, 2001, p.395). According to Tracy (2010, p.844), this umbrella

217    term is applicable to wide ranging paradigmatic approaches, which in our case,

218    complimented the cognitivist underpinnings of the think aloud protocol and our position of

219    ontological relativism (e.g., participants individual realities) and subjectivist epistemology

220    (Sparkes & Smith, 2009).  According to Eccles and Arsal (2017, p. 515) "the results from the

221    method would be different from, and not better or worse than, those obtained by alternative

222    methods of studying thinking." Hence, it is suggested that the number of criteria used in each

223    project can be modified for certain purposes (e.g., Sparkes & Smith, 2009; Smith &

224    McGannon, 2017). Critically member reflections allowed us to adhere to our ethical

225    commitments, whilst allowing participants to reflect upon and critique the understandings

226    (e.g., meaningfulness) and accuracy of our findings.

227         For example, during the taxonomy of raw data, the researchers were divided upon the

228    criteria underpinning the major themes found. Therefore, we liaised with the participants in

229    order to ascertain if the criteria pertaining to the second order themes were true in their

230    associability to first order themes. This provided the participants with the opportunity to

231    define their thoughts and include any further information. Following lengthy discussions and

232    determining of findings with the participants, the researchers then consulted with two

233    independent leading snooker coaches (i.e., critical friends) to provide further reflective

234    scrutiny of our findings. Following this robust feedback and elaboration from the coaches, we

235    conversed with the participants again to ensure all parties were content that the criteria

236    underpinning second order themes were credible in their understandings.

237    **Results**

238         Participants' transcripts revealed 761 stressors from 85 sources (Appendix 1), and

239    1349 coping strategies from 103 sources (Appendix 2). Key stressors identified by the

240    participants were; *table conditions*, specifically, ball polish (35), pace of cloths (36), and

241    kicks (18); *distractions*, specifically, negative/anxious thoughts and commentary (20); and

242    *mistakes*, specifically, shot errors (189). Participants engaged more in problem-focused

243    strategies (1139) than emotion-focused strategies (210) and reported more frequently on

244    *planning shot* (339) and *cueing thoughts* (92) in relation to problem focused strategies,

245    whereas *rationalizing* (99) and *positive appraisal* (44) were essential to emotion-focused

246    coping.

247          Idiographic profiles present a combination of general ongoing cognitions in relation to

248    stressors and coping strategies in-action as well snooker related aspects, hence this

249    combination aided in heightening the completeness of verbalizations. Akin to Nicholls and

250    Polman (2008), to exhibit our coding of TA data, all stressors are followed by the code [S],

251    whereas coping strategy is followed with the code [C].

252    **Stressors**

253    *Ball polish/new balls*. From Michaels's responses (line-up routine), one key stressor was

254    immediately evident and throughout his solo practice session, which was backed up with

255    multiple coping strategies. As explained by Michael "…When we were in Gibraltar the white

256    was like a bar of soap [S], they were slippy [S]…it did not work if you hit any side [S], any

257    sort of unwanted side [S]…even if you played a shot like this you could miss that easily" [S].

258    Following on from these comments Michael reveals how he has tried to cope with ball polish,

259    by altering his technique to control the cueball more efficiently, and use of cueing thoughts,

260    "Well, a lot of time spent in trying to shortening up at the minute [C], especially as I've

261    polished the white [S], hence there's too much on this [S], just center ball [C] and short cue

262    action [C]. Put more simply, Michael says "Just concentrating on the middle of the white [C],

263    I know the potting angles so just running through for this one" [C]. Evidently, Michael plans

264    his shots beforehand in order for him to employ his coping strategy, thereby maximizing his

265    attention on cueing delivery [C] (feathering/timing of strike) and shot execution [C].

266          As Michael's solo practice progressed his responses on coping strategies increased on

267    the issue of ball polish, so much so that Michael declares, "I have to play a little higher on the

268    white [C]…I'm still learning, still recalibrating yeah [C], like that one, due to reaction of

269    polished white [S], awful shot" [S].  But this is followed up by Michael's trying to rationalize

270    (positive appraisal) the outcome of his shot "…but its fine, I'm still on a red [C]…long as I'm

271    hitting middle of the white [C] and I can feel the weight of the cueball on my tip" [C].

272    Interestingly it has emerged that Michael uses a form of bio-sensory feedback (i.e.,

273    body-cue-cueball striking) as a coping strategy to counter the effects of ball polish on the

274    cueball [C]. Markedly this has the potential for Michael to adapt his technique (e.g., timing,

275    striking, and visual-cognitive functioning) more rapidly to the varying playing conditions he

276    is likely to encounter across tournaments and practices [C]. Thus aptly, Michael summates,

277    "Centre of the white [C], so when a problem comes up [S] that's what you're trying to do,

278    give a distraction [C], not necessarily to eradicate but to help you" [C].

279    On another slant, Thomas offers his insight to the difficulties of playing with new

280    balls on thinner cloths, with regards to how they react much differently, and how this creates

281    a multitude of ambiguous cognitions:

282    The other thing as well that I've noticed, like when you're away, if you're playing

283    with new sets of balls or polished balls it's like it seems to break wider [S], and it

284    don't help with the thinner cloth [S], and you just think well "is the polish done that

285    [S], is the slide done that, the slide [S], you think the cloth coz it's so thin [S]" and

286    then you do start to think "is it me, is it the way I'm cueing [S], honestly it's such a

287    strange balance really.

