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4 The prevalence and influence of psychosocial factors on technical refinement amongst

5 highly-skilled tennis players

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23   **Abstract**

24   The present study investigated the prevalence and influence of *psychosocial* factors amongst

25   a sample of highly-skilled athletes who had previously refined their technique. Semi-

26   structured qualitative interviews were conducted with eight players to gain an in-depth

27   understanding of their experiences when making technical refinements. Results revealed that

28   participants sought to change their technique in order to address an 'attenuated' movement

29   pattern and that commitment and confidence were important psychosocial concomitants

30   during the refinement process. Upon reflection, participants indicated that taking a break

31   from competition and dedicating more time to the refinement might have increased their

32   chances of success. Overall, findings showed that psychosocial behaviors have a significant

33   influence on players' ability to successfully enact technical refinement. However, players

34   reported a lack of consideration towards both the scheduling and establishment of

35   refinements in relation to the competitive season. These results suggest the need for

36   improved understanding and planning in terms of how a coach might operationalize these

37   factors within training for the competition environment.

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43   The prevalence and influence of psychosocial factors on technical refinement amongst

44   highly-skilled tennis players

45   Longitudinal sporting involvement at the highest level is most typically depicted as a

46   nonlinear pathway, beset by challenges that should be identified, prepared for, and then,

47   hopefully, negotiated; usually with varying degrees of success (MacNamara, Button, &

48   Collins, 2010). Indeed, effectively confronting such challenges can be *frustrating* for athletes

49   at any performance level, due to the destabilizing effect they can impart. As such, athletes

50   may benefit from support and guidance from a coach and/or sport psychologist. Exemplar

51   challenges reported within the literature include athletes transitioning between sports

52   (MacNamara & Collins, 2015), returning from injury (Podlog & Dionigi, 2010) and making

53   refinements to already long-practiced and well-established motor skills (Hanin, Korjus,

54   Jouste, & Baxter, 2002). Crucially, scholars identified the deployment of key psychosocial

55   skills (e.g., psychological characteristics of developing excellence or PCDEs) as being

56   essential in facilitating the *transition* through, and optimizing benefits from, these disruptive

57   times (MacNamara et al. 2010; Orlick, 1990). It is, therefore, of interest to understand the

58   different contexts in which these skills are utilized and how applied science support might be

59   structured and implemented to optimize the experience through this "rocky road" (Collins &

60   MacNamara, 2012). Considering the current scarcity of research addressing this topic during

61   periods of technical refinement, and recent recognition of its importance within the field of

62   applied sport psychology, the current study focused on exploring the prevalence and

63   influence of psychosocial factors during the refinement process amongst highly-skilled

64   performers (Carson & Collins, 2016).

65   Exemplifying the high-risk nature of technical refinement, anecdotal reports from

66   highly-skilled performers document the difficulties one may face in completing this task. For

67   instance, Luke Donald, the former world number one ranked golfer attempted to refine his

68   swing in order to improve the chances of winning his first major championship.

69   Unfortunately, this process was unsuccessful and Donald dropped to a world ranking of 96

70   subsequently explaining that "it was a big alteration but I thought I could do it as I've always

71   considered myself a fast learner. But I can see how difficult it is to break down 30 years of

72   golfing DNA" (Corrigan, 2014). Indeed, this self-reflection highlights an important

73   distinction between initial *learning* and later *refinement*, suggesting that processes involved

74   in one might not be *directly* applicable to the other (Carson & Collins, 2011). Carson and

75   Collins (2015) recently documented accounts of unsuccessful refinement resulting from

76   concomitant psychosocial factors including a failure to "buy-in" to the prescribed change.

77   Such empirical evidence suggests that altering well-established motor skills involves a degree

78   of risk given that performers are required to "de-chunk" a proceduralized movement pattern

79   before reautomatizing the movement to subconscious control (Beilock, Carr, MacMahon, &

80   Starkes, 2002).

81   In seeking to address this issue, the Five-A Model of technical refinement has been

82   proposed as an interdisciplinary guide for coaches and support specialists, when working

83   with performers to refine their already long-practiced and well-established motor skills

84   (Carson & Collins, 2011). Significantly, these authors identified a number of concomitant

85   *psychosocial* factors (i.e., mental states, psychological characteristics, and aspects of the

86   social environment) that impact upon success. According to these researchers, the

87   psychosocial factors likely to have the greatest bearing on refinement success include an

88   athlete's *involvement*, *commitment*, *trust*, and *confidence*. For example, involvement in the

89   process may be crucial for establishing athlete buy-in (Kidman & Lombardo, 2010).

90   Previous scholarly activity revealed that adherence to technical refinement is enhanced when

91   coaches encourage their athletes to help diagnose and plan an appropriate intervention

92   targeting the cause of the inefficient movement pattern (Carson & Collins, 2015).

