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4 **Defining, assessing, and developing creativity in sport: a systematic**
5 **narrative review**

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24 **Defining, assessing, and developing creativity in sport: a systematic**
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26 Research on creativity in sport is gaining momentum, due to a growing interest
27 from coaches and academics in developing strategies to increase unpredictability
28 in individual and collective behaviour which may allow teams to gain an important
29 advantage over their opponents. The purpose of this paper was to conduct the first
30 systematic narrative review of the literature on sporting creativity, critically
31 synthesising 51 years of published research (1967-2018) and proposing avenues
32 for future research. Six databases were used, and 48 documents met search criteria.
33 The findings are organised in four categories: (a) defining creativity, (b) correlates
34 of creativity, (c) assessing creativity and (d) developing creativity. Creativity
35 definitions and assessments have privileged thought processes over the ability to
36 act. A distinction is warranted between creativity about sport and creativity in sport
37 (in action) and aligned assessment methods. The literature does not support a single
38 strategy for the development of sporting creativity but does support its trainability.
39 Evidence of the effectiveness of programmes for the enhancement of sporting
40 creativity is growing but is still limited. Furthermore, while it is recognised that
41 coaches have a pivotal role in the development of sporting creativity, research
42 involving them is still scarce.

43 Keywords: creativity; sport; complexity; deliberate practice; deliberate play

44 **Introduction**

45 Creativity is a topic that attracts attention from all areas of society and domains
46 of performance (Runco, 2014). Dietrich and Haider (2017, p.1) describe it as the
47 “fountainhead of our civilizations and a defining characteristic of what makes us
48 human”. Since J.P. Guilford’s historical speech as part of the American Psychological
49 Association’s (APA) Presidential Address in 1950, research on creativity has risen
50 dramatically, even though not to a level that can reflect “its importance both to the field
51 of psychology and to the world” (Sternberg & Lubart, 1999, p.12). Over the past seven
52 decades, many different lines of research have been explored – e.g. divergent thinking,

53 intelligence, giftedness – and many frameworks, mostly derived from cognitive
54 psychology, have tried to explain the mechanisms of the creative process – e.g. blind-
55 variation and selective retention (Campbell, 1960), associative theories (Mednick,
56 1962), *geneplore* (Finke, Ward, & Smith, 1992), stage models (Wallas, 1926),
57 componential models (Amabile, 1990), investment models (Sternberg & Lubart, 1991),
58 and contextual models (Gardner, 1993; Csikszentmihalyi, 1996).

59 In sport, creativity has also seen increased interest from researchers and
60 practitioners (Memmert, 2010), with an exponential growth occurring in the last two
61 decades. The advent of performance analysis and the widespread availability of
62 information on teams and players' behaviours mean that creativity in sport has never
63 been more necessary. It is therefore unsurprising that many stakeholders are trying to
64 develop alternative approaches that increase unpredictability in individual and collective
65 behaviour to be more 'successful' (Yamamoto & Yokohama, 2011 in Torrents et al.,
66 2016).

67 While important advancements have been made, much remains to be understood
68 about this complex phenomenon. Therefore, the purpose of this review was to critically
69 explore conceptualisations of sporting creativity and methods recommended for its
70 assessment and development, while also suggesting avenues for future research.

71 **Method**

72 Given the emerging nature of the field and the absence of previous reviews on
73 sporting creativity, it was deemed appropriate to conduct a literature review (Grant &
74 Booth, 2009) that focused on a comprehensive search of the existing literature, without
75 assessing the quality of evidence available. Six databases were used: PUBMED,
76 SportDiscus, Web of Science, ERIC, Scopus, and PsycINFO. Search terms were drawn
77 from the seminal literature on creativity and based on Runco's (2014) definition of

78 creativity and its correlates (e.g. intelligence, innovativeness, imagination,
79 inventiveness, originality). With regards to sport, the search used not only the
80 overarching term – sport – but was complemented by Launder and Piltz’s (2013)
81 definition of team invasion games, court invasion games and court-divided games.
82 Limited time and human resources led to a focus on these three game categories, where
83 creativity is of “crucial importance” (Memmert, 2017, p. 479) when compared to
84 individual sports, which tend to fall on the lower end of the complexity continuum
85 (Brown & Gaynor, 1967; Memmert, 2011; 2017). The keyword search was the
86 following: (creativ* OR imaginat* OR intelligen* OR inventive* OR innovative* OR
87 original*) AND (sport* OR football OR soccer OR handball OR volleyball OR ultimate
88 OR hockey OR lacrosse OR tennis OR rugby OR netball OR basketball OR badminton
89 OR futsal OR korfbal). Searches were adapted to the syntax of each database. No
90 participant age limits nor English language limits were applied to searches.

91 After the initial searches, all titles considered relevant (n=196) were screened to
92 determine their eligibility. One hundred were excluded. The next phase - abstract
93 review – involved screening summaries and comparing them to the inclusion criteria.
94 Eligibility was assessed by using the criteria presented in Table 1. The search did not
95 retrieve any non-English results that would meet all inclusion criteria.

96

97 [insert table 1 here]

98 A full-text review of those documents retained (n=96) was conducted, resulting
99 in the exclusion of 65. Additionally, a manual search process was conducted by using
100 both forward and backwards snowballing approaches (Greenhalgh & Peacock, 2005),
101 with two titles (n=2) being included. Finally, the most published authors in the field of
102 creativity in sport (identified via Research Gate and Google Scholar) were contacted to

103 request further information on ongoing research that had passed the stage of data
104 collection and on other work that could potentially enrich this review. This resulted in
105 the integration of six more titles (n=6). After the initial search on April 2017, a final
106 search was re-run on August 2018 and seven (n=7) more titles were added to the list. A
107 total of 46 articles (see full description in Table 2) met eligibility criteria (see Figure 1
108 for a summary of the selection process). Two documents - an academic book and a book
109 chapter - which did not meet the eligibility criteria (peer-review) were added by
110 recommendation of a scholar who considered them key texts, authored by the most
111 prominent researcher in the field . In total, 48 titles were included.

112 [insert fig.1 near here]

113 To identify potential patterns in the existing literature, organise them coherently,
114 and reflect on their meaning and implications for research, a narrative structure was
115 adopted and thematic analysis was used (Braun, Clarke, & Weate, 2017). An inductive
116 approach was followed in the coding phase, with the content steering the evolution of
117 the analytical process, which followed Braun, Clarke and Weate's (2017) proposed six-
118 step process, although not always sequentially.

119 Higher-order themes (defining creativity, correlates of creativity, assessment of
120 creativity, developing creativity) worked as central organising concepts around which
121 lower-order themes revolve. As part of the active nature of the analytical process,
122 disagreements between authors were resolved through constructive debate that included
123 the opinions of critical friends - a departmental colleague with a background in sport
124 psychology and football, and one of the leading authors contacted during the data
125 collection process - (Berends & Johnston, 2005), until a final structure was agreed.

126

127 [insert fig.2 near here]

128 **Results**

129 *Defining creativity*

130 This higher order theme presents the review of how creativity is defined. It is
131 comprised of four lower order themes: cognitive traditions, tactical creativity; creativity
132 in sport vs creativity about sport; creativity in sport is emergent.

133

134 *Cognitive traditions*

135 Initial research on sporting creativity was based on the previous work of
136 cognitive psychologists. Runco (2014) argues that the prevalence of cognitive theories
137 of creativity can be explained by “an intuitive connection between cognition and
138 creativity and because cognitive research is often very scientific” (p.1). To date, many
139 different lines of research have been explored – intelligence, giftedness, divergent
140 thinking (the ability to generate different possible solutions to a problem), and so forth.
141 These research streams have also inspired work on sporting creativity (e.g. Memmert,
142 2006; Memmert & Roth, 2007; Igorov et al., 2015; Hopsicker, 2011).