288    *Pace of cloths.* In close proximity of balls, the varying cloths on tables resulted in participants

289    giving differing conceptual views of how cloths affect their playing style/approach. For

290    example, Dene narrates the challenges faced when trying to adapt from naturalistic practice

291    conditions to practice and match conditions at a venue:

292    You go onto a practice table at a venue and you do like a similar routine to this and

293    you think "well I'm all over the place why can't I clear them up or anything?" [S] and

294    because, it's like you say it's because this is my table I'll play the shot a certain way

295    and it's just like, I feel like I have to concentrate more on another table [S], as if I'm

296    not concentrating enough on this table [S], does that make sense?

297        To further clarify his points on the difficulties faced when adapting to tournament

298    cloths Dene explains how he has to readjust to angle displacement. So much so that he feels

299    that deliberately practicing more routines involving potting is more beneficial to his game

300    than safety exercises.

301            And sometimes I feel when you go onto the match table from the practice table,

302            because obviously the angles are different [S], so it's like even though I'm practicing

303            the safety [C], you've got to be able to adapt [S]…Yeah not nice when you can't flow

304            [S]. So like I say I think I'll naturally prioritize potting routines over safety routines

305            [C], erm just because it's the name of the game.

306            In substantiation of Dene's remarks on adapting to the table conditions, James reveals

307    that he has had to aim higher on the white [C] and shorten his cue-action [C] to help

308    acclimatize to the thin cloths:

309            On these delicate tables [S], because you know I like to get through the ball erm    [C],

310            and sometimes you feel like you've got to, I've started to play the white a lot

311            higher [C], I can still get through it but I get less spin [C], you still aim on these slippy

312            tables [S], on brand new cloths [S] with brand new balls [S], you just hit the ball in

313            the same place, you lose the white all of the time, I do anyway [S]. If you're not

314            willing to change your strike and have a much shorter action [C], which is difficult,

315            because you're adapting that for every shot [S].

316    **Distractions**

317    *Negative/Anxious thoughts*. As pointed out in the results, negative thinking was frequently

318    referenced to by the participants' during their solo practice sessions. Here, Anthony explains

319    how anxious thoughts during play affect his thoughts and actions:

320            Generally as the match goes a bit scrappy [S], I don't know if anxious is the right

321            word but you feel alright but you just want to get in amongst the balls [S], you know

322            my strengths are to try and win frames in one visit, one go or both [C]…well

323            sometimes you start turning balls down you would normally go for [S] because you

324    start thinking "oh if I miss it there's an easy 20 or 30 on you know [S], you just ain't

325    got to worry about it [C], play to, try and play to your strengths if you can [C],

326    obviously there's times when you might not be feeling very good about yourself [S],

327    so I might have to start turning the odd ball down [S]…erm I think it's just you want

328    to perform [S] rather than emphasize "it should be I want to win"[C], so if I'm

329    struggling, fuming, angry, getting a little bit annoyed with myself [S], remind myself

330    you're here to win [C].

331    Furthermore, Anthony highlights the haphazard nature of anxious thoughts [S], in

332 relation to moods and feelings experienced during matches [S], and claims that these issues

333 may be more situation-specific during matches [S].

334    Erm I don't know, it's situations [S], sometimes obviously you get a bit nervous a bit

335    more [S], other times, sometimes you're just potting them ain't ya, I don't er, yeah

336    you get in the zone or whatever it is, it's not always in the zone all of the time [S],

337    fucking hell I wish I could, I wish I knew how to get in the zone all of the time [S], I

338    don't, sometimes I'm thinking "what am I going to have for dinner ?" [S] do you

339    know what I mean…it can happen in big games where you're supposed to be excited

340    [S], I'm sure at one stage…at the crucible I was just thinking about "what's for

341    tea?" [S] It's mad. I mean obviously sometimes, sometimes it's, they should be the

342    most nerve-wracking moments of your life, but they're not, calmish…and other times

343    where's there's absolutely no need to stress or worry about anything and you're like

344    fucking nightmare with yourself [S], but that's when you've gotta say "get a grip, do

345    what you do" [C] that's where the pre-shot routine comes in [C].

346 *Commentary/earpieces.* In the following excerpt, James highlights the challenges he faces

347 when dealing with commentary during his matches:

348    There's a lot of criticism that goes on in a match [S], in a commentary box [S],

349    whereas in my opinion you're there to paint the picture of what's going on on the

350    table [C], and explaining the nuances of the game [C], and the if's, but's and maybe's

351    [C], not really to slag 'em [S], there's a bit too much of that [S]. If I sense the crowd

352    level of expectation [S], the level of expectancy to play a shot is getting higher [S], I

353    know that's being fed to them in the commentary box that I can see [S], I think we're

354    the only sport where I can see the people that are explaining the action [S]…there's so

355    much I'm trying to keep out [S], keep it out of my brain [S]. You know we're not

356    talking about camera moving [S], distractions in the crowd [S] and mobile phones

357    going off [S], but there's so much going on that I'm aware of [S], or perhaps I'm too

358    aware of [S], that at you, that's taking away from your focus [S].

359         Indeed, James further laments the potential deleterious effects of commentary and the

360  earpieces in the following narration:

361    I tell you what, it's terribly off-putting when you're out there concentrating and the

362    crowd are silent and you know a certain commentator has made a joke in the box [S],

363    so the crowd at home, he's commentating for the crowd at home, but the crowd in the

364    arena have reacted to his joke and laughed while you're on a straight blue [S], well I

365    can't think of anything, I can't think of another analogy for it, I can't think of another

366    performance where that can be affected by that [S]…I remember playing a shot, I can

367    remember playing it at the Crucible as I'm feathering up to the ball getting ready to

368    go, as I'm literally about to take it back to the ball, I can literally hear the

369    commentator say "this is a big shot" [S]  and I had to stop [S], start again [C]. Now he

370    knows, he knows saying this in the commentary box, he knows I've heard him

371    because somebody has got their earpiece turned up [S], and then I'm going home, it's

372    difficult…commentators are like "how's he missed that" [S] and I'm like "well, how

373    long have you got, how long have you got mate?"