93   Commitment is also believed to play a hugely important role in athletic development

94   since it directly influences an athlete's involvement and persistence in a given activity (Weiss

95   & Weiss, 2006) and has a strong relationship with their level of intrinsic motivation

96   (Zahariadis, Tsorbatzoudis, & Alexandris, 2006) and mental toughness (Clough, Earle, &

97   Sewell, 2002). To illustrate, researchers found that commitment (e.g., perseverance at

98   challenging times) facilitated the successful development of athletes from initial involvement

99   to achieving and maintaining a world-class status (MacNamara et al. 2010). Trust is also

100 important in at least two respects, firstly during the execution of the motor skill to enable

101 higher levels of automaticity and, secondly, within the athlete–coach relationship. The level

102 of trust that the athlete places in his/her coach's ability to oversee the process may influence

103 his/her adherence to the prescribed technical change (see Toner, Nelson, Potrac, Gilbourne, &

104 Marshall, 2012). Closeness (i.e., the emotional tone that coaches and athletes experience and

105 express in describing their athletic relationships) is characterized by mutual trust and this has

106 been found to play an important role in an athlete's development as a performer and a person

107 (Jowett & Cockerill, 2003).

108   Finally, the confidence that athletes' possess in their ability to consistently execute the

109 new movement pattern may have an important bearing on the technical change process. High

110 levels of sport confidence are believed to facilitate performance proficiency through their

111 positive effect on athlete's cognitions, affects, and behaviors, while low self-confidence is

112 associated with negative effect, defective cognitions, and ineffective behaviors (Beaumont,

113 Maynard, & Butt, 2015; Hays, Thomas, Maynard, & Bawden, 2009). Relatedly, athletes'

114 self-efficacy about their ability to refine their technique is likely to be influenced by a number

115 of sources of information including their mastery or performance experiences (e.g., previous

116 occasions when they have attempted to enact change), their vicarious experiences (e.g.,

117 whether anyone in their stable of athletes has successfully refined their technique), any verbal

118   persuasion they may have been subjected to by coaches, and their physiological and

119   emotional states (Bandura, 1977). Although the constructs of *trust* and *confidence* bear

120   conceptual similarities, an athlete's trust in their coach assumes that they are confident in

121   his/her qualities (based on the trust giver's expectations of the coach's future behaviours),

122   while confidence in one's ability to successfully refine technique does not imply trust in the

123   coach's ability to oversee the process.

124   Despite the apparent ubiquity of technical refinement within the applied setting,

125   research has yet to explore whether the concomitant *psychosocial* factors identified by the

126   Five-A Model and/or others (e.g., resilience), might underpin successful and unsuccessful

127   cases of technical refinement. This is an important issue to address, as equipping athletes

128   with a range of positive psychosocial assets (e.g., realistic performance evaluations, coping

129   with pressure, self-awareness) will assist both their performance and personal development

130   (Abbott & Collins, 2004; Harwood, 2008; MacNamara et al. 2010; Nicholls, Taylor, Carroll,

131   & Perry, 2016). Therefore, the principal aim of this exploratory study was to identify the

132   prevalence and influence of these factors by conducting interviews with highly-skilled tennis

133   players who had attempted to refine a well-established movement pattern.

134   **Method**

135   *Philosophical orientation*

136   The study was grounded in a post-positivist paradigm (Guba & Lincoln, 2005). This

137   had a number of implications for our study including our ontological (i.e., critical realism)

138   and epistemological stance (i.e., modified dualist/objectivist), our choice of method (i.e.,

139   interviews that were informed by existing literature), data collection (i.e., single interviews),

140   data analysis (e.g., calculating the number of participants who represented each theme),

141   trustworthiness techniques (e.g., peer debriefing), and representation of the findings (i.e.,

142   realist form characterized by experiential authority, the participant's point of view, and

143   conveying interpretive omnipotence).

Participants

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145   Six males and two females aged between 19–30 years ($M_{age} = 23.5$, $SD = 4.3$) with

146   experience of refining their technique within the last 5 years participated in this study.

