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ORIGINAL RESEARCH

Bridging the gap between science and application: The use of co-creation to modulate practice activities employed by professional youth soccer coaches through feedback and workshops

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9 **Abstract**

10 We examined whether practice activities adopted by professional youth soccer coaches are
11 modulated through the implementation and engagement with co-creative evidence-based programmes.
12 Across two experiments, we used systematic observation to identify the practice activities of 7 coaches
13 across 134 sessions. In Experiment A, drill-based and games-based activities were recorded and
14 quantified. To encourage behaviour change across the study, the systematic observation data were
15 compared to skill acquisition literature to provide coaches with quantitative feedback and
16 recommendations during workshops. Post-workshop systematic observation data indicated that practice
17 activities used by coaches changed in accordance with the evidenced-based information (increase in
18 games-based activities) delivered within the workshop. Interview data indicated that coaches typically
19 stated the workshop was a key reason for behaviour change. In a follow-up Experiment B, feedback
20 and recommendations were delivered using an interactive video-based workshop. The systematic
21 observation data indicated that coaches increased the use of soccer activities that contained active
22 decision-making, with coaches citing the workshop as a key reason for behaviour change. These
23 findings indicate that coaching practice activities can be supported and shaped through the
24 implementation of co-created workshops where coaches collaborate with sport scientists and
25 researchers to bridge the gap between science and application.

26
27 **Key Words:** Soccer coaching; Skill acquisition; Education programme and workshop

28 Introduction

29 Although there were over 1.25 million coaches working in the United Kingdom in 2011, two
30 thirds of all coaches reported that they have never undergone continuing professional development
31 (CPD). As a result, sports organisations, governing bodies, and other educational organisations have
32 made the education of coaches a priority (SportsCoachUK, 2011). A main role for a coach is to plan,
33 deliver and evaluate coaching sessions, with the knowledge underlying these processes often acquired
34 from emulation and experience, rather than being based on scientific theory and research findings
35 (Williams & Hodges, 2005). A suggestion posed to close the gap between coaching and science is for
36 coaches, coach educators and applied researchers to ‘co-create’ education programmes (Cushion, Ford,
37 & Williams, 2012; Partington & Cushion, 2013).

38 Soccer players spend large amounts of time in coach-led practice activities with the aim of
39 obtaining the necessary motor and perceptual-cognitive skills required for developing expert
40 performance needed to meet the demands of the professional game (Williams & Reilly, 2000; Ford et
41 al., 2012; 2020). The practice activities employed by coaches are subdivided into two main categories:
42 drill-based, and games-based, activities (Ford, Yates, & Williams, 2010). Drill-based activities involve
43 the repetition of isolated skills involving limited or no opposition, such as fitness activities, technique
44 and skill practice (O’Connor, Larkin, & Williams, 2018). When using drill-based activities, the coach
45 typically pre-determines and plans the outline of the decision(s) for players. This means players are
46 unlikely to have many opportunities to develop these skills alongside related games-based processes
47 such as active decision-making associated with selective-attention and visual search. Games-based
48 coaching activities involve opposition and teammates that closely replicate the demands of the game,
49 such as small-sided games, phases of play, conditioned and possession games (Partington & Cushion,
50 2013; O’Connor, Larkin, & Williams, 2017; O’Connor et al., 2018). These dynamic soccer-specific
51 environments provide a much greater opportunity for players to acquire processes that support the
52 development of planning, selection and execution of appropriate goal-directed actions. Players are
53 therefore constrained to make self-selected active decisions based on the interaction between their own
54 experience, positioning of teammates, opposition, and space. Although games-based activities offer
55 benefits for developing these processes, coaches typically opt to make the game easier for young novice

players by reducing the attentional demands (i.e., decision-making) through the use of drill-based activities (e.g., grid-based passing; turning; ball control). Once coaches determine that these skills have been acquired to an acceptable level, the sessions are progressed (i.e., using a ‘scaffolding’ coaching methodology, see Jones & Thomas, 2015; or at the ‘challenge-point’, see Guadagnoli & Lee, 2004) by introducing more opportunities that encourage coaches/players to be actively involved in the learning process (Jones & Thomas, 2015), and/or by specifically moving session designs toward a games-based approach (Ford et al., 2010) in order to encourage and constrain the acquisition of more advanced (expert-like) soccer specific active decision-making skills.

Expert performance in soccer match-play requires an interaction of motor and perceptual-cognitive skills (Fowler & Turvey, 1978; Hanford et al., 1997; Williams & Ford, 2013). These perceptual-cognitive skills include: *visual search*, which is scanning of the visual environment to evaluate space, the ball, and the movements of opponents and teammates; *anticipation*, which is the ability of a performer to predict what events and/or actions are likely to unfold prior to an event occurring; and *decision-making*, which is the ability to use information from the current situation to plan, select and execute an appropriate goal-directed action (Ford & Williams, 2013). The interaction between motor and perceptual-cognitive skills observed during match-play is very difficult to replicate using drill-based activities. Still, it is suggested (Ford et al., 2010) that coaches should attempt to simulate this interaction in practice drills such that players are provided with the opportunity to develop the motor and perceptual-cognitive skills needed to perform during match-play. Games-based activities go some-way to containing the key elements of match-play. For example, Miller et al. (2016) observed a significant increase in decision-making ability by junior netball players during small-sided games following an increase in games-based activities employed in their practice sessions.

Games-based activities may require random (i.e., attempts at multiple skills occur in a random order such that one skill is usually followed by attempts at another) and variable (i.e., each attempt contains different factors of the same skill, e.g., distance; speed) skill attempts throughout the coaching session. From a skill acquisition perspective, it has been shown that random/variable practice facilitates the development of generalised skill acquisition compared to constant/blocked/serial practice for both motor and perceptual-cognitive skills (Lee & Magill, 1983; Shea & Kohl, 1991; Li & Wright, 2000).

For instance, Broadbent et al. (2015) examined perceptual-cognitive skills in tennis using a laboratory-based task. During practice, skills (forehand groundstroke; forehand smash; forehand volley) were presented in a blocked or random practice order. In a field-based (i.e., similar to match-play) retention test, those who practised in a random/variable order showed superior learning (response accuracy) compared to those who practised in a blocked/serial order. Games-based activities promoted task switching that modulated an increase in cognitive effort, and error detection processing, that developed the underlying processes that facilitated retention and transfer. Therefore, more time spent in games-based activities may be an effective strategy to be incorporated into coaching sessions when the goal is to develop soccer-specific motor and perceptual-cognitive skills (Williams & Hodges, 2005; Ford et al., 2010; Low et al., 2013).

Despite games-based activities facilitating greater acquisition of soccer-specific processes, coaches typically spend more time utilising drill-based, compared to games-based, activities (Ford et al., 2010; Partington & Cushion, 2013; Low et al., 2013; Partington, Cushion, & Harvey, 2014; Hall, Gray & Sproule, 2016; Cope, Partington, & Harvey, 2017). For instance, Ford et al. (2010) used systematic observation to film and analyse 70 practice sessions of soccer coaches in the UK at three different age groups (U9s; U13s; U16s), and three different player ability levels (academy; centre-of-excellence; amateur). The data showed that irrespective of age or player ability coaches had soccer players spend an average of 65% of time in drill-based, compared to 35% in games-based, activities (see also Partington & Cushion, 2013; Partington et al., 2014). The relatively high amount of time spent in drill-based activities is somewhat different to data from motor learning research (Williams & Hodges, 2005; Ford et al., 2010), which indicates that more effective transfer of motor and perceptual-cognitive skill acquisition comes from practice environments that contain elements of variability of practice and contextual interference (i.e., games-based activities). A possible explanation for a 'science-application' gap is that most soccer-coaching knowledge is acquired through coaching experience, emulation of other coaches (e.g., head coach), and via informal activities (e.g., websites; blogs; books). This process can result in the development of craft knowledge that is typically based on established and traditional coaching approaches (Cushion, Armour, & Jones, 2003; Williams & Hodges, 2005; Cassidy & Rossi 2006; Gilbert et al., 2009; Young et al., 2009; Cushion et al., 2012; Partington & Cushion, 2013), rather

than on scientific evidence delivered via formal professional coach education (e.g., courses, workshops, CPD) programmes (Gilbert, Côté, & Mallett, 2006; Stoszowski & Collins, 2016).

To bridge the gap between science and application, coaches, players and applied researchers could ‘co-create’ coach education programmes (Cushion et al., 2012; Low et al., 2013; Partington & Cushion, 2013) via a process of continuing professional development (CPD). A co-creation CPD process that actively includes the learner (i.e., a coach; see Nelson, Cushion, & Potrac, 2013) may be an effective learning environment that takes into account the complexity of many interacting factors that constrain the social-sporting world (Jones, Armour, & Potrac, 2002; Jones et al., 2010). Whilst it has often been assumed that coaching is ‘clean and sequential’ (Cassidy, Potrac, & Jones, 2008), and underpinned by technical, tactical and some forms of bio-scientific data (e.g., GPS; heart rate; blood lactate), it is suggested (Potrac & Jones, 2009) that coaches can be quite persuasive in terms of embedding their own coaching philosophy/agenda. Although professional coaches express ideas that are consistent with some findings from the skill acquisition literature, including processes related to perception-action coupling, and structure of practice (Greenwood, Davids, & Renshaw, 2012), a fitting environment might be to have coaches (e.g., Purdy, Jones, & Cassidy, 2009) collaborate with other key stakeholders (e.g., academy director; scientists) in order to co-design coaching methodologies (Greenwood et al., 2012; Nelson et al., 2013) based on assimilating evidence from experiential knowledge and research findings. In this context, coaches may be more motivated to modify and adapt their philosophy and repertoire such that practice activities also contain evidenced-based (i.e., scientific evidence) information on motor and perceptual-cognitive skills (Williams & Hodges, 2005).

