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## 8 **Developmental activities in the acquisition of creativity** 9 **in soccer players**

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26

## Abstract

27 We examined whether high- or low-creative soccer players who were classified based  
28 on an established soccer-specific creative decision-making test differed based on their  
29 participation history profiles. Their solutions on the test were measured using the three  
30 observation criteria for creativity of originality, flexibility, and fluency of decisions.  
31 Questionnaires were used to record the participation history profiles of players. The  
32 high-creative group spent significantly more average hours per year in free, unstructured  
33 soccer-specific play activity during childhood and early adolescence (i.e., 6-15 years of  
34 age) when compared with their low-creative counterparts. No differences were reported  
35 for hours per year in soccer-specific formal practice and competition between the two  
36 groups across development. Moreover, hours accumulated in other sports, as well as  
37 milestones achieved, did not differentiate groups. Our findings suggest that informal  
38 unorganized, free play in the primary sport is positively associated with and necessary  
39 for the development of superior levels of creative ability in soccer players. Practical  
40 implications, further research avenues and limitations are presented.

41

42 **Keywords:** *Creative decision making; Sport expertise; Player development; Skill*  
43 *acquisition; Deliberate play; Deliberate practice*

## Introduction

44

45       The most skilled professional soccer players create excitement for spectators  
46 when they touch the ball because they often produce outstanding decisional actions  
47 during match play. The ability of players to produce relatively novel solutions in game  
48 situations that are both original (i.e., statistically rare and surprising) and appropriate  
49 (i.e., useful, adequate) is defined as ‘tactical’ creativity (Memmert & Roca, 2019). For  
50 the purpose of this investigation, we will focus on this type of creativity as it plays a  
51 significant role in team ball sports like the game of soccer used in this study. Yet, very  
52 few researchers have studied how this type of creative behavior is acquired and  
53 developed in the sporting domain (e.g., Henry, Williams, & Hodges, 2018; Memmert,  
54 Baker, & Bertsch, 2010). We address this shortcoming in the literature by assessing the  
55 activities that contribute to the development of superior creativity by examining  
56 differences in participation history profiles of skilled soccer players who are classified  
57 as either high- or low-creative players based on their performance on a soccer-specific  
58 creative decision-making test.

59       Over the past two decades, researchers have largely been influenced by the  
60 theory of Deliberate Practice (Ericsson, Krampe, & Tesch-Römer, 1993) to examine the  
61 development and acquisition of expert decision making and performance. The main  
62 proposition that the amount of domain-specific deliberate practice accumulated in by  
63 individuals during their careers is positively correlated to their attained level of  
64 performance has defined several studies across various fields, including sport (for a  
65 review, see Macnamara, Moreau, & Hambrick, 2016), music (Ericsson et al., 1993), and  
66 medicine (van de Wiel, Van den Bossche, Janssen, & Jossberger, 2011). The  
67 characteristics of deliberate practice are that is a highly structured activity with the  
68 primary goal of improving an aspect of current performance, coach-led, individualized,

69 effortful, and relatively low in intrinsic enjoyment. The importance of deliberate  
70 practice has been widely recognized as a key component to the development of sport  
71 expertise (e.g., Baker & Young, 2014), however, it has likewise been criticized for  
72 being overly simplistic and not accounting for the multidimensional nature of athlete  
73 development (Hambrick et al., 2014; Macnamara et al., 2016). Over the past few years,  
74 some researchers (Berry, Abernethy, & Côté, 2008; Roca, Williams, & Ford, 2012;  
75 Williams, Bell-Walker, Ward, & Ford, 2012) have examined whether athletes with  
76 varying levels of expert decision making and performance may be differentiated based  
77 on their participation history profiles. Participants in these studies recall their practice  
78 history via interviews or questionnaires. They started engagement in the primary sport  
79 in early childhood (i.e., 5-7 years of age) and participated in several different activities  
80 throughout their development, including deliberate practice, free play, and competition.  
81 Some between-group differences revealed that the higher-performing groups  
82 accumulated more hours in free play activity in their primary sport of soccer (Roca et  
83 al., 2012; Williams et al., 2012) or in different invasion sports generally (Berry et al.,  
84 2008), particularly during their childhood period (e.g., 6-12 years of age). This provides  
85 evidence that engagement in play (e.g., informal games set-up by the children  
86 themselves, such as street soccer or backyard basketball; see Côté, Baker, & Abernethy,  
87 2007) in combination with deliberate practice is an important antecedent to the  
88 development and attainment of sporting expertise in team ball sports.