143 A plethora of definitions of creativity has been proposed. Sternberg and Lubart
144 (1999) suggested that for an action to be creative it must be novel and useful. Boden
145 (2004) and Simonton (2012) added a third criterion: surprise. With regards to the
146 assessment of the creativity of an individual, (Guilford, 1967) introduced three
147 foundational dimensions: fluency (the ability to generate several responses), flexibility
148 (the ability to generate different categories of responses) and originality (the ability to
149 generate unusual responses). Memmert, the most cited author in the field, who
150 participated in 44% of publications included in this review, frequently uses Guilford’s
151 (1967) dimensions to assess creative solutions in sport.

152 *Tactical Creativity*

153 Memmert adapted Sternberg and Lubart's investment model (1991) to coin a
154 definition of *tactical creativity*, which refers to "those varying, rare, flexible decisions
155 that play an important role in team ball sports like football, basketball, field hockey and
156 handball" (Memmert, 2011, p. 94). Tactical creativity (or divergent tactical thinking)
157 differs from game intelligence or convergent tactical thinking, that relate exclusively to
158 the selection of the most effective solutions for a given problem (Memmert, 2010).
159 Rather, tactical creativity emphasises the ability of players to generate the highest
160 possible number of different motor solutions for a problem. Furthermore, it is proposed
161 that tactical creativity can only occur in the offensive phase of a game, and not in
162 defence (Memmert, Baker and Bertsch, 2010; Kempe and Memmert, 2018). The focus
163 on attacking players and play has influenced the research conducted. For example, as
164 part of participant selection, Memmert et al. (2010) asked coaches to identify the most
165 creative attackers and least creative defenders. In another study, Kempe and Memmert
166 (2018) focused on the creativity of the last eight actions leading to a goal scored in open
167 play in football World Cups and European Championship. Based on their findings they
168 concluded that creativity is particularly important for attackers and that creativity is "a
169 decisive factor for success in soccer" (2018, p.4).

170 In contrast, professional football coach Jose Tavares, interviewed by Tamarit
171 (2016) contends that all players can be creative, in any phase of the game, with and
172 without the ball. That creativeness should be shaped and evaluated against the specific
173 requirements of each player's position. For example, defenders can produce creative
174 actions within the specificity of their role, while a winger can do the same, perhaps
175 through different strategies, more adapted to the position's requirements and dependent
176 on the team's overarching game model – a way of playing. The interdependence

177 between attackers and defenders is supported by the work of Aggerholm, Jespersen and
178 Ronglan (2011), who performed a contextual analysis of the feint in association
179 football. They concluded that other than self-awareness and the cultivation of embodied
180 habits, to be creative “it is also necessary to be absorbed in the other and transcend his
181 or her expectations” (2011, p. 343). Consequently, the emergence of tactical creativity
182 may depend not only on individual or cooperative efforts but also from this relationship
183 with the opposition – the *duel*.

184

185 *Creativity in sport vs Creativity about sport*

186 An aspect of creativity conceptualisation that lacks consensus is the role of
187 performance. Some suggest creativity depends on the final product, creative
188 performance (e.g. Kaufman & Sternberg, 2007), others emphasise the ability to generate
189 ideas, even if these are not materially expressed (see Runco, 2014 for a comprehensive
190 insight on this discussion). Brown and Gaynor (1967) proposed that sporting creativity
191 needs to be expressed through non-verbal motor skills (creativity *in action* as opposed to
192 creativity *about action*). These creative motor skills can be expressed individually or
193 collectively, and the level of creative potential of an action depends on its complexity.
194 For example, running 100 meters in a straight line has less creative potential (i.e. less
195 different possibilities for action) than playing a game of basketball.

196 Brown and Gaynor (1967) also argued that the creative processes in sport
197 operate much in the same way – preconscious incubation preceding the emergence of
198 the creative action - as those of other areas which do not require physical exertion (e.g.
199 writing, composing). Recent neuroscientific findings on the impact of mechanisms of
200 brain inhibition on creative performance suggest this may not be the case. In their
201 reticular-activating hypofrontality (RAH) model of acute exercise, Dietrich and

202 Audiffren (2011) argue that the brain uses two different cognitive systems to acquire
203 and represent information: implicit and explicit. The explicit system deals with
204 abstraction and complex problem-solving, being linked to more traditional forms of
205 creative expression – e.g. writing, composing. It is rule-based, relates to conscious
206 awareness, and can be expressed verbally.

207 On the other hand, the implicit system, to which motor skills are related, relies
208 heavily on procedural knowledge, which cannot be verbalised, depending therefore on
209 task performance to be expressed. Therefore, sporting creativity, in part, may operate
210 differently to creativity in some other domains because the expression of creativity is
211 through action rather than about action. Furthermore, the unstructured nature of many
212 sports, particularly team sports, demands constant reaction and adaptation to different
213 stimuli. Real-time creativity is limited by time constraints and is necessarily
214 spontaneous (Harrison, 2016). This has implications for the conceptualisation and
215 assessment of sporting creativity as well as the design of interventions to facilitate
216 creativity in sport.

217 *Sporting creativity as an emergence*

218 The idea of body-mind integration (Brown & Gaynor, 1967; Hristovski et al.
219 2011; Hristovski et al., 2012; Campos, 2014; Krein & Ilundáin-Agurruza, 2017;
220 Ilundáin-Agurruza, 2017), as opposed to the traditional privileging of the mind, has
221 important implications for the conceptualisation and development of sporting creativity.
222 Challenging established ideas of the brain as the trigger of all action, Gibson (1979)
223 argued that information, i.e. spatiotemporally patterned energy flow from the
224 environment, is the key element to locomotion and manipulation and that the interaction
225 between the individual and the environment was critical. In this perception-action
226 system, meaning comes from the individual's ability to detect information in the

227 environment (Araújo, Hristovski, Seifert, Carvalho, & Davids, 2017). Furthermore,
228 physical exploration of the landscape of action possibilities may result in the discovery
229 or emergence of a novel action.

230 Orth, van der Kamp, Memmert, and Savelsbergh (2017) also emphasise the
231 importance of adaptability to the environment in motor creativity, which they define as
232 “new ways of acting adaptive or acting adaptively in new situations” (p.2). As such “the
233 emergence of highly novel movement forms requires a self-organising system which,
234 under suitable boundary conditions, can create new behavioural structures” (Hristovski
235 et al., 2011, p. 177). These constraints offer the individual opportunities for action,
236 which Gibson (1979) termed *affordances*. For example, Tanggaard, Laursen, &
237 Szulevicz (2016) showed that changes in equipment (material constraints), in this case,
238 the material that handballs were made from (synthetic polyurethane compared with
239 leather), led to new possibilities for creative expression.

240 ***Correlates of sporting creativity***

241 Following the tradition of cognitive psychology, earlier investigations of
242 sporting creativity attempted to identify isolated variables that contribute to increased
243 creativity. Researchers have examined a relatively limited range of variables, which are
244 discussed under three lower-order themes: giftedness, attention and pattern recognition,
245 and other traits and skills.

246 **Giftedness**

247 The research examining giftedness and creativity has demonstrated that gifted
248 children (IQ>130) tend to express creative behaviour earlier than their non-gifted peers.
249 For example, Memmert (2006) investigated the creative performance of children who,
250 once a week and for six months, underwent a sports enrichment programme which

251 consisted mainly of diversified team ball sports practice (using feet, hands, and a
252 hockey stick) in game forms. Memmert found that while there was no significant
253 improvement in the gifted control group, the gifted experimental group showed a
254 significant increase in creative performance after six months. The non-gifted
255 experimental group did not show a significant improvement as a result of the
256 intervention. However, in a different study with non-gifted children, Memmert and Roth
257 (2007) showed a 40% improvement in creative performance after a 15-month training
258 period. Memmert (2006) explained the accelerated improvement of the gifted group in
259 the shorter programme was a result of “faster automation of individual thought
260 processes... This frees attention capacity for other tasks” (p.108). Therefore, creativity
261 is not a characteristic of only gifted children, it can be developed by others but may take
262 longer.