To this end, we designed and conducted a 2-experiment study to investigate the effectiveness of CPD educational workshops on supporting coaches to modify the nature of the practice activities used in a youth UK soccer academy. The aim of Experiment A was to investigate whether coaching behaviour could be supported to implement more ‘gamed-based’ activities during youth coaching sessions. As illustrated in **Figure 1** (top panel), coaches were offered the opportunity to engage in an eight-phase experimental protocol. First, we (lead author, SH) engaged in meetings with the Head of Sport Science and Medicine (HSSM), and the Academy Director (AD) of the professional football club, in order to co-create the educational basis of the workshop. Second, we measured practice activities

(pre-workshop) using systematic observation (Ford et al., 2010). Third, we conducted interviews (Interview A1) in order to gain an understanding of why coaches employed certain practice activities when delivering coaching sessions. Fourth, we then delivered the CPD education workshop based on the data from the systematic observations (SOA1), and evidence from the scientific literature on motor learning, skill acquisition and expert performance (Ford & Williams, 2013). Fifth and sixth, following the workshop, a second block of systematic observations (SOA2), and interviews (Interview A2), were carried out (post-workshop). Seventh and eighth, to establish if and why coaches continued to use modified practice activities after the post-workshop, a third block of delayed systematic observations (SOA3), and interview (Interview A3), were carried out after a 3-month period of no soccer coaching activity. It was predicted that across experimental phases, a significant increase in time using gamed-based activities would be adopted by coaches following the workshop.

Experiment A

Participants

Volunteers were professional youth soccer coaches ($n = 7$) from an English Football Association Youth Academy. The coaches worked with players from 6 to 12 years of age. The coaches mean age was 39.64 ± 8.22 years and their average coaching experience was 13.96 ± 10.80 years. All coaches possessed Union of European Football Associations (UEFA) coaching licenses by 'The Football Association' (The FA). One participant possessed the UEFA 'A' coaching license (Level 4/5 in the coaching qualification pyramid), two participants possessed the UEFA 'B' coaching license (Level 3/5) and the remaining four possessed the UEFA 'C' coaching license (Level 2/5). Four out of the seven coaches had also undertaken the FA Youth Award Modules Level 1, 2 and 3. All participants provided written informed consent and were free to withdraw at any time. The study was designed in accordance with the Declaration of Helsinki and was approved by the host University ethics committee.

Co-creation process

To co-create the CPD education workshop, the lead researcher had four meetings with the HSSM and AD (see top panel of **Figure 1**). These meetings were initiated by the club through existing

communication channels associated with already established working relationships with other research disciplines (i.e., strength and conditioning; physiology). The meetings took place in various facilities within the club (e.g., indoor training centre), and were initially informal in the developmental stage of the working relationship. These meetings included:

(1) The initial meeting between the lead researcher and HSSM was focused on exploring the prospect of conducting evidence-based research within the club. The HSSM initiated the contact by indicating a desire to develop a working relationship with external applied skill acquisition specialists in order to promote and employ the use of evidence-based coaching practices. To facilitate discussion, a number of coaching sessions were observed across different age groups in order to get a context of the types of practice activities being used at the club. The discussion centred on the types of practice activities, terminology used in the club, the philosophy of coaching practice, and the goals of the academy.

(2) Once a working relationship was established between the lead researcher and HSSM, a second meeting was organised with the AD in order to discuss the operational aspects of the academy, the overarching coaching philosophy within the academy, and the fundamental principle of developing a collaborative long-term working relationship working with the club. The lead researcher outlined the scientific expertise of the research team in the areas of systematic observation, motor behaviour, skill acquisition, and coaching. Plus, to confirm that the research team was very motivated to work with the professional club in a collaborative relationship to co-create CPD education workshops. At the meeting, discussions were centred on the types of practice structures used by the coaches (based on the observation made in meeting 1), and how these activities relate to the motor and perceptual-cognitive mechanisms/processes available from motor learning/skill acquisition literature, and the overarching requirements of The Premier League's Elite Player Performance Plan (EPPP). Through these conversations, the needs and philosophy of the club were outlined and explored in relation to collaborative research projects and following these discussions an agreement was made to develop a working and trusting relationship.

(3) In the third meeting, the lead researcher, HSSM and AD observed further coaching sessions followed by discussions on the principles of drill-based and games-based activities, together with

concept of the CPD education workshop and feedback to the coaches. The lead researcher provided examples of evidence-based soccer practice activities to the HSSM and AD in order to outline the benefits of implementing certain sessions (e.g., Harvey, Cushion, & Massa-Gonzalez, 2010; Ford & Whelan, 2016). Given that the AD was principally responsible for the coaches and CPD, further discussions were had in order to explore important issues to do with ethics around CPD educational workshops, and the involvement of the coaching staff. Issues related to data collection, analysis and storage, and importantly that the coaches had the right to consent to volunteer, or not. Following this, the AD and HSSM had independent discussions with the coaches to determine how and if the club wanted to implement the potential study. It was decided that a co-creative approach was the most desirable method to link the club, coaches, and research team.

(4) The fourth meeting set about the process of co-creating the CPD education workshop, as well as the working parameters for the parties. Logistics were discussed surrounding the systematic observation (i.e., coaches, dates, and times). The lead researcher and AD discussed the dialogue type to be used in during the CPD education workshop, as well as the most effective method by which to present the data to the coaches (Nosek et al., 2021) with quantitative feedback from the systematic observation data. It was agreed that a small A5 laminated infographic based technical-report would be produced to convey the quantitative information associated with coach behaviour (i.e., %Time spent in games-based activities) as this would be an effective medium to further promote discussions between the research team and the coaches during the CPD education workshop (Martin et al., 2019).

Coach education workshop

As illustrated in **Figure 1**, a standard CPD educational workshop was delivered to coaches in small groups and consisted of two main parts. First, feedback was provided to each coach in the form of an A5 laminated infographic that contained definitions of drill-based and games-based activities, as well as a description of how these activities impacted skill acquisition in soccer (Ford & Williams, 2013). The infographic also included the practice activity data recorded from the systematic observations (SOA1) (upper panel **Figure 1**), which was illustrated in pie charts alongside descriptive (percentage data) statistics. Drill-based and games-based activity data from Ford et al. (2010) was also

provided to allow a comparison to English Premier League clubs. Finally, the infographic provided feedback for how coaches could increase the amount of games-based activities. Second, the coaches engaged in a CPD education workshop led by the lead researcher, HSSM and AD. The coaches were divided into two groups who each attended one of two workshops. The first workshop contained U7s - U10s team coaches, and the second workshop U11s - U13s team coaches. The workshops lasted for approximately 60 minutes. In the workshop, definitions of drill-based and games-based activities were reiterated and discussed, and where necessary contextualised with soccer examples, and coaches were offered an opportunity to seek clarification and comment. The coaches were asked to be an active member of the process by interpreting the mean percentage drill-based and games-based activity data from the technical infographic. For comparison purposes, and in order to promote discussion about their own findings, the coaches were asked to consider the results from SOA1 to the data reported by Ford et al. (2010), which showed that Premier League academy coaches spent $60 \pm 20\%$ in drill-based, and $40 \pm 20\%$ in games-based, activities. To promote a rationale for increasing games-based activities, the workshop was designed to outline the scientific principles underpinning the benefits of developing motor and perceptual-cognitive skills through the use of more games-based activities such as random and variable skill attempts (Ford et al., 2010; Ford & Williams, 2013). Coaches were again encouraged to be active in the process by discussing the principles of drill-based, and games-based, activities (i.e., peer-to-peer learning; and coach-to-researcher learning) in order to establish how and why they could modify their own practice activities to contain more games-based processes. The examples created and forwarded by the coaches were then discussed with the lead researcher in order to assimilate the new coaching session designs with the scientific principles of games-based practice. Finally, all coaches, and the academy staff (AD and HSSM), agreed to the merits of games-based practice and collectively committed to implementing the new principles in follow-up coaching sessions.

Systematic observation

Systematic observation is a technique adopted by researchers/practitioners to analyse coaching practices (Ford et al., 2010; Low et al., 2013; Partington & Cushion, 2013). It allows an analyst to observe, record and analyse observable behaviours and events based upon based on pre-set guidelines

and criteria (Franks, Hodges, & Moore, 2001; Partington & Cushion, 2013). Based on the work by Ford and colleagues (Ford et al., 2010; Low et al., 2013), three soccer practice activity categories were identified for analysis: drill-based, games-based, and transition (see **Table 1**). Drill-based was defined as ‘activities performed in small groups or isolation that did not have a game play context, such as opponents or teammates’. It included fitness activity without a ball (warm-up; conditioning; cool-down), technique practice, and skills practice. Games-based was defined as ‘activities that had a game play context, with opponents and teammates’. It included phase of play, conditioned small-sided games, small-sided games, and possession games. Transition was defined as ‘when players moved between activities or engaging in activities with no soccer or fitness focus’. The systematic observation instrument used was designed in accordance with Brewer and Jones (2002) and has been used in our previous work (Ford et al., 2010). This five-stage procedure for establishing the instrument was: (1) observer training: the two coders had experience of systematic observation and the definitions of the practice activity categories; (2) instrument modification to ensure content validity; (3) establishing face validity: both of which have already been tested in our previous work (Ford et al., 2010); (4) establishing inter-observer reliability: to obtain reliability with the categories and definitions and time analysis of practice activities; (5) establishing intra-observer reliability: to obtain test-retest reliability.