147   Participants had spent between 1 and 4 years working on the refinement and all but two of the

148   athletes were trained by different coaches. Retrospective in-depth interviews are commonly

149   employed by qualitative researchers (e.g., Swann, Crust, Keegan, Piggott, & Hemmings,

150   2015) and were required in the current context since participants and coaches are often

151   reluctant to discuss the refinement process as it unfolds for fear that this might hinder the

152   athlete's ability to successfully enact change. Researchers have argued, however, that

153   athletes are capable of remembering significant life events a long time after their occurrence

154   (Gould, Finch, & Jackson, 1993). Participants were identified via purposive and snowball

155   sampling. A purposive sample of athletes was sought which entailed those who had

156   competed at an advanced level (i.e., national events and had a Lawn Tennis Association

157   rating of 3.1 or below) at the time of the technical refinement. According to Swann, Moran,

158   and Piggott's (2015) taxonomy of expertise, our sample are representative of semi-elite

159   athletes as they participate just below the top standard possible in their sport (i.e., talent-

160   development programmes). Likewise, they may also be considered as participating along the

161   Elite Referenced Excellence pathway (Collins et al. 2012). Electronic-mail was used to

162   contact potential participants within the United Kingdom. Once initial contact had been

163   made with athletes, we then used snowball sampling; a strategy where further participants are

164   identified from existing participants (Patton, 2002). Ethical approval was granted by the

165   University ethics committee and all participants provided signed informed consent prior to

166   data collection.

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168 | Insert Table 1 about here |

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170 *Procedure*

171   Each participant took part in an in-depth, face-to-face interview. Interview locations

172 and times were selected at the convenience of each participant. The interview guide was

173 informed by the work of scholars in the field of technical refinement (e.g., Carson & Collins,

174 2011) and covered three topics to address the study's aims: (a) *why* the athlete decided to

175 refine their technique and *what* components of technique were refined, (b) the *moderators* of

176 change (i.e., the psychosocial factors that influenced the refinement process), and (c) the

177 participants' *reflections* upon the whole process (what, if anything, they might do differently

178 if they were to go through this process again and, consequently their recommendations for

179 coaches). Accordingly, the interview used a structured and standardized format in order to

180 address time periods pre, during, and post refinement. While participants were asked the

181 same questions in the same way, the sequence of questions varied according to the flow of

182 the conversation and follow-up probes were used in order to elaborate (e.g., "Could you

183 please explain that in more detail?") and clarify (e.g., "What do you mean by that?") some

184 responses. This approach helped establish rapport and allowed for greater depth of

185 information. Interviews lasted between 55–95 minutes, were recorded in mp3 file format,

186 and later transcribed verbatim.

187 *Data Analysis*

188   Following transcription of the interviews, we conducted content analysis involving

189 three stages to this process (Patton, 2002). First, transcribed interviews were read several

190 times to gain a clear comprehension of the participants' responses and subjected to line-by-

191 line analysis to identify raw data codes. Second, we used a combination of inductive and

192   deductive approaches to identify meaning units which were subsequently grouped together to

193   form emergent categories (lower-order themes) based on their similarity to each other and

194   distinction from other categories (Patton, 2002). This process was then repeated in order to

195   generate higher-order themes. Next, higher-order themes were organized to form a

196   chronological representation (i.e., from the start to finish) of participants' experiences of the

197   technical change process. As such, higher-order themes were placed deductively into the pre-

198   determined dimensions of prechange, in-change, and post-change evaluation. Comparative

199   analysis was used to identify common themes across participants and, in line with our

200   philosophical stance, a frequency analysis was conducted to illustrate the number of

201   participants representing each theme (see Table 1).

202   *Trustworthiness*

203   We employed both peer-debriefing and member checking as a means of enhancing the rigour

204   of the findings. Peer-debriefing acts as an external check on the research process while

205   member checking is used to establish the credibility of the findings and interpretations

206   (Creswell, 2007). The first and fourth author started this process by identifying common

207   themes from the transcripts independently and then acted as critical friends (Faulkner &

208   Sparkes, 1999). Here, the authors questioned each other's interpretations, refined emergent

209   themes, and ensured that personal experiences or beliefs did not unduly bias the findings.

210   There was a high level of agreement between the authors, with only a small number of minor

211   discrepancies (less than 5% of data codes) requiring adjustment or further rationale. The

212   identified themes were then discussed with and challenged by the second and third author

213   until a consensus was reached. Next, using an approach based on synthesised member

214   checking (see Birt, Scott, Cavers, Campbell, & Walter, 2016) participants were sent their

215   results and asked to confirm whether or not they were an accurate representation of their

216   experiences. No changes were made at this point.

217   **Results**

218   The first section addresses why athletes decided to make a technical refinement and

219   what aspect of their movement they chose to refine; that is, the important considerations

220   occurring prechange. Next, we outline key psychosocial moderators that influenced the

221   extent to which the process was successful or unsuccessful. Finally, we present results

222   relating to the perceived consequences of the technical refinement process, or in other words

223   the "postprocess review" (see Table 2).

224   **Prechange**

225   Across participants, several different technical components were refined. Four

226   players addressed their dynamic forehand movement, two changed their forehand grip, while

227   two sought to change their backhand. Notably, all intended refinements were individually-

228   specific; as would be expected at this high level, after the development of a well-established

229   movement pattern.