89         Although the ability to think creatively may be seen as an important  
90 characteristic of expert decision making (e.g., tactical intelligence), these are often seen  
91 as not the same. This difference may be based on the theoretical distinction between  
92 ‘divergent thinking’ and ‘convergent thinking’ (Guilford, 1967; Memmert et al., 2010).  
93 Convergent thinking is associated to the ability to find the best solution to a given

94 problem, while divergent thinking refers to the ability to produce a variety of solutions  
95 that are innovative, rare, unusual and, original (Sternberg & Lubart,1999). Nevertheless,  
96 recent research (Dietrich & Haider, 2017) suggests that convergent thinking can also  
97 contribute to creative insights and that it should be similarly considered as a measure of  
98 creative ability when assessing creativity in sporting environments. Likewise, adding a  
99 convergent thinking measure might allow for a more realistic assessment of sporting  
100 creativity (i.e., players in a game can only select and execute a response at a time to  
101 each game situation encountered).

102 In line with research conducted on expert decision making, few researchers  
103 (Greco, Memmert, & Morales, 2010; Henry et al., 2018; Memmert et al., 2010) have  
104 attempted to explore the role of different developmental activities (i.e., deliberate  
105 practice and play) on the acquisition of sport-specific creativity. Greco et al. (2010)  
106 evaluated whether tactical creativity in youth basketball players might be improved by  
107 using either a sport-specific deliberate-play or a more traditional structured training  
108 program. Findings showed significant training improvement on measures of tactical  
109 intelligence and creativity for the deliberate-play group only. Memmert and colleagues  
110 (2010) conducted the first study using retrospective recall questionnaires to identify the  
111 role of different practice activities in the development of creative behavior in team ball  
112 sports. Twelve coaches selected the most and least creative players from their teams  
113 (soccer, basketball, field hockey, and team handball). Participants completed the  
114 participation history questionnaire designed to gather information about the quantity  
115 and type of sport-specific and other related practice activities undertaken throughout  
116 their careers. Findings revealed that the highly creative players accumulated more hours  
117 in free, unstructured play activities in their main sport compared with their less-creative  
118 counterparts, particularly between the ages of 5-14 years. Participants also engaged on

119 average in three to four other sports throughout their development. More recently,  
120 Henry et al. (2018) used participation history questionnaires and coach ratings of  
121 technical, tactical, physical, and creative skills to examine the relationship between  
122 developmental soccer activities and skill evaluations over a period of 5 years. They  
123 found that while structured, sport-specific practice was positively related to the  
124 development of skills, hours in soccer play did not show expected correlations with  
125 ratings of any skill, including creativity. The authors advocated that there may be  
126 benefits to involvement in deliberate practice and play from an early age, given the need  
127 to accumulate a high amount of sport-specific activity, together with sufficient  
128 variations in practice.

129         Despite some research (e.g., Henry et al., 2018; Memmert et al., 2010) stressing  
130 more for the contribution of coach-led practice or play to the acquisition of superior of  
131 sport-specific creativity, authors agree that a blend of both may perhaps be vital to the  
132 development of creativity in sport. While research supports the importance of domain-  
133 specific expertise in creativity (Baer, 2015), evidence also exists that engagement in  
134 other sports during development can similarly create opportunities for athletes to  
135 develop perceptual-cognitive skills that potentially transfer across sports containing  
136 similar cognitive processing and relational/tactical elements (e.g., soccer to basketball  
137 and vice versa; see Abernethy, Baker, & Côté, 2005; Causer & Ford, 2014; Roca &  
138 Williams, 2017).

139         While some researchers (Henry et al., 2018; Memmert et al., 2010) provided  
140 initial attempts in the literature to investigate the role of practice conditions on the  
141 development of domain-specific creativity in sports, these investigations had some  
142 limitations. The studies relied on the subjective judgments of coaches to rate the tactical  
143 creativity ability of each of their own players, which may be prone to systematic biases,

144 such as the coach-player relationships or the player's personality (for a review, see  
145 Ericsson, 2003). The classification of players' skills' levels based on subjective criteria  
146 may compromise the validity of the results by leading to players being classified  
147 incorrectly. Ericsson (2003) states that researchers should attempt to evaluate task  
148 performance using objective measures (i.e., the task employed should provide precise  
149 and reproducible measurements so that the performance can be objectively evaluated).  
150 For example, by using a representative sport-specific creativity test, performance on the  
151 task can be measured more accurately such that (groups of) athletes with varying levels  
152 of domain-specific creativity may be compared under more standardized and  
153 reproducible test conditions.

154 In the present study, we examine whether skilled soccer players who are  
155 classified as either high- or low-creative players based on their performance on a  
156 representative soccer-specific creativity test, can be differentiated based on their  
157 engagement in soccer and sport activities during their development. We used  
158 retrospective recall questionnaires to collect participation history data for both groups.  
159 We predicted that the high-creative players would have accumulated more hours in  
160 soccer-specific activity throughout their development (i.e., 6-18 years of age) when  
161 compared with the low-creative players (e.g., Henry et al., 2018; Memmert et al., 2010;  
162 Roca et al., 2012). We further expected, based on the findings of Memmert et al. (2010),  
163 that the average number of hours per year spent in soccer unstructured play during  
164 childhood and early adolescence (i.e., 6-15 years of age) would be greater for high-  
165 creative compared to low-creative players.