Three blocks of systematic observation took place: before the workshop (SOA1), directly after the workshop (SOA2), and 3-months after the workshop (SOA3) with no formal coaching. In total, 84 coaching sessions were filmed across the three blocks. The coaching sessions took place within an indoor training facility (40m x 40m) and were filmed using a digital video camera (Sanyo, Japan) mounted on a stationary tripod (Libec, USA). The camera was located 10m from the coaching perimeter such that all movements of the players and coaches could be viewed at all times. The video footage from each coaching session was transferred to an Apple iMac computer (Apple, USA). The video footage was analysed using Studio Code software (Sportstec, Australia) using continuous recording method (Darst, Zakrajsek, & Mancini, 1989; Ford et al., 2010) for the amount of time spent in drill-based and games-based activities, as well as transition. All analyses followed the procedure set out by Brewer and Jones (2002) to ensure a valid systematic observation process. Two trained coders with experience of systematic observation coded the coach practice activity data at separate times and

locations, allowing time to analyse all aspects of the video footage and to increase the validity and reliability of the coding (Patton, 2002). The lead observer possessed the UEFA 'C' coaching license. The two coders carried out inter-observer and intra-observer reliability agreements which were calculated using the following observation: $(\text{agreements} / (\text{agreements} + \text{disagreements})) \times 100$ (Darst et al., 1989). Inter-observer and intra-observer reliability were 93% and 97% respectively, both of which exceeded the minimum acceptable level of 85% (Darst et al., 1989).

The percentage of time that coaches spent in two main activities and transition were calculated for each block of systematic observation. The data for the two main activities and transition violated the statistical assumption of independence (Field, 2017). That is, when players spent a large amount of time in one activity, they could only spend a small amount of time in the other activity. To address this issue, and after first examining the mean values for each of the two main practice activities and transition, the percentage of time spent in each was calculated, and analysed using three separate within-subjects repeated measures ANOVAs, with systematic observation block as the repeated factor. *Post-hoc* analysis on the related factor was carried out using Bonferroni comparisons. Statistical significance was set at $p < 0.05$, and partial eta squared (η_p^2) expressed the size of the effect. To provide a description of a significant difference between two means (i.e., pre-workshop to post-workshop), we calculated a percentage change score (see Vincent & Weir, 2012) using for the following equation: $((\text{post-workshop} - \text{pre-workshop}) / \text{pre-workshop}) \times 100$.

Insert **Figure 1** and **Table 1** here.

Coach interviews

The use of interviews, alongside the systematic observation, provided an opportunity to explore, and synthesise (with the *systematic observation data*) the perceptions from the coaches and what motivated them to use certain practice activities (Partington & Cushion, 2013; Partington, Cushion, & Harvey, 2014). This approach allowed us to better capture the complexity of the coaching process and understand why coaches use certain practice activities (see Potrac et al., 2000; Potrac, Jones & Armour, 2002; Partington & Cushion, 2013). The interviews were conducted after each block of

systematic observation (upper panel **Figure 1**). Interview A1 was designed to explore what the coaches underlying rationale was for implementing the practice activities recorded in SOA1, and where the coaches had acquired the knowledge to use these activities. Interview A2 was designed to explore why coaches did or did not increase the %Time spent using games-based activities directly following the CPD education workshop. Interview A3 occurred 3-months after the workshop and was designed to explore why coaches continued to use and implement the practice activities discussed during the workshop and implemented in SOA3 after a period of no formal coaching.

The semi-structured interview process was guided by the methods used by Partington and colleagues (Partington & Cushion, 2013; Partington, et al., 2014). The lead interview questions were developed deductively based on the systematic observation data recorded from SOA1, SOA2 and SOA3 plus evidence from skill acquisition literature (Williams & Hodges, 2005) and data related to the practice activities used by soccer coaches (Ford et al., 2010; Partington & Cushion, 2013). The interview process combined the use of open, and probe, questions to fully explore the topic of questioning until a saturation point (Patton, 2002; 2014) was reached by a coach (i.e., no new information was being provided during the discussion; see Glaser & Strauss, 1967). This questioning style allowed participants to provide rich accounts of their experiences and perceptions to the question posed by interviewer (Patton, 2002; 2014). Similar questions were asked to all coaches in order to ensure consistent responses were provided in terms of depth and complexity to the question (Patton, 1990). In Interview A1 (lasted between 8-19 minutes), a simulated recall method was used to encourage coaches to talk. This involved the interviewer presenting coaches with diagrams and seven videos on a laptop that displayed the practice activities that they had employed during the coaching sessions filmed from SOA1. The activities were selected to include one example of each of the seven sub-activity types defined in **Table 1**. Activities were selected using the ‘most frequently used’ or when frequency was equal, a ‘typical example’ of that activity. Following this, the coaches were asked: (1) “*What are your reasons for using this activity?*” (2) “*Where did you first acquire that activity from?*” In Interview A2 (lasted between 4-14 minutes), the mean percentage of drill-based and games-based activities from SOA2 were provided to each coach. Comparisons were made between the percentages calculated from the two activities employed in SOA1 and SOA2. If the %Time spent using games-based activities had

significantly increased, the coaches were then asked: “*We are interested in knowing your reasons for using more games-based activities in your coaching sessions that followed the CPD session?*” Following their first answer, a prompt question was stated: “*Were there any other factors that led to there being an increase?*” If the %Time spent using games-based activities had increased by less than 10%, then the coaches were also asked: “*What were your reasons for not using more games-based activities?*” Subsequently, following their answer, a prompt question was stated: “*Were there any other reasons for you not using more games-based activities?*” If the %Time spent using games-based activities had not increased, then a coach was asked: “*We are interested in knowing your reasons for not using more games-based activities in your coaching sessions after the CPD session?*” Following their first answer, a prompt question was asked that stated: “*Were there any other factors that led to there being no increase?*” The Interview A3 (lasted between 3-10 minutes) procedure followed the same processes used in Interview A2, but were related to the 3-month delayed period.

Interview data were collected via a digital audio voice recorder (Olympus, Japan) and then transcribed using natural speech and syntactic markers. First, a member of the research team (the interviewer) became immersed in the data by reading and re-reading the individual interview transcripts, plus annotated any initial observations. The analysis process began deductively (Patton, 2002; 2014), where categories and subcategories were identified based on the lead interview questions, scientific evidence from skill acquisition studies (e.g., Williams & Hodges, 2005), practice activities used by soccer coaches (Ford et al., 2010; Partington & Cushion, 2013), and the systematic observation data recorded from Blocks A1, A2 and A3. Whilst carrying out this process, inductive categories and subcategories emerging from the data were also noted and recorded. To reduce personal bias that a single researcher may bring and thus establish further trustworthiness (Silverman, 2001; Graneheim & Lundman, 2004), these two category types were discussed and finalised by all members of the research team. To further ensure trustworthiness, a copy of the data (coach names were removed) was read by the HSSM to establish credibility of the findings through a stakeholder check (Patton, 2002). No issues were raised. Consistent with previous research (Sparkes, 1998; Partington & Cushion, 2013), example quotations were used to present the main categories and subcategories for each lead question. After the initial analysis, and similar to the systematic observation data, in order to further establish trust and to

assure the validity and reliability of the analysis, inter and intra-observer agreements were calculated. In order to do this, a third-party coder was trained in the same analysis procedure as described and asked to analyse an example transcript from each coach interview. Their analysis was compared to the main analysis to measure agreements and disagreements in the thematic coding. Inter-observer and intra-observer reliability were calculated as 94% and 96%, respectively (Darst et al., 1989). The results of the validity and reliability tests were discussed by all members of the researcher team, an independent member of the research team, as well as the HSSM. The aforementioned have experience in skill acquisition, practice activities, and interviews, and collectively this enabled us finalise the emergence of appropriate categories and subcategories.

Results

Systematic observation data

The mean percentage (%) time spent using drill-based activities, games-based activities, and transition are illustrated in **Figure 2**. For drill-based activities (white bars), the ANOVA revealed no significant differences [$F(2, 12) = 1.53, p = 0.26, \eta_p^2 = 0.24$] in the %Time coaches spent using these activities across the three (pre-, post-, delayed-) workshop blocks. A significant [$F(2, 12) = 5.29, p = 0.02, \eta_p^2 = 0.47$] difference was revealed for %Time spent using games-based activities (dark-grey bars), with coaches significantly ($p < 0.05$) increasing (the difference equated to a percentage change score of 17%) the use of these activities from pre-workshop ($M = 31.52, SD = 14.64$) to post-workshop ($M = 48.03, SD = 18.44$). Importantly, there was no significant ($p > 0.05$) difference in %Time spent using games-based activities from post-workshop to delayed-workshop ($M = 40.08, SD = 14.94$). For transition, a significant [$F(2, 12) = 3.78, p < 0.05, \eta_p^2 = 0.32$] difference was revealed with coaches spending significantly ($p < 0.05$) less time (the difference equated to a percentage change score of 5%) in transition in the post-workshop ($M = 19.33, SD = 3.73$) compared to the pre-workshop ($M = 24.42, SD = 5.60$). There was no significant ($p > 0.05$) difference in %Time spent in transition from post-workshop to delayed-workshop ($M = 19.54, SD = 4.97$).

Insert **Figure 2** near here.

Interview data

Thematic analysis data are presented in **Table 2** and illustrate the reasons that coaches used (a) drill-based and (b) games-based activities in their coaching sessions pre-workshop, and where they acquired the knowledge to use these activities (**Table 3**). For the use of drill-based activities, the main categories included: (1) greater opportunity to develop certain technical skills (e.g., passing) through repetition without any opposition; (2) forming part of the warm-up, allowing players to become comfortable with the ball, together with developing fundamental movement skills; (3) allowing players to feel comfortable with executing the skill before introducing opposition; (4) and coaches' perceptions that their players enjoy some of the drill-activities. These activities were typically acquired from *other coaches* (37%), *created on own* (16%), and a combination of *other coaches and created on own* (11%).

For the use of games-based activities, the main categories included: (1) opportunities to develop tactical knowledge that may have been identified based upon previous competition/sessions; (2) the activity was a progression of an earlier activity to more closely replicate the demands of the game; (3) providing greater opportunities to develop their players decision-making; (4) previous positive experiences from engaging in similar activities during coaching licenses (e.g., UEFA 'B') courses; (5) and providing greater opportunities to assess their players learning around the main focus/aim of the session. These activities were typically acquired from *other coaches* (20%), *created on own* (15%), and *coach education courses* (40%).