230   All participants decided to make a technical refinement to improve their performance

231   by altering what they, or their coach, considered to be an "attenuated" aspect of their

232   movement. These players were aware that a feature of their game (e.g., backhand) was weak

233   and was getting targeted by opponents in competitive matches. The coach-athlete dyad

234   reached a mutual decision that a technical refinement was required to address the issue. Six

235   participants were quite explicit about their desire to achieve a world ranking or to compete at

236   a higher level. Take, for example, Mike's comment that "throughout my whole time as a

237   junior the aim was to try and get to a slam and we felt the changes to my game would get me

238   there". Others recognized that they had a technical flaw that was likely to hold them back as

239   they moved to a higher ratings band. For example, Matty revealed:

240   I recognized that it was a problem because in matches I was finding it so hard to

241   attack, because I could never be on the front foot . . . I was always making contact

242   with the ball late, so I'd only be able to attack off real easy balls.

243 Similarly, Scott revealed that "basically my backswing was too big and I was getting caught

244 out if someone hit the ball fast at me".

245

246   Insert Table 2 about here

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248 **In-Change: Psychosocial Factors that Influenced the Process**

249   **Commitment.** The extent to which participants *committed* to the prescribed

250 refinement had a hugely important bearing on its success. In the following section we discuss

251 four specific factors (i.e., competitiveness, discomfort during competition, regulation of

252 performance expectations, process vs. outcome goals) that influenced whether or not

253 participants remained committed to technical refinement. Although all of the participants

254 indicated that they were fully committed to the new movement in practice, this changed for

255 some during a competitive event. Here, a *competitive* urge to win appeared to override the

256 desire to remain committed to trying the new movement. For example, Scott explained that

257 he:

258   Was sticking to the shape but it's almost the competitive side of you . . . . I wanted to

259   win too much to be able to just to stay with it . . . I stuck with the new movement

260   when I hit a top-spin forehand but I wouldn't say that I hit that many of them as I was

261   trying to avoid hitting it.

262 John's competitive instincts led him to revert back to his old movement:

263   My performance was significantly weak for me to go back to the original technique in

264   the first match of a four match tournament . . . I was playing someone who I had

265   preconceived notions that I was going to beat, the fact that I wasn't beating him and

266   that it wasn't feeling good . . . . my natural instinct as a competitor and someone who

267   has a fixed mindset and that I have to take care of this particular match, I can't

268   consider losing this match so I have to change back.

269   Both of these players' commitment to the new movement was also influenced by the degree

270   of *discomfort* they felt when first using it in competition. Scott felt that the new movement

271   was:

272   Awful, timing was off, wasn't really going in the court, there wasn't much power . . .

273   my swing got very short, jittery almost and I wouldn't time it great because of that . . .

274   I was just a sitting duck and thought I might as well hit a slice – I might be able to

275   control that, I didn't feel comfortable with it at all.

276   Although Scott initially committed to the new technique, his level of discomfort was such

277   that he ended up making "adjustments like playing around with my grip just trying to find a

278   way to be able to hit it in the court with the new shape because I couldn't go back to the old

279   one". Significantly, although all of the participants found the new movement uncomfortable,

280   not all of them reverted back to their old technique or experimented with different ways of

281   performing the skill. In fact, as we discuss in the following sections, a number of coaches

282   had persuaded their players that there was little point in doing so and convinced them that

283   setbacks (which were characterized by feelings of extreme discomfort) were a natural part of

284   the process.

285   Even though a number of participants struggled to commit to the new movement, four

286   revealed that, despite initial setbacks in competition and the discomfort they experienced,

287   they steadfastly committed to the prescribed refinement. Participants who *regulated their*

288   *performance expectations* by accepting that it could take many months before they could

289   successfully execute the new movement were more likely to commit to it in the long-term

290   than those who thought the change could be brought about with long-term permanence

291   quickly. Dave drew attention to the important role coaches play in this process when he

292   suggested that "the coaches were saying it's going to take time . . . they re-iterated that to me

293   so I felt under no pressure to quickly change it, I knew it was going to be a long period of

294   time where I really had to focus".

295   In contrast, participants who failed to successfully enact change adopted unrealistic

296   performance expectations; that is, they hoped that the process could be accomplished quite

297   quickly. For example, Paul struggled to execute the new movement (although he eventually

298   did almost 5 years after he started to make the change) because he was thinking of:

299   The time limit . . . I was getting older . . . I knew I was almost on my way out of full-

300   time tennis trying to make it. . . so I was thinking can we get this done as quickly as

301   possible.