263 Attention and pattern-recognition

264 Brown and Gaynor (1967) highlighted the crucial role of extreme awareness in
265 creativity by suggesting that “the athlete who is most creative is most aware, most in
266 tune with reality as it exists. Being aware of the single large problem (the game), he
267 [sic] is able to recognise and to act on smaller problems which arise continually” (1967,
268 p.157). It is, therefore, perhaps, unsurprising that breadth of attention as a correlate of
269 creativity has received the most research attention (e.g. Memmert, 2006b; Memmert &
270 Furley, 2007; Furley, Memmert & Heller, 2010; Moraru et al., 2016). This work has
271 focused particularly on inattention blindness, which relates to the diversion of
272 attention where people fail to notice something unexpected, even when it is in their field
273 of view (Memmert, 2006).

274 In a series of experiments, Memmert and Furley (2007) examined inattention
275 blindness in youth handball players, using a video task. They were interested in

276 participants' ability to notice an unmarked player that appeared unexpectedly in the
277 game and the effect of different instructions and actions of the unmarked player. They
278 found that when there were no other conditions, 45% of participants failed to notice the
279 unmarked player, however, when one group was given closed-end instructions 83% of
280 participants failed to notice the unmarked player. This contrasted with only 17% of
281 those participants who were not given these instructions failed to notice the player.
282 Furthermore, when the unmarked player waved his arms only 6% of participants failed
283 to notice him. Connecting inattentive blindness with creative performance, Memmert
284 (2011) examined the relationship between attention and experience in both general and
285 sporting creative performances. The study involved skilled (with a previous degree of
286 experience in team invasion sports) and non-skilled (with no previous experience)
287 handball players aged between 7 and 13 years. He found that inattentive blindness
288 was higher in the youngest children (7 years of age) and performance of attention tasks
289 improved in children between the ages of 8 and 13 years. Memmert also noted an
290 evident plateau in the children between 10 and 13 years, which was attributed to the
291 decrease in the "absolute number and density of synapses as one grows older, making it
292 harder to improve creative thinking" (Memmert, 2011, p.93).

293 Adding further evidence of the relationship between attention and creative
294 performance, Moraru, Memmert, and van der Kamp (2016) manipulated participants'
295 breadth of attention. Participants in the broad focus group were more inclined to use
296 more different modes of locomotion (flexibility), but not invest as much time on finding
297 solutions within a particular mode (persistence). A broader focus did not significantly
298 enhance originality, which is in contrast to results of previous studies on divergent
299 thinking (e.g., Memmert, 2011). This can be explained by the increased difficulty of
300 performing a wider range of motor skills (which is largely limited by existing motor

301 ability) in comparison to thinking (ideation) skills: “if motor ability is insufficient (e.g.
302 only a few people can walk on hands), then the thought of action cannot be performed”
303 (p.10).

304 Furthermore, Memmert (2006b) demonstrated that a six-month attention-
305 broadening training program had a positive effect on the creative performance of
306 children. He compared an attention-narrowing group (with teachers giving explicit
307 tactical instructions and corrections constantly during play) with an attention-
308 broadening group (with teachers only giving general advice about the games and their
309 rules, and not providing any kind of feedback during play). Memmert found that only
310 the attention-broadening group considerably improved their general creative
311 performance.

312 An association between creative performance and visual search behaviours has
313 also been demonstrated by Roca, Ford, and Memmert (2018) who used a portable eye-
314 movement registration system to examine creativity in decision-making and visual
315 search behaviours of expert football players during simulated 11-a-side matches. They
316 found that more creative players, when compared to their less creative counterparts,
317 displayed a broader attentional focus which included a higher number of fixations, but
318 of shorter duration. They were also able to perceive earlier the location of unmarked
319 teammates and opponents.

320 Other traits and skills

321 The relationships between creativity and a small number of other traits and skills
322 have been examined. These include: working memory, morning-eveningness
323 personality, coping, and regulatory focus. Researchers have examined the role of
324 working memory in sporting creativity – both creative thinking and creative action,
325 however, no evidence has been found that working memory interferes with creative

326 ability (Furley & Memmert, 2015; Moraru, Memmert, & van der Kamp, 2016). With
327 regards to morningness-eveningness personality, Cavallera, Boari, Labbrozzi and Del
328 Bello (2011) found that participants with an intermediate (not morningness nor
329 eveningness-oriented) personality type had significant positive correlations between the
330 number of hours of sport activity per week and scores of elaboration (measured through
331 the Torrance Test of Creative Thinking - TTCT). Creative thinking performance,
332 however, was independent of gender and personality typology. In their study of junior
333 female handball players, Igorov, Predoiu, Predoiu and Igorov, (2016) found a
334 significant positive correlation between fluency and positive reinterpretation as a coping
335 strategy but the relationship between coping and flexibility was not significant. They
336 speculated that these findings relate to situations in which athletes try to find positive
337 aspects in undesirable situations, often through the recollection of past successful
338 performances. In relation to regulatory focus, Memmert, Hüttermann, and Orliczek
339 (2013) found that adult male football players with a promotion (aspirational) focus
340 performed better in a sport-specific divergent thinking video task than those with a
341 prevention (duty-oriented) focus, which corroborates repeated claims (e.g. Hopsicker,
342 2011; Ďuriček, 1992) that risk-taking and open-mindedness enable creative behaviour
343 and an avoidance focus may constrain creative behaviour. Hüttermann, Nerb, and
344 Memmert (2018) have recently replicated the earlier study by Memmert, Hüttermann &
345 Orliczek (2013), to investigate the relationship between regulatory focus, expectations
346 and performance, among a more experienced sample. While promotion focused players
347 displayed, once again, significantly higher values in terms of creativity, there was no
348 main effect on expectation nor any significant interaction.

349 *Assessing Creativity*

350 This higher order theme captures the methods employed to assess creativity in
351 sporting environments. The theme comprised three lower order themes: paper-and-
352 pencil tests, computerised and video tasks, and performance-based situations.

353 *Paper-and-pencil tests*

354 Several different pencil and paper tests have been used to assess sporting
355 creativity, either in part or in full. These tests are largely adapted from psychological
356 tests and assess general creative thinking. One of the most commonly employed
357 measures of creative behaviour is the TTCT). It exists in two formats – figural and
358 verbal – and assesses creative thinking through four components fluency, flexibility,
359 and originality, plus elaboration (amount of detail in responses) (Cavallera, Boari,
360 Labbrozzi, & Bello, 2011; Veraksa & Gorovaya, 2011; Bowers, Green, Hemme, &
361 Chalip, 2014; Santos et al., 2017). The main advantage of the TTCT is that it is one of
362 the few valid and reliable tests of divergent thinking (Kim, 2011). Others tests that have
363 been employed include Roco's (2004) Imagination and Creativity Test (e.g., Igorov,
364 Predoiu, Predoiu, & Igorov, 2016). and Krampen's (1996) Divergent Thinking Test
365 (Memmert, 2007). However, the very small sample (n=11) and lack of detailed
366 information on Roco's (2004) test suggest limited validity and reliability of Igorov et
367 al.'s (2016) results. Moreover, all tests enumerated are tests of generalist *thinking*
368 expressed verbally or through drawing, not a measurement of physical *doing*.