## 166 **Methods**

### 167 *Participants*



168 Participants were 48 skilled, male outfield soccer players ( $M$  age = 20.2 years,  
169  $SD = 2.1$ ). Players were recruited from a range of different semi-professional and  
170 professional soccer clubs in the south-east of England. Seventeen of all participants  
171 were currently playing or had played soccer at a professional level. Written informed  
172 consent was obtained from the participants prior to taking part in the study and all  
173 participants had a right to withdraw at any point. The experiment was conducted in  
174 accordance with the 1964 Declaration of Helsinki and approval was obtained from the  
175 authors' University Research Ethics Committee.

176

#### 177 *Procedure*

178 *Soccer-specific creativity test.* Participants were presented with a representative  
179 task involving video sequences of dynamic 11 vs. 11 attacking situations that offered a  
180 range of multiple decision options for the player in possession of the ball at the time of  
181 video occlusion. Further details on the production of the test film are reported elsewhere  
182 (see Roca, Ford, & Memmert, 2018; 2021). The test comprised of 20 video clips of  
183 approximately 10 s duration that were occluded at a key moment in the action.  
184 Immediately prior to occlusion the player in possession of the ball on the video had a  
185 variety of possible tactical options, including different attacking passes, shooting at  
186 goal, or dribbling forwards. The order of presentation of the clips was the same for all  
187 participants.

188 The video clips were projected onto a large white wall (image size: height 2.5 m  
189 and width 3.4 m) using an LCD projector (Epson EB-X31, Tokyo, Japan). Participants  
190 started each trial in a standing position at 3m from the video screen wall. A soccer ball  
191 (Mitre Cyclone indoor size 4 ball) was directly in front of them on each trial. They were  
192 required to imagine themselves as the attacking player in possession of the ball on the

193 video. Considering that to attain a more comprehensive measure of creative ability  
194 convergent and divergent thinking may be mutually considered (Dietrich & Haider,  
195 2017), a convergent thinking measure was also included in our soccer-specific creativity  
196 test (i.e., participant required to select and execute a tactical decision by physically  
197 playing the ball in response to each presented scenario as quickly as possible as the  
198 screen occluded). Moreover, such methodological approach enhances the ‘real-world’  
199 representativeness and fidelity of participant decision making on the task by allowing  
200 participants to respond similarly to as they would in a real-game situation (e.g., Roca,  
201 Williams, & Ford, 2014). They also had to verbally confirm their decision immediately  
202 after executing the action, which would be either to whom and how they intended to  
203 pass the ball, if they shot at goal or dribbled the ball forward. This approach contrasts  
204 with the methodological norm in research on sport creativity where divergent thinking  
205 tasks have been predominant (for a review, see De Sá Fardilha & Allen, 2020). After  
206 this, the last still frame of the video clip was shown for 45 s during which time the  
207 participants were required to generate all other adequate tactical solutions they would or  
208 could execute for that situation (divergent thinking) (for the transcript on instructions  
209 given to participants, see ‘Supplementary material 1’, Roca et al., 2021, p. 7). The same  
210 procedure was employed across every single trial. In order to offer participants a more  
211 naturalistic and immersive sensation to the task, the real ambient crowd noise of the  
212 stadium was played through multimedia stereo speakers (Logitech Z200,  
213 Lausanne, Switzerland) during testing. Participants first completed three warm-up trials  
214 for pre-test familiarization. The testing for each participant took about 45 min. After  
215 completing the testing procedure participants were informed about the purpose of the  
216 experiment.

217            *Participation history questionnaire.* The Participation History Questionnaire  
218 (PHQ) was used to elicit information relating to the developmental activities undertaken  
219 by players. Indices associated to the reliability and validity of the PHQ have previously  
220 been reported (e.g., Ford, Low, McRobert, & Williams, 2010) and its use is relatively  
221 widespread (e.g., Ford et al., 2010, 2020; Roca et al., 2012; Williams et al., 2012). The  
222 questionnaire contains three sections. The first section of the questionnaire elicited  
223 information on soccer-specific milestones. Participants were required to record the age  
224 at which they first took part in any soccer, supervised training in soccer with an adult,  
225 organized soccer league, youth development training program, semi-professional and/or  
226 professional soccer. The second section recorded information on their engagement in  
227 soccer activities. Three soccer activities were examined: practice, play, and competition.  
228 These activities used were based on previous research in which retrospective  
229 questionnaires were used (e.g., Roca et al., 2012; Ward, Hodges, Starkes, & Williams,  
230 2007) and to match the recommendations proposed by Côté, Ericsson, and Law (2005).  
231 Practice referred to soccer activity undertaken alone or in a group under the supervision  
232 of coaches or adults in which the intent is to improve performance (e.g., practice with  
233 team). Play activities referred to play-type games with rules supervised by participants  
234 themselves in which the intent is enjoyment (e.g., “kick around” with friends).  
235 Competition included time spent playing organized competitive matches against another  
236 team in which the intent is to win (e.g., league games). Participants recorded the number  
237 of hours per week and the number of months per year spent in each of the soccer  
238 activities. Additionally, they recorded in weeks any time away from soccer (i.e., injured  
239 and unable to participate) that occurred across the course of the season. Soccer-specific  
240 information was reported retrospectively for the present season/year, then working  
241 backwards in two-year intervals until the age they first started playing soccer.