302   Commitment was enhanced by coaches who sought to remove pressure from their

303   players by emphasizing that practice and competitive results were not important in the early

304   stages of the change process. Here, the coaches encouraged their athletes to focus on the

305   *process* (i.e., getting the technique right) rather than the *outcome* and this helped them to

306   accept that they were likely to make a large number of errors early on. Dave had a number of

307   conversations with his coach which helped him realize that it was inevitable that he would:

308   Hit a lot of errors but in my head I knew it was better going for it and making the

309   errors then just running around it or hitting a slice and winning . . . because I won a

310   couple of matches where I was like 'but yeah, you didn't do the right thing', so the

311   winning and losing part became secondary, so it was all about the performance goals

312   rather than the outcome goals.

313   Paradoxically, John revealed that his commitment to the new action was negatively

314   influenced by the fact that he so was so focused on the outcome of the action:

315   I wasn't prepared to make even one forehand error . . . I created that mindset for

316   myself where I wasn't allowed to make mistakes and to fail with it . . . I created a fear

317   of making mistakes and a fear of losing.

318   Encouraging the players to focus on process rather than outcome goals also seems to

319 have enhanced commitment by helping them to cope with anxiety experienced during this

320 process. Mike noted how his coaches reassured him, "if you miss it's okay, make sure you

321 are doing the right things" and "I bought into that so then the anxiety was taken away because

322 I felt under no pressure to win or lose the match". In contrast, John, who struggled to make

323 the change, mentioned that if he had worked closely with a coach (he saw coaches

324 intermittently as part of a performance squad) it might have helped him through the process:

325   It was kind of me by myself so to feel that I'd made that breakthrough was a really

326   nice feeling to then having that blown apart in day one and it was difficult not to have

327   someone reassuringly say 'okay it's fine, it's part of a long-term process'.

328 In this case, a lack of psychological support left John "with less motivation to train over

329 subsequent weeks . . . my motivation to commit to the change was lower".

330   **Confidence.** Participants' confidence in the process also had an important bearing on

331 their ability to successfully enact change. Participant confidence was influenced by a number

332 of specific factors, including; the belief they had in their coach's ability, belief in their own

333 ability, competitive setbacks, and positive feedback.

334   The belief they had in their coaches' ability meant that the majority of the participants

335 were highly confident that the prescribed course of action would help them improve their

336 games. In fact, it would seem that coaches had to do very little to get the players' buy-in for

337 the refinement. Scott recalled when the idea was introduced to him that he felt:

338   Pretty confident, I was just so happy with my tennis at the time and again because of

339   the two people working with me I was like 'for sure this is going to work . . . it's not

340   going to effect me'.

341   Similarly, Mike was hugely confident in the process because of his coach's previous

342   experience: "at the time he was working with some other good players I felt like he'd gone

343   through the process before – the way he delivered it to me". However, although all of the

344   participants had a great deal of confidence in their coach, some lacked confidence in their

345   *own ability* to make the change. Paul noted that he:

346   Was going down there [to work with a new coach] to make it better . . . is there a

347   perfect result? Every technique is different but I had the goal that I wanted to be

348   happy with it . . . I wanted to be able to repeat it. Did I want a forehand as good as

349   him [his coach]? Yeah but that wasn't achievable I don't think.

350   Interestingly, Paul's apparent lack of confidence in the process appears to have stemmed

351   from his belief that he was, at 18 years of age, quite old to be making such a significant

352   refinement. John echoed similar sentiments when he revealed that he was only "moderately"

353   confident "if I was to put it on a scale I'd say 60% probably . . . I had quite an awareness

354   even at that stage of the science behind muscle memory and those kind of things . . . I knew

355   these things take a lot of time".

356   Early *setbacks* in competitive events had a considerable impact on a number of the

357   participants' confidence in the new technique. For example, John explained that:

358   There had been an overall dent in my morale because of the way the tournament went

359   and looking back that would have resulted in my training attitude being low . . . the

360   morale of the change was dented, I kept going with it but with a different morale and

361   motivation towards it . . . it was quite demoralizing really . . . I was thinking it

362   couldn't have gone any better in practice the day before the tournament and I still

363   couldn't do it so my confidence in it and my enjoyment of doing it would have been

364   less in subsequent weeks.

365   Scott's confidence in the technique was also influenced by his initial experiences of using it

366   in competition:

367   I'd be going into a match when there were so many other things going on, different

368   pressures, someone's trying to find ways to beat you, to pick holes in your game and

369   it wasn't ready to stand up to that test at that time which maybe shot my confidence in

370   that a little bit and in myself and in my own tennis.