369 *Video and monitor tasks*

370 Memmert and colleagues (Memmert, 2011; Memmert, Hüttermann, & Orliczek,
371 2013; Furley and Memmert, 2015; Roca, Ford & Memmert, 2018; Hüttermann, Nerb, &
372 Memmert, 2018) are the only researchers, to date, who have used video and monitor
373 tasks to examine the relationship between sporting creativity and other cognitive skills

374 or traits – e.g. attention, working memory, visual search behaviour, regulatory focus.
375 The tasks involve participants watching videos of sporting gameplay and then being
376 asked to provide possible attacking options. For example, in a handball-specific task
377 (Memmert, 2011), participants watched five videos of a handball game involving four
378 attackers and four defenders. After one minute, the video would stop, and the last frame
379 would remain on the screen. Participants would then be asked to imagine they were an
380 attacker and indicated all potential opportunities that could lead to a goal. The proposed
381 options are assessed for creativity using traditional criteria of originality, flexibility and
382 fluency. A football-specific video task has also been developed. It is composed of 20
383 different football attacking scenes from 46 Bundesliga 1 and 2 matches (Germany,
384 season 2010/2011), selected by experienced certified coaches (Memmert, Hüttermann,
385 & Orliczek, 2013; Furley & Memmert, 2015; Hüttermann, Nerb, & Memmert, 2018).

386 Video tasks are more representative of sport when compared to paper-and-pencil
387 tests. Memmert (2015) suggests that although standardised video tasks are less complex,
388 they have less confounding variables and the selection of clips shown to participants can
389 be adjusted to reflect specific situations. Roca, Ford and Memmert (2018)
390 acknowledged the limited physical realism of these tasks, which “might alter the natural
391 role of the underlying perceptual-cognitive processes underpinning players' creative
392 behaviour” (p.2), proposing instead the adaptation of Furley and Memmert’s (2015) task
393 to life-size-video based simulations in which participants had to play an actual ball in
394 addition to providing a verbal response.

395 However, despite in different degrees, video tasks still focus on divergent thinking as
396 the only measure of creative ability. Convergent thinking, i.e. the orientation “toward
397 deriving the single best (or correct) answer to a clearly defined question” (Cropley,
398 2006, p. 391) also contributes to creative insights (Dietrich & Haider, 2017) but is not

399 considered. Furthermore, like paper-and-pencil tests, most of these tasks do not allow
400 for a realistic assessment of sporting creativity *in action*.

401

402 *Performance-based situations*

403 Performance-based situation tests, where participants' actual performance is assessed
404 for creativity, have been developed and employed by researchers (e.g., Memmert, 2007;
405 Torrents et al., 2016). Moraru, Memmert and van der Kamp (2016), used an agility
406 ladder in a divergent doing task. Participants were asked to perform the highest possible
407 number of different actions on the agility ladder, i.e. using their feet and hands for
408 stepping, hopping, skipping, walking, and so forth. While this approach is arguably
409 more representative of creativity in action compared with paper and pencil tests and
410 video tasks when considering its use, researchers perhaps should ask how well it
411 represents creativity in specific sporting contexts.

412 The use of small-sided formats is an alternative that has enhanced
413 representativeness in comparison to the agility ladder, as it tests players in actual game
414 forms. Criteria of originality, flexibility, and fluency are used to assess performance,
415 with scores being averaged into a single measure of creativity. For example, Memmert
416 and Roth (2003) created *game-test situations (GTS)* where creative performance is
417 assessed through *orienting and supporting* and *identifying gaps* actions of participants
418 during small-sided games (for a detailed description see Memmert, 2006). In Memmert
419 and Roth (2007), children performed with hands, feet and a hockey stick, but in other
420 studies, only one of the skills was evaluated (e.g. Memmert, 2010).

421 Along similar lines, Torrents and colleagues (2016) examined differences in
422 exploratory behaviour motivated by numerical superiority, equality, or inferiority with
423 44 football players (22 professional and 22 amateur players) using small-sided games (4

424 vs 3, 4 vs 5, and 4 vs 7). An observation instrument (adapted from Owen et al., 2014,
425 and Costa et al., 2011) was used to record the possible actions from attackers with the
426 ball (e.g. run to the ball, control, pass, shoot) or without the ball (e.g. wall, support,
427 unmark) and from defenders (e.g. press, delay, dissuade). Santos and colleagues (Santos
428 et al., 2017; Santos et al., 2018) also used small-sided games and an observation
429 instrument (Creativity Behavior Assessment in Team Sports - CBATS) to assess in-
430 game individual (passing, dribbling and shooting actions) and collective behaviour
431 (regularity of team movements and distance between players which was assessed
432 through GPS measurements). A creative behaviour score was established and included
433 attempts – defined as the effort to perform different actions, successful or
434 unsuccessfully -, fluency – the ability to execute the highest possible number of
435 successful movement actions, and versatility – the ability to generate a diversity of
436 actions within the same category, e.g. different types of passing or shooting.
437 The design and use of game-based situations and accompanying observation tools to
438 assess sporting creative behaviour is an important development with regards to task
439 representativeness and ecological validity, particularly when it includes assessment of
440 individual as well as collective behaviours (e.g., Santos et al., 2017; 2018). Only
441 Torrents and colleagues (2016) included creative defensive behaviour, although they did
442 not include goalkeepers, which again limits our understanding of sporting creativity in
443 all phases of the game. Furthermore, Santos and colleagues (2017; 2018) and Memmert
444 and Roth (2007) measured creativity in situations of numerical equality, or superiority,
445 however, Torrents and colleagues (2016) found that numerical inferiority might lead to
446 greater exploratory behaviour.

447 Memmert (2015; 2017) has proposed the use of game observation of real
448 matches as a new standard to evaluate tactical performance due to its “very high

449 ecological validity” (p.482). These observations can be aided by game play protocols
450 which combine quantitative (e.g. frequency of certain behaviours) and qualitative
451 components (the subjective yet knowledgeable opinions of experts). Finally, Memmert
452 (2017) suggests that technology can play an important role in analysing creative
453 behaviour. For example, using neural networks to categorise action processes in team
454 sports (e.g. Memmert & Perl, 2009).

455 *Developing Creativity*

456 Understanding how to develop creative players is one of the key ambitions of
457 academics and practitioners. It is then unsurprising that a growing body of literature on
458 the topic is emerging. Four lower-order themes were developed through the review:
459 deliberate practice and deliberate play; social priming; programmes for the development
460 of sporting creativity; the central role of coaches in creative development.

461

462 *Deliberate Practice, Deliberate Play*

463 In line with research conducted on expertise, skill acquisition and talent
464 development (Davids, Güllich, Shuttleworth, & Araújo, 2017), six studies on sporting
465 creativity (Memmert, 2006; Memmert, Baker, & Bertsch, 2010; Greco, Memmert, &
466 Morales, 2010; Bowers, Green, Hemme, & Chalip, 2014; Martin & Cox, 2016; Hendry,
467 Williams, & Hodges, 2018) have devoted attention to deliberate practice and deliberate
468 play. Deliberate practice is “the engagement in practice activities with a clear goal of
469 improving a specific aspect of performance beyond its current level”. (Ericsson, 2017,
470 p. 4). In turn, deliberate play, which is usually fostered during sampling years (ages 6-
471 13), does not intentionally focus on performance improvement, prioritising instead
472 “developmental physical activities that are intrinsically motivating, provide immediate
473 gratification, and are specifically designed to maximize enjoyment” (Berry, Abernethy,
474 & Côté, 2008, p. 687).

475 After a six-month intervention, Memmert (2006) found that deliberate play had
476 a positive impact on the tactical creative performance of gifted children. Similarly, in a
477 field study involving Brazilian youth basketball players, Greco, Memmert, and Morales
478 (2010) discovered that unstructured play significantly improved measures of tactical
479 creativity and tactical intelligence (i.e. finding the most appropriate solution for a
480 problem). In contrast, in an examination of professional youth football academy coaches
481 and players' skill-ratings over a period of 5 years, Hendry and colleagues (2018) found
482 that while ratings of top players were positively related to practice, they were negatively
483 related to the proportion of play vs practice. Hours spent in play were not correlated
484 with ratings of any skill, including creativity. The authors concluded (2018, p. 7) that
485 "there may be benefits to participation in coach-led practice and play from an early age,
486 potentially due to the need to accumulate a high volume of sport-specific activity, as
487 well as sufficient variations in practice".