Insert **Table 2** and **Table 3** near here.

Thematic analysis data are presented in **Table 4** and illustrate the reasons that coaches increased or maintained the percentage use of games-based activities in their coaching sessions post-workshop. From the five coaches that increased the percentage use of games-based activities, the main categories included: (1) implementing the evidence-based principles discussed in the CPD workshop; (2) the coaches observations of how much more their players enjoyed the games-based activities; (3)

players are more motivated (i.e., effortful); (4) and providing opportunities to develop their players skills such as decision-making, as well as opportunities to assess their players ability to adapt to the increased attentional demands consistent with match-play. From the two coaches that maintained the percentage use of games-based activities, the only category was: (1) drill-based activities were sometimes required to better ‘breakdown’ the technical skill.

Insert **Table 4** near here.

Thematic analysis data are presented in **Table 5** and illustrate the reasons that coaches decreased or maintained the percentage use of games-based activities in their coaching sessions delayed-workshop. From the five coaches that decreased the %Time spent using games-based activities, the main categories included: (1) conflicting information that was provided in an external workshop during the 3-month period; (2) constraints associated with the total session time, as well as the use of a new curriculum to meet the requirements of the EPPP; (3) the difficulty of progressing from the main theme of the session to a game-based activity. From the two coaches that maintained the %Time spent using games-based activities, the main categories included: (1) continuing to implement the evidence-based principles discussed in the CPD workshop; (2) the topics associated with the club curriculum being more engaging through the use of games-based activities; (3) providing greater opportunities compared to drill-based activities to develop their players skills.

Insert **Table 5** near here.

Discussion

Consistent with previous work in soccer (Ford et al., 2010; Partington & Cushion, 2013), the pre-workshop systematic observation data (SOA1) indicated that the coaches spent more time using drill-based, compared to games-based, activities. Whilst drill-based activities are typically used by coaches to facilitate the development of soccer related technical skills (Ford et al., 2010), they are suggested to limit the development of motor and perceptual-cognitive processes needed for dynamic

match-play (Ford et al., 2010). Importantly, the post-workshop data indicated that coaches increased (17%, **Figure 2**) the time spent using games-based activities across all age groups following the evidence-based CPD educational workshop. Although we might have expected a reduction in drill-based activities, we in fact observed that coaches decreased the amount of time spent in transition (period of time moving between activities) by 6%. Therefore, the decision to reduce transition time seems to have been made to allow more time to implement the games-based activities from the intervention, which is a positive outcome as it provided academy players with extra time in games-based activities to develop important motor and perceptual-cognitive processes needed for dynamic match-play. To examine whether the coaches continued to use any changes in practice activities, we employed a third block of systematic observation after a 3-month delayed period (SOA3). Although there was a slight decrease in the amount of time spent in games-based activities, this remained above pre-workshop data (32%) and therefore indicated that the modulation of practice activities employed by coaches across the first two blocks of the study remained suggesting some level of learning.

The significant increase observed in the amount of time spent in games-based activities supported our hypothesis that the practice activities delivered in soccer coaching sessions can be influenced by engaging coaches in evidenced-based CPD educational workshops that are co-created. Following the workshop, coaches adopted more games-based activities (e.g., 4 v 4 phase of play) that have the potential to develop the acquisition of motor and perceptual cognitive processes (Williams & Hodges, 2005; Ford et al., 2010) that can be transferred by players from the coaching sessions to match-play. The data recorded from the coaches during interpretive interviews indicated that one of their main motivations for modifying coaching behaviour was the evidence-based information discussed during the intervention. For example, *“Obviously from the CPD, the guy who went through it told us rather than breaking it down and doing one-on-one and bring it down to it rawest form, you’re better doing those sorts of situations in game time”* (C1). Taken together, these data illustrate that practice activities adopted by professional soccer coaches can be modulated through co-creative interventions, which seems to be an effective way of closing the gap between science and application (Cushion et al., 2012).

Although we found these positive effects for games-based activities, it is important to acknowledge that this came at the cost of a reduction in transition time, which could have impacted the

opportunity for players to receive instructions and feedback that are important for skill acquisition (Ford et al., 2010; Salmoni, Schmidt, & Walter, 1984), plus hydration and recovery (Nédélec, et al., 2012). Therefore, the fact that the amount of time spent in drill-based activities was not significantly different (**Figure 2**) across the study offers an opportunity to examine whether this area of coaching behaviour can also be changed by targeted interventions that modify drill-based activities to contain aspects of decision-making as per those employed in games (Ford & Whelan, 2016). The interpretive interview data suggests that the main reasons for using drill-based activities was to develop technical skills, warm-up sessions, progression of the drill and perceived player enjoyment (see **Table 2**). In our previous work in cricket (Low et al., 2013), we made specific suggestions for how drill-based activities employed by coaches could be modified to contain elements of ‘active’ decision-making, and therefore be categorised as games-based because they would require players to make decisions based on the positioning of teammates, space, and opposition formations (Williams & Ford, 2013). Whilst these active decision-making drills have the potential to facilitate the acquisition of both motor (i.e., technical) and perceptual-cognitive skills, it is likely that some coaches may require help from applied sport scientists and researchers in order to develop these practice activities (Ford et al., 2010; Cushion et al., 2012; Low et al., 2013). Therefore, a follow-up CPD educational workshop was conducted within the same club (see In Experiment B) in an attempt to modify the practice activities used by coaches to include active decision-making. To explore the efficacy of different educational CPD methods, we adopted a video-based feedback based methodology instead of the paper booklet used in Experiment A because it has been shown within an educational context to change coaches’ non-verbal behaviours (Meeûs, Serpa, & De Cuyper, 2010), and soccer coaches and players have had positive experiences from engaging with video-based feedback when working on professional development and coaching practice (Groom & Cushion, 2004; Raya-Castellano et al., 2020).

To this end, in the follow-up Experiment B we aimed to investigate whether providing coaches with a co-creative workshop involving video-based feedback would modulate the practice activities used by coaches resulting in an observed increase in drills that contain active decision-making. As per Experiment A, first we first engaged in informal meetings with key stakeholders in order to co-create the video-based intervention. Following this discussion, a six-phase experimental protocol was

employed (lower panel **Figure 1**; **Note: no delayed phase was conducted in Experiment B as two coaches, as well as the HSSM, left the club over the summer period**). Second, and third, we adopted similar methods of systematic observation of coaching sessions (SOB1), and coach interviews (Interview B1). Fourth, for the workshop, a roundtable (as per Experiment A) discussion with the coaches was employed that focused on the observation and appraisal of videos that contained pre-workshop practice drill-based activities, as well as videos of example drill-based activities that had been manipulated to contain active decision-making (see methods). Fifth and sixth, following the workshop, a second block of systematic observation (SOB2) and interview (Interview B2) were carried out. It was predicted that across experimental phases, a significant increase in activities that contained active decision-making would be adopted by coaches following the co-created intervention.

Experiment B

Participants

All participants from Experiment A were recruited for Experiment B.

Co-creation process

As per Experiment A, the implementation of a co-created educational workshop was discussed during a meeting at the soccer club between the lead author and the HSSM (lower panel **Figure 1**).

Coach education workshop

We used the same general procedures to those used in Experiment A when developing and running the CPD educational workshop. Specifically, rather than using a technical report to form the discussion process, we used a soccer-based video intervention. First, the coaches were provided with the definitions (see **Table 6**) of active, and non-active, decision-making activities and offered a chance to discuss these amongst themselves, followed by an opportunity to seek clarity from the last author (SH). To contextualise these written definitions, the coaches watched the soccer-based video that was created to show a battery of video examples that illustrated soccer drills that had been manipulated to contain active decision-making. These active decision-making soccer activities were devised by the

second and last author, and further developed and refined with consultation from the HSSM, and the AD. Once finalised, and in order to create the video, the activities were simulated by a group of players from a squad (U18s) within the youth academy. The players performed the simulated coaching sessions on the training pitches at the academy wearing the club kit. The sessions were ran by the HSSM, and the AD, and were filmed using the same general filming protocol and apparatus as in Experiment A. The simulated active decision-making sessions were then edited to create the in-house soccer-based video workshop. Second, during the actual intervention, the coaches watched the individual videos, and then discussed the scenarios amongst themselves in relation to the written definitions. The discussion was facilitated and developed with input from the last author, the HSSM, and the AD. The coaches were then asked to try and implement what was covered in the workshop across the next block of coaching sessions filmed in the study (SOB2).

Systematic observation

As per in the lower panel of **Figure 1**, two blocks of systematic observation took place. In total, 50 coaching sessions were filmed across the two blocks. We used the same general filming protocol, apparatus, and analysis as Experiment A. Importantly, however, we created new categories for the soccer practice activities used in the analysis: active decision-making, non-active decision-making, fitness and transition (see **Table 6**). For active decision-making, the categories used by coaches required elements of decision-making (e.g., the main action execution decision/s for the player/s in possession must have at least two or more options, usually involving moving opposition who make the requirement for that decision. In the systematic observation analysis, we quantified the following: drills with an active decision-making component; small-sided games; unidirectional games; phase of play; conditioned small-sided-games; possession games). For non-active decision-making, the decision was specified/constrained to the player within the drill (e.g., the main action execution had only one option that was usually pre-determined by the coach such as a 10m driven pass to a partner). Inter-observer and intra-observer reliability from the systematic observations were 96% and 98% (Darst et al., 1989).

The percentage of session duration that players spent in the two categories of active decision-making and non-active decision-making, as well as the transition and fitness, was calculated for each

block of systematic observation. This was calculated using the same method as in Experiment A. The data for the two main practice activities, fitness and the transitions violated the statistical assumption of independence (Field, 2017). Again, after first examining the mean values for each of the two main practice activities, fitness and transition, the percentage of session duration spent in each variable in the pre-workshop and post-workshop were analysed using separate one-tailed *t*-tests. Statistical significance was set at $p < 0.05$ and Cohen's *d* expressed the size of the effect.