374         As a result of the aforementioned information, we can see how the

375  interchangeableness of distractors becomes increasingly difficult to control, regrettably to the

376  extent that it can cost a player a match.  In greater ponderance James adds:

377       It's the unexpected distracted noise [S], well for years I used to play through things

378       like that [C], if a phone went off, if I was down on a shot and a phone went off [S],for

379       lots of reasons I would carry on and play the shot [C], I didn't want anybody to know,

380       and almost admit that it had distracted me, pride [C], I wanted to show, demonstrate,

381       that I could play through that, you know that phone's not going to put me off [C],

382       whereas it's already put me off, it's already in [S].

383  While in a humorously, witty grandiloquence, James says:

384       I'm trying to win the World Championship [S], to this red and get up for the blue [C],

385       and I'm also trying to demonstrate to the man in F6 that his phone hasn't put me off

386       [S], but it's difficult isn't it.

387  *Mistakes (e.g., shot errors, hitting thick, finishing straight, anxious thoughts).* A high

388  frequency was reported by players concerning the arbitrary nature of mistakes during play.

389  To the onlooker, these mistakes go unnoticed, however to the expert player, there's an

390  unceasing battle of emotions (e.g., dissatisfactory), judgements and/or calculations to

391  consider when performing. Here Anthony reveals his thoughts:

392       That's straight [S], 20, two behind, 6, 15, 20 [C], I need the red, color and the blue

393       [C], potting the pink, stroking it and making sure I'm leaving plenty of angle [C],

394       straight's no good to any man [S].

395       On the other hand, Steven demonstrates the extreme difficulties faced when the

396  cueball is not under perfect control, and how the effects of this play havoc with conscious

397  thought processing when performing:

398       So if all of a sudden I've started to lose the white [S] and I've got to pull out a mid-

399       range pot [S], after mid-range pot after mid-range pot [S], all of a sudden more

400       pressure starts coming on your cue-action doesn't it [S], because everything has to

401       hold up better [S] (64-68)…see how my white is a "loosey goose" [S]…that was

402       because I finished almost straight [S], and I wanted to finish slightly lower on the blue

403       [S], I'd just gone through slightly too much [S]…it's just because I'm trying to be so

404   precise [S], and I wasn't precise as I wanted to be [S], so it's not an annoyance [C],

405   it's a realization of "ok well I'm trying to be this precise" so you know [C], just try

406   and learn from what I'm doing [C]. Quite often I'm just over-cueing the backswing

407   just slightly too much [S], so bringing it back too far [S].

**Problem-focused coping**

409   *Planning shot*. Evidently the key highlight of our findings was shot preparation. Shot

410   preparation involves many aspects from; planning, decision making, knowing the shot,

411   leaving the desired angles, pace of shots, identifying solutions and cueball paths among

412   others (see Appendix 2). In respect of consolidating this information (e.g., Appendix 2) the

413   critical reflections aided greatly with this (Bloor, 2001). Accordingly there were numerous

414   amounts of similar explanatory verbalizations on this task-related topic from players. Here

415   Dene explains:

416   Yeah options [C], I'll play into the area I think [C], I've come a little too far there [S],

417   could have been a little closer to give myself choices again [S], but I'm straight

418   enough on this red, the roll through here [C], with the other reds gone the position on

419   the black is not as important so more space to move the white [C], so even if I leave

420   myself straight or slightly off straight it's not too much of a problem [C].

421   In the following excerpt Steven highlights the ability to think shots ahead from his

422   current cueball position, thereby showcasing his ability to problem solve his way through

423   break-building:

424   Well I'm thinking now screw back [C], leave the white low on the black [C], so I can

425   run through or stun through and play for one of these two [C], so I'm playing 2-3

426   shots ahead in this situation really [C], so yeah it's just playing for an area [C],

427   although if you said I want you to play this red to the black for the bottom red [C], if

428   you told what red to play for each time, then obviously you're thinking differently

429   aren't you [C]. Depending on where the balls are, so like obviously I can play for any

430   area here now [C], doesn't really matter but you're still at the same time "I don't want

431    to be moving my white from there to there to there" [C], it needs to be all within 5-6

432        inches of each other do you know what I mean [C], keep everything simple [C].

433        While here, James offers his unique insight to the thinking and planning of shots

434    ahead with regards to; leaving the right angles, what colors to take, the outcome of potential

435    shots, and identification of key balls to win the frame.  However interestingly, James makes

436    reference to how this situation heightens his senses at this point:

437        Right we're running out of loose reds [C], starting to look at the problem [C], getting

438        close to the winning line in the frame, I've sensed that [C], probably need three or

439        more reds [C], erm loose reds are at a premium [C], so here I'm trying to, knowing

440        that the only loose red that pots is that one which is difficult to get to [C], I'm starting

441        to see a situation where if I pot this red and leave it short on the blue but high on the

442        pink [C], would leave the angle [C], then to move red [C] out of the way [C] which

443        frees that one up [C], I will then be able to pot that red [C], this red [C], and that red

444        near the corner [C], that also puts these two reds available to this middle pocket [C],

445        and you know if I get the next two shots right the frame is there [C].