488 Despite some studies highlighting a more pronounced influence of deliberate
489 practice or deliberate play on creative development, most authors (e.g. Memmert, Baker
490 & Bertsch, 2010; Bowers et al., 2014) concur that the combination of both strategies
491 may be essential in the development of sporting creativity. This is further supported by
492 work developed by Richard, Abdulla, and Runco (2017), who explored the influence of
493 skill level, experience, and hours of sport training and participation on everyday
494 creativity (e.g. divergent thinking related to diary and distraction management, creative
495 attitude and values) on a sample of 208 Canadian athletes (21 intermediate, 73
496 advanced, and 114 experts, including Olympic and world-class competitors) aged
497 between 14 and 37, across 17 different sports. Richard and colleagues found that expert
498 athletes displayed a significantly higher cognitive flexibility, while athletes who

499 engaged in a higher number of sports were significantly more creative in comparison to
500 those who only practised one sport.

501 Finally, having explored the early life experiences of former NBA star Steve
502 Nash, Martin and Cox (2016) found other factors that may have contributed to Nash's
503 creative development: parental influence, intrinsic motivation, peer support, and self-
504 determination. Bowers and colleagues (2014) suggest that improving creativity does not
505 require "a complete reimagining of entrenched youth sport development models"
506 (p.325)" but could be achieved through the redistribution of time allocated to each
507 activity.

508

509 *Social priming*

510 To date, only one study (Furley & Memmert, 2018) has examined the impact of
511 social priming, i.e. the use of world-class creative players as role models, on creative
512 thinking. This study, with amateur adult football players, demonstrated that asking
513 participants to write down the characteristics of the creative player (e.g., Lionel Messi)
514 and imagine a typical situation that this player would be involved in led to more creative
515 responses to attacking scenarios. Furley and Memmert concluded that it is possible to
516 prime creative thinking in football players, by activating "cognitive representations of
517 creativity which in turn can activate associated mindsets, information processing modes,
518 and response tendencies" (2018, p.7).

519 *Programmes for the development of creativity*

520 While much of the research on sporting creativity has focused on isolating traits
521 and processes, there have been recent efforts to provide macro-structures (e.g.
522 frameworks, programmes) for the development of creativity. Three such programmes
523 are the Tactical Creativity Approach (Memmert, 2015), the Creative Development
524 Framework (CDF), which includes the Skills4Genius programme (Santos et al. 2016)

525 and The Creative Soccer Platform (TCSP) (Rasmussen & Østergaard, 2016).
526 Preliminary research, although limited, suggests these programmes do develop sporting
527 creativity.

528 The Tactical Creativity Approach (TCA) is the result of Memmert’s extensive
529 research on sporting creativity and represents the translation of his key findings into an
530 operational framework. The TCA (Memmert, 2015) is composed by 6 D’s: deliberate-
531 play, 1-dimension games, diversification, deliberate coaching, deliberate motivation,
532 and deliberate practice. Memmert (2015; 2017) proposes that special emphasis is placed
533 on the first four D’s during earlier stages of player development. Deliberate play and
534 deliberate coaching relate to unstructured play without coaches or teachers actively
535 providing instructions to players, in order to allow the latter to come up with multiple
536 different solutions while keeping a wide attentional focus. 1-dimension games are basic
537 game forms specifically aimed at improving tactical components. They are based on
538 “clearly defined games ideas, fixed number of players, and defined rules and
539 environmental conditions” (Memmert, 2015, p.51). Diversification refers to the contact
540 with different sports and different stimuli within the same sport (e.g. playing with balls
541 of different sizes, shapes, and materials in football). At more advanced stages of player
542 development, Memmert (2015) highlights the importance of deliberate motivation and
543 deliberate practice. With regards to the former, the TCA favours promotion instructions,
544 which according to earlier research by Memmert, Hüttermann, and Orliczek (2013),
545 may favour creative expression. Finally, the later can be developed through sport-
546 specific, task-centred practice “to explore seldom but adequate solutions” (p.96).

547 The Creative Development Framework (CDF) is another model for the long-
548 term development of creative behaviour in team sports. Development is divided into
549 five stages where free-play and diversification are encouraged at the earlier stages of

550 youth development, advocating a transition to specialisation that is completed around
551 the age of 16. The CDF puts an emphasis on fundamental movement skills (Smith,
552 2014), fundamental game skills (Smith, 2014), non-linear pedagogy (Chow, 2013),
553 differential learning (Schöllhorn et al., 2009), teaching games for understanding (Tan,
554 Chow, and Davids, 2012), and constraints-led approach (Hristovski et al., 2011), as
555 ways of developing creative behaviour in sport. One of the key aspects of this model is
556 the belief that sporting creativity does not depend solely on skill mastery, but also relies
557 on the ability to think creatively.

558 The CDF has been partially tested ('Explorer' phase only – Skills4Genius
559 programme) with Portuguese primary school children (Santos, Jimenez, Sampaio &
560 Leite, 2017). Findings suggest the programme leads to improvements in general creative
561 thinking, increased fluency, elaboration, and originality. Effects on motor skills are less
562 clear. However, improvements were demonstrated for in-game creativity (attempts,
563 fluency, and versatility). Another empirical study based on the CDF (Santos et al.,
564 2018) examined the impact of differential learning, with an emphasis on small-sided
565 games, as an enhancement strategy for creative behaviour in youth football. While the
566 control groups did not alter their practice routine, the experimental groups took part in a
567 differential learning program, with three 30-minute training sessions per week, taking
568 place at the beginning of their team's training session. The training programme involved
569 playing small sided games with a constant variation of conditions such as balanced and
570 unbalanced number of players, different balls, pitches with different shapes, and
571 numerous body constraints (e.g., visual occlusion, hands behind head). Creative
572 performance was assessed through the CBATS (Santos and colleagues, 2017). The
573 experimental group demonstrated a significant reduction in failed actions and increased
574 attempts and versatility.

575 The Creative Soccer Platform (TCSP) (Rasmussen & Østergaard, 2016), based
576 on Byrge and Hansen’s work (2009, 2014) in educational settings, has four pillars: task-
577 focus, parallel thinking, lateral thinking, and no experienced judgement. The
578 programme focuses on “establishing a creative environment (i.e. a playful atmosphere)
579 by facilitating creative processes (i.e. soccer-specific creativity exercises) where players
580 try to develop creative products (e.g. new feints, dribbles or first touches) and train their
581 creative abilities (not fearing to make mistakes)” (p.9). The impact of the TCSP was
582 assessed through a focus group with some players and an interview with the coach.
583 Rasmussen and Østergaard (2016) identified some limitations such as initial resistance
584 to change and the difficulty of operating in a hybrid system (after the ‘creativity’
585 training in the first half of the session, players resumed normal structured training).
586 They found that experiencing a variety of actions with the ball during the creativity
587 exercises increased the chances of players trying different actions in competitive
588 matches.

589 *Creative coaches, creative players?*

590 To date, only two studies have examined coaches’ perceptions of creativity and
591 its development. Distributing open-ended questionnaires to Korean football coaches
592 completing their C and B licenses, Oh, Joung, Kim, Choi, Kim and Sung (2010) found
593 that coaches associated “unpredictability, adaptability, improvisation, and mediating”
594 (2010, p.65) with football creativity and prioritised the promotion of fundamental skills
595 and self-determination as tools for its development.