Insert **Table 6** near here.

Coach interviews

Semi-structured interpretive interviews were conducted after each block of systematic observation (one coach was unavailable after the second block of systematic observation). In the first interview, examples of non-active decision-making activity were shown, the questions asked for each of the activities were: (1) *“What are your reasons for using this activity?”* (2) *“Where did you first acquire that activity from?”* In the second interview, the mean percentage data for active decision-making, non-active decision-making, fitness and transition was provided. Comparisons were made between percentages in SOB1 and SOB2. If the %Time spent using activities with non-active decision-making had decreased, coaches were asked: *“We’re interested in knowing your reasons for using less non-active decision-making activity in your coaching sessions that followed the CPD session?”* Following their first answer, a prompt question was stated: *“Were there any other factors that led to there being a decrease?”* If the %Time spent using activities with non-active decision-making had not changed, then coaches were asked: *“What were your reasons for using the same amount of non-active decision-making activity in your coaching sessions after the CPD?”* Subsequently, following their answer, a prompt question was stated: *“Were there any other reasons for you using the same amount of non-active decision-making activity?”* In the instances where the %Time spent using activities with non-active decision-making had increased, then coaches were asked: *“We’re interested in knowing your reasons for not using less non-active decision-making activity in your coaching sessions after the CPD session?”* Following their first answer, a prompt question was asked that stated: *“Were there any other*

factors that led to there being no decrease?” Coaches were then asked question regarding their understanding of the intervention: “From your understanding, what was the purpose of this session’s CPD?” and whether they had a preference for either delivery method used: “You have now been involved in two CPD sessions with us. The first involved a formal delivery of the material. The second was a more interactive session that used video footage to stimulate discussion. Do you have any comments regarding these two different delivery methods?” Prompt questions were used throughout to encourage coaches to expand where needed.

Interview data was processed and analysed as per Experiment A. Inter-observer and intra-observer reliability were 90% and 97% respectively (Darst et al., 1989).

Results

Systematic observation data

The mean percentage (%) time spent using active decision-making, non-active decision-making, transition, and fitness are illustrated in **Figure 3**. The %Time spent using activities with active decision-making (white bars) in the pre-workshop ($M = 63.41$, $SD = 14.7$) sessions was significantly [$t(6) = 3.03$, $p = 0.01$, $d = 1.16$] different to the %Time spent in the post-workshop ($M = 76.57$, $SD = 6.33$) sessions (this difference equated to a percentage change score of 13%). For activities with non-active decision-making (light-grey bars), the %Time spent used in the pre-workshop ($M = 14.22$, $SD = 12.49$) was significantly [$t(6) = 2.37$, $p = 0.03$, $d = 1.04$] different to the %Time spent used in the post-workshop ($M = 4.72$, $SD = 3.20$) sessions (this difference equated to a percentage change score of 9%). There were no significant differences observed from pre-to-post workshop for transition [$t(6) = 1.58$, $p = 0.08$, $d = 0.60$; see dark-grey bars] or fitness [$t(6) = 0.72$, $p = 0.25$, $d = 0.32$; see black-bars]. Because the active decision-making dependent variable contained multiple activities (where the main action contains two or more degrees of freedom or options, see **Table 6** and Low et al., 2013) that were measured during the systematic observation, we performed an additional analysis to further explore the active decision-making effect. Here, and based on the descriptive analysis, we focused on two active decision-making activities: drills with active decision-making, and small-sided games. The analysis indicated no significant difference from pre-to-post workshop for the amount drills used with active

decision-making [$t(6) = 1.7, p = 0.14, d = 0.94$], but, the %Time spent using small-sided games in post-workshop was significantly [$t(6) = 0.72, p = 0.03, d = 1.32$] different (i.e., higher) than %Time spent in the pre-workshop sessions (this difference equated to a percentage change score of 23%).

Insert **Figure 3** near here.

Interview data

Thematic analysis data are presented in **Table 7** and illustrates the reasons that coaches used activities with non-active decision-making in their coaching sessions pre-workshop, as well as where they acquired these activities (**Table 8**). The main categories included: (1) more opportunities to observe and subsequently develop all their players technical skills within a short period of time; (2) forming part of the warm-up, where players performed fundamental movement skills; (3) progression of the skill to move into a game; (4) the coaches observations of how much players enjoyed activities which the coach perceived as ‘dull’; (5) repetition of the skill providing more opportunities to develop and progress the skill. These activities were typically acquired from *creating on own* (33%), *coach education courses* (24%), and *other coaches* (10%).

Insert **Table 7** and **Table 8** near here.

Thematic analysis data are presented in **Table 9** and illustrates the reasons that coaches increased the percentage use of active decision-making activities in their coaching sessions post-workshop. The main categories included: (1) implementing the evidence-based principles discussed in the CPD education workshop; (2) opportunities for the coaches to develop their players decision-making skills; (3) the ease of implementing activities that contain elements of active decision-making due through modifying previous practice activities/sessions; (4) coupled with new larger facilities (i.e., pitch size).

Insert **Table 9** near here.

Thematic analysis data are presented in **Table 10** and illustrates the perceptions of the coaches as to the purpose of the workshops. The main categories included: (1) increasing the opportunities for their players to develop decision-making skills; (2) to modify their sessions such that they closely replicated the demands of the game (i.e., "...more realistic,"); (3) decreasing the amount of time spent in activities that are unopposed; (4) providing more practice time for their players and ensuring a greater chance of player retention (i.e., increasing player attendance); (5) provide opportunities to develop their coaching practice; (6) and receive feedback of their coaching sessions.

Insert **Table 10** near here.

Thematic analysis data are presented in **Table 11** and illustrates the preferences of the coaches as to the use of the video-based workshop in Experiment B compared to the standard workshop in Experiment A. From the five coaches that preferred the interactive video-based delivery style, the main categories included: (1) the video style helped coaches to see where (i.e., pre-workshop examples), and how (i.e., U18s simulated activates), they could modify their practice activities; (2) opportunities to discuss their own and other coaches practice activities; (3) greater opportunities to retain the information from the workshop; (4) videos from their own club (i.e., U18s) allowed for a more personal learning experience. From the one coach that had no preference, the only category was: (1) both workshops developed their coaching practice.

Insert **Table 11** near here.

Discussion

Consistent with our hypothesis, results from Experiment A (i.e., pre-workshop drill-based activity data), and the scientific literature (Williams & Hodges, 2005; Ford et al., 2010), the workshop data from Experiment B indicated that coaches spent more time employing coaching session activities that contained non-active decision-making (**Figure 3**). Whilst this form of coaching session(s) is not

always optimal for developing the processes that are typically used in dynamic soccer games, the post-workshop data indicated that coaches employed significantly more sessions containing active decision-making. Specifically, the subsidiary analysis provided a greater insight into this effect by showing that coaches opted to significantly change the percentage of small-sided games used in post-workshop. Similar to the development of games-based activities in Experiment A, the fact that we replicated this development in the form of ‘active-decision making’ is important because it is likely to have provided the players with an opportunity to acquire motor and perceptual-cognitive skills that closely replicate the demands of the game, and which would hopefully facilitate transfer to match-play (Ford et al., 2010). The interpretive interview data indicated that the coaches reported the workshop was one motivating factor for implementing more ‘active-decision making’ activities. For example, Coach 7 stated: *“It was just seeing how much, obviously the ideal thing we want to do is have the kids making as many decisions as possible. So, we took that on board and tried to put it into all the sessions, whether it be the warmup, whether it be the cool down at the end or the main chunk of the session. Just trying to make sure the kids have as many decisions to make as possible”* (Table 9). What is noteworthy is the fact that the coaches decided to increase the use of small-sided games, rather than specific drill-based activities that contained active decision-making (Low et al., 2013). Importantly, there was no difference in the percentage of time in transition where other important aspects of coaching are often implemented such as instruction and feedback, and hydration. As reported by Coach 7 in the previous quotation, it seems that in Experiment B, the underlying principles of the video-based workshop (i.e., ‘active-decision making’) were implemented across the whole coaching session (e.g., *“Just trying to make sure the kids have as many decisions to make as possible.”*).

General discussion

The two-experiment study was designed to examine whether practice activities adopted by professional youth soccer coaches could be modulated and adapted by actively engaging coaches in CPD educational workshops that were based on scientific evidence. Data from Experiment A and B indicated that coaches significantly increased the percentage of time employing games-based (i.e., small-sided/conditioned games), and active decision-making activities after engaging in a standard

(roundtable), or enhanced (video feedback) interactive, CPD educational workshop involving coaches and a researcher from an external partner institution. What was particularly important from a methodological perspective was after a 3-month period away from the club the coaches continued to use the level of games-based activities observed post-workshop (see **Figure 2**). By not returning to pre-workshop levels indicates that the modulation of practice activities was retained resulting in a relatively permanent change in coach behaviour. Although our study was quite short, the change behaviour effect supports the idea that longitudinal approaches might be an effective workshop strategy for modulating practice activities in coaching (Harvey et al., 2010).

The increase we observed in the amount of the time spent by coaches using games-based activities, and/or activities that contained active-decision making, have the potential to provide players with a greater opportunity to develop motor and perceptual-cognitive skills such as visual search, anticipation, and decision-making (Ford & Williams, 2013), which are central to expert performance in sport (Williams & Reilly, 2000; Ford et al., 2010). Although data from lab-based, or controlled simulated games-based, studies show that motor and perceptual-cognitive skills can transfer to match-play (Williams & Hodges, 2005; Ford et al., 2010), the data from our two experiments extends this work by showing that the underlying skill acquisition principles from lab-based studies can be delivered via CPD educational workshops to promote behaviour change in coaches. Data from the interviews indicated that the coaches supported the use of these workshops, with the coaches suggesting the feedback and active CPD educational workshop process was a motivating factor for changing their behaviour. Whilst it has consistently been reported (Williams & Hodges, 2005; Gilbert et al., 2009; Cushion et al., 2012; Partington & Cushion, 2013) that coaches develop their knowledge from emulating other coaches, and modifying their own practice, rather than from using evidence from science, the current study shows these ‘traditional’ practice activities can be modified via education.