446    *Cueing thoughts*. The second most frequently cited problem-focused coping strategy by

447    participants was their use of cueing thoughts. While there were many examples of cueing

448    thoughts, here Michael gives an excellent example of how he uses cueing thoughts to manage

449    stressors during performance:

450        I know when I'm going to play well if I'm nice and smooth [C], so if I'm struggling

451        or anything like that [S] I consciously tell myself "smooth" on every shot [C], every

452        time I'm down on the shot, on my backswing, I'm pulling it back and I'm saying

453        "smooth" and "dead still"[C].

454        Interestingly, from within the extant literature (e.g., Beilock & Carr, 2001; Dreyfuss

455    & Dreyfuss 1986; Masters, 1992) it is purported that if participants' consciously attend to or

456    monitor their performance (i.e., execution) it is likely to prove deleterious to performance,

457    hence leading to reinvestment, yet in Michaels case, it aids in the facilitation of optimal

458    performance.

459    To further explicate Michael says:

460         I know if I stay dead still [C] and my cueing arm is smooth [C], don't matter if I'm

461         shaking like mad [S], nervous [S], not nervous, sometimes totally chilled out [C], you

462         know sometimes you don't feel like playing [S], but I know if I tell myself "stay dead

463         still, dead still" [C] and "stay smooth, smooth" [C] they're the two words that make

464         me lock my arm in how I like it [C], makes it feel like everything is going to go in if

465         I'm like that, "smooth" [C], "head still" [C] and "smooth" [C], that's it, that's it, key

466         word yeah. (159-166)

467    **Emotion-focused coping**

468    *Rationalize*. An essential part of coping in snooker was associated with players recognizing

469    that they need to keep their emotions at bay during performance. This led to players

470    explaining their thoughts on having to be rational in their thought processes. Here Anthony

471    expresses his thoughts on recognizing that sometimes the balls do not run kindly by adding:

472         So I'm going to play for the yellow [C], always the same, always play a shot [C],

473         Selby never wastes a shot, erm know like when you get the hump sometimes [S], you

474         know like trying to force the issue [S], pot balls, don't land on one [S], instead of just

475         getting down and chipping a shot and just putting the white safe [C], instead of going

476         back to your chair sulking [S], you know having a little second so you can actually do

477         something with it [C], even though  I'm not happy with what's just happened [S],

478         "can I actually do something with this shot?" [C], do you know what I mean, so yeah

479         try and have a purpose for every shot [C].

480    In similar vein, James extends upon Anthony's views by saying:

481         I often dip into this when I play, I won't play for the blue [C], because playing for the

482         blue brings in the risk of being short [S], and now you can just make 6 and play safe

483         [S]. In a situation like this, just play for the green or the brown [C]…so just run away

484    and then come back [C], if you finish there the break is over [S], or it's much more

485    difficult than it should have been [S].

486         While in philosophical tongue, Steven concedes that it is all about giving one's all

487    irrespective of the outcome:

488         Because I'm a laid back person [C], so I don't always ever think "I must win this

489         match at all costs [C]…you know I do obviously play every game to win [C] but it's

490         more about 'do everything I can to win' [C] and if that's good enough it's good

491         enough do you know what I mean [C],…I would just make myself as repeatable as

492         possible [C].

**Discussion**

494         The novel and original exploratory findings of this study demonstrated that super-elite

495    and elite professional snooker players' real-time cognitions were generally directed towards

496    stressors, coping strategies, and snooker related aspects. From the collection of snooker

497    players thought processes, three key stressor themes emerged: (a) Table Conditions, (b)

498    Distractions, and (c) Mistakes. Alternatively, our main finding was that super-elite and elite

499    professional snooker players engaged in an extensive amount of problem-focused strategies,

500    explicitly Shot Preparation, than emotion-focused strategies, namely Rationalizing.

501    Analogous to the extant TA and coping literature, the task orientated verbalizations varied

502    continually over solo practice performances. The findings provide further support that coping

503    occurs as a cognitive process to manage internal or external demands (Lazarus, 1999).

504         In reaffirmation, no naturalistic TA study on super-elite and elite professional snooker

505    players' cognitions during solo practice existed. Although our TA study is the first to provide

506    a significant contribution to the sport psychology literature on understanding super-elite and

507    elite professional snooker players real-time thoughts within ecologically valid settings, there

508    are limitations that necessitate consideration. Indeed, even though we utilized practice

509    settings and real full-size matchplay tables, the fact that participants needed to be reminded to

510    TA and continue to explain their thoughts would appear unnatural, especially in terms of

511    reinvestment (e.g., Beilock & Carr, 2001; Masters, 1992). However, as explained in the

512    procedures, players were very adept at verbalizing during performances suggesting they have

513    a high allocation of cognitive processing resources (e.g., attentional control, goal-directed).

514    As a matter of fact, only five pots were missed during nearly ten hours of playing between

515    seven players. Therefore, while we did not measure performance per se, the study signifies

516    that this procedure did not truly impede the performances of our super-elite and elite cohort.

517    Though, measuring performance would be desirable for future research purposes.

518        Within the TA literature (e.g., Nicholls & Polman, 2008; Whitehead et al., 2015,

519    2018) it is acknowledged that there cannot be complete certainty that verbalizations are a true

520    representation of the thought(s) being elicited at the time (i.e., not all cognitive processes are

521    conscious). Thus, individuals cannot explain what is happening outside of their awareness as

522    unconscious processes cannot be verbalized (e.g., Nisbett & Wilson, 1977). Hence, in our

523    study, players may have given implicit theories about their thought processes which may

524    directly relate to their general snooker cognitive processes during both practice and

525    matchplay (as pointed out in the results). Contrariwise, we argue that these generalizations

526    offer sport psychology practitioners and consultants to better understand all possible thought

527    processes during snooker performance. Undoubtedly this can help players to maximize their

528    performances and well-being. Nevertheless, our understandings of real-time cognitive

529    processes across all levels of snooker (and self-paced sports) would certainly benefit from

530    experimental studies employing competitive situations; such as practice matches (e.g.,

531    pressurized conditions and/or environments) to see how players cope. Hence, a limitation of

532    the current study is the absence of a competitive situation.