596 Moreover, coaches indicated a lack of knowledge on how to teach creativity and
597 revealed that they used personal experiences to overcome that gap. This study also
598 identified several barriers to the improvement of sporting creativity, such as autocratic
599 coaching styles, a focus on results which put coaches under pressure to win matches, the

600 league systems, and a lack of appropriate training facilities. Leso, Dias, Ferreira, and
601 Gama (2017) examined football coaches' perceptions of creativity and game
602 intelligence through a questionnaire containing a set of closed questions. They found
603 that coaches associated creativity with magical thinking.

604 **Discussion**

605 The purpose of this paper was to critically examine the existing literature on
606 sporting creativity, exploring conceptualisations of sporting creativity and methods
607 recommended for its assessment and development. While the first paper reviewed dates
608 from 1967, the last two decades have seen an exponential increase in the number of
609 publications on sporting creativity. This review contributes to our understanding of
610 sporting creativity by providing the first review of research on defining, assessing and
611 developing creativity in sport.

612 A single definition of sporting creativity has yet to be universally accepted.
613 Understanding what is meant by creativity is considered “the single most fundamental
614 problem in the field” (Simonton, 2012, p.97). While there is an overall convergence on
615 the general criteria that make an action creative (i.e., novel and useful), deciding on the
616 appropriateness and novelty of an action or idea is invariably conditioned by both the
617 context and the experiences and beliefs of those judging them. With regards to the
618 context, what is valued in a given time and location will determine whether an action is
619 indeed novel, surprising, and appropriate for a given situation. For example, even the
620 most common actions performed by a handball player in Germany, where the sport is
621 widely developed, are likely to be considered original by most of the British population,
622 who are almost entirely unfamiliar to the sport. The degree of appropriateness or
623 originality of an action depends on who is judging it and on his/her previous

624 experiences. For example, a football coach that favours positional attacking may
625 consider the Spanish style of playing *tiki-taka* a useful strategy, while another,
626 favouring a direct game, may disagree.

627 The use of experts has been proposed and widely adopted to mitigate the
628 relativism of evaluations, – including in sporting creativity (e.g. Memmert, Hüttermann,
629 & Orliczek, 2013; Torrents et al., 2016; Hendry et al., 2018). This solution is criticised
630 by Runco and Chand (1994), who question why expert ratings should deserve higher
631 credit than self-reported, peer or teacher evaluations. However, it must be recognised
632 that coaches and scouts are central figures in the identification and development of
633 creativity in sport, having key roles in shaping players’ experiences and opportunities.
634 Future research focused on the evaluation of creative behaviour in sport should consider
635 extending the use of expert ratings beyond the criteria of originality (current practice),
636 to include the assessment of adequateness of solutions as well.

637 Conceptualisations of creativity must also be clear about the social-cultural
638 context in which the action takes place and provide detailed justifications on the choice
639 of judges, as these elements influence what is deemed creative. Stein’s (1953 in Runco
640 & Jaeger, 2012) definition of creative work - “a novel work that is accepted as tenable
641 or useful or satisfying by a group in some point in time” (p.94) could be used to upgrade
642 the existing definition of tactical creativity coined by Memmert (2011). This definition
643 should also consider both attacking and defensive play, and the interdependence
644 between attackers and defenders.

645 A constructive alignment between definitions of creativity and research methods
646 used to assess creativity should be considered. The use of game-based situations has
647 improved ecological validity, albeit in quasi-naturalistic settings (researcher-controlled,
648 non-competitive). Definitions of creativity operationalised through these assessments

649 should also be reconsidered (e.g., creativity only occurs in attacking play), together with
650 potential limitations to creative expression ‘imposed’ on participants through task
651 design, e.g., inferiority vs superiority of numbers in games.

652 Because of the clear influence of cognitive traditions in much of the research on
653 creativity in sport, creativity definitions and evaluations have privileged the thought
654 process over the ability to act, limiting the understanding of *doing* (performance) as an
655 integral feature of sporting creativity. Performance, real-time expression, and a reliance
656 on the brain’s implicit system suggest that creativity should be conceptualised as ‘in
657 sport’ - in action - rather than ‘about sport’ and assessed and developed accordingly. If a
658 driver for examining sporting creativity is the desire to increase unpredictability in
659 performance and therefore a competitive advantage, then the final product of the
660 creative process - performance of the creative action - ought to be a critical feature of
661 how creativity is conceptualised.

662 With regards to developing sporting creativity, research is advancing towards
663 more integrative approaches that can be implemented over an extended period and
664 accompany players’ developmental journeys. However, despite encouraging initial
665 results, more research is needed to evaluate the long-term effects of these programmes
666 on creativity due to creativity developing over a long period (Memmert & Roth, 2007).
667 Furthermore, while Memmert’s TCA (2015) proposes a holistic framework, creativity
668 training in both the CDF and TCSP was limited to a small part of training sessions.
669 Future research could explore the effects of programmes in settings that do not treat
670 creative training as an appendix or an isolated section of a session but instead adopt the
671 philosophical underpinnings of creative development as an orienting matrix for the
672 whole session planning, delivery and reflection.

673 A much more detailed description of the tasks executed by players during
674 training programmes is needed, to allow for more accurate categorisation of what
675 constitutes deliberate practice and deliberate play. The way both concepts are depicted
676 in existing research is too broad. Also, participant sampling could be more consistent to
677 increase the validity of findings. For example, in Memmert, Baker, and Bertsch's
678 (2010) study direct comparisons were made between players with different roles -
679 attackers and defenders - who occupy different areas of the pitch and perform different
680 actions, which may have had an impact on results. It must also be recognised that while
681 important, strategies like deliberate practice or deliberate play are merely partial
682 influences in the overall development of children. For example, in Bowers and
683 colleagues' (2014) work, sporting activities accounted for only 30% of the total leisure
684 time of participants. Consequently, interdisciplinary and multi-dimensional approaches
685 that look beyond the sporting arena are recommended, to establish a more complete
686 description of the development of creativity across the lifespan.

687 The existing literature indicates that sporting creativity can be trained. It does
688 not, however, support a single strategy for its development. So far, a balance between
689 deliberate practice and deliberate play appears likely to be advantageous. Social priming
690 may also be a promising avenue for future research to further our understanding of how
691 creativity is developed. Some programmes for the enhancement of sporting creativity
692 have been recently proposed (e.g. CDF, TCSP) and, although limited, the evidence does
693 support their effectiveness. However, which of the many features of these programmes
694 is responsible for creative development and why remains unclear. Developing this
695 understanding, however, will assist practitioners to implement programmes to develop
696 creativity. Also, while it is recognised that coaches have a pivotal role in the
697 development of sporting creativity, research involving them is still scarce. A potential

698 'cascade effect' could be investigated, based on the assumption that more creative
699 coaches could develop more creative conditions and, consequently, more creative
700 players. Furthermore, Rasmussen, Østergaard, and Glăveanu (2017) have criticised a
701 perspective of sporting creativity that exclusively emphasises performance, in-game
702 benefits and technical expertise. They propose that creativity should be seen instead as
703 a developmental resource and argue that current performance-oriented visions may lead
704 to overlooking the broader educational benefits that may arise from simply taking part
705 in creative activities, such as increased self-confidence and self-esteem. Along similar
706 lines, Richard and colleagues' (2017) showed that sport diversification and expertise
707 may improve everyday creativity.

708 Our review found that most of the research conducted, thus far, has employed
709 quantitative and experimental or quasi-experimental designs. Additional insight could
710 be gained from employing other methods such as observation, interviews, or
711 ethnographies to examine *in situ* creativity and its development. This will involve going
712 to the training environment as well as exploring the impact of the broader socio-cultural
713 milieu and personality on sporting creativity. Due to the relative nature of creativity and
714 the importance of domain-specific experts in its understanding and development, such
715 approaches should also engage practitioners (e.g. coaches, scouts) as active participants
716 in all stages of the research process.