The significant changes we observed across both studies is important evidence showing that ‘bridging the gap’ between science and application (Ford et al., 2010; Cushion et al., 2012; Low et al., 2013) can be achieved by engaging clubs with sport scientists and researchers to ‘co-create’ CPD education workshops. By adopting this pedagogical approach, we believe that we removed some of the barriers that typically impact the transfer of scientific knowledge to application such as researchers not

considering the interests of coaches (e.g., sport psychology; Williams & Kendall, 2007), as well as the difficulties that some coaches may experience accessing and integrating scientific evidence into their own coaching practice (Martindale & Nash, 2013). The co-creation method used in the present study was designed specifically to develop a professional working relationship with key members of the academy, that being the HSSM and AD. This relationship enabled us to develop workshops that met the needs of the club but was also underpinned by our expertise in science and motor behaviour. Moreover, we were motivated as a team to work very closely with the club in order to take into consideration the outlined needs and philosophy such that all working parameters and goals were attained. The information from many roundtable discussions informed, via 'co-creation', the basis of the research question, methodology, workshop and ethics. This approach also developed a learning environment within the CPD educational workshops that seemed to increase engagement in the workshop, whereby informed discussions between the coaches, club staff, and the researcher was similar to typical methods of how soccer coaching knowledge is acquired (i.e., emulation) and thus resulted in greater engagement ('buy-in') from coaches (Stoszkowski & Collins, 2016). We are mindful however that the rationale, and generation of the CPD educational workshops, that led to these changes were initially developed without the direct involvement from the coaches, and/or players. Whilst this approach was not a deliberate strategy based on a predefined organisational hierarchy, we do recognise the multifactorial nature of the specific social-sporting environment (see 'activity theory in sports coaching' forwarded by Jones, Edwards, & Viotto Filho, 2016) and acknowledge the potential benefits to player development and performance based on a more conjoined approach that values the viewpoints from invested parties (i.e., players, coaches, researchers, academy heads etc).

Although the two CPD co-creative workshops successfully modified coach practice activities via behaviour change, the subsidiary analysis indicated that drills that contain active decision-making (Low et al., 2013) were not significantly changed across the workshop. Based on our experience (Low et al., 2013), it might be that coaches opted to use small-sided games as opposed to bespoke active decision-making drills as there was more scope, or it was easier, to change/modify these types of games from their own coaching repertoire. A method that could be implemented to increase the number and soccer specificity of active decision-making drills is to upskill and support coaches (and perhaps

755 players) by developing mentorship programmes (Cushion, 2015; Dawson, 2014; Jones, Harris, & Miles,
756 2009) that target specific aspects of coaching practice, and/or at particular stages [e.g., a youth
757 development coach has very different needs ('technical detail') to an elite ('micro-politics') coach] of
758 a coach's career (Leeder & Sawiuk, 2020). For example, junior Australian soccer coaches significantly
759 changed the delivery type of practice sessions employed in youth coaching (i.e., increased use of playing
760 form), and coach behaviours (i.e., increase in positive coaching behaviours related to verbal feedback),
761 following a 15-week multi-approach intervention that contained face-to-face workshops, ongoing
762 mentoring, modelled training sessions, peer assessments, and group discussions (Eather et al., 2020).
763 This intervention was deemed beneficial because it was high-dosage (15-weeks), rather than low-
764 dosage (i.e., one session as per our workshop), which indicates that mentorship schemes should
765 carefully consider the length and structure of the programme. Perhaps more importantly is the fact that
766 soccer environments are typically complex and constrained by many interacting personal-social-
767 sporting-environmental factors, which means that mentorship programmes are not a one-size fits all
768 mechanism and therefore should consider these multiple factors in design. Indeed, it has been suggested
769 (Leeder & Sawiuk, 2020) that effective mentoring schemes should consider implementing multiple-
770 mentors [to cover different domain (e.g., cross-sport; sport v non-sport) areas of expertise],
771 developmental networks mentorships, technology and e-learning, interpersonal skills training, mentor
772 learning programmes, gender representation, and culture.

773 To conclude, across two experiments we have shown that practice activities adopted by
774 professional youth soccer coaches can be influenced and changed in accordance with the evidenced-
775 based information (increase in games-based and active decision-making activities) (Ford et al., 2010),
776 thus closing the gap between science and application that exists in soccer coaching (Williams & Hodges,
777 2005). This was achieved through coaches and applied reserchers working together to 'co-create'
778 evidence-based CPD educational workshops (Ford et al., 2010; Cushion et al., 2012; Partington &
779 Cushion, 2013). By working closely with key stakeholders prior to the workshop, the needs and
780 philosophy of club were understood, a working and trusting relationship was developed, and the
781 working parameters were set out. The fact that the delayed-workshop data indicated the increase in
782 games-based activities did not return to pre-workshop levels, suggested some level of learning as the

783 coaches opted to use the new adapted practice activities after a 3-month period of no formal coaching.
784 We propose that co-creating sports-specific evidence-based multi-factorial workshops via conjoined
785 working relationships with players, professional coaches and stakeholders could be an effective tool for
786 facilitating behaviour change in coaches leading to benefits in player development and performance.
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Table 1. Categories and definitions of soccer practice activities for Experiment A (adapted from Ford et al., 2010).

Drill-Based Activities	
Categories	Definition
Fitness	Improving fitness aspects of the game with no focus on technical or tactical skill (e.g., warm-up; cool-down; conditioning).
Technical	Isolated technical skills unopposed either alone or in a group.
Skills	Isolated technical or tactical skills from game situations, in a small group with some opposition.
Games-Based Activities	
Categories	Definition
Small-Sided Game	Match-play with reduced pitch size, two equal goals and reduced number of players, although can be unequal to the amount of two extra players on one side).
Phase of Play	Uni-directional match play towards one goal.
Conditioned Small-Sided Game	As small-sided games, but with variations to rules, goals, or areas of play (e.g., teams scoring by dribbling across end-line, players playing for both teams in possession, zones etc.).
Possession Games	Games with no goals in which the main intention is for one team to maintain possession of the ball from another.
Transition	
Categories	Definition
Transition	Movement from one activity to another or activity that is not soccer-related (e.g., drinks breaks). This includes the coach’s explanation of the forthcoming activity and debrief of preceding activity.

Table 2. Interview A1: Categories, subcategories and example quotes outlining the reasons for using (a) drill-based and (b) games-based activities pre-workshop in Experiment A.

(a) Reasons for Using Drill-Based Activities		
Categories	Subcategories	Example Quotes
(1) Develop Technical Skills	<i>Proactive</i>	“Basically, getting them as many touches as they can. Like to get them over at least a 1,000 touches in a session if not more. So just getting every boy a ball, running with the ball, dribbling, lots of touches as you can see. And getting the heads up.” (C2)
	<i>Reactive</i>	“We’ve struggled in games keeping possession. So it’s a build up from the game, we need to pass the ball better... We need to learn to pass the ball better and it’s better unopposed than putting someone in there oppose.” (C6)
(2) Warm-Up	<i>Preparation</i>	“Just a warm-up... and lots of touches on the ball. So just that they come really, really comfortable with the ball at their feet.” (C1) “It’s just a warm-up... to get the heart rate up.” (C4)
	<i>Developing Fundamental Movement Skills</i>	“This is just fundamental movements... to get them warmed up... just to get them going.” (C6)
(3) Progression		“So yeah just basically to get comfortable with the ball come at their feet being pressured..... It’s relatively passive it’s just to get them used to... being opposed basically.” (C1)
(4) Player Enjoyment		“It’s more or less little bit fun for them.” (C6)
(b) Reasons for Using Games-Based Activities		
Categories	Subcategories	Example Quotes

(1) Developing Tactical Knowledge		“...something we’ve seen maybe they needed a little bit of work on, or to be honest, not just from the Sunday it would be a reoccurring sort of thing, 2/3 weeks where we thought, alright we need to sort of bit do a session on that.” (C3)
(2) Developing Technical Skills	<i>Progression of Skill</i>	“Bring up the skill... into the small sided game...” (C2)
	<i>Proactive</i>	“It’s mainly for the movement, the passing and the movement amongst... them.” (C3)
(3) Developing Decision-Making		“Obviously looking at their awareness on the ball, first touch, their decision making, the movements off the ball in terms of trying to support the man on the ball.” (C7)
(4) Coach Development		“I think this was my B license sort of mark assessment. So that’s why I kind of had to do some work on that.” (C3)
(5) Measure Learning		“So, this is something we always do at the end of the session to see whether they can do things we’ve been trying to do within the session, in free play at the end.... Like a reward if they work well, if they work well in the session, the boys want to play, they want to play football and one of the best ways to learn is by playing football as well isn’t it? Or that is sort of the way we sort and try and look at it.” (C7)

Table 3. Interview A1: The frequency (percentage) and example quotes of coaches sources for using drill-based (Drill) and games-based (Games) activities pre-workshop in Experiment A.