242 The third section of the questionnaire recorded information on engagement in  
243 other sport activities. Participants were provided with a comprehensive list of sports and  
244 were required to indicate those they had taken part in on a regular basis (i.e., a minimum  
245 period of three months in total), excluding school physical education classes. Any sports  
246 that were not on the list could be added by participants to the end of the list. They were  
247 required to provide the age at which they started playing each sport, the number of  
248 hours per week and the number of months per year they had spent in each sport, and the  
249 age they finished taking part in each sport (unless they were still involved in the sport).

250 Questionnaires were completed individually at a desk in the laboratory and  
251 under supervision of the main experimenter. Participants were instructed on how to  
252 complete each section of the questionnaire before commencing that section. For the  
253 second section, participants had to specify the team and coach that they played for in  
254 each age group during their development to aid memory recall of the hours in the soccer  
255 activities (e.g., Ford et al., 2020). Participants completed the questionnaire in  
256 approximately 1 hr.

#### 257 *Creativity data analysis*

258 Creative performance on the soccer-specific creativity test was measured using  
259 the three criteria *originality*, *fluency*, and *flexibility*. These measures have been part of a  
260 standard procedure repeatedly used to assess athletes' creative performance in previous  
261 research (for a review, see Memmert, 2015). *Originality* referred to the production of  
262 responses that are rare or a-typical according to the norm. Three independent experts  
263 (qualified UEFA soccer coaches) judged the originality of the solutions given by  
264 participants for each scene using a Likert scale ranged between 1 (not original at all) to  
265 5 (very original). The inter-rater reliability between coaches for originality measure was  
266 above the critical limit of 0.80 (intraclass correlation coefficient). The first decision

267 made by the participant in a trial was analyzed separately because it was the most  
268 realistic decision-making response akin to that made in a real-match situation (i.e., Roca  
269 et al., 2018; 2021). These ratings were used to compute two mean originality scores for  
270 each participant, one for the first initial response (convergent thinking) and another for  
271 the responses given when the last frame was shown afterwards for 45 s (divergent  
272 thinking) (summed ratings for each response were divided by the total number of  
273 responses). *Fluency* was measured by the number of appropriate tactical solutions  
274 produced by a participant per trial. *Flexibility* was assessed by diversity of responses.  
275 All solution options given by the participants were categorized based on Roca et al.  
276 (2018: short pass, lofted pass, through ball, wall pass, back heel pass, outside of the foot  
277 pass, feinting, turn, crossing, dribbling, shot at goal). A point was awarded for each  
278 category selected by a participant and summed for the respective trial, before being  
279 divided by the total number of trials to establish a flexibility score for each participant.

280       Each of the four components (originality of initial response, originality, fluency,  
281 flexibility) were analyzed separately followed by averaging the z-transformed values of  
282 each component into a merged creative performance score for each participant as per  
283 previous creativity research (cf. Furley & Memmert, 2015; Hüttermann et al., 2018;  
284 Memmert et al., 2013). A quartile-split approach was employed as an objective method  
285 for stratifying participants into significantly different sub-groups based on players'  
286 creative performance scores (total, z-value) from the soccer-specific creativity test (e.g.,  
287 see Ford et al., 2010; Roca et al., 2018; Williams et al., 2012). The top 12 ranked  
288 players were classified as 'high creative', whereas the 12 players with the lowest  
289 creativity scores were classified as 'low creative'. A priori power analysis was  
290 conducted using G\*power (Faul, Erdfelder, Lang, & Buchner, 2007). Calculations were  
291 based on the main effect sizes for creative performance response scores reported by

292 Roca et al. (2018, 2021) who employed the same task and skill-based groups and using  
293 the lower between-factor effect size ( $d = 1.68$ ) and power of 0.95, the total sample size  
294 required was 18 participants. Response scores for originality of initial response,  
295 originality, fluency, flexibility, and the total creativity score were analyzed using  
296 independent *t*-tests between the high- and low-creative groups.

#### 297 *Participation history data analysis*

298 Participation history data were analyzed for the high- and low-creative groups.  
299 First, the milestones data were analyzed separately using independent *t*-tests between  
300 groups. Second, the accumulated hours in soccer activity were recorded for every other  
301 year between the current season and start age, so linear interpolation was used for the  
302 missing years (i.e., average of the year preceding and succeeding). These hours were  
303 split into two age periods (i) 6-12 years (i.e., childhood) and (ii) 13-18 years (i.e.,  
304 adolescence) for practice, play, and competition. The number of hours per year was  
305 calculated by multiplying hours reported per week by weeks per year, minus weeks  
306 players reported being injured and unable to participate. The number of weeks per year  
307 was based on a 40-week season for soccer practice and competition activities. Separate  
308 2 Group (High-creative, Low-creative)  $\times$  3 Activities (Practice, Play, Competition)  
309 ANOVAs with repeated measures on the last factor were performed for (i) 6–12 years  
310 and (ii) 13–18 years of age. Any significant main effects were followed up with  
311 pairwise comparisons. The Bonferroni correction method was used to adjust the alpha  
312 level required for significance for post hoc pairwise comparisons only. Finally, we also  
313 conducted separate independent *t*-tests for the number of other sports and hours  
314 accumulated in other sports for these two age ranges between groups.