717 **Conclusion**

718 This review has demonstrated the lack, as yet, of a widely accepted definition of
719 sporting creativity. We identified important considerations for the conceptualisation of
720 sporting creativity including the distinction between creative thinking (prominent in the
721 research) and creative action, context-specificity, and its emergent nature. The review
722 also demonstrated the influence cognitive conceptualisations of creativity have had on

723 how creativity is assessed, privileging assessment of creative thinking about sport over
724 creative action. Some researchers are beginning to employ ecologically valid
725 assessment (i.e., game-based situations), although these still have limitations often as a
726 result of the definition of creativity that is operationalised. With regards to correlates of
727 creativity, a small range of variables have been examined. Again, the privileging of
728 cognitive definitions has seen attention and pattern recognition being the most
729 commonly researched variables. The review also identified several strategies and
730 programmes that have been proposed for the development of sporting creativity. These
731 show some promise and suggest creativity is trainable, particularly when they include a
732 combination of deliberate practice and deliberate play or less instruction from coaches
733 thereby encouraging greater self-regulated learning. Much remains to be explored and
734 understood about creativity, which presents a range of exciting opportunities for
735 researchers to contribute to this area and further creativity in sport.

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742

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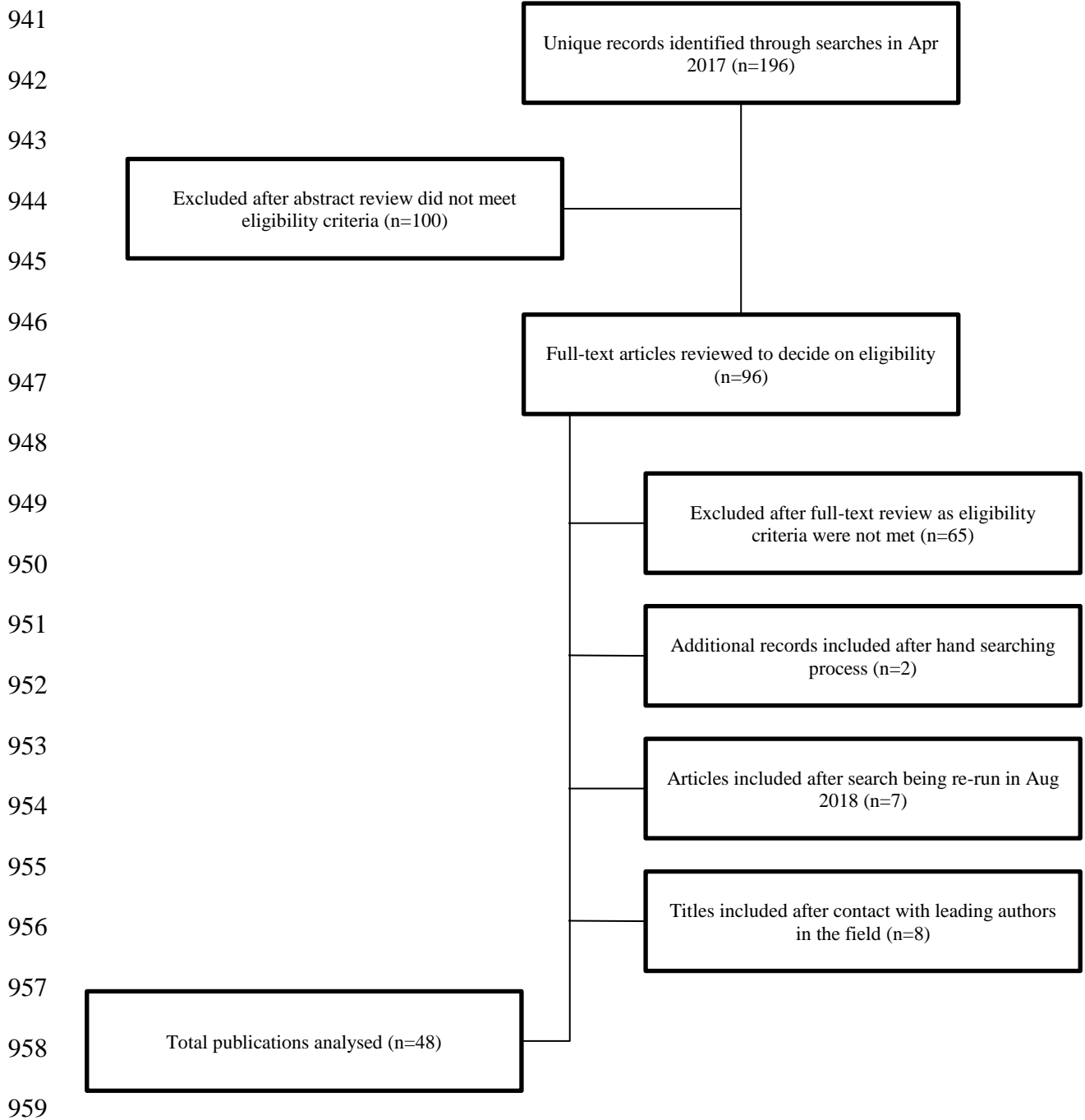
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960 Figure 1: Selection process

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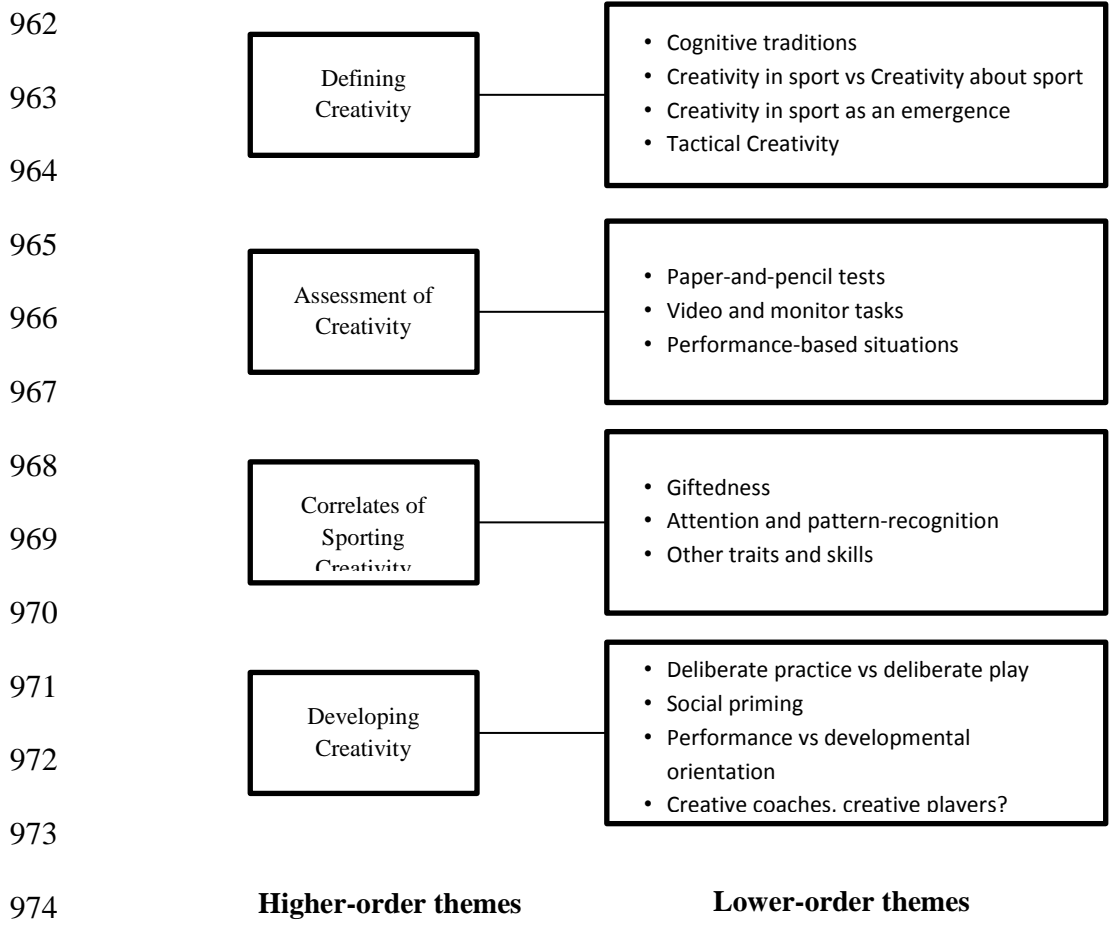


Figure 2: Distribution of higher and lower-order themes.