Sources	Frequency (%)		Example Quotes
	Drill	Games	
Other Coaches	7 (37%)	4 (20%)	<p>“Again, just from coaching manuals or from any courses that I’ve been on. I think that particular one was from a course I’ve been on.” (C1)</p> <p>“...probably men’s football, my own football when I was a kid, done the same thing. Just getting warm.” (C2)</p>
Created on Own	3 (16%)	3 (15%)	<p>“But it is all sort of based on triangles, sort of drills from Ajax and Barcelona and stuff like that but generally it is sort of something I come up with myself.” (C3)</p>
Coach Education Course	1 (5%)	8 (40%)	<p>“Yeah again level 1, level 2 a good experience from now...” (C2)</p> <p>“Probably from the courses, you see a lot of them on the.. I think the youth module courses, I think that’s where I picked this one in particular up.” (C3)</p>
Coaching Books	1 (5%)	1 (5%)	<p>“I think it’s in the future game, the FA future game.” (C4)</p> <p>“That’s probably out of a book. I probably read it in a book and just jogged it down and tried it and then on yeah. I like that.” (C6)</p>
Created on Own and Internet	1 (5%)		<p>“...actually, I saw this at the head of the youth academy’s session. I think he put it on the session planner that we got. I just adapted it from there really.” (C7)</p>
Created on Own and Coaching Books		1 (5%)	<p>“...again, probably through manuals... things like that or it could have been a variation I’ve seen and adapted myself.” (C1)</p>
Other Coach and Created on Own	2 (11%)	1 (5%)	<p>“So, we just taken our bits from it and you know, copied it identically or we modified them and sort of made our own changes to them so...” (C1)</p>

Not Sure	4 (21%)	2 (10%)	“I don’t know, it has always been my sort of preference to do this type of work.” (C3)
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Table 4. Interview A2: Categories, subcategories and example quotes outlining the reasons for (a) increasing, or (b) maintaining the %Time spent using games-based activities post-workshop in Experiment A.

(a) Reasons for Increasing the Percentage Use of Games-Based Activities		
Categories	Subcategories	Example Quotes
(1) CPD Workshop		“Obviously from the CPD, the guy who went through it told us rather than breaking it down and doing one-on-one and bring it down to it rawest form, you’re better doing those sorts of situations in game time.” (C1)
		“I thought that was what they wanted us to do. My impression is that they wanted more games-based activities than drill-based activities. So, we altered our training.” (C3)
		“Just after the CPD, you know, it put me in a different mind-set of maybe, you know, it’s, it’s how you perceive.” (C5)
		“What ... told me, you know, I am not that blind to that, you know, to say ‘my way is the best way’, you know, I am open to ideas and I think that’s what you’ve got to be, you’ve got to be adaptive as a coach to say, you know, I’ve looked through my sessions and it kind of moulded into a different way.” (C5)
(2) Player Enjoyment		“Obviously the increased playing time the kids seem to enjoy it a lot more.” (C1)
		“So, we give them more games-based activities or phases of play, small-sided games and most of it, the kids enjoyed it to be honest. They enjoyed it, they seemed to enjoy it more.” (C2)
(3) Player Motivation		“When you do sort of technical drills based with youngsters, they know they are not being challenged. So, they’ll at a certain percentage, they only put so much effort in but when you add even just one defender, they know they have got to be a bit more switched on.” (C3)
(4) Player Development	<i>General</i>	“Well, we took it into games, we had a few games and the phases of play certainly, have definitely worked. You could see it coming off and it’s good when it does come off, especially at that age group. So, it is working, seems to be working a lot more.” (C2)
	<i>Decision-Making</i>	“A lot more thinking and decisions for the lads to make.” (C7)

“You’re putting them into match situations, and they use them techniques that come with the decision making that they’ll take onto the game on the weekend.” (C7)

(b) Reasons for Maintaining the Percentage Use of Games-Based Activities		
Categories	Subcategories	Example Quotes
(1) Develop Technical Skills		“...I think you definitely need the sort of, the more breakdown, slower technical stuff like passing drills you definitely need them...” (C7)

Table 5. Interview A3: Categories, subcategories and example quotes outlining the reasons for (a) decreasing, or (b) maintaining the %Time spent using games-based activities delayed-workshop in Experiment A.

(a) Reasons for Decreasing the Percentage Use of Games-Based Activities		
Categories	Subcategories	Example Quotes
(1) Conflicting Information		“...and in the meantime, we’ve had the FA in haven’t we and a CPD day with them. And they’ve given us sort of a more mixed view. That’s the way I’ve taken it anyway. It’s difficult to know which to take and I’ve tried to take a bit of both as I’m obviously still trying to progress myself.” (C1)
		“For me personally, I have been on a couple of courses, coaching courses, and they just make you look at the game differently. Totally different. So that’s one of the main reasons I think.” (C2)
(2) Club Constraints	<i>Session Time</i>	“Well, we only have an hour. So, it doesn’t help but that’s what we’ve got, and we just have to get on with it. But we would like more time with them.” (C2)
	<i>Curriculum</i>	“The method of the training this season is different to last season. Last season us as coaches decided what we were doing. This year we’re following a path of what to coach. So, we’re being given different things to train this year and told different things, whereas last year it was our own thing.” (C3)
		“I just feel that the structure we’ve been given this year under the EPPP, where we’ve got to do... Yeah, I don’t think we do enough playing drills but if the topic we’re doing is say, heading, it’s hard to bring that into games-based activities.” (C5)
		“Possibly, just because we’ve got more of a structure. In particular what we’ve got to coach.” (C7)
(3) Progression		“Yeah, we need to progress it and then, obviously, sometimes we get stuck in at the end.” (C5)
(a) Reasons for Maintaining the Percentage Use of Games-Based Activities		
Categories	Subcategories	Example Quotes
(1) CPD Workshop		“Probably, after the CPD just working to the same format that we told at the CPD last year.” (C6)

(2) Club Curriculum

“With the curriculum we’ve been given, for the learning for the boys, probably the topics might engage more game time than the other stuff.” (C6)

(3) Player Development

“I think the children learn more from it. They learn a lot more, rather than doing a training drill, if you have a little game. If its game related, they take a lot more from it.” (C4)

“So that you learn it within the game, not me and you running to each other and then when I get a touch I run to the other kid.” (C6)

Table 6. Categories and definitions of soccer practice activities for Experiment B (adapted from Low et al., 2013).

Non-Active Decision-making	
<i>Activity in which the main action execution decision/s for the player in possession of the ball has only one degree of freedom option that is usually pre-determined by the coach.</i>	
Categories	Definition
Drill Without Active Decision-Making	Activity either alone with a ball or in a small group involving no opposition or somewhat passive opposition so that the main action execution decision/s for the player/s in possession of the ball has only one degree of freedom or option <i>that is usually pre-determined by the coach</i> . Also, at least the majority of time for that drill meet this definition.
Active Decision-making	
<i>Activity in which the main action execution decision/s for the player in possession has at least two or more degrees of freedom or options, mostly involving moving opposition.</i>	
Categories	Definition
Small-Sided Game	Match-play with match-like goals, but reduced pitch size and reduced numbers of players, usually equal amounts of players, although can include players who play for whichever team is in possession.
Conditioned Small-Sided Game	As small-sided games, but with variations to rules, goals, or areas of play (e.g. teams scoring by dribbling across end-line or into zones).
Possession Games	Games with no goals in which the main intention is for one team to maintain possession of the ball from another.
Uni-Directional Games	As conditioned and/or small-sided games, but possession moves mainly in one direction only and player numbers are 2 vs. 1, 3 vs. 1, 3 vs. 2, or 4 vs. 2.
Phase of Play	Match-play but possession moves mainly in one direction towards one goal with at least three defenders involved.

Transition	
Categories	Definition
Transition	Movement from one activity to another or activity that is not soccer-related (e.g., drinks breaks). This includes the coach’s explanation of the forthcoming activity and debrief of preceding activity.

Table 7. Interview B1: Categories, subcategories and example quotes outlining the reasons for using activities with non-active decision-making pre-workshop in Experiment B.

Categories	Subcategories	Example Quotes
(1) Develop Technical Skills		“Because I find it good for doing unopposed turning on the ball. I think it’s a good little technique for how many numbers we had there as well. Its keeps them all repetitive. As you see within five seconds all the players have has go, they’re running around. Not waiting long are they.” (C3)
		“Yeah it’s as technique. They’re not checking their shoulder so we’re getting them to receive side on.” (C5)
(2) Warm-Up	<i>Preparation</i>	“Yeah, I don’t want everyone sitting around waiting. I’ve got my set up, so I don’t want to let them have a game because I don’t want to destroy my set up. So, I’m thinking ball each, go practice your keep ups. It’s a simple thing until everyone or most of the group turn up.” (C4)
		“That’s just the warm-up, to get them going with the ball. They’re meant to get five balls going. So, you end up playing it in and then going round the other side, if it’s the same one. Yeah it is.” (C6)
	<i>Developing Fundamental Movement Skills</i>	“It’s just a server and a player. Then go and get the ball off the next one to get them moving. There’s all different fundamental movements and dynamic stretches as they’re moving round. Probably start of the session that.” (C4)
(3) Progression		“This was a progression yeah of teaching different types of heading.” (C5)
		“To run with the ball, it would be to get out and then that, yeah, again is part of building up the session to get into switching play or whatever the topic may be.” (C6)
(4) Player Enjoyment		“Yeah, enjoyment in what I class as a quite a dull session. Just ball heading. So trying to bring some fun really into that dull training session. I’m a big believer that if they’re enjoying it they’re learning. And I do believe they improved their heading from it.” (C5)
(5) Repetition		“So, they keep going round, everyone is changing, getting a go. Yeah so repetition and then just starting basic so we can move it up.” (C1)

**(6) Maximise
Participation**

“That was a good way for the size of the group that we have got so we could have different groups working at a time. So, maximising the amount of time players have on the ball.” (C7)

Table 8. Interview B1: The frequency (percentage) of coaches sources for using activities with non-active decision-making pre-workshop in Experiment B.