315 The Greenhouse-Geisser and Huynh-Feldt corrections were employed in the  
316 case of violations of Mauchly's test of sphericity (Girden, 1992). Effect sizes are

317 reported using partial eta squared ( $\eta_p^2$ ) in all instances and Cohen's  $d$  for comparisons  
318 between two means. The alpha level ( $p$ ) required for statistical significance was set at  
319 .05 for all tests.

## 320 **Results**

### 321 *Creativity test*

322 The high-creative group ( $M_{Creativity\ score} = 1.00 \pm 0.32$ ) recorded a significantly  
323 higher creative performance score on the test compared with the low-creative group  
324 ( $M_{Creativity\ score} = -0.87 \pm 0.34$ ),  $t(22) = 13.95$ ,  $p < .001$ ,  $d = 5.66$ . For the different  
325 components of creativity, the high-creative players produced more original decisions for  
326 the initial response ( $M_{Originality\ 1st\ response} = 3.30 \pm 0.33$ ),  $t(22) = 5.39$ ,  $p < .001$ ,  $d = 2.19$ ,  
327 and for the responses given when the last frame was shown ( $M_{Originality} = 2.77 \pm 0.17$ ),  
328  $t(22) = 4.15$ ,  $p = .001$ ,  $d = 1.71$ , as compared to the low-creative group ( $M_{Originality\ 1st$   
329  $response} = 2.60 \pm 0.31$ , and  $M_{Originality} = 2.47 \pm 0.18$ , respectively). Also, the high-creative  
330 group made more appropriate ( $M_{Fluency} = 3.06 \pm 0.23$ ),  $t(22) = 8.27$ ,  $p < .001$ ,  $d = 3.37$ ,  
331 and flexible ( $M_{Flexibility} = 2.92 \pm 0.32$ ),  $t(22) = 8.54$ ,  $p < .001$ ,  $d = 3.46$ , tactical solutions  
332 when compared with the low-creative group ( $M_{Fluency} = 2.25 \pm 0.25$ , and  $M_{Flexibility} =$   
333  $1.94 \pm 0.24$ , respectively).

### 334 *Participation history data*

335 *Milestones.* The descriptive and inferential statistics for milestones between  
336 groups are presented in Table 1. There were no differences between the high- and low-  
337 creative groups for their chronological age or for any of the milestones. Furthermore,  
338 we analyzed the participants' current playing positions with the high-creative group  
339 being comprised of three defenders, seven midfielders, and two attackers and the low-  
340 creative group of four defenders, three midfielders, and five attackers.

341

342

Insert Table 1 about here

343

344           *Soccer activity.* The total hours accumulated in soccer activity by 18 years of age  
345 differentiated the high- from the low-creative group,  $t(22) = 2.55, p < .05, d = 1.04$ . The  
346 high-creative group ( $M = 6589.6 \pm 1975.9$  h) accumulated more hours in soccer  
347 compared with the low-creative group ( $M = 4717.5 \pm 1599.6$  h). Figure 1 presents the  
348 average hours per year in soccer activities between 6 and 18 years of age for the high-  
349 and low-creative groups.

350

351

Insert Figure 1 about here

352

353           There was a main effect for activity in childhood,  $F(2, 44) = 41.89, p < .001, \eta_p^2$   
354  $= .66$ . *Post-hoc* tests showed that the average hours per year during childhood in soccer  
355 play activities ( $M = 288.6 \pm 182.4$  h · year<sup>-1</sup>) was higher compared with soccer-specific  
356 practice ( $M = 91.6 \pm 65.7$  h · year<sup>-1</sup>) and competition ( $M = 42.0 \pm 21.6$  h · year<sup>-1</sup>)  
357 (both  $p$ 's  $< .001$ ). There was a main effect for group,  $F(1, 22) = 4.34, p < .05, \eta_p^2 = .17$ ,  
358 and a significant Group x Activity interaction,  $F(2, 44) = 4.51, p < .05, \eta_p^2 = .17$ . *Post-*  
359 *hoc* tests showed that the high-creative group spent significantly more average hours per  
360 year during childhood in soccer-specific play activity when compared with their low-  
361 creative counterparts ( $M = 366.6 \pm 194.0$  h · year<sup>-1</sup> vs.  $M = 210.5 \pm 136.6$  h · year<sup>-1</sup>,  $p$   
362  $< .05, d = 0.93$ ) (see Figure 1).