Inclusion criteria (studies had to meet <u>all</u> criteria)	<ul style="list-style-type: none"> a) Studies referred to sport, in general, or to team invasion games/rugby/court invasion games/court-divided games as defined by Launder & Piltz (2013) b) Studies were published in peer-reviewed journals and/or conference proceedings and were directly related to creativity or its correlates; c) Studies were original and published in languages spoken by the authors of this review (English, French, Italian, Portuguese, and Spanish).
Exclusion criteria	<ul style="list-style-type: none"> a) Non-peer-reviewed books or book chapters and dissertations were not considered due to lower peer-evaluation standards and difficulties in access; b) Documents published by institutions with commercial affiliations (e.g. company foundations) were not included;

979 Table 1: Inclusion and exclusion criteria

980

Author(s)	Year	Study Type	Participants	Country participants	Assessment of Creativity
Brown, G.; Gaynor, D.	1967	Position paper	n.a.	n.a.	
Đuriček, M.	1992	Position paper	n.a.	n.a.	
Everhart, B.; Kernodle, M.; Turner, E.; Harshaw, C.; Arnold, D.	1999	Quantitative/ Experimental	24	USA	
Memmert, D.	2006a	Quantitative/ Experimental	2 experiments (Exp.1 - 33; Exp.2 - 112)	Germany	Game-test situations
Memmert, D.	2006b	Quantitative/ Experimental	48	Germany	Game-test situations
Memmert, D.; Furley, P.	2007	Quantitative/ Experimental	3 experiments (Exp.1 - 34; Exp.2 - 29; Exp.3 - 16)	Germany	
Memmert, D.; Roth, K.	2007	Quantitative/ Experimental	135	Germany	
Memmert, D.	2009	Quantitative/ Experimental	55	Germany	
Memmert, D.; Perl, J.	2009	Instrument Validation	42	Germany	
Memmert, D.	2010	Quantitative	195	Germany	
Oh, J I; Joung, K; Kim, H. K.; Choi, H.; Kim, N.; Sung, J.	2010	Qualitative/ Survey	52	South Korea	
Greco, P.; Memmert, D.; Morales, J.	2010	Quantitative	22	Brazil	
Lacerda, T.; Mumford, S.	2010	Position paper	n.a.	n.a.	

Memmert, D.; Baker, J.; Bertsch, C.	2010	Quantitative/ Survey	72	Germany	
Hopsicker, P.	2011	Position paper	n.a.	n.a.	
Aggerholm, K.; Jespersen, E.; Ronglan, L.T.	2011	Position paper	n.a.	n.a.	
Cavallera, G. M.; Boari, G.; Labbrozzi D.; del Bello, E.	2011	Quantitative/ Experimental	61	Italy	TTCT figural series (1989)
Memmert, D.	2011	Quantitative/ Experimental	120	Germany	Divergent Thinking Test (Krampen, 1996) – subtest + Video handball- specific divergent thinking
Veraksa, A. N.; Gorovaya, A. E.	2011	Quantitative/ Experimental	31	Russia	TTCT verbal and figural
Hristovski, R.; Davids, K.; Araujo, D.; Passos, P.	2011	Position paper	n.a.	n.a.	
Hristovski, R.; Davids, K.; Araujo, D.; Passos, P.	2012	Position paper	n.a.	n.a.	
Memmert, D.; Hüttermann, S.; Orliczek, J.	2013	Quantitative/ Experimental	30	Not reported	Video soccer- specific divergent thinking
Bowers, M. T.; Green, B. Ch.; Hemme, F; Chalip, L.	2014	Quantitative/ Survey	99	USA	Abbreviated Torrance Test for Adults (ATTA)
Campos, D.	2014	Position paper	n.a.	n.a.	
Furley, P.; Memmert, D.	2015	Quantitative/ Experimental	61	Germany	Video soccer- specific divergent thinking
Memmert, D.	2015	Academic Book	n.a.	n.a.	

Rasmussen, L.; Østergaard, L.	2016	Mixed methods/ Experimental	15 players + 1 coach	Denmark	
Igorov, M.; Predoiu, R.; Predoiu, A; Igorov, A.	2016	Quantitative/ Experimental	11	Unreported	Imagination and Creativity Test (Roco, 2004) – first task only
Torrents, C.; Ric, A.; Hristovski, R.; Torres- Ronda, L.; Vicente, E.; Sampaio, J.	2016	Quantitative/ Experimental	44	Unreported	Small-sided games
Arslan, K. S.; Akpunar, F.; Ulucan, K.	2016	Position paper	n.a.	n.a.	
Harrison, C.	2016	Qualitative/ Auto- ethnography	1	Australia	
Moraru, A.; Memmert, D.; van der Kamp, J	2016	Quantitative/ Experimental	2 experiments (Exp.1 - 57; Exp.2 - 56)	Unreported	
Santos, S. D. L.; Memmert, D.; Sampaio, J.; Leite, N	2016	Position paper	n.a.	n.a.	
Martin, J.; Cox, D.	2016	Qualitative/ Biographical	Multiple	Canada/USA	
Tanggaard, L.; Laursen, D.; Szulevicz, T.	2016	Qualitative/ Material Biography	n.a.	n.a.	
Santos, S.; Jiménez, S.; Sampaio, J.; Leite, N.	2017	Quantitative/ Experimental	40	Portugal	TTCT – figural version + small- sided games (GK+3v3+GK)
Ilundain-Agurruza, J. Rasmussen, L.:	2017	Position paper	n.a.	n.a.	
Østergaard, L.; Glaveanu, V.	2017	Position paper	n.a.	n.a.	

Leso, G.; Dias, G.; Ferreira, J. P.; Gama, J.; Couceiro, M. S.	2017	Quantitative/ Survey	34 coaches + 118 players	Portugal	
Orth, D., van der Kamp, J.; Memmert, D.; Savelsbergh, G.	2017	Position paper	n.a.	n.a.	
Memmert, D.	2017	Book chapter	n.a.	n.a.	
Richard, V.; Abdulla, A.M; Runco, M.	2017	Quantitative/Experimental	208 athletes (94 males, 114 females)	Canada	Runco Creative Assessment Battery
Santos, S.; Coutinho, D.; Goncalves, B.; Schollhorn, W.; Sampaio, J.; Leite, N.	2018	Quantitative/ Experimental	40	Portugal	Small-sided Games (GK+5v5+GK)
Hendry, D.; Williams, A.M.; Hodges, N.	2018	Quantitative/ Survey	102	UK	
Furley, P.; Memmert, D.	2018	Quantitative/ Lab-based Experiment	120 (39 women) players	Germany	
Kempe, M.; Memmert, D.	2018	Quantitative/ Match- analysis	153 games, 311 goals	Worldwide	
Roca, A.; Ford, P.; Memmert, D.	2018	Quantitative/ Experimental	44 male players	England	Life-size soccer- specific divergent thinking
Hüttermann, S.; Nerb, J., Memmert, D.	2018	Quantitative/Experimental	30 male players	Germany	Video-based divergent thinking task

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