533        Moreover, key questions arising from our findings, such as: 'how' and 'when' do

534    stressors disrupt thoughts and motor processes? Some possible suggestions within our

535    findings (i.e., Anthony) are that stressors may become more negatively heightened during

536    situation-specific game scenarios (e.g., multiple shot choices), or around key pressure pots

537    (e.g., frame/match winning balls). Conceivably these situations would induce more

538    prominent anxious/negative thoughts than others (i.e., thinking time process). These

539    appraisals draw comparisons with other TA investigations who found that verbalizations vary

540    over distances in cycling time-trials and distance running, with more stressor related

541    cognitions combatted by mental/pacing strategies during the early stages of performance

542    (e.g., Samson et al., 2015; Whitehead et al., 2017, 2018). In contrast, to counter such thoughts

543    in our study, the players explained that they use emotion-focused strategies (e.g., internal),

544    such as, imagining themselves being another top player when playing certain shots (i.e., task-

545    oriented coping strategy - imagery).

546          Highlighted earlier, the exploratory findings of this study provide some support for

547    the transactional model within the context of sport (e.g., Lazarus, 1999), yet the study did not

548    examine the emotional aspects of the model. Furthermore we did not examine the intensity of

549    stressors experienced, so it is problematic in ascertaining how these stressors would be

550    experienced during real-time matchplay performance (e.g., Nicholls & Polman, 2008;

551    Samson et al., 2015). Thus, construct validity could be evaluated by comparing verbalizations

552    with physiological measures, such as, heart rate and blood pressure, and psychometric

553    instruments.

554          It may be judicious for experimental researchers in cognitive psychology to recreate

555    naturalistic situation-specific snooker scenarios to determine how and when stressors truly

556    impact upon performers cognitions during performance. Insofar as to greater understand why

557    players appear to have the ability to cope with setbacks (such as forgetting mistakes) yet

558    continue to consistently perform. Whitehead et al. (2015) reported that higher skilled golfers

559    did not dwell on mistakes or ruminate on technical errors, and actively sought out solutions

560    through greater use of deliberate planning and gathering of information. Recognizably our

561    findings accord with Whitehead et al. (2015) and Nicholls and Polman (2008), in terms of

562    substantial planning strategies (i.e., shot preparation) used by the players. Alternatively,

563    cognitive researchers using the directed forgetting paradigm have demonstrated that mentally

564    tough individuals have the enhanced ability to prevent unwanted information from interfering

565    with current goals (Dewhurst, Anderson, Cotter, Crust, & Clough, 2012). Saliently therefore,

566    it could be perceived that a key coping mechanism of our super-elite and elite cohort is their

567    ability to forget, and this may be a contributing factor for the differences in their success.

568    However, this should be explored further.

569         While this study did not measure behavioral coping, the Level 3 TA protocol enabled

570    the players to describe, demonstrate, and explain their use of behavioral strategies (see

571    Appendix 2) when confronted with situational game dynamics during practice. For example;

572    getting up off the shot and walking around the table to clear their thoughts, having the cueball

573    cleaned to gather their thoughts positively, slowing their pace of play down (e.g., build

574    momentum, gamesmanship, aid decision making), timing/feathering the cueball an equal

575    amount of times, and aiming/striking center of the cueball (e.g., plain ball potting to avoid

576    playing with side/unwanted side). Comparably, Whitehead et al. (2017, 2018) found that

577    cyclists used pacing strategies during certain phases of 16.1 km time trials that enable better

578    effective cognitive control during stressful episodes (e.g., negative feedback) in relation to

579    task goals.

580         Irrespective of this information, it is vitally important to stress that the criteria

581    underpinning pacing in cycling (or running) is markedly dissimilar to that of snooker, with

582    particular reference to the physiological aspects. Thus, while we feel it is important to make

583    generalizations (Smith, 2018), what pacing is to cycling or running are poles apart to what

584    pacing is in snooker. And what planning strategies are to golf and chess, are highly disparate

585    to professional snooker, given that these strategies are underpinned by domain-specific

586    nuances. For instance, and to our knowledge, there are no other sports like snooker which

587    require a performer to strike a stationary ball onto another stationary ball and then onto a

588    target (pocket). Indeed, this could warrant further investigation to gaze behavior. Still

589    however, and using hedging prose (Chenail, 2010), the results potentially offer further

590    support for the existing TA and coping literature in that mental strategies (i.e., planning,

591    strategic thinking) are continually used to manage stressors across disciplines, but remain

592    distinct from one another at the same time. Thus, researchers should duly recognize that the

593    findings from this study are snooker-specific.

594           Lazarus and Folkman (1984) concede that individuals rely more on certain strategies

595    at different times throughout a stressful encounter because coping is a 'shifting process'.

596    More explicitly, it is the constancy of appraisal and re-appraisal of a stressful situation that

597    shapes coping, which alters the cognitive re-appraisals (Nicholls and Polman, 2008).