363

364

365

366

          There was a main effect for activity in adolescence,  $F(1.70, 37.43) = 12.55, p <$   
 $.001, \eta_p^2 = .36$ . *Post-hoc* tests showed that the average hours per year during  
adolescence in soccer-specific practice ( $M = 206.3 \pm 109.2$  h · year<sup>-1</sup>) and play  
activities ( $M = 151.0 \pm 91.9$  h · year<sup>-1</sup>) were higher compared with competition ( $M =$



367 92.5 ± 33.9 h · year<sup>-1</sup>) (both *p*'s < .01). There was no main effect for group,  $F(1, 22) =$   
368 3.47,  $p = .076$ ,  $\eta_p^2 = .14$ , and the Group x Activity interaction approached significance,  
369  $F(1.70, 37.43) = 3.21$ ,  $p = .059$ ,  $\eta_p^2 = .13$ . To test our a priori prediction that the high-  
370 creative group would spend on average more time per year in soccer-specific play  
371 activities during the *early* stage of their adolescence (13 to 15 years of age), we  
372 conducted a post hoc planned contrast. This comparison revealed that the high-creative  
373 group engaged in more hours per year in soccer play activity during early adolescence  
374 when compared with the low-creative group ( $M = 202.6 \pm 93.0$  h · year<sup>-1</sup> vs.  $M = 93.1$   
375  $\pm 57.6$  h · year<sup>-1</sup>,  $p < .01$ ,  $d = 1.42$ ) (see Figure 1).

376 *Other sports activity.* The descriptive and inferential statistics for engagement in  
377 other sports between groups are presented in Table 2. The number of other sports  
378 engaged in and the hours accumulated in those sports did not differentiate groups for  
379 either of the two developmental stages examined (i.e., 6-12 and 13-18 years of age).  
380 Participants in the high-creative group engaged in an average of 3 other sports in the  
381 childhood stage and 2 other sports during adolescence, whereas the low-creative  
382 engaged in 2 other sports throughout their development. The most popular other sports  
383 in which players participated across the two groups were athletics ( $n = 10$  players),  
384 swimming ( $n = 8$  players), basketball ( $n = 7$  players), and rugby ( $n = 5$  players).

385

386 Insert Table 2 about here

387

## 388 Discussion

389 In line with our hypothesis, the results showed that the players classified as high-  
390 creative from the test had accumulated more total hours in soccer-specific activity  
391 throughout their development compared to those classified as low-creative. This

392 difference is primarily the result of the main finding that the high-creative group spent  
393 significantly more average hours per year in soccer play activity during childhood and  
394 early adolescence (i.e., 6-15 years of age) when compared with their low-creative  
395 counterparts. The high-creative group were engaging in around  $345 \text{ h} \cdot \text{year}^{-1}$   
396 (corresponding to  $7 \text{ h} \cdot \text{week}^{-1}$ ) of soccer-specific play activity during this  
397 development period compared to just  $192 \text{ h} \cdot \text{year}^{-1}$  (around  $4 \text{ h} \cdot \text{week}^{-1}$ ) recorded for  
398 the low-creative players. There were no other between-group differences in milestones,  
399 soccer-specific activity, or other sports.

400         Our findings support those reported by Memmert et al. (2010) who showed that  
401 free, unstructured sport-specific play activity may be an important contributor to the  
402 development of superior creativity in team ball sports such as soccer. The high-creative  
403 group in our study had accumulated around 2760 h of this activity up to the age of 14,  
404 which is greater than the 1341 h reported by Memmert et al. (2010) for highly creative  
405 athletes from the sports of soccer, basketball, handball, and field hockey. However, this  
406 comparison is challenging to make since Memmert and colleagues either merely  
407 reported the average hours accumulated in sport-specific play in the main sport across  
408 all the four sports combined or for each sport when the data for the two creative groups  
409 was merged.

410         Multiple and greater benefits are thought to be gained by increased engagement  
411 in sport-specific, play activity when compared to the more structured deliberate practice  
412 activities. Such playful, non-linear environments provide children the freedom to  
413 problem-solve and greater opportunities to experiment with new movements and  
414 various technical and tactical skills within their sport (Memmert et al., 2010; Turnnidge,  
415 Allan, & Côté, 2019). This offers youngsters the chance to improvise, innovate and be  
416 adaptable, re-creating those conditions that are crucial at the top level in numerous