371   These participants felt that setbacks may have arisen because they had spent an insufficient

372   length of time automatizing their new action in practice before it was exposed to competitive

373   pressure. Paul conceded that maybe things were progressed "a bit too quick so I hadn't built

374   the foundation – so the hand feed I hadn't really perfected that and we're trying to rush it

375   because I was still competing in competitions". Nevertheless, it is important to note that

376   although a number of participants lost a certain amount of confidence in their own ability to

377   bring about the technical refinement, they retained a great deal of confidence in their

378   coaches' ability throughout the process. That is, none of the players thought that they might

379   need to start working with someone else in order to improve performance, or even abort the

380   change process. In fact, a number of players discussed how coaches used *positive feedback*

381   to restore their confidence after they had experienced initial setbacks in competitions. For

382   example, although Matty discussed how "getting battered dented my confidence", in the

383   following weeks his coach:

384   Spent a lot more time with me on squads . . . spent more time than he would have

385   previously done . . . I kind of always felt he was watching even if he was at the other

386   end of the centre . . . he'd appear from nowhere and tell me to slow it down a bit,

387   speed it up a bit . . . his feedback gave me confidence that I was making progress".

388   After Michelle's new backhand technique was badly exposed in an important competition,

389   her coach told her "not to beat herself up about it" and that "she was making good progress".

390   This reassurance increased her confidence that she could successfully refine her technique in

391   the long-term. Although Scott initially struggled with the change, he revealed that his

392   relationship with his coach played an important role in helping him to eventually execute the

393   desired movement: "I still respect him an awful lot, I'd started to improve again, he got me

394   through it, they [both coaches] had been really positive and encouraging".

395   Participants who retained belief in their ability to refine their technique were working

396   with coaches who used a variety of other strategies to deliver positive feedback and develop

397   their confidence in the new technique. For example, as we noted in the previous section,

398   these coaches encouraged their players to focus on process rather than outcome goals. In

399   doing so, a number of coaches used recorded footage to show their players evidence that they

400   were achieving the desired movement positioning. Andrea felt that seeing this made it "clear

401   in my mind what I was doing and what I was aiming for" and that this enhanced her

402   confidence that her action was improving in the desired direction.

403   **Postchange Evaluation**

404   **Performance proficiency.** Although four participants felt that the process had been

405   unsuccessful, four participants declared it as an unqualified success even though each of them

406   spent time struggling to adopt the new movement pattern. For example, Matty revealed that

407   changing his forehand takeback eventually gave him "counter-punching ability . . . the court

408   just felt bigger . . . as soon as it clicked I could recognize different situations and my feet

409   were moving in the right way". For Mike, the new movement meant that he was:

410   Back so quickly I was able to move the racket back and was therefore able to give

411   myself time to get into position and hit a much cleaner ball. I could wait a split

412   second and hit a top spin or I could just go full out and hit flat so there were two

413   things that automatically were better.

414   In contrast, it was more difficult for the remaining four participants to determine

415   whether the process had been successful. Interestingly, although none felt that their

416   proficiency had regressed as a result of making the changes, three felt that it had taken too

417   long before their new movement produced noticeably improved results. Unfortunately, these

418   participants had reduced their commitment to competitive tennis, owing in part to the slow

419   nature of their progress, to focus largely on coaching instead, by the time that they eventually

420   became comfortable with the new movement.

421   **Dedicate more time to practicing the new technique.** In general, these participants

422   felt that it had taken them a long time to acquire the desired technique due to an insufficient

423   period of time being spent breaking the movement down and practicing it in a repetitive

424   manner before they needed to use it in competition. However, they acknowledged that this

425   was difficult given their tournament schedule at the time. For example, Paul argued that "if

426   we'd stripped it back even more we probably would have done better. I think we would have

427   done better if we'd hand fed and repeated that thousands of times, but I was 18 and still

428   playing tournaments". While participants may need to increase the amount of time they

429   dedicate to practicing the new technique, it is also essential that there is considerable

430   behavioural correspondence between the practice and performance contexts in which the new

431   technique will be used (e.g., the practice environment presents the performer with functional

432   or relevant action affordances; see Araújo & Davids, 2016).

433   **Remain patient.** These participants also discussed a number of things that they

434   would do differently if they were to go through this process again. Four players spoke about

435 the need to accept that they were engaged in a challenging process that would require them to

436 remain extremely patient when inevitable setbacks arose. For example, John recommended

437 that there should have been an:

438   Environment where it's okay to lose . . . where I said I can have a free swing this

439   tournament . . . I'm going to accept that I can see that this change is making me better

440   . . . for the sake of 4 months down the line playing great tennis I'm going to be

441   prepared to miss forehands this weekend.