598    Accordingly this process can be likened to the fundamentals of professional snooker, with

599    coping in snooker described as "continual reactive-adaptive cognitions and behaviors to

600    manage differing internal and external visual-somatosensory stimuli". Whitehead et al. (2017,

601    2018) assert that trained athletes employ both proactive and reactive cognitive control of

602    focus of attention to facilitate performance, and have the ability to self-regulate attentional

603    focus in response to internal (e.g., sensory monitoring) and external distractors (e.g.,

604    monitoring) during performance. And phenomenological researchers on esoteric expertise

605    claim that this 'somaesthetic awareness' or 'embodied cognition' helps experts fine-tune their

606    cognitive representations through heightened sensorimotor processes during real-time

607    performance (Shusterman, 2008). Therefore, future TA studies on snooker could benefit from

608    phenomenological research exploring the effects of 'touch' and 'feel' on cognitions during

609    performance.

610           Moreover, it is important to note that the process of stress and coping varied both

611    intra- and inter-individually throughout our findings. For example, there were occasions of

612    players being able to experience a continuation of stressors before employing a coping

613    strategy, and other instances of players consistently reporting problem-focused strategies

614    without experiencing a stressor (e.g., Nicholls & Polman, 2008; Samson et al., 2015;

615    Whitehead et al., 2017, 2018). Explanations for these variations may be that higher ranked

616    players experience a lower frequency of stressors to their counterparts due to; their superior

617    proficiency of cueball control and deep knowledge structures, their ability to rapidly encode,

618    recall, recognize structured perceptual information, and superior accuracy of evaluative and

619    discriminative measures when comparing strengths and weaknesses of varying game

620    situations, (Abernethy et al., 1994; Charness & Gobet, 2006; de Groot, 1965).

621        The findings of this study are representative of the cohort of players involved; hence

622    the findings cannot truly represent all professional snooker players coping related thoughts.

623    However, using Level 3 verbalizations enabled a higher amount of general snooker related

624    thoughts, and with the world professional snooker circuit being relatively small (e.g., 128

625    players), the breadth of players (i.e., various rankings) thoughts may be hedged as

626    generalizable to a greater extent (Chenail, 2010; Smith, 2018). Despite this, intra- and inter-

627    individual differences do exist between our participants, for example; one has won multiple

628    tournaments, and some have reached latter stages, while some are lower ranked. Certainly, it

629    may be the case that the differences in achievements are due to other factors that affect

630    coping, such as, personality, age, or their natural ability to cope with stressful situations (e.g.,

631    Kaiseler, Levy, & Madigan, 2017). Thus, it may be wise for future TA studies to employ

632    personality surveys to address such potential differences.

633        This exploratory investigation has provided a unique insight into the real-time

634    relationship of stressors and coping in professional snooker, but there are other areas in which

635    future snooker research could progress. Indeed our participant sample consisted only of male

636    super-elite and elite players, thus making generalizations of coping across genders and sport

637    difficult. Kaiseler, Polman, and Nicholls (2013) encountered differing cognitions in stress,

638    appraisals, and coping between males and females using TA during a golf putting task.

639    Hence, with the rapid growth of female professional snooker of late, it would be

640    advantageous to examine the cognitive differences of super-elite and elite female and male

641    snooker players.

642        Positively, it could be implied our findings do corroborate with many of Abernethy et

643    al.'s (1994) overtures despite ecological concerns. Yet simultaneously, there needs to be

644    greater clarification of the meaning and abilities of the 'experts' used in their study in relation

645    to the 'super elite' and 'elite' performers of our study (i.e., true knowledge). Hence, although

646    we can make inferences with regards to professional snooker players appearing to; recognize

647    structured perceptual information with rapidity, are able to evaluate and discriminate the

648    strength and weaknesses of varying game situations (i.e., percentage snooker), and have the

649    intuitive expertise to plan out multiple shots in advance of their current cueball position, we

650    did not measure these directly. Therefore, drawing accuracies is somewhat limited here.

651    Likewise we did not directly examine the visual components of real-time performance in

652    snooker, but critically, we do support Abernethy et al. in their view that snooker is very much

653    about problem-solving ability and not visual skills, based upon our findings. Thus, replicating

654    Abernethy et al.'s study with super-elite and elite players would be extremely advantageous

655    for theoretical purposes.

656            In this study we took an alternative stance to the extant post-positivist/cognitivist

657    approaches permeating the TA literature, and utilized a relativist position. Indeed, following

658    on from the recommendations of Smith and McGannon (2017), it is theoretically important to

659    offer insights on the other side of the philosophical coin. And in agreement with Eccles and

660    Arsal (2017), our results from this position were different but not better or worse.

661    Importantly, our theoretical position allowed us to go above and beyond our initial

662    interpretations of the data, and through the adoption of member reflections and critical

663    friends this enabled our findings to achieve heightened verification (Bloor, 2001).

664            This paper has provided a significant original and novel contribution to applied

665    cognitive science in sport psychology. The paper further contributes to the limited research

666    on super-elite and elite sporting performers *in situ*, and provides a rich and in-depth

667    understanding of professional snooker players' cognitive processes in an ecologically valid

668    sporting environment for the first time. Markedly, this study extends and highlights the

669    promising utilization of Level 3 TA verbalizations within the domain of expertise (Whitehead

670    et al., 2015) and we recommend future research to this consider this methodological

671    approach. Equally, this methodological procedure facilitated the discovery of stressors,

672    coping, and practices involved in professional snooker, also for the first time, and therefore

673   burgeons our knowledge of coping in self-paced sports generally. The exploratory findings of

674   this study extend previous research utilizing TA in self-paced sport and have afforded

675   researchers the opportunity to examine thoughts during real-time practice performance(s),

676   thus providing support for TA as feasible method. Likewise, we have provided many other

677   exciting areas in which snooker could be further explored, particularly within the

678   experimental and phenomenological areas of literature. Such endeavors are critical for

679   theoretically enhancing our understandings of human cognition in general.