417 sports (Santos, Memmert, Sampaio, & Leite, 2016; Williams, Ford, Eccles, & Ward,  
418 2011). As researchers have found, children’s sport practice under the supervision of a  
419 coach (i.e., team practice in soccer academies) is often overly prescriptive, with coaches  
420 providing constant instruction relating what players should do and when (Ford, Yates,  
421 & Williams, 2010), potentially inhibiting the development of creativity and the ability  
422 to be adaptive to changing match situations. Additionally, some empirical support exists  
423 (e.g., Henry et al., 2018; Martin & Cox, 2016; Richard, Abdulla, & Runco, 2017) to  
424 indicate that too much investment in ‘specialized’ deliberate practice, with a more rigid  
425 skill-based approach, can lead athletes to rely on established knowledge and preventing  
426 them from exploring new ideas/solutions that are crucial for the development of specific  
427 creative performance. Hence, considerable engagement in free play activity in the  
428 primary sport during the initial periods of youth development may be a necessary  
429 antecedent to the acquisition and attainment of domain-specific expert creativity. There  
430 is evidence to suggest that those players who can retain a sense of spontaneity,  
431 ‘mischievousness’, and creativity at the top level of their sport are more likely to shape  
432 a game than those who are ruthlessly well-drilled (Memmert & König, 2019). With  
433 respect to practical implications for sport organizations, clubs, and coaches, we  
434 emphasize the growing need for implementing well-founded youth programs and  
435 training activities that encompass key elements of deliberate play such as fun, freedom  
436 to experiment with new ideas, and greater opportunities to be adaptive to the ever-  
437 changing game situations so as to facilitate athletes’ development of superior levels of  
438 sporting creativity. Perhaps this proposal has never been more relevant in the modern  
439 times for sports like soccer where we have seen the extinction of the so called ‘street  
440 soccer’ in the developed world and children joining youth soccer academies and clubs at  
441 increasingly younger ages (Machado et al., 2019).

442           The two groups were not statistically differentiated in other sport engagement  
443 during the two development periods. The high creative group participated in a mean  
444 number of three other sports during childhood (i.e., 6-12 years of age) when compared  
445 to two other sports for their low-creative counterparts (this difference achieved a  
446 medium effect size). The number of hours spent in other sports during childhood  
447 equated to around  $3 \text{ h} \cdot \text{week}^{-1}$  over a 50-week year for the high- and low-creative  
448 groups. In comparison, the high-creative group participated in twice as many hours in  
449 weekly self-led soccer play activity (around  $7 \text{ h} \cdot \text{week}^{-1}$  over a 50-week year). The  
450 lack of between-group differences in other sports contradicts the early diversification  
451 model (i.e., participants sample a number of different sports during childhood) proposed  
452 in the Developmental Model of Sport Participation (Côté et al., 2007), albeit both  
453 groups were engaging in meaningful amounts of other sports during their development.  
454 The higher amount of soccer activity compared to other sports during childhood in the  
455 participation history profiles of the players supports the early engagement hypothesis  
456 proposed by Ford, Ward, Hodges, and Williams (2009). According to this hypothesis,  
457 players spend a meaningful amount of time in their primary sport during childhood,  
458 particularly in soccer through free play.

459           A potential limitation with the method employed in this study to elicit  
460 information relating to the developmental activities undertaken by players is that the  
461 operational definitions of deliberate practice and deliberate play may be seen as  
462 relatively too broad and simplistic in nature (De Sá Fardilha & Allen, 2020; Henry et  
463 al., 2018). For example, the diversity and quality of training sessions/programs (e.g.,  
464 coaches' ability to design effective practice activities) that players may have  
465 encountered during their soccer clubs' youth developmental years could have also  
466 played a valuable part in the acquisition of creativity. In future, researchers should

467 attempt to explore the nature and acquisition of the underlying perceptual-cognitive  
468 processes associated to different types of deliberate practice and play activities to better  
469 understand how these activities may facilitate and contribute to the development of  
470 sporting creativity.

471           In summary, we have attempted to identify the activities that contribute to the  
472 development of creative decision making in soccer by examining differences in  
473 participation history profiles of skilled soccer players who were objectively classified as  
474 either high- or low-creative players based on their performance on a soccer-specific  
475 creativity test. We have reported that high-creative players spent more hours in free,  
476 unstructured soccer-specific play activity during childhood and early adolescence (i.e.,  
477 6-15 years of age) when compared to low-creative players, suggesting that this type of  
478 engagement is positively associated with and essential for the development of superior  
479 levels of creativity in this sport. In future, there is a need for longitudinal and  
480 intervention-based research to help establish processes that can enhance or accelerate  
481 the development of creative decision-making ability.

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612 Table 1. The statistical and descriptive analyses for soccer milestones (in years)

Variable and comparison	<i>t</i>	Cohen's <i>d</i>	Mean ± <i>s</i>
Chronological age <sup>a</sup>	0.61	0.25	High creative = 21.1 ± 2.3 Low creative = 20.6 ± 1.7
Start ages			
In soccer <sup>a</sup>	0.99	0.40	High creative = 5.4 ± 0.9 Low creative = 5.9 ± 1.5
In supervised training	0.93	0.34	High creative = 7.6 ± 2.5 Low creative = 8.6 ± 2.9
In soccer league <sup>a</sup>	0.83	0.30	High creative = 8.6 ± 2.3 Low creative = 9.5 ± 3.0
In elite training program	0.06	0.04	High creative ( <i>n</i> = 11) = 12.2 ± 2.6 Low creative ( <i>n</i> = 12) = 12.3 ± 2.7
At semi-professional level	0.77	0.67	High creative ( <i>n</i> = 10) = 17.7 ± 2.3 Low creative ( <i>n</i> = 10) = 17.1 ± 0.9
At professional level	0.22	0.12	High creative ( <i>n</i> = 5) = 18.0 ± 1.7 Low creative ( <i>n</i> = 4) = 17.8 ± 1.7