Sources	Frequency (%)	Example Quotes
Other Coaches	2 (10%)	“I think it was [another coach] who had done that. A session quite similar to this with the youth team when I was at [another club] a couple of years ago.” (C7)
Created on Own	7 (33%)	<p>“...specifically, that one. I probably just made it up myself.” (C1)</p> <p>“Probably made it up. Adapted it, made it up.” (C6)</p> <p>“It’s a simple thing that I’ve done when I was younger. I mean I played a little bit, and if I was waiting for session to start I’d practice my keep ups.” (C4)</p>
Coach Education Course	5 (24%)	“I think this one was from a course, from when I did my module one course. That’s probably where I took it from.” (C2)
Coaching Books	1 (5%)	“I probably got that out of a book. Or you know the FA when they send you those magazines, I’ve probably seen that in there.” (C6)
Internet	1 (5%)	“Again, this was another on that I thought of and picked up off the internet in a smaller version and I tried it in a bigger one.” (C5)
Not Sure	5 (24%)	“... that’s probably years old that. I don’t know. It is just to get them moving around.” (C6)

Table 9. Interview B2: Categories and example quotes outlining the reasons for increasing the %Time spent using activities with active decision-making post-workshop in Experiment B.

Categories	Example Quotes
(1) The CPD Workshop	<p>“It was just [researcher’s] train of thought. It wasn’t anything we hadn’t already done it was just tweaking what we were doing. I still think the decisions were in there, but it was really pulling out them decisions.” (C5)</p> <p>“It was just seeing how much, obviously the ideal thing we want to do is have the kids making as many decisions as possible. So, we took that on board and tried to put it into all the sessions, whether it be the warmup, whether it be the cool down at the end or the main chunk of the session. Just trying to make sure the kids have as many decisions to make as possible.” (C7)</p>
(2) Develop Decision-Making	<p>“Where’s the decision? I’m massive on the decisions in matches. And that made me think about it as well. I’m massive about decision making in games but in training I’m not looking at it much. You know because you get lost in technical, tactical you know. Whereas now I’m looking at bringing the decision making into the training as well.” (C5)</p>
(3) Easy to Implement	<p>“It’s not rocket science to add it in it’s just tweaking what we were already doing.” (C5)</p>
(4) Facilities	<p>“It’s probably gone into more of a game format because we’ve got half a pitch at (new venue).” (C6)</p>

Table 10. Interview B2: Categories and example quotes outlining the coaches' perceptions of the purpose of the workshop in Experiment B.

Categories	Example Quotes
(1) Increase Decision-Making	<p>“Well, not necessarily the topic but what games they’re doing, what sort of decisions the boys are having to make, individually, decisions they’ve had to make as a team. Little bits like that. So that’s worked quite well”. (C7)</p> <p>“This season’s CPD? It was about your decision making. You know last year was drill- and games-based activities so this year was your decision making and the active decision making the in the session.” (C5)</p>
(2) Increase Match Realism	<p>“To get it more realistic, the training sessions have more game realism than just standing on a cone. I was never a believer in that to be honest before. I never saw the point of that. I always wanted it more game based, more end zone games where you can make it more realistic.” (C4)</p> <p>“Make them more game related. Within the game, there are decisions to be made there so they’re making their own minds up. As you say, doing lines of repetition you tell them what’s going to happen before they get there so there’s no thought gone into that. Whereas in a game, small sided, they’re going to have repetition by having loads of touches and those decisions within the game are going to be more realistic all over the pitch rather than in straight lines.” (C1)</p>
(3) Increase Opposition	<p>“To cut down the time they’re playing unopposed. Instead of just passing drills where they are all looking nice and cosy and comfy, making it opposed all the time. Even if it is just 3 v 1, or 6 v 6, or 4 v 4.” (C6)</p> <p>“So, it’s not sort of boring or unopposed all the time.” (C3)</p>
(4) Maximise Participation	<p>“If they’re not doing stuff, they’ll get bored. Which is what we’ve just talked about. So, it’s keeping them involved right through the session from start to go and then they want to come back next week, which is what it’s all about.” (C2)</p>
(5) Coach Development	<p>“To help us as a coach. Obviously if we didn’t have this then we wouldn’t be moving forward.” (C2)</p>
(6) Provide Feedback	<p>“Just to highlight what the sessions are looking like.” (C7)</p>

Table 11. Categories and example quotes outlining the coaches’ preferences for the CPD workshop delivery style of the intervention.

Preference to the interactive video-based workshop in Experiment B	
Categories	Example Quotes
(1) Use of Video	“Yeah if someone said to me ‘[coach], that warm up you done you could have added this’ I wouldn’t have got it really but where I’d seen it. I thought wow, and that’s what twigged for me. We already do that, let’s just add that. And that’s what we did, yeah.” (C5)
(2) Discussion	“I like the discussion. Everyone has an opinion and not everyone’s opinion is the same, I think that’s why football is great. You know someone might have a different opinion about football to me but that’s why we all love football. I like that. I prefer the discussion type.” (C4)
(3) Better Learning Opportunity	“Yeah, and I think it stays there more when you do that. If someone is telling you it can go over your head and you switch off.” (C5)
(4) Tailored Audience	“I thought it worked better where it was more personal. It was more personal to the actual group itself. Like you might have a few people switching off if it’s not their group. But I thought it worked better like that, actually seeing some of the sessions.” (C7)
No Preference to either workshop	
Categories	Example Quote
(1) Developing Coaching Practice	“Oh no, they were both really good, obviously.” (C2)

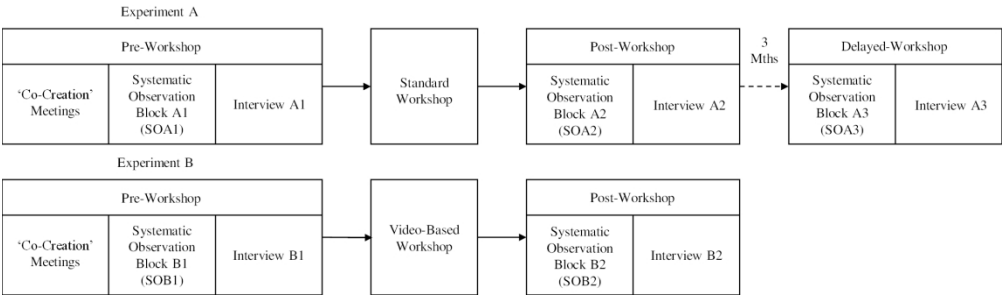


Figure 1. Timeline depicting the experimental design and procedure of Experiment A and B.

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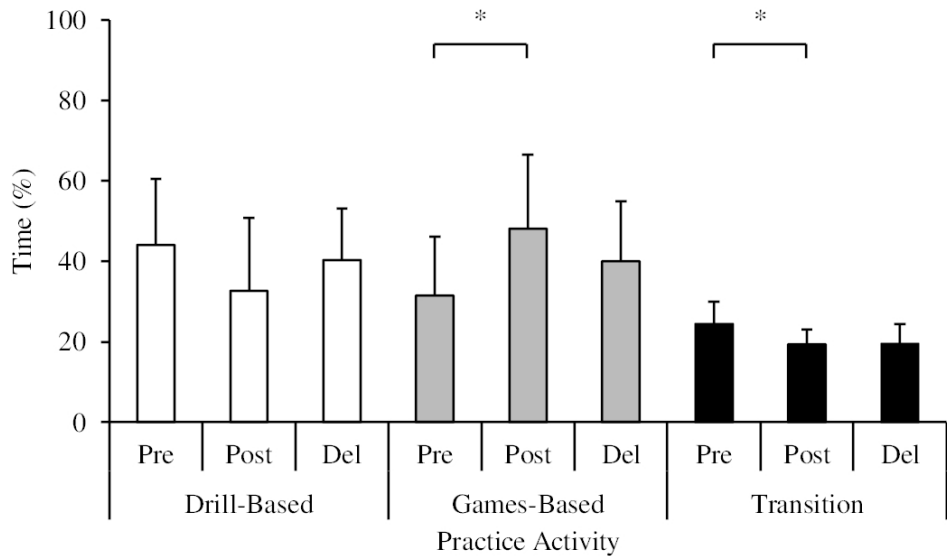


Figure 2. Mean (standard deviation) %Time spent using drill-based activities (white bars), games-based activities (dark-grey bars) and transition (black bars) activities presented as a function of activity and phase. * denotes significance $p < 0.05$.

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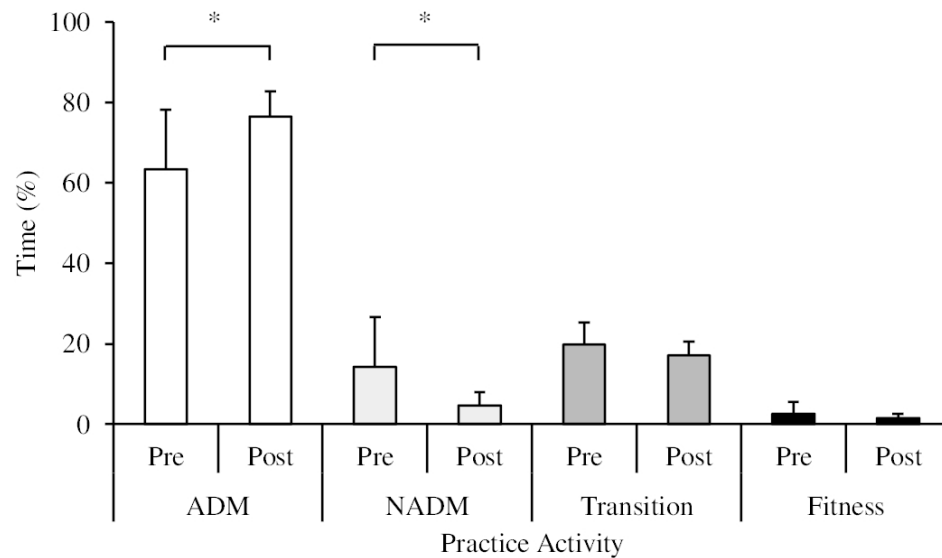


Figure 3. Mean (standard deviation) %Time spent using using activities with active decision-making (white bars), non-active decision-making (light-grey bars), transition (dark-grey bars) and fitness (black bars) presented as a function of activity and phase. * denotes significance $p < 0.05$.

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