442   **Take a break from competition.** Four participants are now full-time coaches and

443 drew on this experience to consider what they would do differently if they were working with

444 a player who they thought required a significant technical change. These participants noted

445 that they would devote more time to helping the player get comfortable with the new

446 movement before exposing it to the rigours of competition. Scott suggested that he was not

447 sure if he should "have played tournaments so soon after making the change" and that a better

448 approach may have been to "just get comfortable with it first before putting it into a match

449 situation under pressure because it was getting torn apart". John expressed similar sentiments

450 when revealing what he would do if he were to coach a skilled player who was considering

451 making a technical change:

452   I'd have to outline the risks and that we're going to need at least a minimum of a

453   week training block and possibly two further weeks without competition where you'll

454   play practice competition. Within that block you'd move from closed to open practice

455   . . . closed points up until eventually playing full practice sets. Again, there's no

456   pressure hitting it in or out, the only pressure is trying to maintain the technical goal

457   and then maybe progress to a rally and then give them a specific shot to start the point

458   off . . . no pressure at all and eventually moving to pressure and maybe put another

459   player on the other side of the net where it's realistic.

460   Insert Table 3 about here

461   **Discussion**

462   The aim of this exploratory study was to identify the prevalence and influence of

463   psychosocial factors amongst a group of high-skilled athletes who had previously refined

464   their technique. This is the first study to provide a detailed account of athletes' experiences

465   during the technical refinement process. The findings showed that establishing and retaining

466   athlete's *commitment* and *confidence* in the refinement, were crucial in this regard, therefore

467   justifying their inclusion within the Five-A Model (Carson & Collins, 2011). Unfortunately,

468   a failure to apply, or systematically cater for, these psychosocial factors appeared to

469   contribute to a number of unsuccessful outcomes too. Similar to other highly-skilled athletes

470   (Carson & Collins, 2016), the impact extended beyond skill development possibilities to

471   players' long-term involvement in competitive tennis. This is one of the first studies to

472   provide empirical support for the proposal that skill refinement represents a significant and

473   career defining transition along the performance pathway (Carson & Collins, 2011; Toner &

474   Moran, 2015). It is encouraging to note, however, that four participants felt that the process

475   had been extremely successful and that it had contributed to the improvement of their game.

476   In the following sections we explain why the presence or absence of certain psychosocial

477   factors may have contributed to successful or unsuccessful cases of technical refinement, and

478   provide practical recommendations relating to *how* coaches, psychologists, and athletes may

479   apply these psychosocial behaviors.

480   A number of participants found it difficult to commit to technical refinement and

481   either reverted back to their old technique or started to adopt a compromise technique (i.e.,

482   something "in-between" the old and the new movement) when first attempting the new

483   movement in competition. These findings mirror the recent discovery that coaching

484   interventions designed to refine the technique of European Tour golfers often led to a

485   regression back to the original technique and that this was represented by fluctuations

486   between automated and de-automated states (Carson, Collins, & MacNamara, 2013). Our

487   results revealed that players who failed to commit were less likely to have regulated their

488   expectations about the change and that they became frustrated and impatient when they

489   realized the difficultly of this process. Coaches and psychologists may need to make athletes

490   aware that initial setbacks, and the feelings of discomfort which characterize these events, are

491   inevitable and that they should not be taken as evidence that change is not working, or that

492   the chosen course of action is likely to hinder athlete development in the long-term. In fact,

493   data from longitudinal studies has revealed that successful refinement can take several

494   months and that further improvement may be evident even after 1 and 2 year follow-up tests

495   (Carson & Collins, 2015; Carson, Collins, & Jones, 2014).

496   A number of the players revealed that early setbacks dented their *confidence* in their

497   ability to execute the new technique. These players felt that they needed more time to

498   become comfortable with the new movement before they were forced to use it in competition.

499   It was interesting to note that few of the players' coaches seem to have made an effort to

500   secure the new movement during practice (i.e., pressure-proof it) before it was exposed to the

501   psychological rigors of high-level competition (see Table 2 and Kearney, Carson, & Collins,

502   2017, for similar accounts from athletics coaches). In contrast to the Five-A model

503   guidelines, it seems that players were introduced to the challenge of competitive pressure,

504   both psychological and physiological, too early before the new skill version had been

505   automatized, pressure-proofed, and confidence in the execution regained. Pressure-proofing

506   is an important feature of the Assurance stage as it can enhance an athlete's confidence that

507   the new movement is fully established and that it requires no further modifications. In fact,

508   the participants who successfully refined their technique revealed that their coaches used a

509   variety of strategies (e.g., encouraging a process focus) and certain training drills, and that

510   this enhanced their confidence in their ability to execute the new movement.

511   It may be that for some players in the current study the process (not the technical

512   modification) was insufficiently understood by and/or sold to them. It is interesting to note

513   that players only recognized the need for a progressive, or systematic, approach during their

514   post-process review. Even then, there was a distinct lack of appreciation toward the need to

515   proactively pressure-proof the skill, as one of several absent features of the Five-A Model.