680         In conclusion, our evidence provides support for the transactional model of coping

681   (Lazarus, 1999) whereby thought processes change continuously during performance, and in

682   particular, at highly dynamical situation-specific moments. In addition, our exploratory

683   findings further lend support to the knowledge that problem-focused strategies are vital

684   psychological characteristics of expert and optimal performances in general. However, it is

685   important to remain aware of the fact that the cognitions elicited from this study are purely

686   snooker-specific and are reflective of super-elite and elite performers in professional snooker.

687   Therefore, we warrant researchers and practitioners to remain cautious in their approaches to

688   generalizations. Although concurrently, it would be desirable for future TA studies to

689   continue to utilize a relativist lens, as it may lead to more robust and verifiable

690   generalizations across sports. The findings ought to be used in assisting coaches,

691   psychologists, and players in evolving the applied praxis of interventions and pedagogical

692   understandings to maximize playing performance and support well-being.

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793  **Appendices**

794  *Appendix 1. Stressors*

| Second order theme | First order theme | Frequency |
|---|---|---|
| Table conditions | Ball polish, new balls | 35 |
| | Pace of cloths (fast, slow, grip) | 36 |
| | The break-off | 8 |
| | Playing shots hard | 2 |
| | Inconsistent tables (e.g., heavy, fast) | 6 |
| | Cushions e.g., pings, squaring off, slide | 20 |
| | Kicks | 8 |
| | Bad contacts | 1 |
| | Cueball physics (throw) (9) | 2 |
| Table management | Ball positions/available shots (e.g., object balls, colors) | 10 |
| | Shot selection – e.g., screw, swerve, check-side, follow through, stun/stun-run, reverse-screw | 5 |
| | Shot difficulty (e.g., balls down side-cushions, funny angles, cueing over balls, cannons, cushion play, forcing shots, delicate holds, dead weight, straight) | 29 |
| | Cushion pings | 8 |
| | Shot pace | 6 |
| | Cueball distances (long) (6) | 3 |
| Distractions | Venue atmosphere | 4 |
| | Audience/crowd moving | 3 |
| | Other balls in peripheral vision | 4 |
| | Commentary/commentator remarks/terminology | 22 |
| | Stigma (negative play) | 2 |
| | Other players remarks | 1 |
| | TV negative sport promotion | 2 |
| | Social media abuse | 10 |
| | Wanting to perform | 3 |
| | Mobile phones | 4 |
| | Cameras | 2 |
| | Media | 3 |
| | Lacking confidence/uncomfortable | 7 |
| | Wanting to impress the audience, be appreciated | 11 |
| | Ear pieces | 5 |
| | Public expectation/perception/insecurity of types of shots you play, playing to the crowd | 8 / 15 |
| | Match pressure/pre-match nerves (e.g., not thinking clearly) | 12 |
| | Player status | 5 |
| | No practice time on match table | 2 |
| | Practice opportunities at venues/practice cloth speeds | 3 |
| | Poor preparation (e.g., not having table recovered) (21) | 3 |
| | Waiting to play shots | 14 |
| | Slow play/opponents/expertise of opponent | 7 |

|  | | |
|---|---|---|
| | Playing arena | 1 |
| | Multiple shot choices/Indecision/decision-making | 17 |
| | Negative peer perception | 1 |
| | Negative/Anxious thoughts/moods/feelings, mind wandering, overthinking, boredom, frustration, sulking in chair, self-talk, thinking time, watching other player | 45 |
| | Lacking concentration | 2 |
| | Parental expectations | 1 |
| | Ego (e.g., trying to match opponent, go toe-to-toe) | 10 |
| | Gamesmanship | 1 |
| | Winning tournaments | 4 |
| | Winning (e.g., frames and matches) | 3 |
| | Tip | 12 |
| | Practice partners behaviors | 3 |
| | Amotivation with practice (e.g., tedious shots, routines) | 11 |
| | Pending shot outcomes | 7 |
| | Life issues (e.g., family) | 2 |
| | Travelling to tournaments | 1 |
| | Radio music | 1 |
| | High level playing consistency (e.g., expectations) (22) | 9 |
| Environment | PTC tables (heavily played) | 1 |
| | Warm venues | 2 |
| | Same modes of practice (knowing what to practice) | 2 |
| | Practice environment (e.g., no pressure, negative people) | 4 |
| | Time between tournaments | 1 |
| | Making the step up/learning curve | 5 |
| | Feeling comfortable | 2 |
| | Used to playing on same table (e.g., lack of concentration) (8) | 2 |
| Mistakes | Missed pots (2) | 5 |
| | Shot errors/dwelling (trying to be perfect, poor position/incorrect angle, take balls for granted, overrun, under-hit, loose white, finishing straight, deceleration, quick delivery/bad timing, cueball striking – e.g., hitting thick, unwanted side, potting off jaws/wobblers, bad break-offs, tying the black up, cannons, splitting packs) | 190 |
| Luck | Dealing with bad runs of the ball (1) | 12 |
| Frame scores | Score/points available (1) | 5 |
| Performance | Expectations | 7 |
| | Rest play | 9 |
| | Overall performance/embarrassment | 4 |
| | Pressure balls/game situations (e.g., frame balls, leaving everything if you miss) | 14 |
| | Remembering past negative shots/outcomes of matches | 7 |
| | Pressure clearances | 2 |
| | Own pace of play | 3 |
| | Scrappy frames | 2 |
| | Shot perfection (feathering too much) | 1 |
| | Middle pocket shots (e.g., thin cut blues, pinks, reds etc) | 2 |
| | Long blues | 1 |
| | Adapting to match table (and each shot) | 10 |
| | Not getting through the white (e.g., jabby) | 2 |
| | Bad losses | 3 |
| | Tactical game | 2 |

795
796          *Note*. Number of stressors reported by the seven participants during their solo practice performances.