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614

615 Table 2. The statistical and descriptive analyses for engagement in other sports

Variable and comparison	<i>t</i>	Cohen's <i>d</i>	Mean ± <i>s</i>
Number of other sports			
6-12 years	1.62	0.64	High creative = 2.6 ± 1.2 sports
			Low creative = 1.8 ± 1.3 sports
13-18 years	0.39	-0.11	High creative = 1.5 ± 1.0 sports
			Low creative = 1.6 ± 0.8 sports
Hours accumulated			
6-12 years	0.65	0.26	High creative = 1103.8 ± 738.1 h
			Low creative = 863.9 ± 1054.9 h
13-18 years	-1.32	-0.54	High creative = 425.3 ± 446.9 h
			Low creative = 794.4 ± 859.5 h

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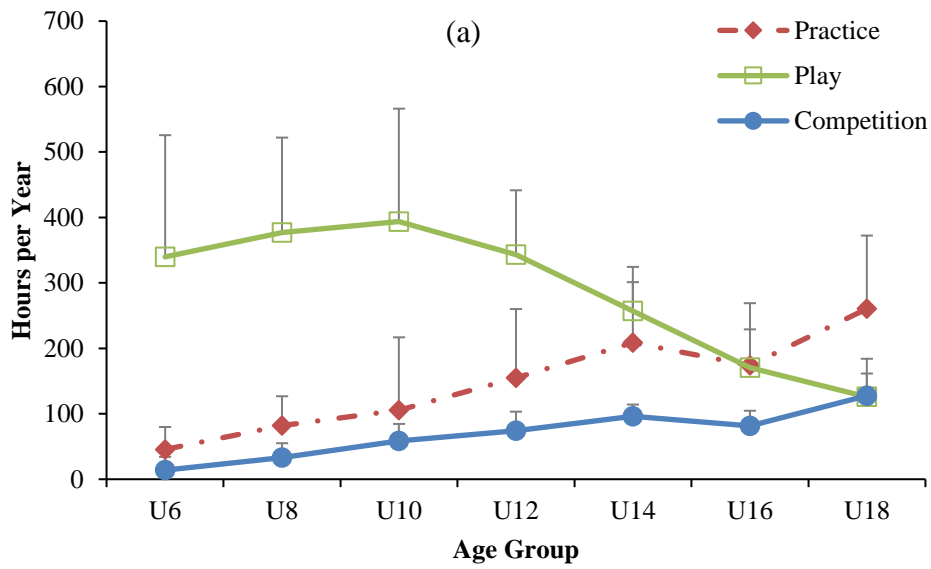
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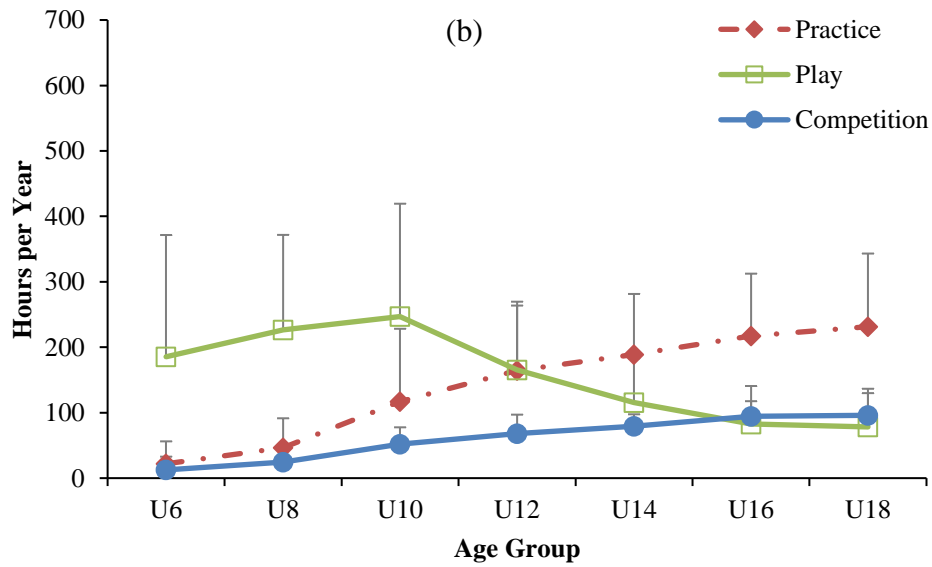
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634 Figure 1. Mean ( $\pm s$ ) hours per year spent in each of three soccer activities (practice, play,  
635 competition) as a function of age group for (a) high-creative and (b) low-creative players.