516   Equally, however, it is probable (based on evidence of coaching knowledge in other sports;

517   cf. Carson et al. 2013; Kearney et al. 2017) that coaches did not have, or understand, a

518   systematic approach that would enable success. Planning prior to enacting change appears to

519   have been uncomprehensive; for example, few players conducted a detailed analysis with

520   their coach whereby the pros and cons of technical refinement, and other alternatives, were

521   evaluated. Indeed, this process needed to include consideration towards the macro-level

522   timing within a competitive season, but no such planning was reported as taking place.

523   Although the interview process devoted some attention to an exploration of the mechanisms

524   which underpinned coaches' attempts to enact change, this was not its primary focus. Future

525   research could devote more attention to this issue by conducting in-depth explorations of the

526   approaches used by coaches in order to facilitate change (e.g., practice schedules). This

527   enquiry seems particularly relevant given recent findings which suggest that coaches and

528   athletes appear unclear about the most effective way of conducting this process (Carson et al.

529   2013). A systematic approach (e.g., the FIVE-A model) would seem to be justified at the very

530   least. Future research could interview coaches post-training and include a video debrief to

531   better understand and probe their decision making on-action/in-context as they oversee the

532   technical refinement process. Researchers could also explore whether varying practice

533   conditions influences an athlete's ability to successfully adapt to new task demands (i.e.,

534   technical refinement) or conduct a phenomenological investigation of the different

535   trajectories that athletes might take as a result of making refinements/changes (e.g., how

536   setbacks experienced at different stages of the process might influence the athlete's decision

537   to remain committed to the refinement or drop out of the sport).

538   To conclude, our results suggest the need for improved planning in terms of how

539   tennis coaches might operationalize these psychosocial factors in a systematic manner within

540   the training environment for competition. Ultimately, the results should prove helpful to

541   coaches and psychologists who wish to understand some of the physical and/or psychological

542   difficulties that athletes may face during the technical refinement process. We suggest that

543   development programs may need to devote greater consideration towards operationalizing

544   these factors within their specific domain in order to optimize the development and

545   performance of skilled athletes.

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668 Table 1: *Participants and technical refinements*

Name (Pseudonym)	Age and rating when refinement was made	Technical refinement
Scott	16 (3.1)	Shorten forehand takeback
John	17 (2.1)	Adopting 'eastern' grip on forehand
Mike	15 (3.1)	Shorten backhand takeback
Matty	18 (3.1)	Shorten forehand takeback
Paul	18 (1.2)	Adopting 'continental' grip on forehand
Luke	28 (1.1)	Alter forehand path
Michelle	21 (2.2)	Shorten backhand takeback
Andrea	20 (3.1)	Square racket face on forehand

669 *Note*: For junior and adult players there are 20 rating bands, starting with 10.2, which is the
670 lowest, progressing to 10.1, 9.2, 9.1 etc. until you reach 1.1, which is the highest rating.

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684 Table 2. *Summary of the prevalence of perceived antecedents, moderators, and process*

685 *evaluation of technical change*

Lower order themes	Higher order themes	Dimensions
Competitiveness (6) Attenuated movement pattern (8)	Continuous improvement	Prechange
Discomfort during Competition (8) Regulating performance Expectations (6) Process versus outcome goals (5) Competitiveness (4)	Commitment	In-change
Trust in coach's ability (7) Own ability (6) Competitive setbacks (6) Positive feedback (5)	Confidence	
Performance proficiency (8) Dedicate more time to practicing the new technique (6) Remain patient (5) Break from competition (4)		Postchange

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687   Table 3. *A comparison of recommended psychosocial practices by the Five-A Model against those actually reported by participants.*

Psychosocial Factors	Five-A Model Stages				
	Analysis	Awareness	Adjustment	(Re)automation	Assurance
Five-A Model exemplars	Consider the pros vs. cons (e.g., to make the change at all? What? When? How? Why?). Gain buy-in/trust. Establish realistic expectations. Sell the process to important stakeholders.	Continuous personal support via discussion aided by video, goal-setting and monitored through self-reported confidence levels.	Coach and video feedback to enhance confidence, acceptance and commitment. Work on unaffected skills to maintain progress.	Use of imagery scripts and self-set goals to sell progress to the athlete. Practice in context to enhance understanding. Reduced coach involvement to increase athlete independence.	Provide proof that movement is robust in order to maintain and build confidence. Discuss and implement varied game plans in preparation to compete (i.e., tactics/playing style).
Study examples of adherence	Discussing the efficacy of various techniques.	Personal support via coach discussion aided by video.	Use of video to reinforce progression towards the new technique.	Use of practice activities to develop confidence.	No examples evident.
Study examples of inconstancy	Lack of planning and detailed analysis and athlete input.	Goal-setting against realistic but challenging targets.	Monitoring goals to maintain progress.	Failure to sell progress to the athlete.	No attempt to "pressure-proof" the new movement.

688   *Note*: Examples listed do not reflect a systematic application by coaches nor do they reflect the practices reported by every participant.