797   *Appendix 2. Classification and frequencies of coping strategies*

| Coping function | |
|---|---|
| Second order theme | First order theme (frequencies) |

**Problem-focused coping**

| | |
|---|---|
| Shot preparation | Planning shot (359) (e.g., decision-making, play cueball into areas, see/sighting/know the shot early, knowing various ways to play shots/knowhow, leave the right angle, cueball paths, use of cushions, identify key balls/angles, split packs, shots ahead, pace of shot, knowing the balls you need before getting to the table for the clearance) Identify solutions to obstacles (i.e., pattern recognition/shot templates, intuition) |
| Mathematics | Maths (13) |
| Strategic snooker | Percentage snooker (e.g., margins for error, knowing when and when not to take a shot) (39) Use experience (7) Focus on the table (5) Put opponent in for break-off (2); Take the loose reds (2) |
| Tactics | Play to strengths (e.g., turn odds into your favor, open the game up) (10); Good pace of play/rhythm (10) Make sure of the pot (9) Break-building/scoring (e.g., intimidating opponents) (8) Always use the cushion when playing brown to blue (6) Alter tactics to differing playing styles (4); Aiming thin not thick (4); Play the first shot (4); Playing up for a baulk color to clearance easier (4) Get around the black (3); Commit to the shot (3); Always play two cushions off black to yellow (3) Keeping it safe (2) Grinding (1) |
| Cueball control | Leave options/angles (60) Short cueball distances (10) Leave the white in the middle of the table (2) |
| Cueball physics | Manipulating the cueball (4) |
| Behavioral coping | Pre-shot routine (26) Get up off shot (walk around table, clear thoughts) (8) Trusting yourself (7) Feeding off opponents' bad shots/body language (4) Visualizing (e.g., seeing the ball go in) (3); Identifying technicalities (3) |
| Behavioral technique coping | Technique (e.g., timing/cue-action) (44) Alignment (e.g., straight cueing) (17) Centre of the white (16) Feathering the same amount/length, increase feathering (10) Head down/still (8) Stay down after the shot (4) Stance (3); Pause (3); Slower pace play (3); Have the cueball cleaned (3) Grip (2); Look at pocket (2); Bridge close to the white (2); Judgement (2); Confident body language (e.g., chest up) (2); Playing shots with purpose (2) Eyes on the object ball (1); Don't think on the shot (1) |

| | |
|---|---|
| Cognitive technique orientated coping | Cueing thoughts/Positive instructions (92)<br>Positive/firm cueball striking (35) – more control (e.g., use two cushions instead of one, stun shots)<br>Staying high with the white (28)<br>Biofeedback/somatosensory – tactile (e.g., chin, chest, bridge, grip)/auditory/visual/ (e.g., punching sound, looking at the arrows) (23)<br>Painting a picture (5) |
| Focus | Increased concentration on shot (e.g., pressure game situation) (20)<br>Win the frame in one visit, play to win (8)<br>In the zone/flow/bubble (don't think) (6)<br>Keeping count of break (4); Concentrate on the table/shot (4)<br>Being patient (1); Clearing to hurt your opponent (1) |
| Deliberate practice | Working with coach (e.g., discuss all aspects of the game) (10)<br>Getting through the ball, timing (8)<br>The break-off (7)<br>Shortened action (6); Safeties (6); Clear the colors (6); Pressurized game specific scenarios e.g., knowing available points, playing for imaginary money (6)<br>Walking around/visualizing the table more (5); Never waste a shot/purposeful shots (5); Short games - Cross, line-ups (e.g., black with red), N's zig-zag for flow/finding groove – small cueball distance practices (5)<br>Continual improvement (4); Slow cushions (4)<br>Master cueball journey (3); Long blues (e.g., to baulk and black pockets) (3)<br>Get the basics right (2); Work ethic (2); Potting clean/play it properly (2)<br>Achieving mastery (1); Routines that work on weaknesses (1); Know every shot (1); Cueing balls across the D-line (1); Long pots (1); Middle pocket routines (1); Pink to middle, black to corner sets (1); Dedicated practice (1); Blue line-ups (1); Playing frames (e.g., train working memory) (1); Practice matches as proper matches (e.g., play for money) (1) |
| Emotion-focused coping | |
| Positive attitude/feelings | Positive appraisal/mood (46)<br>Enjoyment (2) |
| Relaxation | Running commentary (15)<br>Visualization (e.g., imagining being another top player) (9)<br>Practicing imaginary snooker (1); Music (1); Take time to collect positive thoughts before match (1) |
| Philosophical | Rationalize (99)<br>Optimistic (seeing difficult shots/matches as challenging/rewarding) (9)<br>Forgetting (8)<br>Acceptance (5)<br>Good performances irrespective of outcome (2) |
| Cognitive avoidance | Disengagement (12) |

798

**Highlights**

- A Think Aloud protocol (Level 3) was used to explore the real-time cognitions of super-elite and elite professional snooker players during solo practice performances within naturalistic settings

- Analyses revealed an array of cognitions relating to stressors, coping strategies, and general snooker related aspects

- Key stressor themes were: Table Conditions, Distractions, and Mistakes

- Shot Preparation was essential to problem-focused coping, with Rationalizing integral for emotion-focused coping

- Our key finding was that problem-focused coping is critical for optimal performance in professional snooker